ELECTRICAL

BATTERIES AND GROUND CONNECTIONS

GENERAL

A 12-volt, negative ground, dc system is used which utilizes the frame and body for the ground return circuit.

CAUTION: *Burns or other damage may be caused by accidentally grounding circuits through careless use of tools or by not tightening connections in energized circuits.*

A 12-volt electrical system can generate an arc that can ignite gasoline that has been spilled or seeped from the fuel system. Disconnect the battery ground cable before removing any electrical component.

GROUND CONNECTIONS

Check for a poor or no-ground condition when servicing electrical malfunctions such as: erratic temperature and fuel gauge readings; directional lamps glowing when headlamps are operated; windshield wiper motor attempting to operate when some other electrical component is operated.

All models have the battery ground cable attached directly to the engine. An additional ground wire connected to the battery negative cable terminal end is attached to the dash panel on CJ models and to the right front fender inner panel on Cherokee-Wagonner-Truck models. To complete the ground return circuit from the load (bulb, gauge, etc.) back to the battery, the ground connections and their locations are as follows:

Instrument Panel—The hi-beam lamp, turn signal indicator lamps, panel lighting lamps and the constant voltage regulator (CVR) for the fuel and temperature gauges ground at the instrument cluster or panel for all models.

Frame-to-Engine Ground—All models utilize a ground strap. The strap is attached to the left motor mount.

CJ Models

The instrument cluster is grounded by the four mounting studs welded to the instrument panel (fig. 3-1)

Note the ground contact for the CVR (fig. 3-2). The regulator is part of the fuel gauge and depends on this ground to regulate voltage to the gauges.

The wiper/washer, lights, and heater control lights are grounded by a wire attached to a screw at the lower lip of the instrument panel.

Cherokee-Wagoneer-Truck

The cluster is grounded from a pin terminal on the cluster to a mounting screw on the lower lip of the instrument panel above the parking brake mechanism.

MAIN HARNESS CONNECTOR

All models have a main wiring harness connector located at the left upper corner of the toeboard (dash panel).

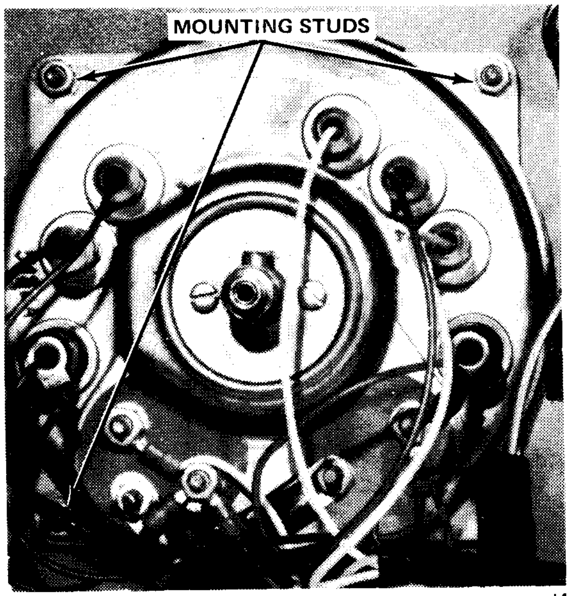


Fig. 3-1 Instrument Cluster Ground—CJ Models

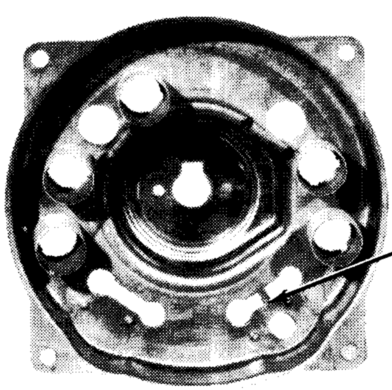


Fig. 3-2 Constant Voltage Regulator Ground—CJ Models

The connector can be removed from the dash panel by removing the center bolt from the engine compartment side and the two fuse block attaching screws from the driver's side. Be careful not to bend the male spade terminals when removing or installing the connector.

If any wires are replaced on the engine compartment side, the terminal opening must be resealed with a durable sealer.

NOTE: *Do not use string-type body caulk as a sealer.*

Located near the left upper corner of the main harness connector is a connector for the frame harness and the electrical tailgate window. On models without the electric tailgate, one of the terminals of the 3-way connector may be used to supply power for other accessories if desired by installing a 30-amp fuse or circuit breaker in the power tailgate position on the fuse block located next to the 4-way flasher.

CAUTION: *This circuit is hot regardless of the ignition switch position.*

BATTERIES

Three models are used, each having a different ampere hour rating to provide the starting power needed for various engine applications. All batteries used are 12-volt, lead-acid units. Batteries with cells anchored in epoxy are used to prevent damage from vibration encountered in off-road use. Replacement batteries should meet utility vehicle specifications. A regular passenger car battery would have a relatively short life if used in a utility vehicle.

The battery part number, reserve capacity rating, and cold cranking rating appear on a label affixed to the top of the battery. Use the Capacity Rating Chart to determine the amp hour rating for testing purposes.

Battery Capacity Rating Chart

Part Number	Amp. Hr. Rating	Reserve Capacity (Minutes)	Cold Cranking at 0° F (Amps)
5457114	50	73	290
5457116	60	93	345
5457115	70	106	370

60588

Cold Cranking Rating

The cold cranking test rating appears as an amperage rating at 0°F. This rating is the minimum amperage which must be maintained while cranking at 0°F (battery temperature) for 30 seconds with 1.25 volts minimum required per cell.

Reserve Capacity Rating

Reserve capacity is defined as the number of minutes a new, fully charged battery at 80°F (26.7°C) can be discharged at a steady rate of 25 amperes and maintain a voltage of 1.75 volts per cell (10.50 volts total battery voltage) or higher.

Starting Procedure—Discharged Battery

The correct method for starting a car with a discharged battery is with a portable starting unit or a booster battery. **When using either method, it is essential that connections be made correctly or serious damage to the electrical system may occur.**

When using a portable starting unit, **the voltage must not exceed 16 volts or damage to the battery, alternator, or starter may result.** Because of the

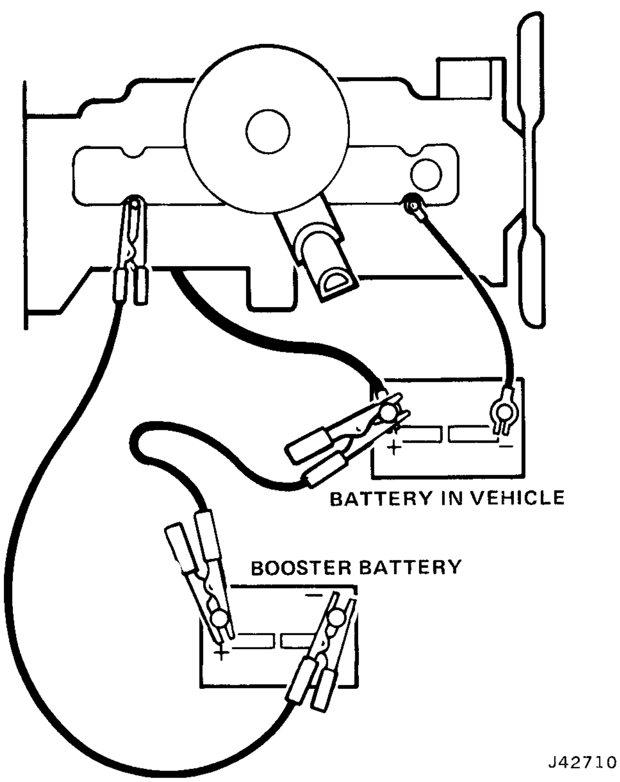


Fig. 3-3 Battery Jumper Cable Connections

accompanying high voltage, **a fast charger must not be used for booster starting.** Before connecting jumper cables to a discharged battery, remove the vent cap and cover the cap openings with a cloth.

CAUTION: *Battery action generates hydrogen gas which is flammable and explosive. Hydrogen gas is present within a battery at all times even when a battery is in a discharged condition. Keep open flames and sparks (including cigarettes, cigars, pipes) away from the battery. Always wear eye protection when working with a battery.*

WARNING: *During cold weather, if fluid is not visible or ice is evident, do not attempt to jump-start as the battery could rupture or explode.*

The battery must be brought up to 40°F and water added (if necessary) before it can be safely jump-started or charged.

Remove the vent caps from the booster battery and cover the cap openings with a cloth.

CAUTION: *If the car is being jump-started by a battery in another car, the cars must not contact each other.*

Connect a jumper cable between the positive posts of the two batteries. The positive post may be identified by the POS embossed on the battery cover in 1/4-inch letters adjacent to the battery post.

Be sure the clamps are making good contact. DO NOT CONNECT THE OTHER END OF THE JUMPER CABLE TO THE NEGATIVE TERMINAL OF THE DISCHARGED BATTERY. **Connect to a bolt or nut on the engine. Do not connect the jumper to the carburetor, air cleaner, or fuel line. Keep the cable clear of belts and pulleys (fig. 3-3).**

When removing the jumper cables, disconnect the clamp on the engine first.

Discard the cloth used to cover the cap openings as they have been exposed to sulfuric acid.

Install the vent caps.

BATTERY CHARGING

Slow Charge

Slow charging is the preferred method of recharging a battery. The slow charge method may be safely used, regardless of charge condition of the battery provided the electrolyte is at the proper level in all cells and is not frozen.

CAUTION: *Do not attempt to charge or use a booster on a battery with frozen electrolyte as it may cause the frozen battery to explode.*

The normal charging rate for a battery is one amp per positive plate per cell. For example, a 54-plate battery has nine plates per cell (54 divided by 6). There is always one more negative plate per cell than positive. The charging rate should be four amps. A 70-amp hour battery has 66 plates or 11 plates per cell.

The charging rate for this battery would be five amps (5 positive and 6 negative plates per cell). A minimum period of 24 hours is required when using this method.

The battery may be fully charged by this method unless it is not capable of accepting a full charge. A battery is in a maximum charged condition when all cells are gassing freely and three corrected specific gravity readings, taken at hourly intervals, indicate no increase in specific gravity.

Fast Charge

Always disconnect one battery cable before using a fast charger.

A battery may be charged at any rate which does not cause the electrolyte temperature of any cell to exceed 125°F and which does not cause excessive gassing and loss of electrolyte.

A fast charger cannot be expected to fully charge a battery within an hour, but will charge the battery sufficiently so that it may be returned to service and then be fully charged by the vehicle charging system, provided the vehicle is operated a sufficient length of time.

Frozen Electrolyte

A 3/4-charged automotive battery is in no danger of damage from freezing. Therefore, **keep the batteries at 3/4 charge or more, especially during winter weather.**

A battery in which the electrolyte is either slushy or frozen should be replaced. Batteries with this condition, depending on the severity of the freeze, may accept and retain a charge and even perform satisfactorily under a load test. However, after 120 to 150 days in service, a reduction in capacity and service life will become apparent as the individual plates lose their active material.

Freezing Temperature Chart

Specific Gravity (Corrected to 80°F)	Freezing Temperature Degrees Fahrenheit
1.270	-84°F
1.250	-62°F
1.200	-16°F
1.150	+05°F
1.100	+19°F

60339

Discharge Chemical Action

A cell is discharged by completing an external circuit such as cranking a starter motor. Sulfuric acid, acting on both positive and negative plates, forms a new chemical compound called lead sulfate. The sulfate is supplied by the acid solution (electrolyte). The acid becomes weaker in concentration as the discharge continues. The amount of acid consumed is in direct proportion to the amount of electricity removed from the battery. When the acid in the electrolyte is partially used up by combining with the plates and can no longer deliver electricity at a useful voltage, the battery is said to be discharged.

The gradual weakening of the electrolyte in proportion to the electricity delivered is a helpful action in that it allows the use of a hydrometer to measure how much unused acid remains with the water in the electrolyte. This information then can be used to determine approximately how much electrical energy is left in each cell.

Charge Chemical Action

The lead sulfate in the battery is decomposed by passing a current through the battery is a direction opposite to that of the discharge. The sulfate is expelled from the plates and returns to the electrolyte, thereby gradually restoring it to its original strength. Hydrogen and oxygen gasses are given off at the negative and positive plates as the plates approach the fully charged condition. This is caused by an excess of charging current not totally accepted by the plates.

BATTERY MAINTENANCE

CAUTION: *Always observe the correct polarity. Reversed battery connections may damage the alternator diodes.*

The NEGATIVE battery terminal is connected to the engine and to the fender inner panel.

It is very important that the battery be in a fully charged condition when a new car is delivered. The continual operation of a partially charged battery could shorten its life and result in replacement.

Fluid level in the battery should be checked periodically and replenished with distilled water, if possible. However, drinking water free of high mineral content may be used. Add water to each cell until the liquid level reaches the bottom of the vent well. DO NOT OVERFILL.

The engine should be operated immediately after adding water, particularly in cold weather, to assure proper mixing of the water and acid.

The external condition of the battery and the cables should be checked periodically.

The holddown should be kept tight enough to prevent the battery from shaking to prevent damage to the battery case. It should not be tightened to the point where the battery case will be placed under a severe strain.

Particular care should be taken to see that the top of the battery is free of acid film and dirt between the battery terminals. For best results when cleaning the battery, wash with a diluted ammonia or soda solution to neutralize any acid present and then flush with clean water. Care must be taken to keep vent plugs tight so that the neutralizing solution does not enter the cells.

To ensure good contact, the battery cables should be tight on the battery posts. **Check to be sure the terminal clamp has not stretched.** This could cause the clamp ends to become butted together without actually being tight on the post. If the battery posts or cable terminals are corroded, the cables should be disconnected by loosening the terminal clamp bolt and removing the clamp with the aid of a puller. **Do not twist or pry on the cable to free it from the battery post.** Clean the terminals and clamps with a soda solution and a wire brush. After the cables are connected to the battery posts, a thin coat of grease should be applied. The battery ground cable and engine-to-crossmember ground strap also should be inspected for a good connection and condition.

WARNING: *Explosive gases are present within the battery at all times. Avoid open flames and sparks.*

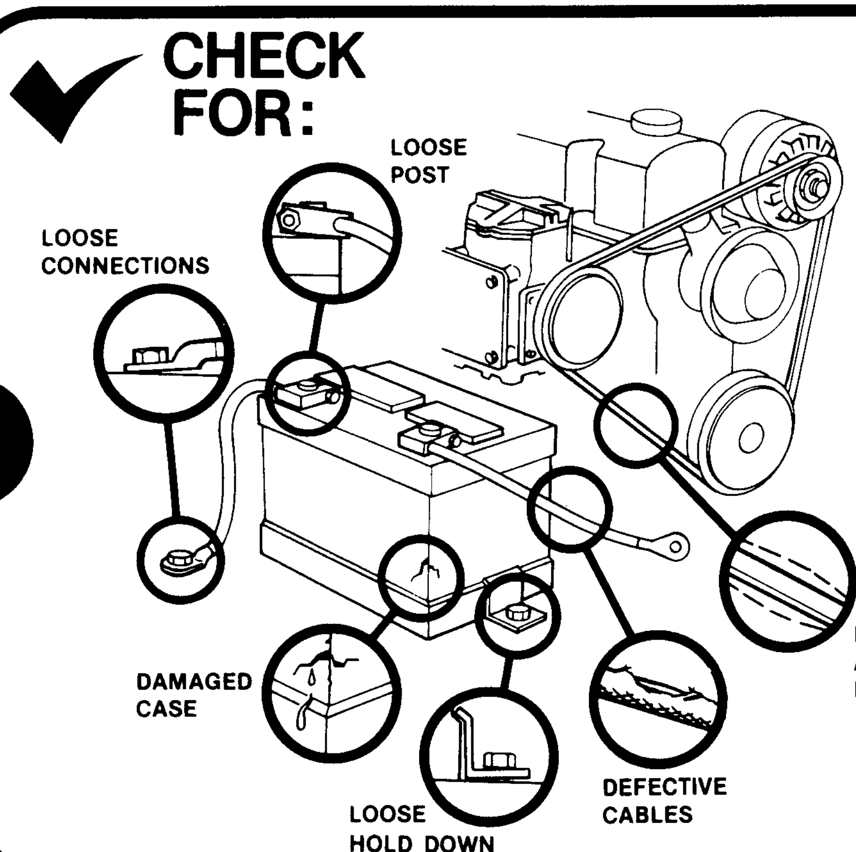
BATTERY TESTING

When testing a battery, perform the steps in the sequence listed in the Battery Test Procedures Chart.

Battery Test Procedures

STEP | SEQUENCE | RESULT

1

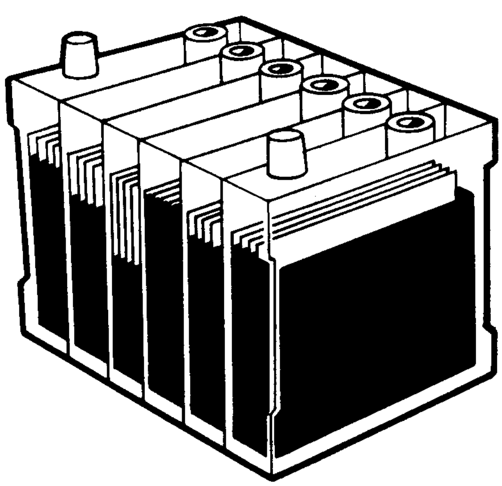


Repair Or Replace If Necessary

→ **2**

2

ELECTROLYTE LEVEL AND SPECIFIC GRAVITY IN EACH CELL AND RECORD READINGS.



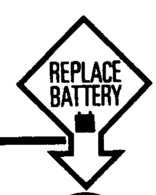
ELECTROLYTE LEVEL TOO LOW FOR SPECIFIC GRAVITY TEST- ADD WATER. CHARGE BATTERY FOR 10 MIN. at 20 AMPS. MEASURE SPECIFIC GRAVITY.

OK

Average Reading 1.225 Or More. All Cells Equal Within .050 → **5**

~~OK~~

Average Reading 1.225 Or More. Cell Readings Vary .050 Or More →



→ **6**

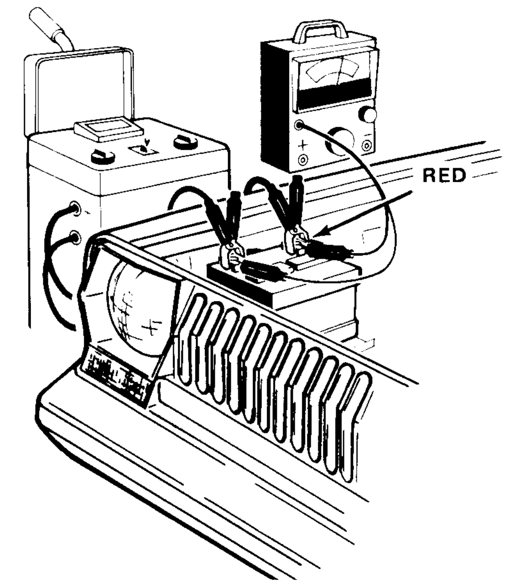
Average Reading Below 1.225 → **3**

60589A

STEP | SEQUENCE | RESULT

3

- CONNECT BATTERY CHARGER AND VOLTMETER
- CHARGE BATTERY FOR 3 MINUTES AT 40 AMPS
- AT THE END OF 3 MINUTES READ VOLTMETER WHILE CHARGER IS STILL CHARGING



OK

Voltage Is 15.5 Or Less — **4**

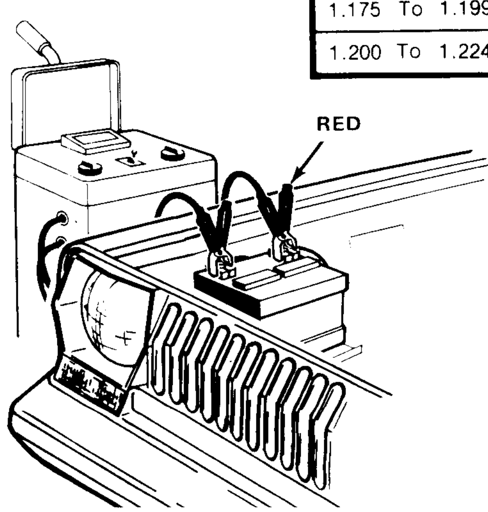
~~OK~~

Voltage Above 15.5 — REPLACE BATTERY — **6**

4

CHARGE BATTERY AS INDICATED IN CHART, AFTER CHARGE IS COMPLETED, RECHECK SPECIFIC GRAVITY.

AVERAGE SPECIFIC GRAVITY	CHARGE RATE (AMPS)	TIME
Less Than 1.125	5	12 Hours
1.125 To 1.149	20	90 Min.
1.150 To 1.174	20	70 Min.
1.175 To 1.199	20	50 Min.
1.200 To 1.224	20	30 Min.



OK

Average Specific Gravity 1.225 Or More.
Cell Readings Equal Within .050 — **5**

~~OK~~

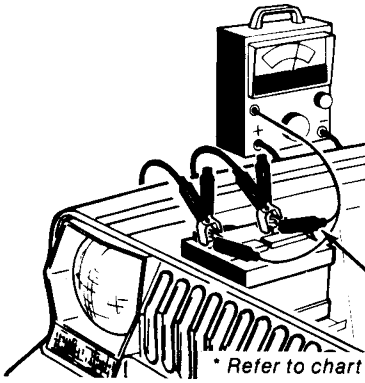
Average Specific Gravity 1.225 Or More,
But Cell Readings Vary .050 Or More — REPLACE BATTERY — **6**

60589B

STEP	SEQUENCE	RESULT

5

HEAVY LOAD OUTPUT TEST



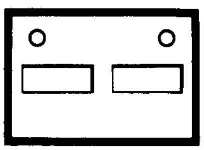
- CLEAN BATTERY POST AND CABLE ENDS
- CONNECT HEAVY LOAD TESTER
- ADJUST LOAD TO 3 TIMES THE BATTERY AMP HR. RATING*
- HOLD LOAD FOR 15 SECONDS
- READ VOLTMETER

Voltage Reading 9.6 Or More — 6

Voltage Reading Less Than 9.6 — REPLACE BATTERY — 6

* *Refer to chart below to determine AMP HR. RATING*

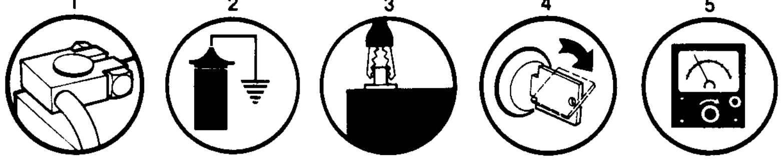
BATTERY AMP. HOUR IDENTIFICATION



Part Number	Amp. Hr. Rating	Reserve Capacity (Minutes)	Cold Cranking at 0° F (Amps)
5457114	50	73	290
5457116	60	93	345
5457115	70	106	370

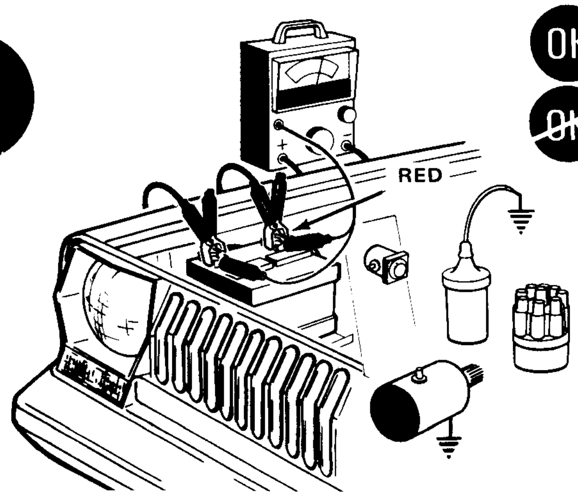
6

STARTER DRAW TEST



1. CLEAN AND CONNECT BATTERY CABLES
2. REMOVE COIL WIRE FROM DISTRIBUTOR. AND CONNECT TO GROUND
3. CONNECT HEAVY LOAD TESTER
4. CRANK ENGINE
5. TURN LOAD CONTROL UNTIL VOLTMETER SHOWS SAME VOLTAGE AS WHEN CRANKING.

READ AMMETER



OK
6 Cyl. – 150-180 Amps
8 Cyl. – 160-210 Amps — 8

~~OK~~
6 Cyl. – Above 180 Amps
8 Cyl. – Above 210 Amps

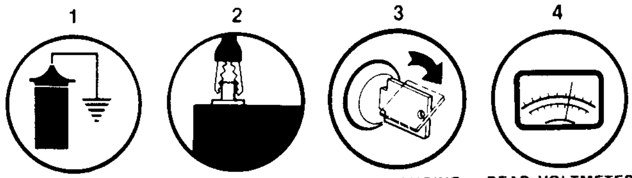
- Battery Cables And Solenoid Not Tested — 7

Or

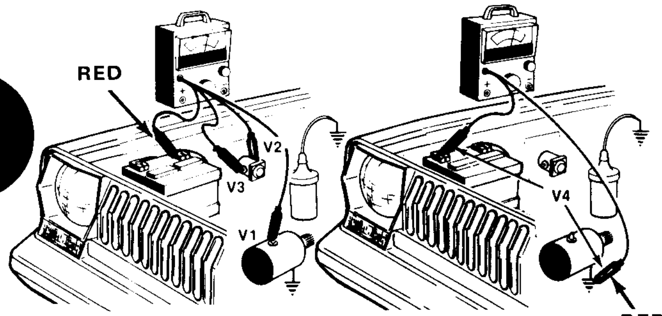
- Battery Cable And Solenoid Repairs Completed — REPAIR STARTER — 8

STEP | SEQUENCE | RESULT

7



1. GROUND COIL WIRE
2. CONNECT VOLTMETER [As shown in V1]
3. CRANK ENGINE.
4. READ VOLTMETER [See Chart for MAXIMUM]



CONNECTIONS for V1-V3 — CONNECTIONS for V4

MAXIMUM VOLTAGE DROP CHART				
Test	Voltage Drop By Starter Draw Amperage			
	150-210	215-295	300-420	425-600
V1	0.5V	0.7V	1.0V	1.5V
V2	0.3V	0.5V	0.6V	0.9V
V3	0.2V	0.3V	0.4V	0.5V
V4	0.2V	0.3V	0.4V	0.5V

VOLTAGE DROP TEST

V1 – Reading OK (At Or Below Max.) – Repeat Test Sequence Except Connect Voltmeter As Shown For V4

V1 – Reading ~~OK~~ (Above Max.) – Repeat Test Sequence Except Connect Voltmeter As Shown For V2

V2 – Reading OK (At Or Below Max.) – Repair Solenoid-To-Starter Cable. Repeat Test Sequence Except Connect Voltmeter As Shown For V4

V2 – Reading ~~OK~~ (Above Max.) – Repeat Test Sequence Except Connect Voltmeter As Shown For V3

V3 – Reading OK (At Or Below Max.) – Repair Solenoid. Repeat Test Sequence Except Connect Voltmeter As Shown For V4

V3 – Reading ~~OK~~ (Above Max.) – Repair Battery-to-Solenoid Cable. Repeat Test Sequence Except Connect Voltmeter As Shown For V4

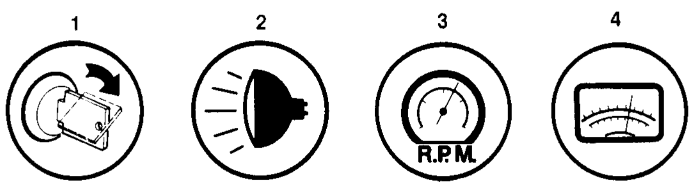
V4 – Reading OK (At Or Below Max.)
- Repairs To Solenoid Or Cables Performed → 6

Or
- Repairs To Solenoid Or Cables Not Required → REPAIR STARTER → 8

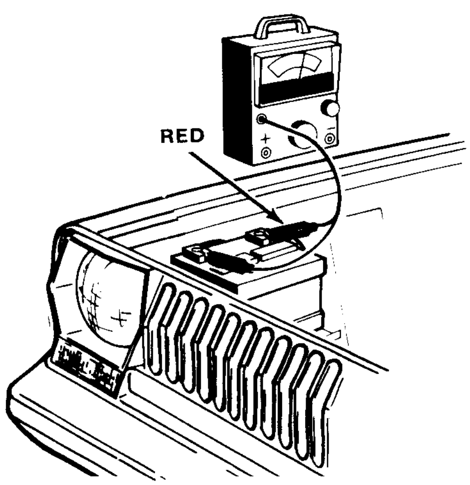
V4 – Reading ~~OK~~ (Above Max.) – Repair Engine-To-Battery Cable → 6

8

CHARGING SYSTEM QUICK TEST



1. START ENGINE
2. TURN ON HEADLAMPS
3. SET ENGINE TO 1,000 RPM
4. READ VOLTMETER



OK

Voltmeter Indicates 13V. To 15V. → STOP

~~OK~~

Voltmeter Indicates More Than 15V
Voltmeter Indicates Less Than 13V. → REPAIR CHARGING SYSTEM

60589D

Self-Discharge Rate Chart

Temperature	Approximate Allowable Self-Discharge Per Day For First Ten Days
100°F (37.8°C)	0.0025 Specific Gravity
80°F (26.7°C)	0.0010 Specific Gravity
50°F (10°C)	0.0003 Specific Gravity

60338

In rare cases where a battery goes dead and no apparent cause can be found, the battery should be fully charged and allowed to stand on a shelf for three to seven days to determine if self-discharge is excessive. The Self-Discharge Rate Chart shows allowable self-discharge for the first ten days of standing after a battery has been fully charged. A fully charged battery is a battery which does not increase the electrolyte specific gravity after three continuous hours of charging.

Hydrometer Test

Prior to testing, visually inspect the battery for any damage (broken container, cover, loose post, etc.) that would make the battery unserviceable. The correct method of reading a hydrometer is to have the liquid in the hydrometer at eye level (fig. 3-4). Disregard the curvature of the liquid where the surface rises against the float due to surface tension. Draw only enough liquid in to keep the float off the bottom of the barrel. The hydrometer must be kept vertical while drawing in liquid and taking the reading. **Care should be taken when inserting the tip of the hydrometer into the cell, to avoid damage to separators.** Broken separators could result in premature battery failure.

Hydrometer floats are generally calibrated to indicate correctly only at one fixed temperature—80°F. The temperature correction amounts to approximately 0.004 specific gravity (referred to as 4 points of gravity). For each 10°F above 90°F, subtract 4 points. Always correct the readings for temperature variation. Test the specific gravity of the electrolyte in each battery cell.

Example: A battery is tested at 10°F and has a specific gravity of 1.240. The actual specific gravity is found as follows:

Number of°above or below 80°F equals 70°(80°minus 10 degrees).

70°divided by 10°(each 10-degree difference) equals 7.

7 x 0.004 (temperature correction factor) equals 0.028.

Temperature is below 80°F, so temperaturee correction is subtracted.

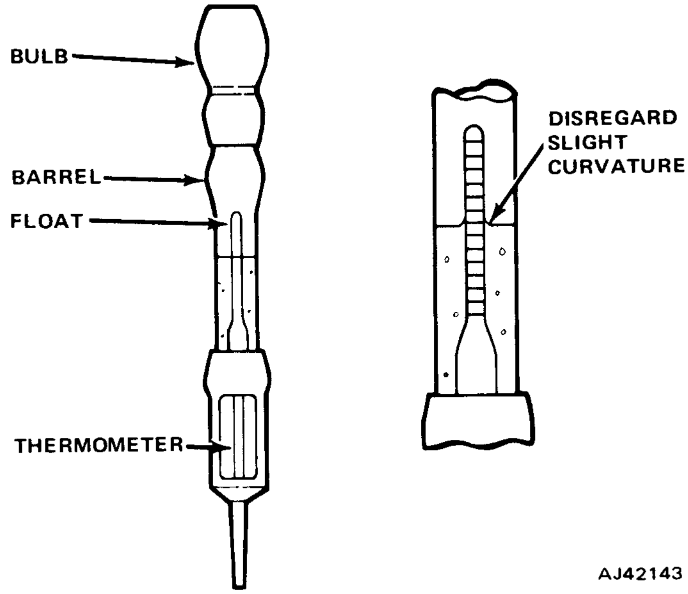


Fig. 3-4 Hydrometer and Proper Method of Reading

Temperature-corrected specific gravity equals 1.240 minus 0.028 equals 1.212.

A fully charged battery should have a specific gravity of 1.250 to 1.265.

If the specific gravity of all cells is above 1.235 (1.196 tropical climate), but the variation between cells is more than 50 points (0.050), it is an indication of an unserviceable battery, and the unit should be removed from the car for further testing.

NOTE: *A fully charged tropical climate battery will have specific gravity of 1.225 at 80°F.*

If the specific gravity of one or more cells is less than 1.235, recharge the battery at approximately 5 amperes until three consecutive hourly readings are constant.

At the end of the charge period, if the cell variation is more than 50 points (0.050), replace the battery.

When the specific gravity of all cells is above 1.235 and variation between cells is less than 50 points, the battery may be tested under load.

Specific Gravity Reading

State of Charge	Specific Gravity As Used in Cold and Temperate Climates
Fully Charged	1.265
75% Charged	1.225
50% Charged	1.190
25% Charged	1.155
Discharged	1.120

60340

Perform the hydrometer test as follows:

(1) Clean outside of battery with a solution of baking soda and water. Make a visual inspection of container, covers, and terminal posts. Remove vent plugs.

(2) Add water if necessary to bring electrolyte to the proper level and apply a fast boost charge of approximately 35 amperes for 10 minutes. Then take and record **temperature corrected** hydrometer readings. Proceed to step (3).

(3) Apply a fast boost charge of approximately 35 amperes for 30 minutes. Record temperature corrected hydrometer readings. If cells show a slight or no increase in hydrometer reading, proceed to step (4); otherwise, determine replacement as follows:

(a) If the variation in **temperature corrected** hydrometer readings found in step (3) is 50 points or more for the individual cells within a battery, replace battery.

(b) If one cell lags behind in gravity, and its electrolyte when drawn into the hydrometer is discolored with the remaining cells relatively clear, replace battery.

(c) If the electrolyte in one or more cells is discolored, replace battery. A battery in this condition has been damaged in service by heavy cycling or electrolyte has been frozen.

NOTE: *When replacing a battery with damage caused by heavy cycling, the alternator should be checked to determine if it has sufficient output to satisfy the electrical demands of that particular vehicle. Also the next larger size battery should be installed, if possible.*

(d) If all cells show a more than slight increase in **temperature corrected** gravities (with variation **within** 50 points) and have clear electrolyte, battery is probably only discharged and can be returned to service.

(4) Sulfated batteries may be brought back to service condition by a slow charge (3 to 4 amperes) for 48 to 72 hours. After this charge, all cells should read at least 1.250 corrected gravity and have clear electrolyte; if not, the battery is not serviceable. If the variation in hydrometer readings is more than 50 points, replace battery.

Heavy Load Test

NOTE: *The following instructions refer to amserv Battery-Alternator-Regulator Tester, Model 21-307.*

(1) Before performing a heavy load test, battery must be fully charged (refer to Slow Charge).

(2) Turn carbon pile knob of battery tester to OFF position.

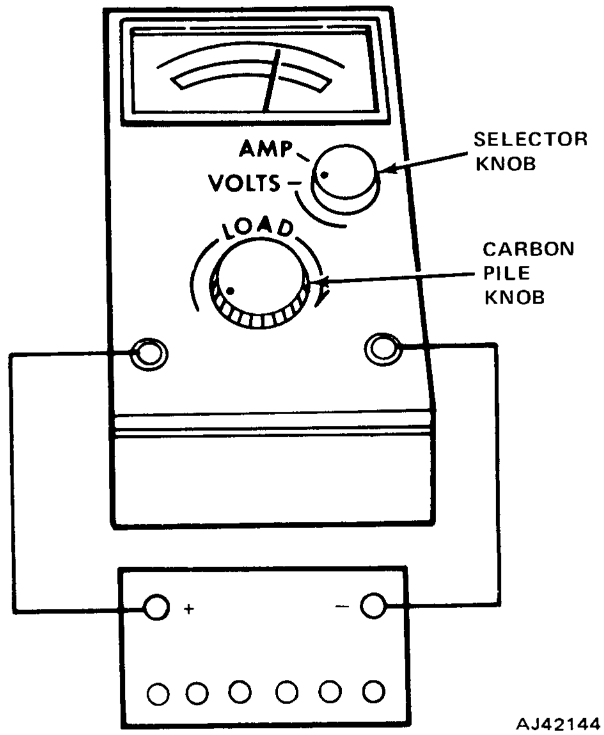


Fig. 3-5 Heavy Load Test

(3) Turn selector knob to AMP position.

(4) Connect test leads as shown in figure 3-5.

(5) Turn carbon pile knob clockwise until ammeter reading is equal to three times the ampere hour rating of the battery:

- 150 amperes for 50 amp hour battery
- 180 amperes for 60 amp hour battery, etc.

(6) Maintain load for 15 seconds, turn selector switch to VOLTS and read the scale.

If the voltmeter reading was 9.6 volts or higher with the battery temperature at a minimum of 70°F, the battery has good output capacity. If less than 9.6 volts, replace the battery.

Battery Storage

All automotive wet batteries will discharge slowly when stored. Batteries discharge faster when warm than when cold. For example: at 100°F (37.8°C), a normal self-discharge of 0.0025 specific gravity per day could be expected. At 50°F (10°C), a discharge of 0.0003 specific gravity would be normal.

Before storage, clean the battery case with a baking soda solution and wipe the case dry. When storing a battery, charge fully (no change in specific gravity after three readings taken one hour apart) and then store in as cool and dry a place as possible (refer to Freezing Temperature Chart).

MOTORCRAFT ALTERNATOR

GENERAL

The Motorcraft charging system is a negative ground system consisting of three main components: an alternator, a regulator, and a battery. **It is used on all V-8 engines.**

The alternator is belt driven by the engine. Its major components are the front and rear housings, the stationary stator windings, the rotating field windings or rotor, and six rectifying diodes. Current is passed to the rotating field through two brushes mounted in the rear housing and two slip rings attached to the rotor.

The regulator is an electro-mechanical device (non-solid state) and nonadjustable. It has two major components: the field relay and the voltage limiter. The field relay connects the voltage limiter into the system. The voltage limiter is a vibrating type which regulates current applied to the field and maintains charging voltage within prescribed limits to keep the battery properly charged.

OPERATION

When the ignition switch is turned to the ON position, current flows through the ignition switch (and ammeter, if equipped) to the regulator S-terminal (fig. 3-6 and 3-7). From the S-terminal, current flows through the field relay coil which closes the field relay contacts. With the field relay contacts closed, current passes from the regulator A-terminal through the field relay contacts and voltage limiter upper contacts to the regulator F-terminal. From the F-terminal, current to the alternator FLD terminal, through the insulated brush and slip ring to the rotor coil, and through the other slip ring to the grounded brush (fig. 3-6 and 3-7).

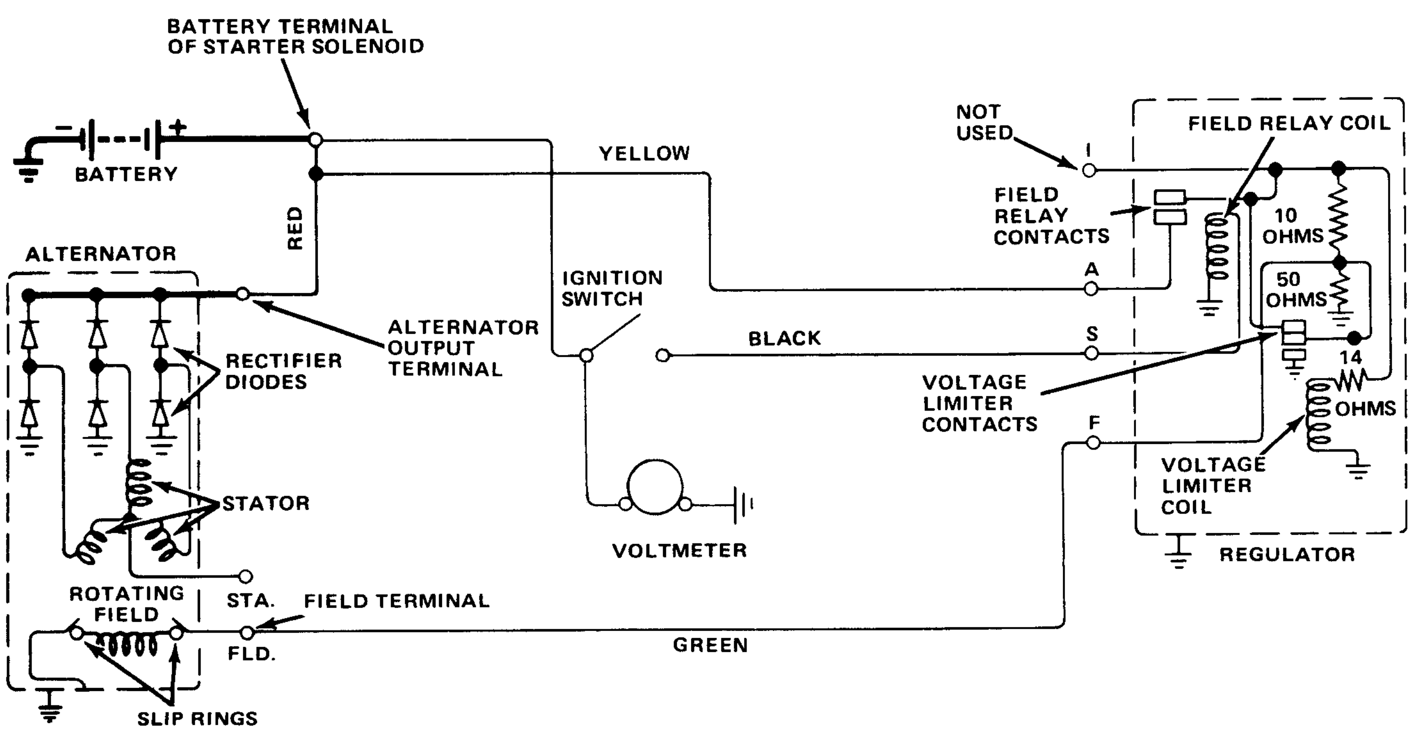


Fig. 3-6 Charging System Schematic—CJ Models with V-8 Engine

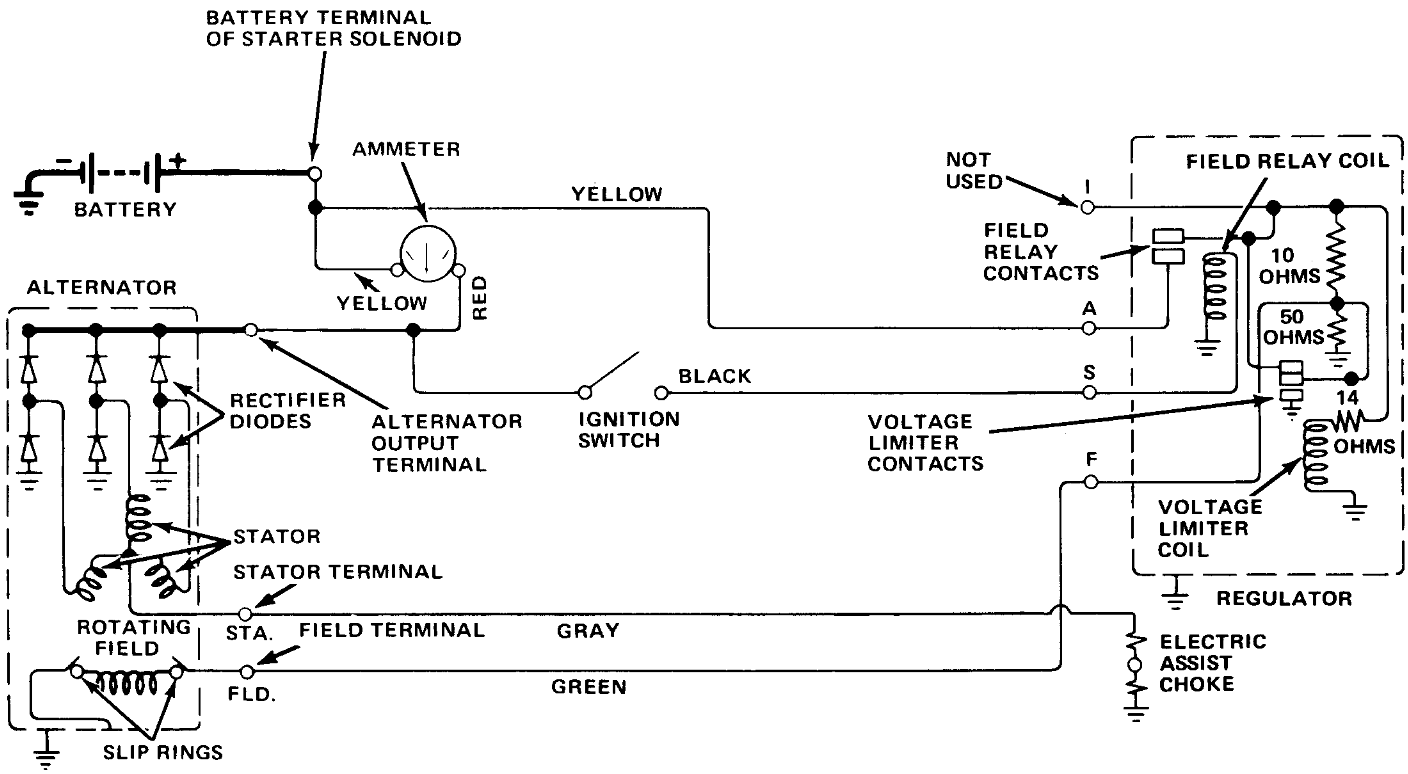


Fig. 3-7 Charging System Schematic— Cherokee-Wagoneer-Truck with V-8 Engine

This circuit provides current to rotor windings to create a magnetic field. When the engine is started, the rotor is rotated, causing the rotor magnetic field to act on the stator windings which begin producing voltage. The voltage limiter now begins metering current to the rotor field coil to maintain desired output voltage.

The voltage regulator operates through the limiter upper contacts when alternator speed is low or when the system is under a heavy load. Output voltage is controlled through the upper contacts which vibrate open and Closed. When closed, the upper contacts pass the maximum allowable current (about 3 amps) to the field. When open, field current passes through the 10-ohm resistor which produces a decrease in field current and ouptut voltage. When alternator speed is high or the system is under a light load, voltage attempts to increase and the regulator then operates on the voltage limiter lower contacts. The increase in voltage causes current to pass through the 14-ohm resistor to the voltage limiter pull-in coil (fig. 3-6 and 3-7). The pull-in coil is energized and pulls down the limiter armature closing the lower contacts. With the lower contacts closed, field current passes directly to ground which causes the rotor field to collapse and decrease voltage output. The decrease in voltage allows the lower contacts to open which again applies 10 ohms of resistance to the field circuit, but in this case serves to increase voltage produced.

The voltage limiter operates on the upper contacts or lower contacts, but never both. The upper contacts allow maximum field current to pass to the rotor. The lower contacts prevent any field current to pass to the rotor. When neither contacts are closed, field current is reduced by the 10-ohm resistor. The contacts vibrate open and closed many times per second maintaining accurate voltage regulation.

The voltage regulator operates by metering field current to the alternator through the FLD terminal. An insulated brush is connected to the FLD terminal and passes current from the regulator to a slip ring attached to one end of the rotor windings. After passing through the rotor windings, current grounds through a second slip ring which contacts a grounded brush. The field current passing through the rotor field coil produces a magnet field. The strength of this field is determined by the amount of current provided by the regulator.

The rotor magnetic field acts on the windings of the stator to produce alternating current through electromagnetic induction. The stator is wye wound around the stator core. One end of each winding is connected to a common neutral junction. The other end of each winding is connected to a pair of diodes. The diodes serve to change the three-phase alternating current produced in the stator windings into direct current required for the car electrical system. This is accomplished by the characteristic of the diodes to flow current in one direction only. The positive diodes pass current to the alternator BAT terminal while the negative diodes pass alternating current flowing in the opposite direction, directly to ground. In this way, the alternating current is changed to direct current available at the alternator output terminal.

NOTE: *On vehicles equipped with 4V carburetors, current for electric assist choke operation is obtained from the alternator STA terminal. The STA terminal passes approximately 7 volts to the heating element in the choke cover (fig. 3-7).*

TROUBLESHOOTING

Voltage Output Quick Test

(1) Connect positive voltmeter lead to positive battery post and negative lead to negative post.

(2) Start engine. Apply a load by turning on heater or air conditioner blower to high speed, then turn on high-beam headlamps.

(3) Slowly increase speed to approximately 2000 rpm.

(4) Allow voltmeter to stabilize and note indication. Compare it to specifications in Output Voltage Chart.

Output Voltage Chart

Ambient Temperature In Degrees Fahrenheit	Acceptable Voltage Range
0 to 50	14.8 to 14.1
50 to 100	14.5 to 13.7
100 to 150	14.2 to 13.4
150 to 200	13.8 to 13.1

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(5) If voltage output is as specified, charging system is operating properly. If voltage is below specifications, perform Undercharge Troubleshooting Procedure. If voltage is above specifications, perform Overcharge Troubleshooting Procedure.

Voltage Output No-Load Test

This test, together with the Output Load Test, should be performed whenever an overcharging or undercharging condition is suspected. Belt tension, wire connections, and battery condition must be checked before performing these tests.

(1) Connect voltmeter positive lead to battery positive cable and negative lead to negative cable.

(2) Be sure that all electrical accessories are turned off, including the radio and door operated dome lamps and courtesy lamps.

(3) Note battery voltage.

(4) Start engine and slowly increase speed to approximately 1500 rpm.

(5) Note voltmeter reading. Voltage should increase, but not more than 2 volts above voltage noted in step (3).

Test Results

(1) If voltage does not increase, or if increase is within 2-volt limit, proceed to Output Load Test.

(2) If the voltage increase exceeds 2 volts, proceed to Overcharge Troubleshooting Procedure.

Output Load Test

(1) Connect positive voltmeter lead to positive battery post and negative lead to negative post.

(2) Be sure that all electrical accessories are turned off, including radio and door operated dome lamps and courtesy lamps.

(3) Note battery voltage for use later in test.

(4) Start engine. Apply a load by turning on heater or air conditioner blower to high speed and headlamps on high beam.

(5) Slowly increase speed to approximately 2000 rpm.

(6) Note voltmeter reading. It should increase at least 0.5 volt above that noted in step (3).

Test Results

(1) If voltage increase exceeds 0.5 volt, charging system is operating satisfactorily.

(2) If voltage increase is less than 0.5 volt, proceed to Undercharge Troubleshooting Procedure.

Undercharge Troubleshooting Procedure

Perform the Output Load Test to determine if an undercharge condition exists before performing this procedure. A voltmeter, ohmmeter, and jumper wire are required for testing.

(1) Turn ignition on and check for battery voltage at regulator S-terminal. If no voltage is indicated, check for open circuit between ignition switch and regulator. If battery voltage is indicated, proceed to step (2).

(2) Turn ignition off and check for battery voltage at regulator A-terminal. If voltage is not indicated, or it is less than battery voltage, check yellow wire for open or faulty terminal connections at regulator and starter solenoid.

(3) Using an ohmmeter, disconnect regulator connector and check brush and rotor circuit by connecting one ohmmeter lead to regulator connector F-terminal and other ohmmeter lead to a good ground (fig. 3-8). Ohmmeter should indicate 4 to 250 ohms. Less than 4

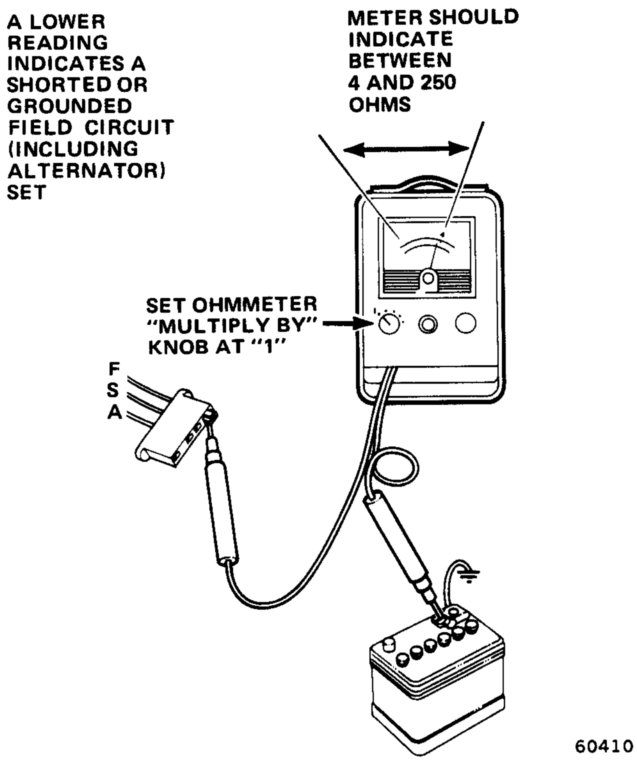


Fig. 3-8 Grounded Field Circuit Test

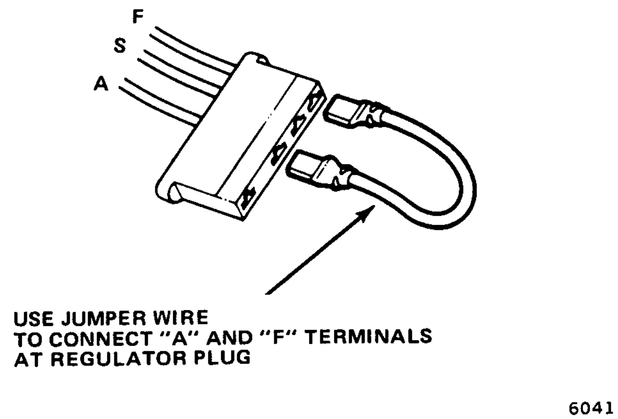


Fig. 3-9 Regulator Connector Jumper Wire Connections (Regulator Bypassed)

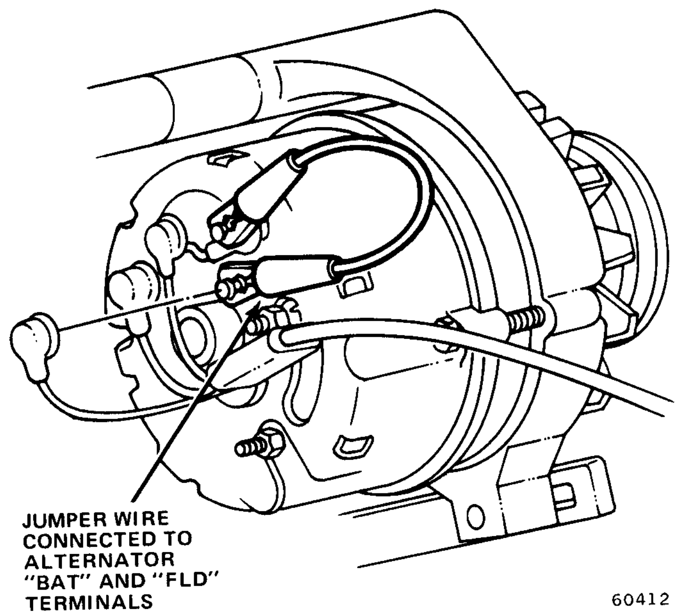


Fig. 3-10 Alternator Jumper Wire Connections

ohms indicates a shorted condition. More than 250 ohms indicates an open condition or dirty brushes or slip rings.

NOTE: *Alternator will have to be disassembled to determine if the problem is brushes or rotor. Refer to the Rotor Continuity Test.*

(4) If alternator brush or rotor circuit are within specifications, proceed to step (5). If a shorted condition was indicated in step (3), the voltage regulator may have been damaged and the regulator field circuit must be checked as follows.

(5) Connect an ohmmeter between regulator terminals I and F. Ohmmeter should indicate no resistance. If approximately 10 ohms are indicated, regulator should be replaced.

(6) Connect a jumper wire between A and F terminals of regulator connector (fig. 3-9) and repeat output test. If output voltage is as specified, replace regulator.

(7) Disconnect jumper wire installed in step (5) and leave regulator connector removed. Disconnect wire harness from FLD terminal of alternator and connect jumper wire between BAT and FLD terminals of alternator (fig. 3-10). Repeat output test.

If output is as specified, replace alternator wire harness. If output is still below specification, alternator is faulty and must be tested and repaired.

Overcharge Troubleshooting Procedure

Perform Output No-Load Test to determine if an overcharge condition exists before performing this procedure.

(1) Clean and tighten ground connections at alternator and regulator. Repeat Output Test.

(2) Disconnect regulator connector from regulator and repeat Output Test. If voltage is as specified, replace regulator.

(3) If voltage still remains above specifications, alternator wire harness is shorted and must be replaced. Voltage regulator must be replaced also since the shorted condition will damage it.

TESTING

Stator Ground and Negative Diode Test (Alternator Removed)

(1) Set ohmmeter at 10 scale and calibrate meter.

(2) Touch one ohmmeter to lead STA terminal and other lead to GRD terminal.

(3) Check continuity in other direction by reversing leads.

A reading of approximately 60 ohms should be indicated in one direction and infinity (no needle movement) in the other direction.

NOTE: *Ohmmeter must be on 10 scale or incorrect indications will result.*

Test Results

An indication of 60 ohms or less in both directions may be due to:

(a) Defective negative diode

(b) Grounded positive diode plate

(c) Grounded alternator BAT terminal

(d) Grounded STA terminal

(e) Grounded stator winding (laminations grounded or windings grounded to front or rear housing)

Infinity (no needle movement) indication is caused by an open STA terminal connection.

Field Circuit Open or Ground Test (Alternator Removed)

(1) Set ohmmeter at 1 scale and calibrate.

(2) Touch one ohmmeter lead to FLD terminal and other lead to GRD terminal.

(3) Spin drive pulley and note ohmmeter indication. Ohmmeter should indicate between 3.5 and 250 ohms and fluctuate while rotor is turning.

Test Results

An indication lower than 3.5 ohms may be due to:

(a) Grounded positive brush

(b) Grounded field terminal

(c) Defective rotor

An indication of higher than 250 ohms may be due to:

(a) Worn out or hung brushes

(b) Open brush lead

(c) Defective rotor

Rotor Continuity Test

(1) Separate front housing and rotor assembly from rear housing and stator assembly.

(2) Set ohmmeter at 1 scale and calibrate.

(3) Touch one lead to one slip ring and other lead to other slip ring (fig. 3-11). Ohmmeter indication should be 3.5 to 4.5 ohms.

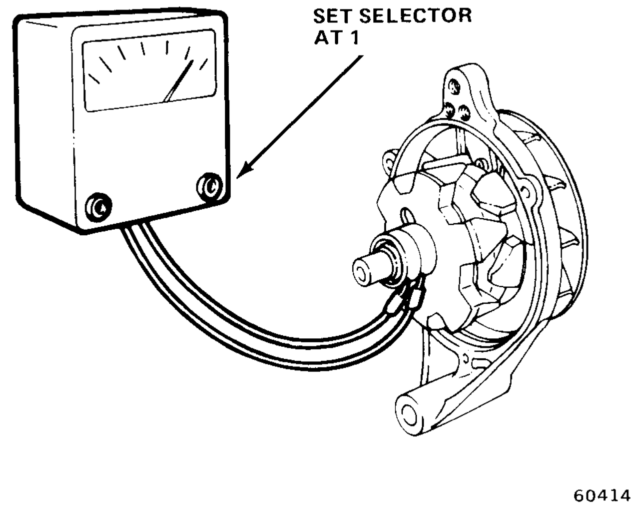


Fig. 3-11 Rotor Continuity Test

Test Results

(1) Indications higher than 4.5 ohms may be due to damaged solder connection at slip rings or broken wire.

(2) Indications lower than 3.5 ohms may be due to a shorted wire or slip ring.

(3) Replace rotor if damaged beyond repair.

Rotor Ground Test

(1) Separate front housing and rotor assembly from rear housing and stator assembly.

(2) Set ohmmeter at 1000 scale and calibrate.

(3) Touch one ohmmeter lead to rotor shaft and other lead to first one slip ring and then the other. Ohmmeter should indicate infinity (no needle movement) in both cases.

Test Results

If ohmmeter indicates other than infinity, a short to ground exists. Check soldered connections at slip rings to make sure they are secure and not grounding out against rotor shaft, or that excess solder is not grounding rotor coil. Replace rotor if damaged.

NOTE: *If the Field Circuit Open or Ground Test showed trouble and both Rotor Tests prove satisfactory, the brushes are the cause.*

Stator Continuity Test

(1) Remove stator and rectifier assembly from rear housing and disconnect stator leads from rectifier.

(2) Set ohmmeter at 1 scale and calibrate.

(3) Touch ohmmeter leads to two of the bare stator lead wires (fig. 3-12).

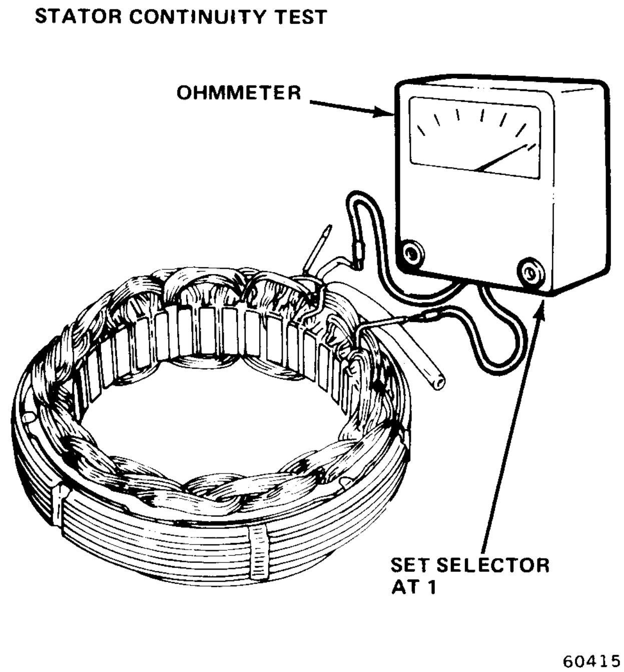


Fig. 3-12 Stator Continuity Test

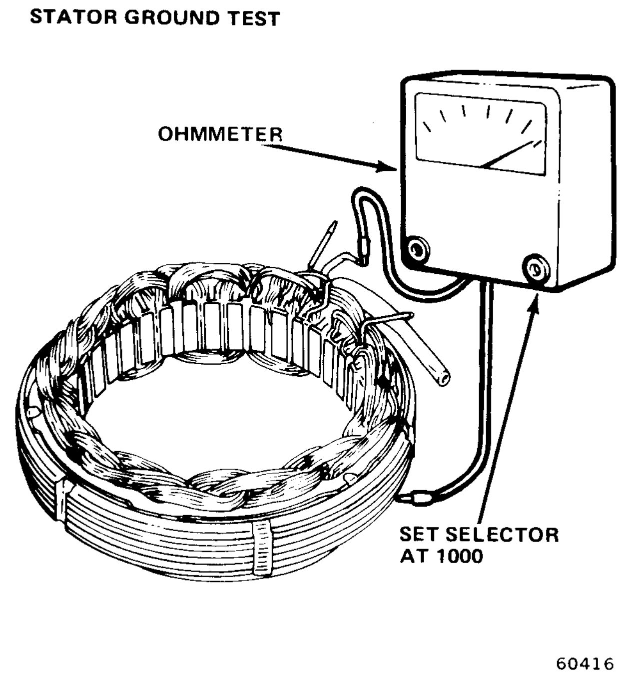


Fig. 3-13 Stator Ground Test

(4) Move one probe to third stator wire. Equal readings should be obtained between each pair of leads.

Test Results

If unequal indications are obtained, stator is open. Check neutral junction splices. If a break is found, make necessary repairs and retest. If unequal readings still exist, replace stator.

Stator Ground Test

(1) Remove stator and rectifier assembly from rear housing and disconnect stator leads from rectifier.

(2) Set ohmmeter at 1000 scale and calibrate.

(3) Touch one ohmmeter lead to bare metal surface of stator core and other lead to a bare stator lead wire (fig. 3-13). Ohmmeter should register infinity (no needle movement). Be sure probe makes good contact with core.

Test Results

If ohmmeter indicates other than infinity, stator is grounded and must be replaced.

Rectifier Diode Testing

(1) Remove rectifier assembly from rear housing.

(2) Set ohmmeter at 10 scale and calibrate.

(3) Test negative diodes by touching one ohmmeter lead to ground terminal and other lead to each stator lead terminals (fig. 3-14).

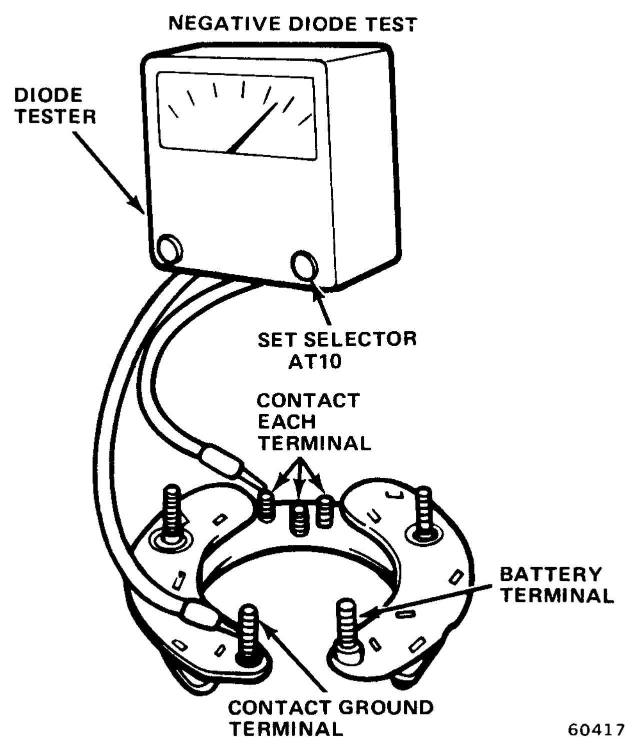


Fig. 3-14 Testing Negative Diodes

(4) Test positive didoes by touching one lead to rectifier battery terminal and other lead to each stator lead terminal (fig. 3-15). Reverse leads to check diodes in other direction.

All diodes should show continuity (approximately 60 ohms) in one direction and no continuity (infinity) in the other direction.

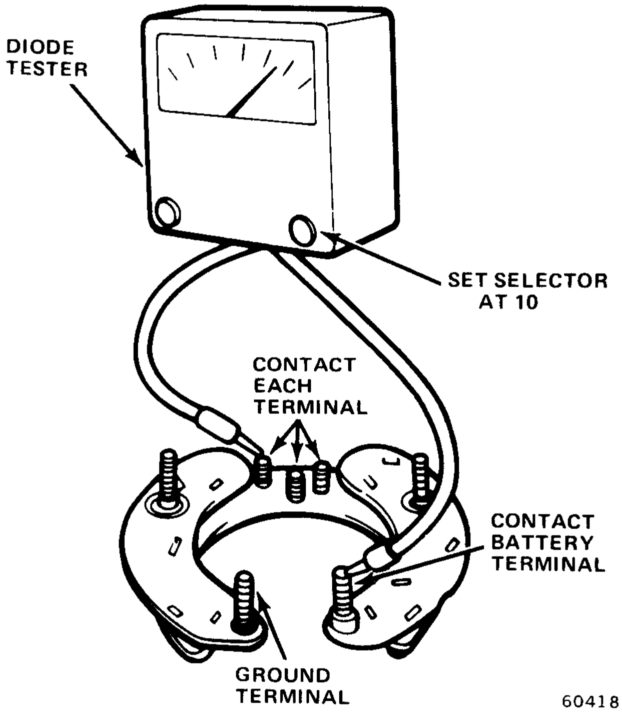


Fig. 3-15 Testing Positive Diodes

Test Results

If continuity is observed in both directions, the diode(s) is shorted. If no continuity is observed in both directions, the diode(s) is open. Replace the rectifier assembly if open or shorted diodes are found.

ALTERNATOR REMOVAL AND INSTALLATION

Removal

(1) Disconnect battery negative cable.
(2) Loosen alternator mounting bracket bolts.
(3) Remove alternator adjustment bolt.
(4) Remove alternator drive belt.
(5) Disconnect wire harness from rear of alternator.
(6) Remove alternator pivot bolt and remove alternator.

Installation

(1) Install alternator and pivot bolt. Do not tighten pivot bolt.
(2) Install adjustment bolt but do not tighten.
(3) Install drive belt.
(4) Tighten mounting bracket bolts to 28 foot-pounds torque.
(5) Tighten drive belt to specified tension.
(6) Tighten pivot bolt to 33 foot-pounds torque and tighten adjusting bolt to 18 foot-pounds torque.
(7) Connect wire harness to alternator.
(8) Connect battery negative cable.

DISASSEMBLY

NOTE: *Refer to figure 3-16 for parts identification.*

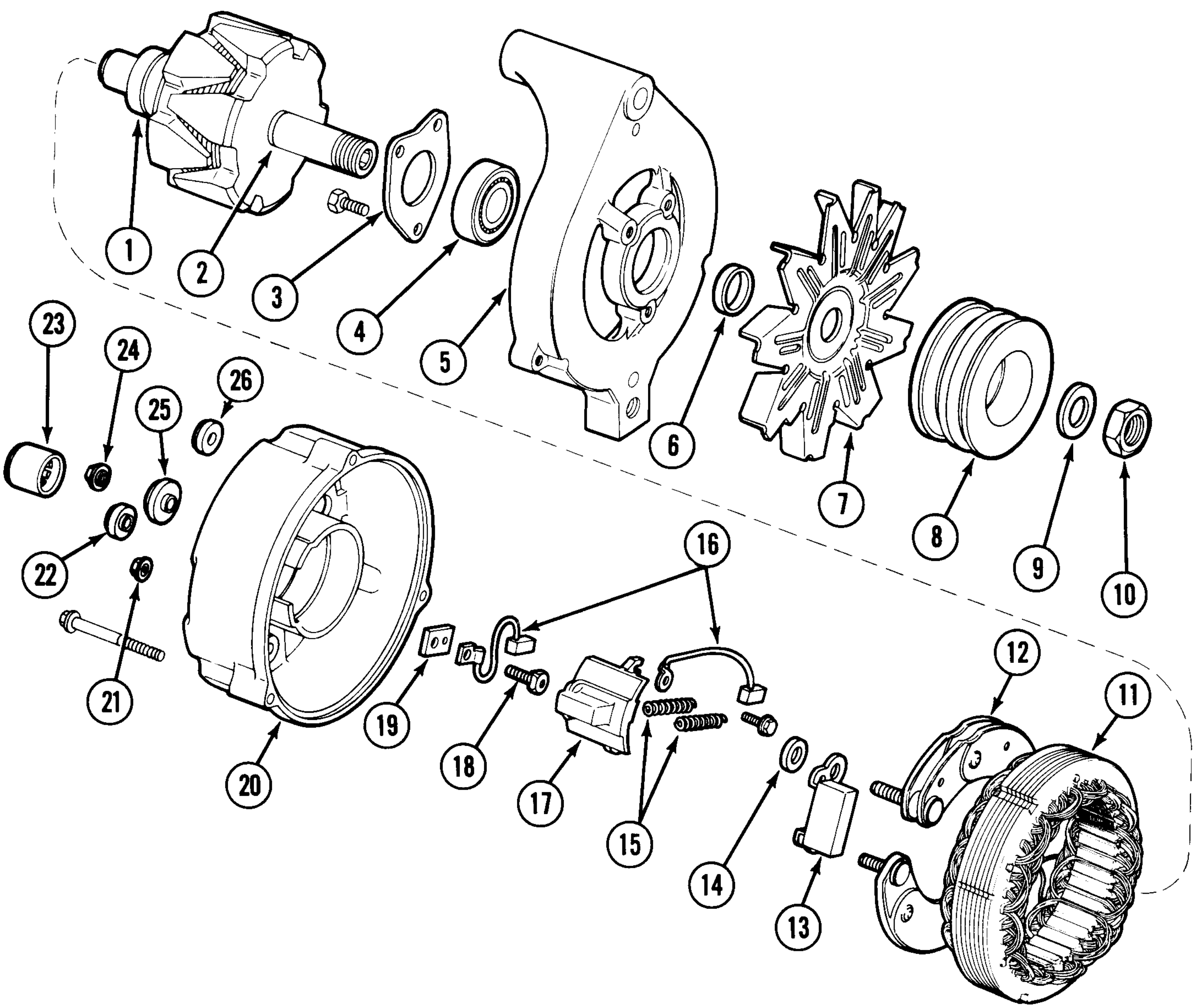
(1) Mark both end housings and stator with a scribe mark for assembly.
(2) Remove three housing through-bolts.
(3) Separate front housing and rotor from stator and rear housing.
(4) Remove all nuts and insulators from rear housing and remove rear housing from stator and rectifier assembly.
(5) Remove brush holder mounting screws and remove brush holder, brushes, brush springs, insulator and terminal.
(6) If replacement is necessary, press rear bearing from rear housing, supporting housing close to bearing boss.
(7) If rectifier assembly or stator is being replaced, unsolder stator leads from rectifier printed circuit board terminals, using a 100-watt soldering iron.

NOTE: *Production alternators have two types of rectifier assemblies. One has a circuit board spaced away from exposed diodes and the other has a circuit board with built-in diodes. These assemblies are interchangeable. Refer to figures 3-17 and 3-18 for parts identification.*

(8) Disconnect stator neutral lead from rectifier assembly with exposed diodes by turning stator terminal clockwise 1/4-turn to unlock.
(9) Disconnect stator neutral lead from rectifier assembly with built-in diodes by pressing stator terminal straight out of rectifier.

CAUTION: *On rectifier assemblies with built-in diodes, do not twist stator terminal during removal as rectifier serrations may be damaged. Do not remove ground terminal screw unless it or insulator must be replaced.*

(10) Separate rectifier assembly from stator.
(11) Clamp front housing in vise and remove drive pulley nut using Tool J-21501 (fig. 3-19).
(12) Remove lockwasher, pulley, fan, fan spacer, front housing, and front bearing spacer from rotor shaft.
(13) Remove front end bearing retainer screws and remove retainer. If bearing is damaged or has lost its lubricant, support housing close to bearing boss and press out bearing.
(14) Test stator, rectifier, and rotor.



1. ROTOR
2. STOP RING
3. FRONT BEARING RETAINER
4. FRONT BEARING
5. FRONT HOUSING
6. FRONT BEARING SPACER
7. FAN
8. PULLEY
9. WASHER
10. NUT
11. STATOR
12. RECTIFIER ASSEMBLY
13. RADIO NOISE SUPPRESSION CAPACITOR
14. INSULATOR CAPACITOR
15. BRUSH SPRING
16. BRUSH SET
17. BRUSH HOLDER
18. BRUSH TERMINAL SCREW
19. BRUSH TERMINAL INSULATOR
20. REAR HOUSING
21. GRD TERMINAL NUT
22. FIELD INSULATOR (ORANGE)
23. REAR BEARING
24. BAT TERMINAL NUT
25. BATTERY INSULATOR (RED)
26. STATOR INSULATOR (BLACK)

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Fig. 3-16 Motorcraft Alternator—Exploded View

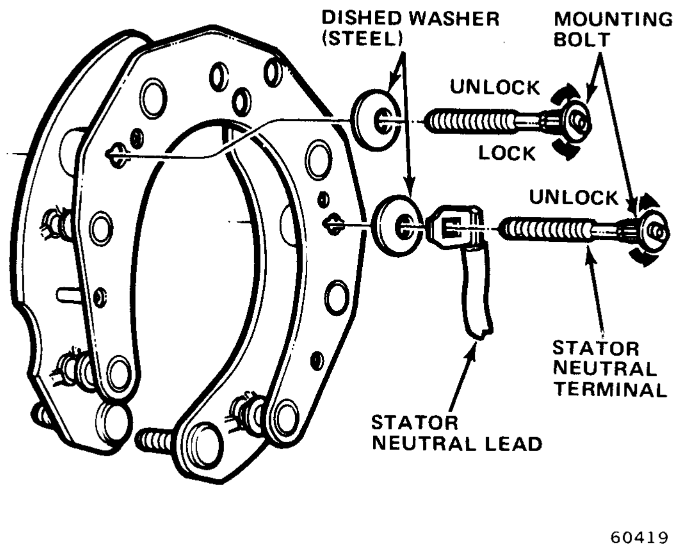

Fig. 3-17 Rectifier Assembly with Exposed Diodes

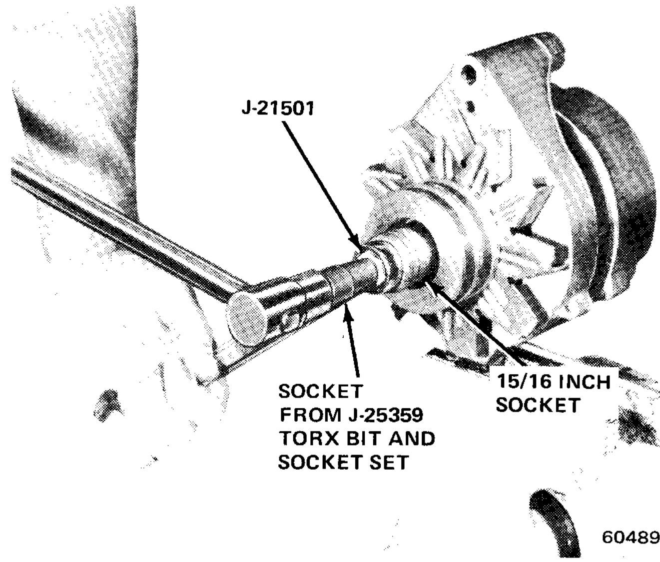

Fig. 3-19 Pulley Removal and Installation

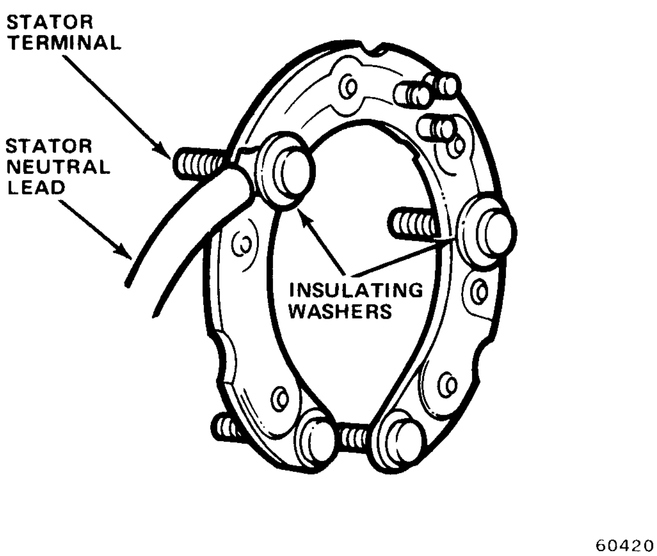

Fig. 3-18 Rectifier Assembly with Built-In Diodes

Cleaning and Inspection

(1) Clean rotor, stator, and bearings with clean cloth. Do not clean with solvent.

(2) Rotate front bearing on drive end of rotor shaft. Check for any scraping noise, looseness, or roughness. Look for excessive lubricant leakage. If any of these conditions exist, replace bearing.

(3) Inspect rotor shaft rear bearing surface for roughness or severe chatter marks. Replace rotor assembly if shaft is not smooth.

(4) Place rear bearing on slip ring end of rotor shaft and rotate bearing. Make same check for noise, looseness, or roughness as was made for front bearing. Inspect bearing rollers and cage for damage. Replace bearing if these conditions exist or if lubricant is lost or contaminated.

(5) Check pulley and fan for excessive looseness on rotor shaft. Replace any pulley or fan that is loose or bent out of shape.

(6) Check both front and rear housings for cracks, particularly the webbed areas and at mounting ear. Replace damaged or cracked housings.

(7) Check all wire leads on both stator and rotor assemblies for loose or broken soldered connections and for burned insulation. Resolder poor connections. Replace parts that show signs of burned insulation.

(8) Check slip rings for nicks and surface roughness. Nicks and scratches may be removed by turning down the slip rings. Do not go beyond minimum diameter of 1.22 inches. If rings are badly damaged, replace rotor assembly.

(9) Replace brushes if worn shorter than 5/16 inch.

ASSEMBLY

(1) Press front bearing in front housing bearing boss (put pressure on outer race only), and install bearing retainer. If stop ring on rotor drive shaft was damaged, install new stop ring. Push new ring on shaft and into groove. Do not open ring with snap ring pliers as permanent damage will result.

(2) Position front bearing spacer on drive shaft with recessed side against stop ring.

NOTE: *Front bearing spacer is black and larger in diameter than fan spacer.*

(3) Position front housing, fan spacer, fan, pulley, and lockwasher on rotor shaft and install drive pulley nut.

(4) Clamp front housing in vise and tighten drive pulley nut to 60 to 100 foot-pounds torque (fig. 3-19).

(5) If rear housing bearing was removed, support housing near bearing boss and press in replacement bearing flush with outer housing.

(6) Place brush springs, brushes, brush terminal and terminal insulator in brush holder and hold brushes in position by inserting a wooden or plastic toothpick in the brush holder (fig. 3-20).

(7) Position brush holder assembly in rear housing and install mounting screws.

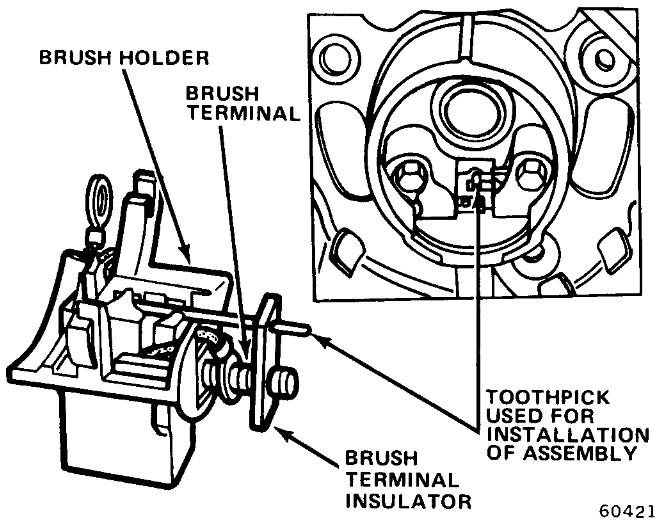

Fig. 3-20 Brush Holder Assembly Installation

(8) Wrap three stator winding leads around circuit board terminals.

(9) Install stator neutral lead on rectifier with exposed diodes by inserting stator terminal through neutral lead, dished washer, and rectifier. Turn stator terminal counterclockwise 1/4-turn to lock.

(10) Install stator neutral lead on rectifier with built-in diodes by inserting stator terminal through neutral lead, insulating washer, and rectifier. Align serrations of stator terminal and rectifier hole and press terminal into rectifier.

(11) Install radio noise suppression capacitor on rectifier terminals (fig. 3-21).

(12) Install BAT terminal insulator and STA terminal insulator (fig. 3-21).

(13) Position stator and rectifier assembly in rear housing.

(14) Position STA (black), BAT (red), and FLD (orange) insulators on terminal bolts, and install retaining nuts.

(15) Position rear housing and stator assembly over rotor and align scribe marks made during disassembly.

(16) Seat machined portion of stator core into step in both end housings.

(17) Install housing through-bolts.

(18) Remove brush retracting toothpick and put a dab of waterproof cement over hole to seal it.

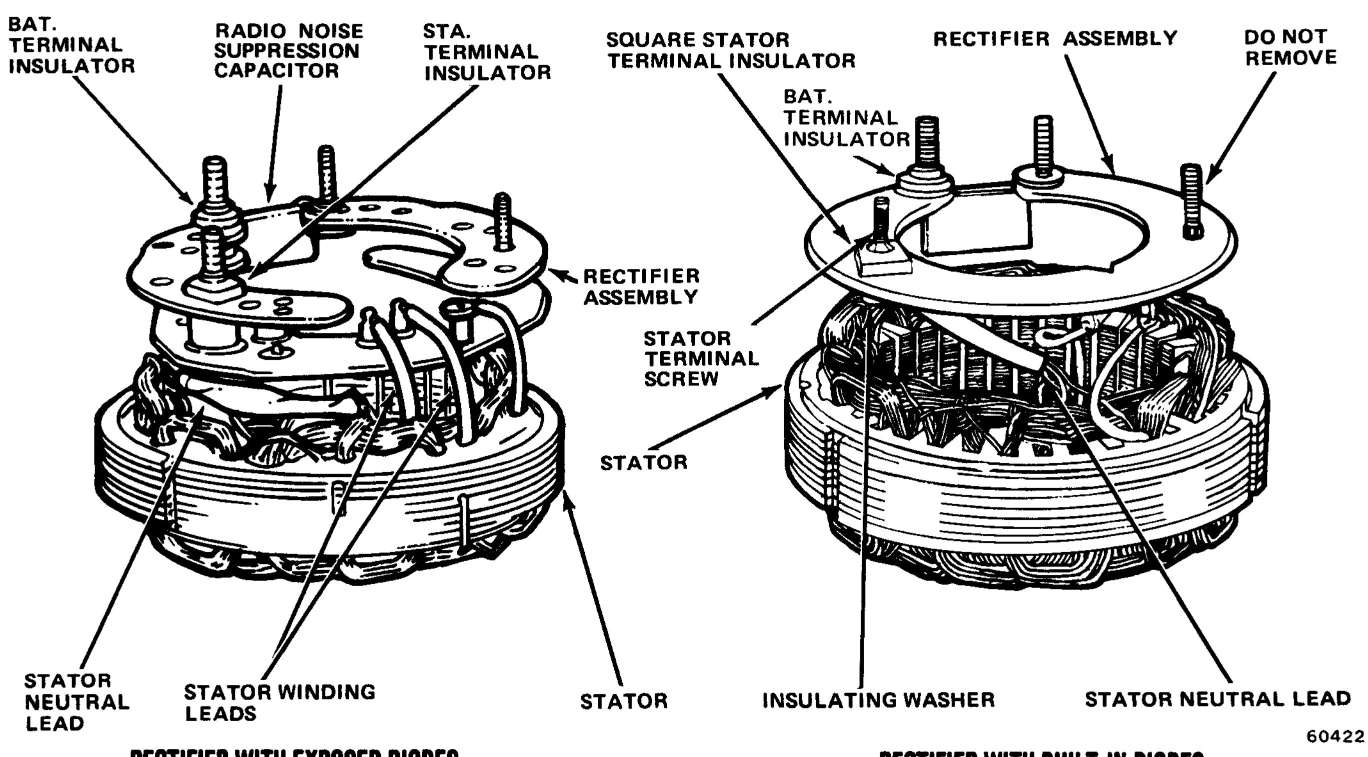

Fig. 3-21 Stator and Rectifier Assemblies

DELCO ALTERNATOR

GENERAL

The 10-SI Series Alternator (fig. 3-22) is typical of a variety of models. **It is used on all six-cylinder engines.** A solid-state regulator having an integrated circuit is built into the end frame. All regulator components are enclosed in a solid mold, and this unit along with the brush holder assembly is attached to the slip ring end frame. The regulator voltage setting never needs adjusting, and no provision for adjustment is provided.

The alternator (fig. 3-22) consists primarily of two end frame assemblies, a rotor assembly, and a stator assembly. The rotor assembly is supported in the drive end frame by a ball bearing and in the slip ring end frame by a roller bearing. These rotor bearings contain a supply of lubricant sufficiently adequate to eliminate the need for periodic lubrication. Two brushes carry current through the two slip rings to the field coil mounted on the rotor and, under normal circumstances, will provide long periods of attention-free service. No periodic adjustments or maintenance are required on the alternator assembly.

The stator windings are assembled on the inside of a laminated core that forms part of the alternator frame. A rectifier bridge connected to the stator windings contains six diodes (three positive and three negative) molded to an assembly which is connected to the stator windings. This rectifier bridge changes the stator ac voltages to dc voltages which appear at the output terminal. The blocking action of the diodes prevent battery discharge back through the alternator.

Because of this blocking action, the need for a cutout relay in the circuit is eliminated. Alternator field current is supplied through a diode trio which is also connected to the stator windings.

A capacitor, or condenser, mounted in the end frame protects the rectifier bridge and diode trio from high voltages, and suppresses radio noise.

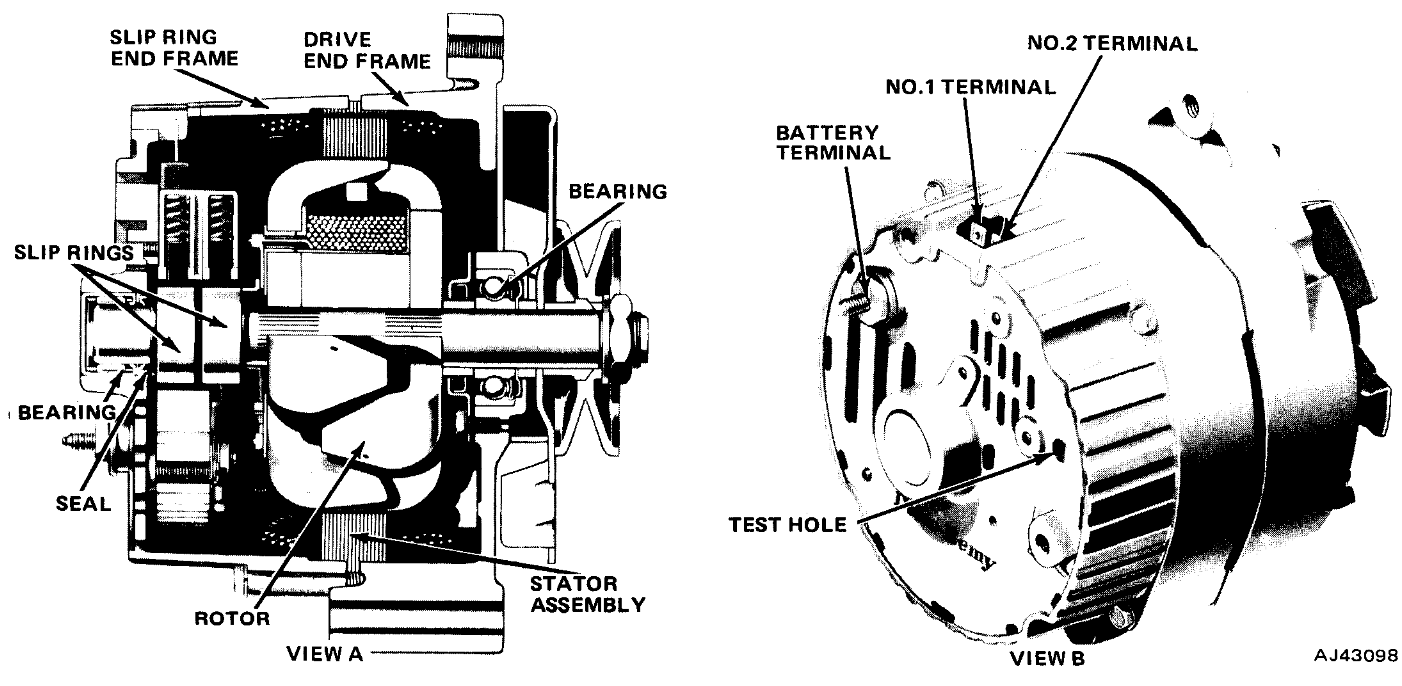

Fig. 3-22 Delco 10-SI Series Alternator

OPERATION

The basic operating principles of the 10-SI Series Alternator (fig. 3-23) are explained as follows:

When the ignition switch is closed, current from the battery flows through the 10-ohm resistor to the alternator No. 1 terminal, through resistor R1, diode D1, and the base-emitter of transistor TR1 to ground, and then back to the battery. This turns on transistor TR1 and current flows through the alternator field coil and TR1 back to the battery. The indicator lamp then lights.

With the alternator operating, ac voltages are generated in the stator windings, and the stator supplies dc field current through the diode trio, the field, TR1, and then through the grounded diodes in the rectifier bridge back to the stator. Also, the six diodes in the rectifier bridge change the stator ac voltage to a dc voltage which appears between ground and the alternator BAT terminal. As alternator speed increases, current is provided for charging the battery and operating electrical accessories. Also with the alternator operating, the same voltage appears at the BAT and No. 1 terminals, and the indicator lamp goes out to indicate the alternator is producing voltage.

The No. 2 terminal on the alternator is always connected to the battery, but the discharge current is limited to a negligible value by the high resistances of R2 and R3. As the alternator speed and voltage increase, the voltage between R2 and R3 increases to the point where zener diode D2 conducts. Transistor TR2 then turns on and TR1 turns off. With TR1 off, the field current and system voltage decrease, and D2 then blocks current flow, causing TR1 to turn back on. The field current and system voltage increase, and this cycle then repeats many times per second to limit the alternator voltage to a preset value.

Capacitor C1 provides voltage continuity across R3, R4 prevents excessive current through TR1 at high temperatures, and D3 prevents high induced voltages in the field windings when TR1 turns off. Resistor R2 is a thermistor which causes the regulated voltage to vary with temperature, thus providing the optimum voltage for charging the battery.

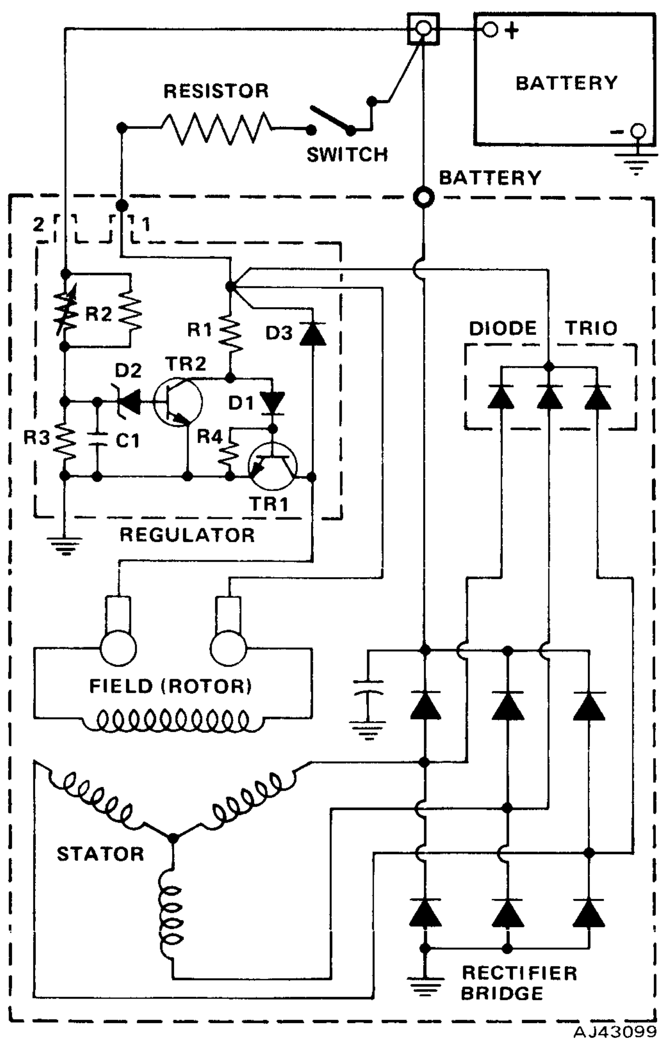

Fig. 3-23 10-SI Alternator Schematic—Typical

NOTE: *On vehicles equipped with electric assist choke, a phase tap is used at the alternator to provide current for choke operation. A strap attached to the rectifier bridge provides about 7 volts to an additonal terminal at the rear of the alternator (fig. 3-24).*

TROUBLESHOOTING PROCEDURES

Close adherence to the following procedures in the order presented will lead to the location and correction of charging system defects in the shortest possible time.

Figure 3-25 is a basic wiring diagram showing lead connections.

To avoid damage to the electrical equipment, always observe the following precautions:

- Do not polarize the alternator.
- Do not short across or ground any of the terminals in the charging circuit except as specifically instructed.
- **NEVER** operate the alternator with the output terminal circuit open and No. 1 and No. 2 terminals connected to the alternator.
- Make sure the alternator and battery have the same ground polarity.
- When connecting a charger or a booster battery to the vehicle, connect negative to negative and positive to positive.

NOTE: *For charging rate indication, an ammeter is used for Cherokee, Wagoneer, and Truck. CJ Models use a voltmeter.*

Trouble in the charging system will show up as one or more of the following conditions:

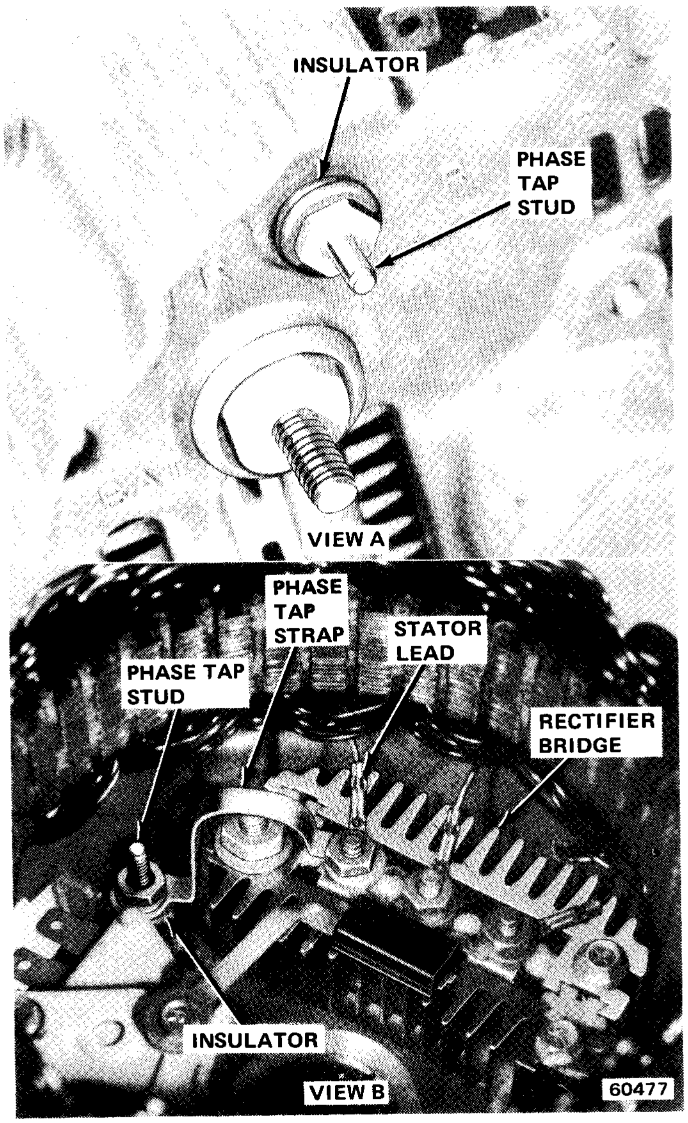

Fig. 3-24 Phase Tap for Electric Assist Choke

A—Faulty voltmeter or ammeter operation.

B—An undercharged battery as evidenced by slow cranking and low specific gravity readings.

C—An overcharged battery as evidenced by excessive water usage.

Before making any electrical checks, visually inspect all connections, including slip-on connectors, to make sure they are clean and tight. Inspect all wiring for cracked or broken insulation. Be sure alternator mounting bolts are tight and unit is properly grounded. Check for loose fan belt.

Noisy Alternator

Noise from the alternator may be caused by a loose drive pulley, loose mounting bolts, worn or dirty bearings, defective diode, out-of-round or rough slip rings, hardened brushes or defective stator.

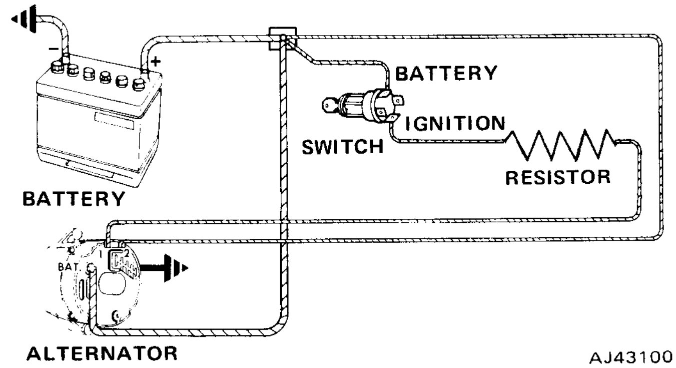

Fig. 3-25 Basic Lead Connections (Negative Ground Shown)

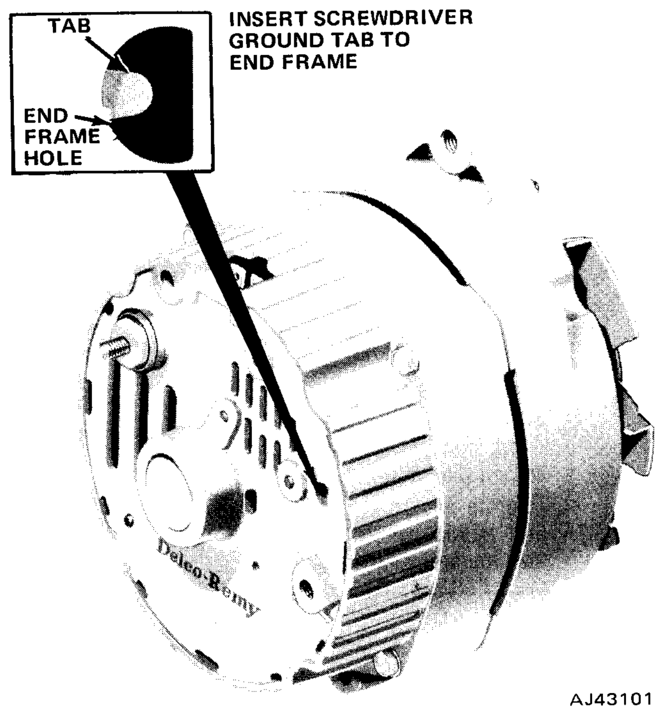

Fig. 3-26 Grounding Alternator Field Windings (Wiring Connections not Shown)

Faulty Ammeter or Voltmeter Operation

Check the ammeter or voltmeter for normal operation. If the meter operates normally, proceed to Overcharged-Undercharged Battery Diagnosis Guide.

Overcharged-Undercharged Battery

For battery overcharged-undercharged diagnosis, refer to the Overcharged-Undercharged Battery Diagnosis Guide.

Overcharged-Undercharged Battery Diagnosis Guide

UNDERCHARGED

This condition, as evidenced by slow cranking and low specific gravity readings, can be caused by one or more of the following conditions even though the voltmeter may be operating normally. The following procedure also applies to circuits with an ammeter.

1. Insure that the undercharged condition has not been caused by accessories having been left on for extended periods.
2. Check the drive belt for proper tension.
3. If a battery defect is suspected, refer to battery testing in this section.
4. Inspect the wiring for defects. Check all connections for tightness and cleanliness, including the slip connectors at the alternator and firewall, and the cable clamps and battery posts.
5. With ignition switch on connect a voltmeter from:
   a. Alternator BAT. terminal to ground
   b. Alternator No. 1 terminal to ground
   c. Alternator No. 2 terminal to ground

   A zero reading indicates an open between lead connection and battery.
6. If previous Steps 1 through 5 check satisfactorily, check the alternator as follows:
   a. Disconnect battery negative cable.
   b. Connect an ammeter in the circuit at the BAT. terminal of the alternator.
   c. Reconnect battery negative cable.
   d. Turn on radio, windshield wipers, lights high beam and blower motor high speed. Connect a carbon pile across the battery.
   e. Operate engine at moderate speed as required, and adjust carbon pile as required, to obtain maximum current output.

If ampere output is within 10 amperes of rated output as stamped on alternator frame, alternator is not defective; recheck Steps 1 through 5.

If ampere output is not within 10 amperes of rated output, ground the field winding by inserting a screwdriver into the test hole **(Fig. 3-26)**. CAUTION: Tab is within ¾ inch of casting surface. Do not force screwdriver deeper than one inch into end frame.

Operate engine at moderate speed as required, and adjust carbon pile as required to obtain maximum current output.

If output is within 10 amperes of rated output, replace regulator as covered in ALTERNATOR REPAIR AND TESTING section, and check field winding.

If output is not within 10 amperes of rated output, check the field winding, diode trio, rectifier bridge, and stator as covered in ALTERNATOR REPAIR AND TESTING section.

OVERCHARGED

1. To determine battery condition refer to battery testing section.
2. Connect a voltmeter from alternator No. 2 terminal to ground. If reading is zero, No 2 lead circuit is open.
3. If battery and No. 2 lead circuit check good, but an obvious overcharge condition exists as evidenced by excessive battery water usage, proceed as follows:
   a. Separate end frames as covered in "DISASSEMBLY" section under heading of "ALTERNATOR REPAIR." Check field winding for shorts. If shorted replace rotor and regulator.
   b. Connect ohmmeter using lowest range scale from brush lead clip to end frame as shown in **Step 1, Fig. 3-32, Ohmmeter 1, then reverse lead connections.**
   c. If both readings are zero, either the brush lead clip is grounded or regulator is defective.
   d. A grounded brush lead clip can result from omission of insulating washer **(Fig. 3-32)**, omission of insulating sleeve over screw, or damaged insulating sleeve. Remove screw to inspect sleeve. If satisfactory, replace regulator as covered under heading of ALTERNATOR REPAIR AND TESTING.

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Alternator Leakage Troubleshooting Procedure

If the alternator is suspected of discharging the battery because of excessive leakage, perform the following procedure. A bulb socket with jumper wires attached and a No. 158 bulb are required.

(1) Disconnect battery lead to alternator.

(2) Connect No. 158 bulb in series with battery lead and alternator output terminal. Bulb should not light. If bulb lights (even dimly), replace rectifier bridge.

(3) Disconnect connector from No. 1 and 2 terminals of alternator.

(4) Connect No. 158 bulb in series with No. 1 terminal at alternator and the battery positive post. Bulb should not light. If bulb lights (even dimly), test diode trio. If diode trio is not defective, replace voltage regulator.

(5) Connect No. 158 bulb in series with No. 2 terminal at alternator and battery positive post. Bulb should not light. If bulb lights (even dimly), replace voltage regulator.

REMOVAL AND INSTALLATION

Removal

WARNING: *Failure to disconnect battery negative cable may result in injury from hot battery lead at the alternator.*

(1) Disconnect battery negative cable.

(2) Remove two-terminal plug and battery lead on back of alternator.

(3) Remove mounting and adjusting bolts and washers.

(4) Remove alternator drive belt from alternator pulley and remove alternator from mounting bracket.

(5) Remove pulley and fan from alternator.

(a) Insert allen wrench into shaft to hold shaft while removing nut (fig. 3-27).

(b) Remove retaining nut and washer.

(c) Slide pulley, fan, and spacer from shaft.

Installation

(1) Install pulley on replacement alternator.

(a) Install spacer, fan, and pulley.

(b) Attach washer and nut.

(c) Tighten nut to 40 to 60 foot-pounds torque (fig. 3-28).

(2) Install alternator to mounting bracket with washers and bolts. Tighten bolts finger-tight only.

(3) Install alternator drive belt.

(4) Tighten belt to the specified belt tension. Refer to Section 2 for proper belt tensioning procedures.

(5) Tighten bolt at sliding slot bracket to 20 foot-pounds torque. Tighten remaining bolts to 30 foot-pounds torque.

(6) Install terminal plug and battery lead to alternator.

(7) Connect battery negative cable.

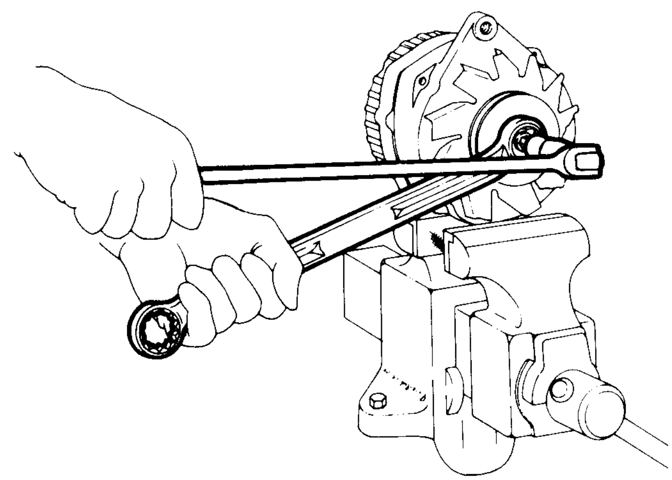


Fig. 3-27 Pulley Removal

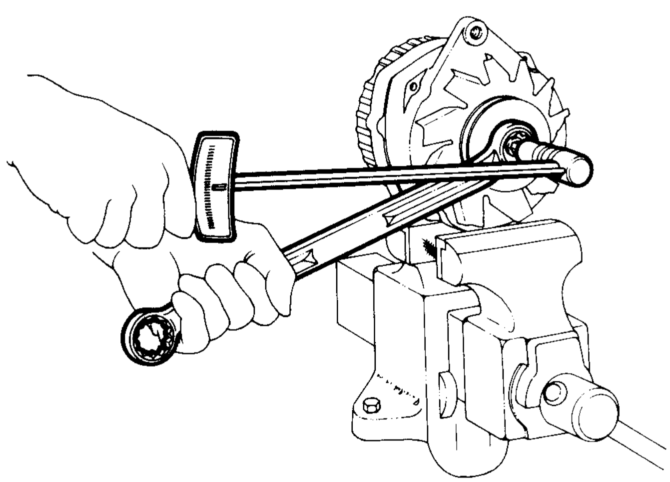


Fig. 3-28 Tightening Pulley Nut

REPAIR AND TESTING

Disassembly, Testing, and Assembly

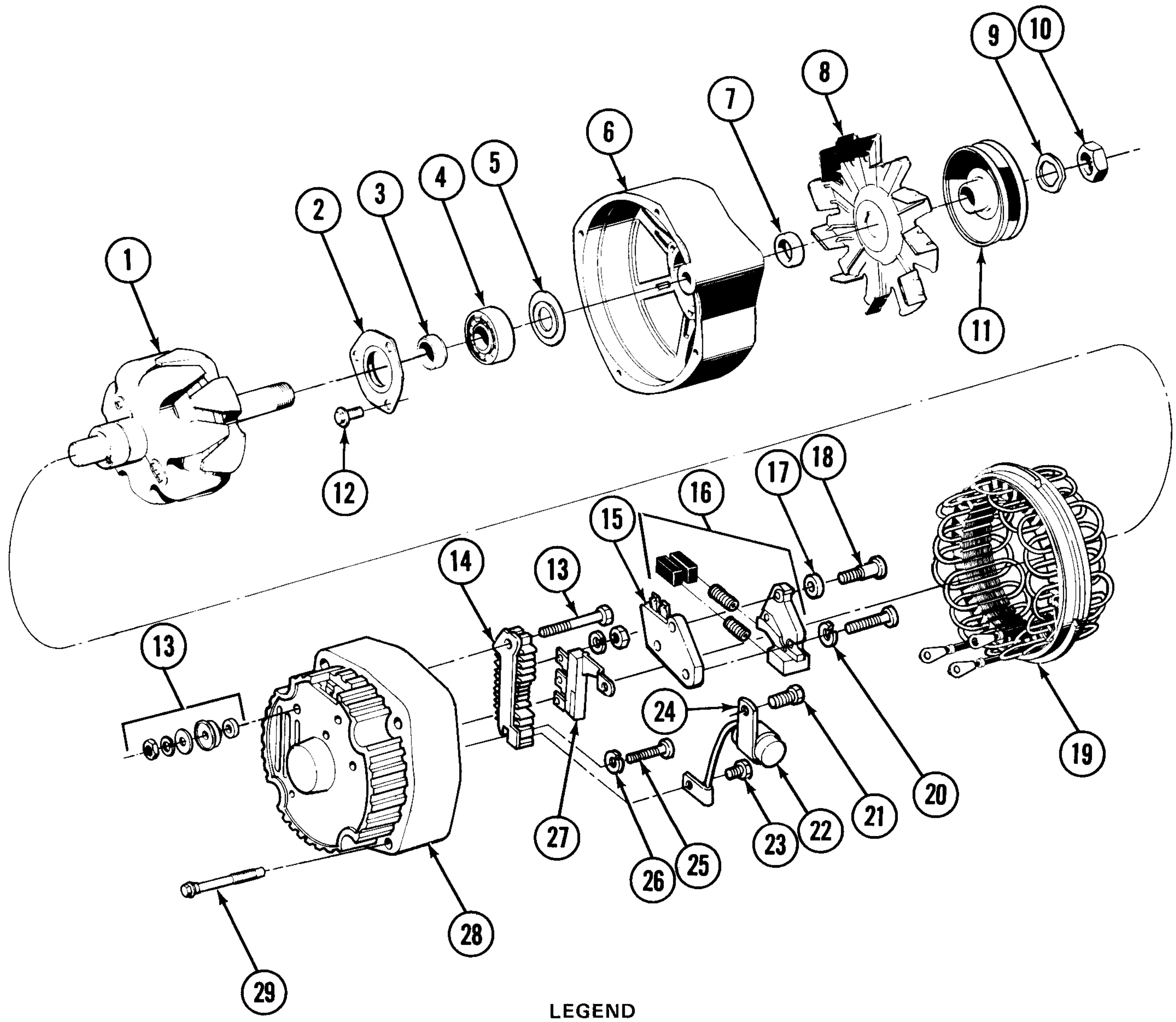
CAUTION: *As rotor and drive end frame assembly is separated from slip ring frame assembly, the brushes will fall down onto the shaft and come in contact with* *lubricant. Brushes which come in contact with shaft should be cleaned immediately to avoid contamination by oil, or they will have to be replaced.*

(1) Scribe marks on alternator case for location reference.

(2) Remove four through-bolts, connecting slip ring and end frame and drive end frame (fig. 3-29).

(3) Separate drive end frame and rotor assembly from the stator assembly by prying apart with a screwdriver placed between stator assembly and drive end frame.

NOTE: *After disassembly, place a piece of tape over the slip ring end frame bearing to prevent entry of dirt and other foreign material, and also place a piece*



LEGEND

1 ROTOR	11 PULLEY	21 SCREW
2 RETAINER	12 SCREW	22 CAPACITOR
3 COLLAR (INNER)	13 TERMINAL PACKAGE	23 SCREW
4 BEARING	14 RECTIFIER BRIDGE	24 CLAMP
5 WASHER	15 REGULATOR	25 SCREW
6 HOUSING	16 BRUSH ASSEMBLY PACKAGE	26 WASHER
7 COLLAR (OUTER)	17 WASHER	27 DIODE TRIO
8 FAN	18 SCREW	28 HOUSING
9 WASHER, LOCK	19 STATOR	29 THROUGH-BOLT
10 NUT, PULLEY	20 WASHER	

Fig. 3-29 10-SI Alternator—Exploded View

of tape over the shaft on the slip ring end. Use pressure-sensitive tape and not friction tape which would leave a gummy deposit on the shaft. If brushes are to be reused, clean with a soft, dry cloth.

(4) Place rotor in vise and tighten only enough to permit removal of shaft nut.

CAUTION: *Avoid excessive tightening of the rotor in the vise as this may cause rotor distortion.*

(5) Remove shaft nut, washer, pulley, fan, and collar.
(6) Separate drive end frame from rotor shaft.

Rotor Testing

The rotor may be checked electrically for grounded, open, or short-circuited field coils as follows.
(1) Check for ground by connecting a 110-volt test lamp or ohmmeter from either slip ring to rotor shaft or to rotor poles. If lamp lights or ohmmeter reading is low, the field winding is grounded (fig. 3-30).
(2) Check for opens by connecting the test lamp or ohmmeter to each slip ring. If lamp fails to light, or if the ohmmeter reading is high (infinity), the winding is open (fig. 3-30).
(3) Check winding for short circuits by connecting a battery and ammeter in series with two slip rings. The field current at 12 volts and 80°F should be between 4.0 to 4.5 amperes. Any ammeter reading above 4.5 amperes indicates shorted windings.

NOTE: *The winding resistance and ammeter readings will vary slightly with winding temperature changes. A reading below the specified value indicates excessive resistance. An alternate method is to check the resistance of the field by connecting an ohmmeter to the two slip rings (fig. 3-30). If the resistance reading is below 2.6 ohms at 80°F, the winding is shorted. If resistance is above 3.0 ohms at 80°F, the winding has excessive resistance.*

(4) Replace rotor assemblies which fail the above test.
(5) Clean and inspect rotor as follows:
(a) Clean magnetic poles or rotor by brushing with mineral spirits.

CAUTION: *Do not clean with degreasing solvent.*

(b) Inspect slip rings for dirt and roughness. Clean with solvent if necessary. These may also be cleaned and finished with 400 grain or finer polishing cloth. Do not use sandpaper. Spin rotor in lathe or otherwise spin rotor, and hold polishing cloth against rings until they are clean.

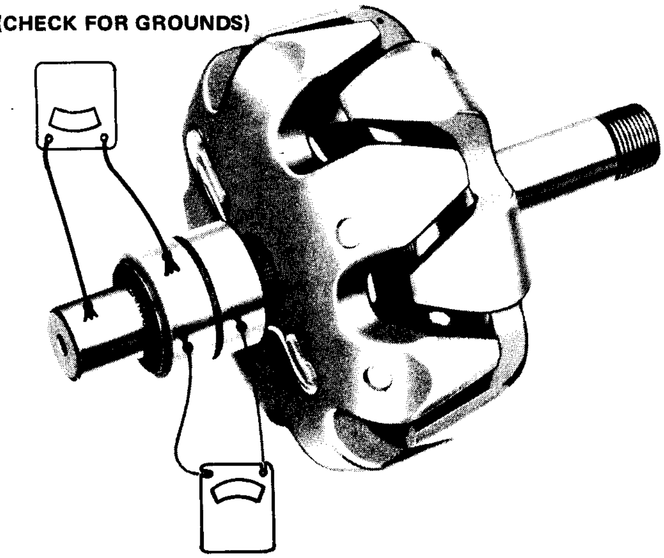


Fig. 3-30 Checking Rotor

CAUTION: *The rotor must be rotated in order that slip rings will be cleaned evenly. Cleaning slip rings by hand, without spinning rotor, may result in flat spots on slip rings, causing brush noise.*

(c) True rough or out-of-round slip rings in lathe to 0.002 inch maximum indicator reading. Remove only enough material to make rings smooth and round. Finish with 400 grain or finer polishing cloth and blow away all dust.

If the rotor is not defective, but the alternator fails to supply rated output, the defect is in the diode trio, rectifier bridge, or stator.

Stator

Disassembly

(1) Remove three stator lead attaching nuts and washers and remove stator leads from rectifier bridge terminals.
(2) Remove phase tap strap, if equipped.
(3) Separate stator frame from end frame. The fit between the stator frame and end frame is not tight, and the two can be separated easily.

Testing

The stator windings may be checked with a 110-volt test lamp or ohmmeter as follows:
(a) Check for grounded windings by connecting lamp or ohmmeter from any stator lead to frame. If lamp lights or ohmmeter reading is low, the stator is grounded (fig. 3-31).
(b) Test for opens by successively connecting test lamp or ohmmeter between stator leads. If lamp

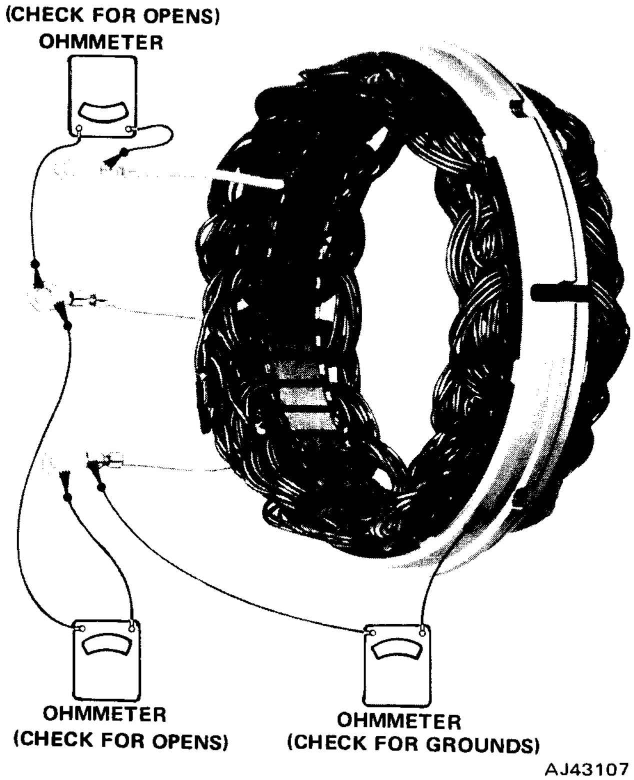


Fig. 3-31 Checking Stator

fails to light or ohmmeter reading is high, there is an open in stator windings (fig. 3-31).

(c) Locate short circuits in stator windings.

NOTE: *A short circuit is difficult to locate without laboratory test equipment, due to low resistance of windings. However, if all other electrical checks are normal and alternator fails to supply rated output, shorted stator windings are indicated.*

(d) Replace stator which fails above test.

CAUTION: *Do not clean in solvent.*

(1) Clean stator, if necessary, by brushing with mineral spirits or equivalent.

Assembly

(1) Position stator frame and end frame together.
(2) Install phase tap strap, if removed.
(3) Attach stator leads to rectifier bridge terminals. Secure with washers and nuts.

Diode Trio

Testing

NOTE: *Testing is performed before further disassembly of the diode trio to isolate malfunctions.*

CAUTION: *Do not use high voltage, such as 110-volt test lamp, to check this unit.*

(1) Before removing the diode trio, connect an ohmmeter, using lowest range scale, from brush lead clip to end frame (fig. 3-32).
(2) Reverse lead connections. If both readings are zero, check for grounded brush lead clip caused by omission of insulating washer, omission of insulating sleeve over screw, or damaged insulation (fig. 3-32).
(3) Remove screw to inspect sleeve.

NOTE: *If screw assembly is correct and both ohmmeter readings are the same, replace voltage regulator.*

Disassembly

(1) Remove three stator attaching screws.
(2) Remove stator leads from rectifier bridge terminals.
(3) Remove phase tap strap, if equipped.
(4) Remove stator.
(5) Remove diode trio lead clip attaching screw and remove diode trio. Note that the insulating washer on the screw is assembled over the top of the diode trio connector.

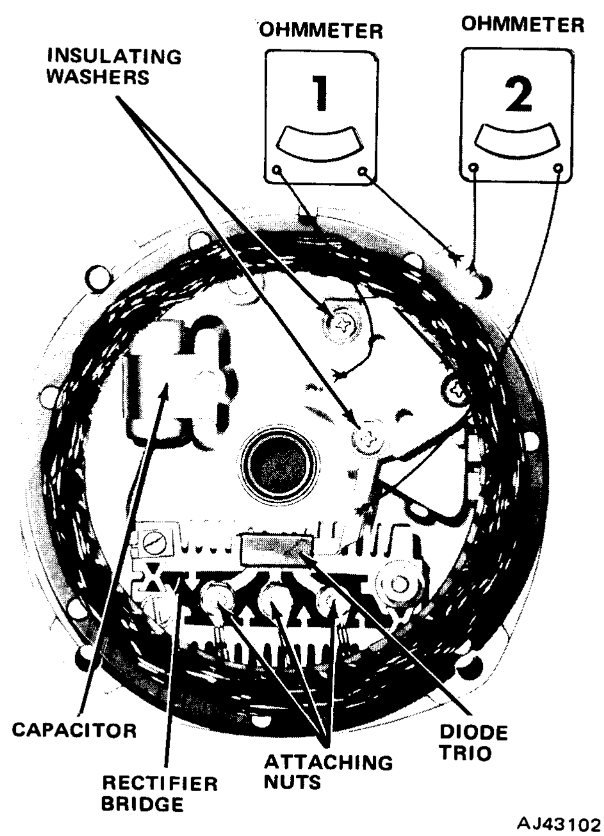


Fig. 3-32 Slip Ring End Frame Assembly

Final Testing

(1) Check diode trio after removing it from end frame assembly.

(a) Connect an ohmmeter having a 1-1/2-volt cell to the single brush connector and one of the stator lead connectors (fig. 3-33). Observe reading on lowest range scale.

(b) Reverse leads to same two connectors.

(2) Replace the diode trio if any or all of the readings when reversing connections are the same. A good diode trio will give one high and one low reading.

(3) Connect ohmmeter to each pair of three connectors. If any reading is zero, replace diode trio.

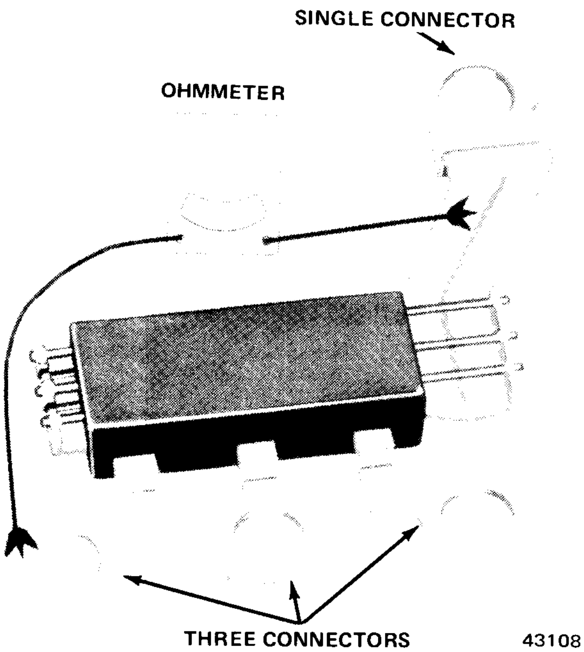


Fig. 3-33 Checking Diode Trio

Assembly

(1) Position diode trio to end frame.

(2) Install diode trio lead clip screw, making sure insulating washer is over the top of diode trio connector.

(3) Install phase tap strap, if removed.

(4) Install stator and attach leads to rectifier bridge terminals. Secure with washers and nuts.

Rectifier Bridge

NOTE: *The rectifier bridge contains all of the diodes found in the heat sink and slip ring end frame. If one diode is defective, the entire rectifier bridge must be replaced.*

Testing

CAUTION: *Do not use high voltage, such as a 110-volt test lamp, to check these units.*

(1) Connect ohmmeter to grounded heat sink and one of three terminal tabs (fig. 3-34). Note reading.

(2) Reverse lead connections to the grounded heat sink and same terminal tab. Note reading.

(3) Replace rectifier bridge if both readings are the same.

NOTE: *A good rectifier bridge will give one high and one low reading. Do not replace either unit unless at least one pair of readings is the same.*

(4) Repeat steps (1) and (2) between the grounded heat sink and the other two terminal tabs, and between the insulated heat sink and each of the three terminal tabs. The ohmmeter check of the rectifier bridge, and of the diode trio as previously covered, is a valid and accurate check.

Disassembly

(1) Remove phase tap strap, if equipped.

(2) Remove capacitor lead attaching screw.

(3) Disconnect capacitor lead from rectifier bridge.

(4) Remove rectifier bridge attaching screws and battery terminal screw.

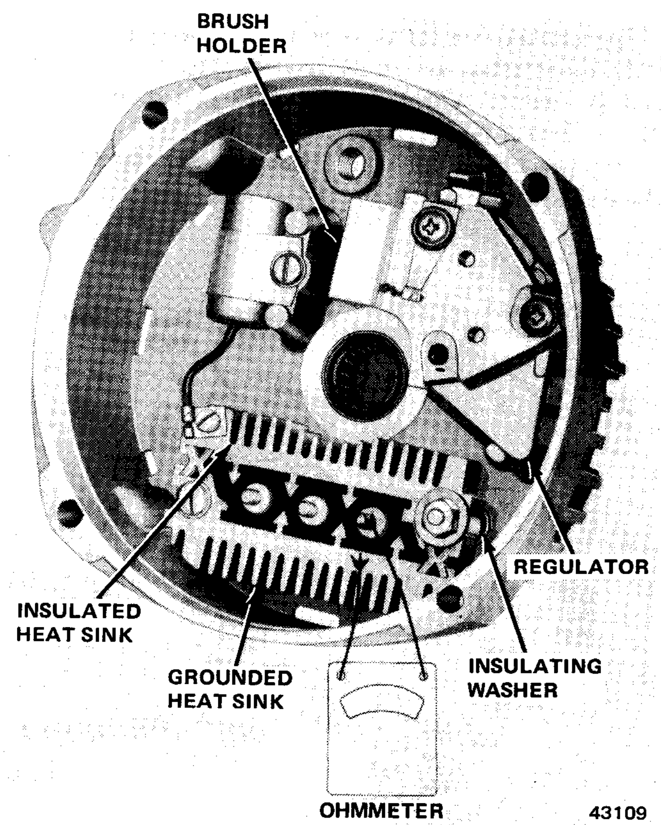


Fig. 3-34 Rectifier Bridge Check

(5) Remove rectifier bridge. Note insulator between insulated heat sink and end frame (fig. 3-34).

Assembly

(1) Position rectifier bridge to end frame with insulator between insulated heat sink and end frame.
(2) Install phase tap strap, if removed.
(3) Install rectifier bridge attaching screw and battery terminal screw.
(4) Connect capacitor lead to rectifier bridge and tighten securely.

Brushes

Disassembly

(1) Remove two brush holder screws and one diode trio lead strap attaching screw. Note position of all insulator washers for assembly (fig. 3-35).
(2) Inspect brush holder screws for broken or cracked insulation.
(3) Remove brush holder and brushes. Carefully note stack-up of parts for assembly.

NOTE: *The voltage regulator may be removed at this time.*

Inspection

Inspect brush springs for evidence of damage or corrosion.
Inspect brushes for wear or contamination.
If old brushes are to be reused, they must be thoroughly cleaned with soft, dry cloth and must be completely free of oil.
Replace brush springs if there is any doubt about their condition.

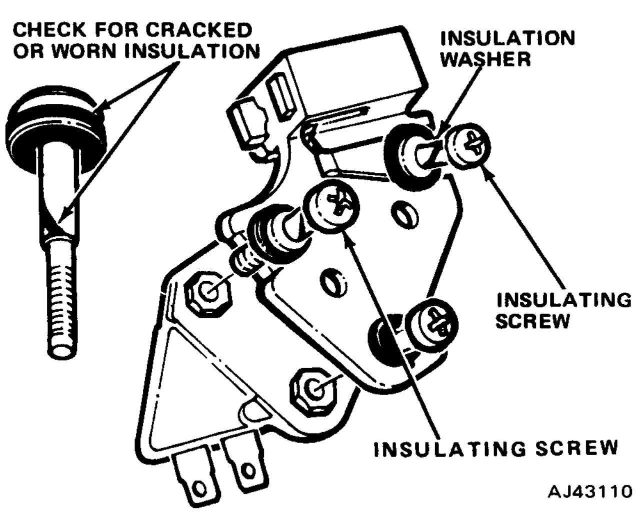


Fig. 3-35 Brush Holders

Assembly

NOTE: *Should any of the brush holder assembly parts require replacement, it will be necessary to replace the entire brush holder assembly. Individual parts are not serviced for this particular assembly.*

(1) Install springs and brushes into brush holder.

NOTE: *Brushes should slide in and out of brush holder without binding.*

(2) Insert a straight wooden or plastic toothpick (to prevent scratching brushes) into hole at bottom of holder to retain brushes.

NOTE: *Install voltage regulator at this time.*

(3) Attach brush holder into end frame, noting carefully stack-up of parts (fig. 3-35). Allow wooden or plastic toothpick to protrude through hole in end frame.
(4) Install diode trio lead strap attaching screw and washer.
(5) Securely tighten remaining two brush holder screws.

Bearing Replacement and Lubrication

Disassembly

Drive End Frame

(1) Remove bearing retaining plate screws.
(2) Press bearing from the end frame with suitable tube or collar.

NOTE: *If the bearing is in satisfactory condition, it may be reused.*

Slip Ring End Frame

(1) Press out bearing using a tube or collar that fits inside the end frame housing.
(2) Press out bearing from the inside of the housing toward the outside.

NOTE: *The bearing in the slip ring end frame should be replaced if its grease supply is exhausted. No attempt should be made to lubricate and reuse the bearing.*

Assembly

Drive End Frame

NOTE: *Prior to assembly, fill the cavity one quarter full between the retainer plate and bearing with Delco-Remy lubricant No. 1948791, or equivalent.*

CAUTION: *Do not overfill as this may cause the bearing to overheat.*

(1) Assemble bearing and slinger into end frame (fig. 3-36).

(2) Press bearing in with the use of a suitable tube or collar that fits over the outer race.

NOTE: *It is recommended that a new retainer plate be installed if the felt seal in the retainer plate is hardened.*

(3) Install retaining plate and screws.

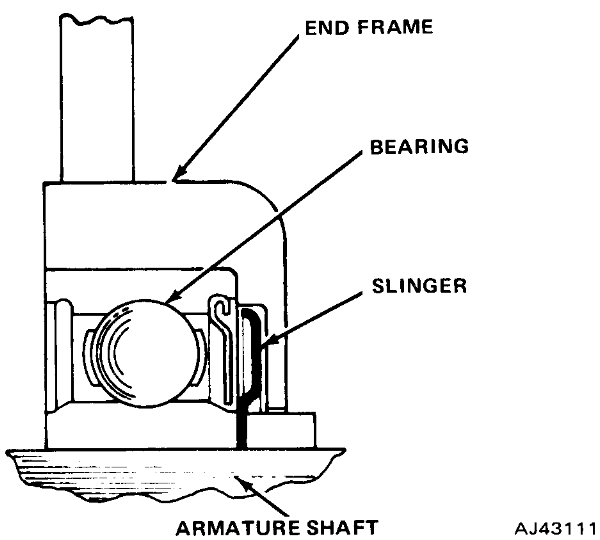


Fig. 3-36 Drive End Bearing Assembly

Slip Ring End Frame

(1) Support the inside of the frame with a hollow cylinder to prevent breakage of the end frame.

CAUTION: *Use extreme care to avoid misalignment or placing undue stress on the bearing.*

(2) Place a flat plate over bearing and press in from the outside toward the inside of the frame until bearing is flush with the outside of the frame.

NOTE: *If the seal is separated from the bearing, it is recommended that a new seal be installed whenever the bearing is replaced. Lightly coat the seal lip with oil to facilitate assembly of the shaft into the bearing. Press the seal in with the lip of the seal toward the rotor when assembled, away from the bearing.*

Alternator Final Assembly

(1) Before assembling rotor and drive end frame to slip ring end frame, be sure that bearing surfaces of shaft are perfectly clean.

(2) Position the slip ring frame and drive ring frame together, aligning the scribe marks.

(3) Install four through-bolts and securely tighten.

(4) Remove wooden or plastic toothpick from brush holder assembly.

STARTING SYSTEM

GENERAL

The starting system includes the starter motor and drive, battery, starter relay, starter switch (ignition switch), and the necessary cables and wiring to connect the components. A starter safety switch, on vehicles equipped with automatic transmissions, prevents operation of the starter in all selector positions except N (neutral) and P (park).

NOTE: *All models equipped with an automatic transmission have a combination neutral-start backup lamp switch mounted on the steering column. When equipped with a manual transmission, the neutral-start wires are connected together, resulting in a direct connection between the ignition switch and the starter motor relay S-terminal.*

A low and high current circuit make up the starting system (fig. 3-37). The low current is the control circuit and includes the connections and wires from the ignition switch to the S-connection at the starter relay. This circuit activates the pull-in winding in the starter solenoid and closes the switch to complete the high current circuit. The high current circuit is from the battery through the starter relay switch to the starter motor to ground.

The Starter Motor Diagnosis Guide may be used to trace the source of the problem when the starter will

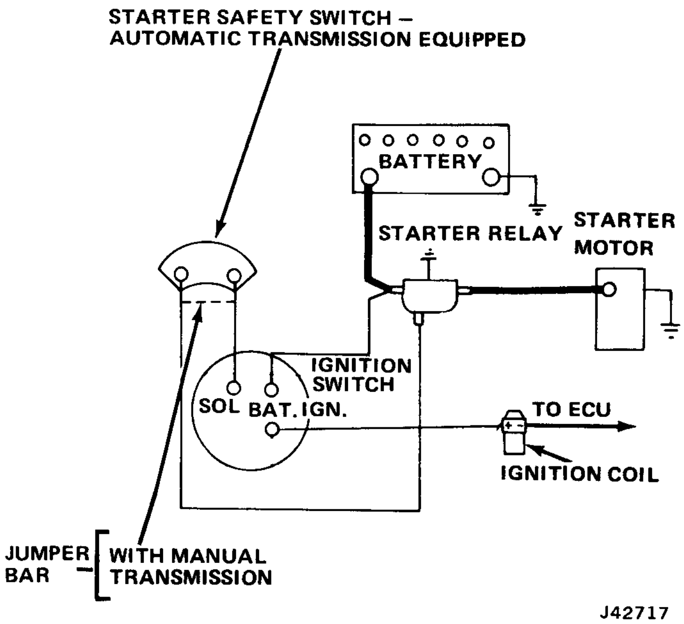


Fig. 3-37 Starting System Wiring Diagram

not crank the engine or cranks slowly.

If the starter motor cranking speed is normal and the engine does not start, the problem usually can be found in the fuel or ignition system.

STARTER MOTOR

The starter has an integral positive engagement drive. When the starter is not in use, one of the field coils is connected directly to ground through a set of contacts (fig. 3-38). When the starter is first engaged, a heavy current flows through the grounded field coil actuating a movable pole shoe. The pole shoe is attached to the starter drive actuating lever, thus the drive is engaged with the flywheel.

When the movable pole shoe is fully seated, it opens the field coil grounding contacts and is connected in parallel with the other pole shoes while the armature is rotating. A holding coil is used to maintain the movable pole shoe in the fully seated position during the time that the starter is cranking the engine.

Identification

The starter motor identification code is stamped on the frame, below the Jeep Part number, at the time of manufacture.

Example:

6	F	C	A
Year	Month	Week	Work
(1976)	(June)	(3rd Week)	Shift

The letter I is never used in starter coding.

Current Draw Test—On Vehicle

(1) Prior to performing a current draw test, battery must be fully charged as described under Hydrometer Tests in this section.

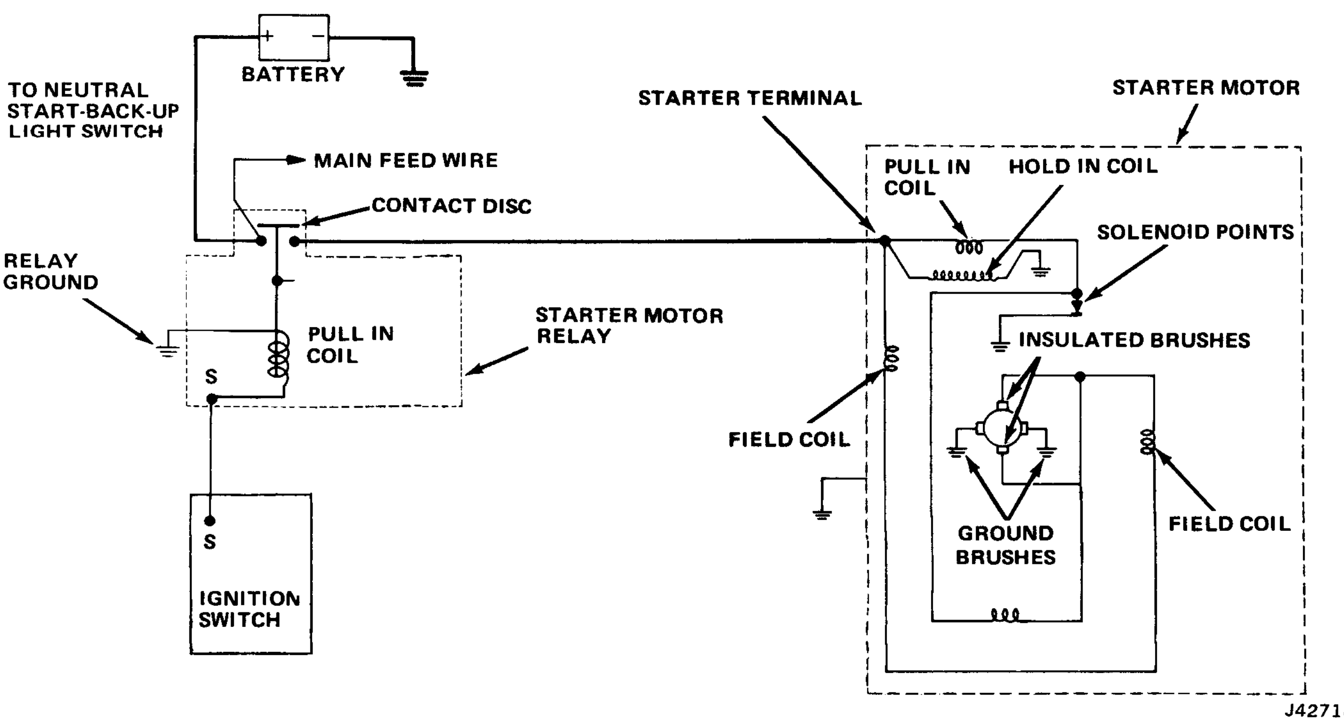


Fig. 3-38 Starter Motor—Wiring Diagram

NOTE: *The lower the voltage, the higher the amperage draw.*

(2) Disconnect and ground ignition coil secondary wire.

(3) Connect a remote control starter switch between positive battery terminal and S-terminal of the starter solenoid.

(4) Connect battery-starter tester leads as shown in figure 3-39. Operate remote control starter switch and read voltage indicated on voltmeter while starter is cranking engine.

CAUTION: *Do not operate for more than 15 seconds.*

(5) Turn remote control starter switch off.

(6) Turn load control knob clockwise or to Increase until the voltmeter reading is exactly the same as it was when the starter was cranking.

Read the current draw on the ammeter scale. This is the current being used by the starter under full load conditions. If the current draw is not 180 to 220 ammperes at room temperature, remove the starter motor from the engine for bench testing.

NOTE: *Do not take ampere draw reading until starter motor has obtained maximum rpm.*

No-Load Test—Out of Vehicle

The starter motor no-load test will indicate such faults as open or shorted windings, worn bushings (rubbing armature), or bent armature shaft. This test is run with the starter on the bench.

NOTE: *The tester load control knob must be in the Decrease or extreme clockwise position.*

(1) Operate starter with test equipment connected as shown in figure 3-40. Note voltage reading.

(2) Determine exact starter rpm using a mechanical tachometer (not shown).

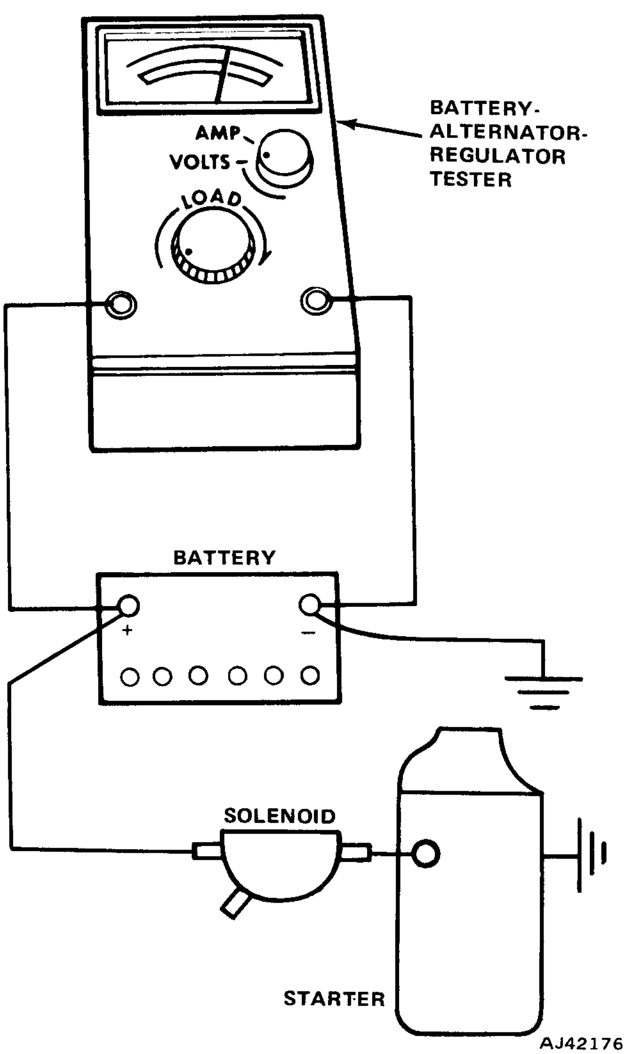


Fig. 3-39 Starter Motor Current Draw Test

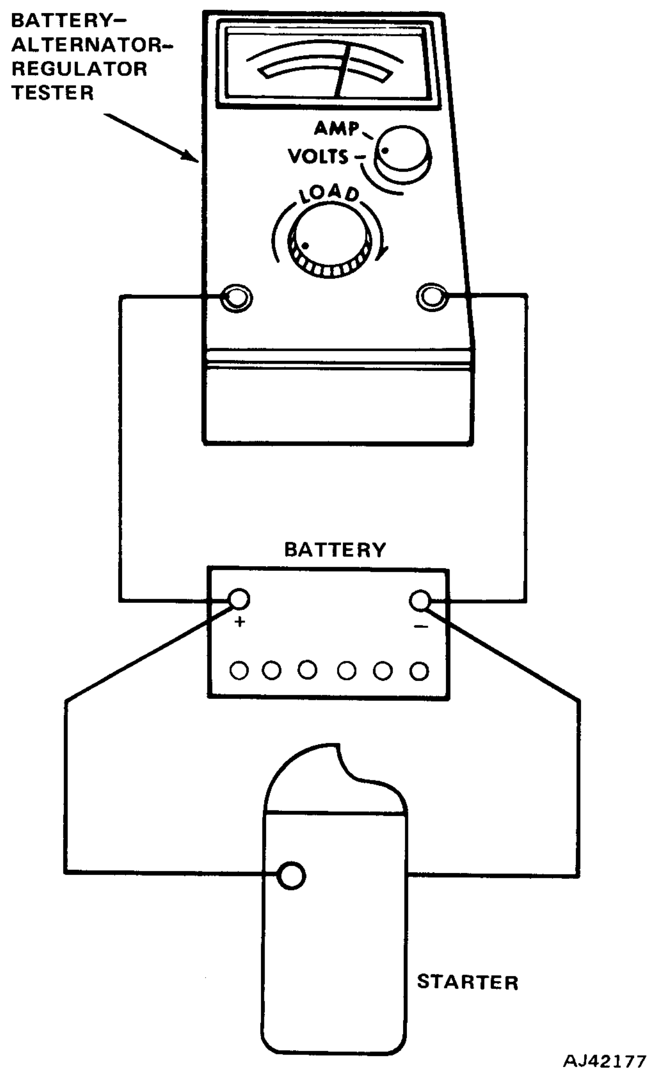


Fig. 3-40 Starter Motor No-Load Test

NOTE: *To use a mechanical tachometer, remove seal from drive end housing and clean grease from end of armature shaft.*

(3) Disconnect starter from battery.

(4) Turn load control knob clockwise (Increase) until voltmeter reading is exactly the same as it was with the starter connected to the battery.

(5) If ammeter reading at no-load speed is below specifications, starter has high electrical resistance and should be repaired or replaced.

(6) If ammeter reading is higher than specifications and starter is running slower than it should, starter should be disassembled, cleaned, inspected, and tested as outlined in the following paragraphs.

Disassembly

Refer to figure 3-41 for parts identification.

(1) Remove brush cover band and protective tape, drive yoke cover and gasket.

(2) Remove brushes from brush holders.

(3) Remove through-bolts, drive end housing, and drive yoke return spring.

(4) Remove pivot pin and starter drive yoke.

(5) Remove armature and drive assembly.

(6) Remove brush end plate.

Cleaning and Inspection

(1) Use a brush or air to clean starter frame, field coils, armature, drive assembly, and drive end housing.

(2) Wash all other parts (except field coils) in solvent and dry parts.

(3) Inspect armature windings for broken or burned insulation and unsoldered connections.

(4) Check armature for open circuits and grounds as outlined in Armature Test Procedure.

(5) If the commutator is dirty, it may be cleaned with No. 400 or No. finer sandpaper.

NOTE: *Never use emery cloth to clean the commutator.*

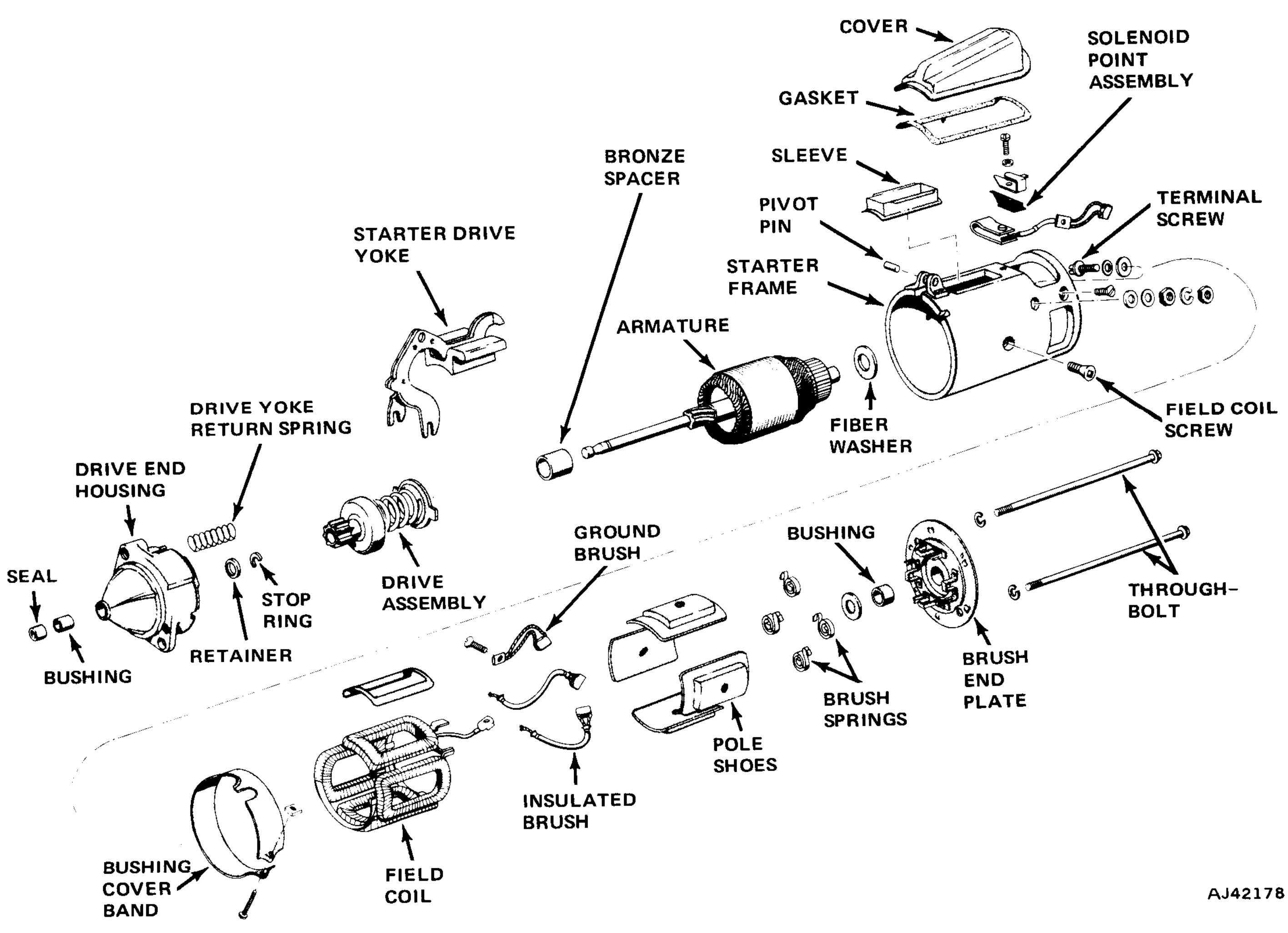


Fig. 3-41 Starter Motor—Disassembled View

(6) If armature commutator is worn, out-of-round (0.005 inch or more), or has high insulation, it should be turned down on a lathe.

(7) Inspect armature shaft and front and rear bushings for scoring and excessive wear.

(8) Inspect drive assembly pinion gear for damage.

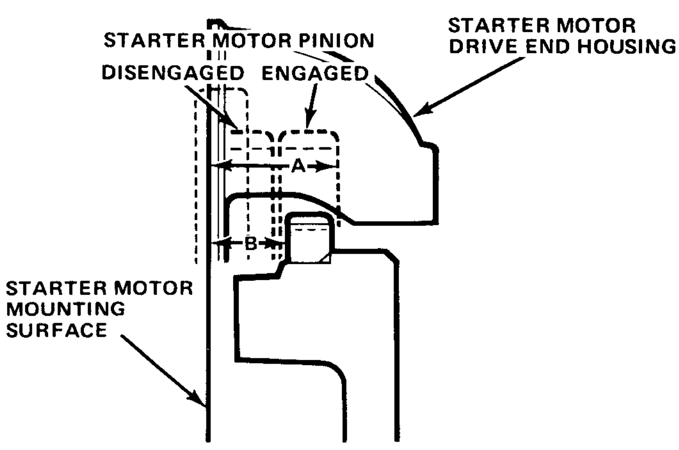
NOTE: *The entire circumference of the ring gear must be inspected for damage when the teeth of the drive assembly pinion gear are damaged.*

NOTE: *An engine that has repeated starter motor pinion failures should be checked for proper ring gear location (fig. 3-42 and 3-43), missing or improper parts or misaligned bell housing. For wobbling ring gear, the maximum allowable runout is 0.030 inch. Check for broken welds or broken flex plate.*

(9) Check drive assembly clutch by grasping and rotating pinion gear. Gear should rotate freely in one direction and lock up in opposite direction.

(10) Check brush holders for broken springs and insulated brush holders for shorts to ground. Tighten any rivets that may be loose. Replace brushes if worn to 1/4 inch or less in length.

(11) Check brush spring tension. Replace springs if tension is not within specified limits (40 ounces minimum).



ENGINE	FLYWHEEL (INCHES)			
	A		B	
6 CYLINDER	1.2465 TO 1.2060	1 - 1/4 TO 1 - 13/64	0.8365 TO 0.7660	27/32 TO 49/64
V-8	1.2465 TO 1.2035	1 - 1/4 TO 1 - 13/64	0.8365 TO 0.7635	27/32 TO 49/64

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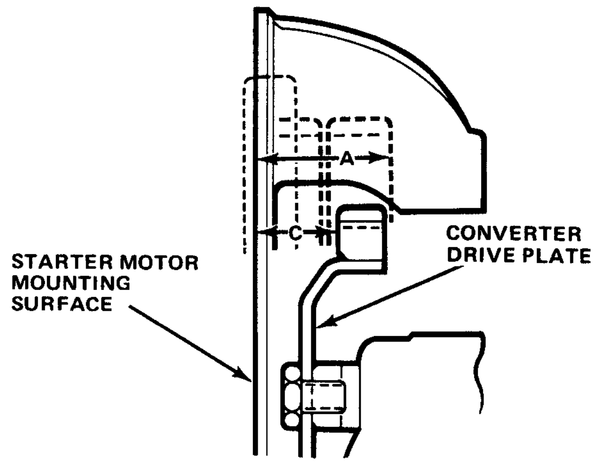
Fig. 3-42 Ring Gear Location—Manual Transmission



ENGINE	DRIVE PLATE (INCHES)			
	A		C	
6 CYLINDER	1.2465 TO 1.2060	1 - 1/4 TO 1 - 13/64	0.8305 TO 0.7700	53/64 TO 49/64
V-8	1.2465 TO 1.2035	1 - 1/4 TO 1 - 13/64	0.8305 TO 0.7675	53/64 TO 49/64

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Fig. 3-43 Ring Gear Location—Automatic Transmission

(12) Inspect field coils for burned or broken insulation and for broken and loose connections. Check field brush connections and lead insulation.

COMPONENT TESTING AND REPLACEMENT

Field Ground Circuit Test (On Test Bench)

This test will determine if the field winding insulation has failed, permitting a conductor to touch the frame.

(1) Place insulated brushes aside so that brushes do not touch any part of starter.

(2) Remove screw that attaches solenoid point assembly brush lead to frame.

NOTE: *Do not allow ground brush to contact starter.*

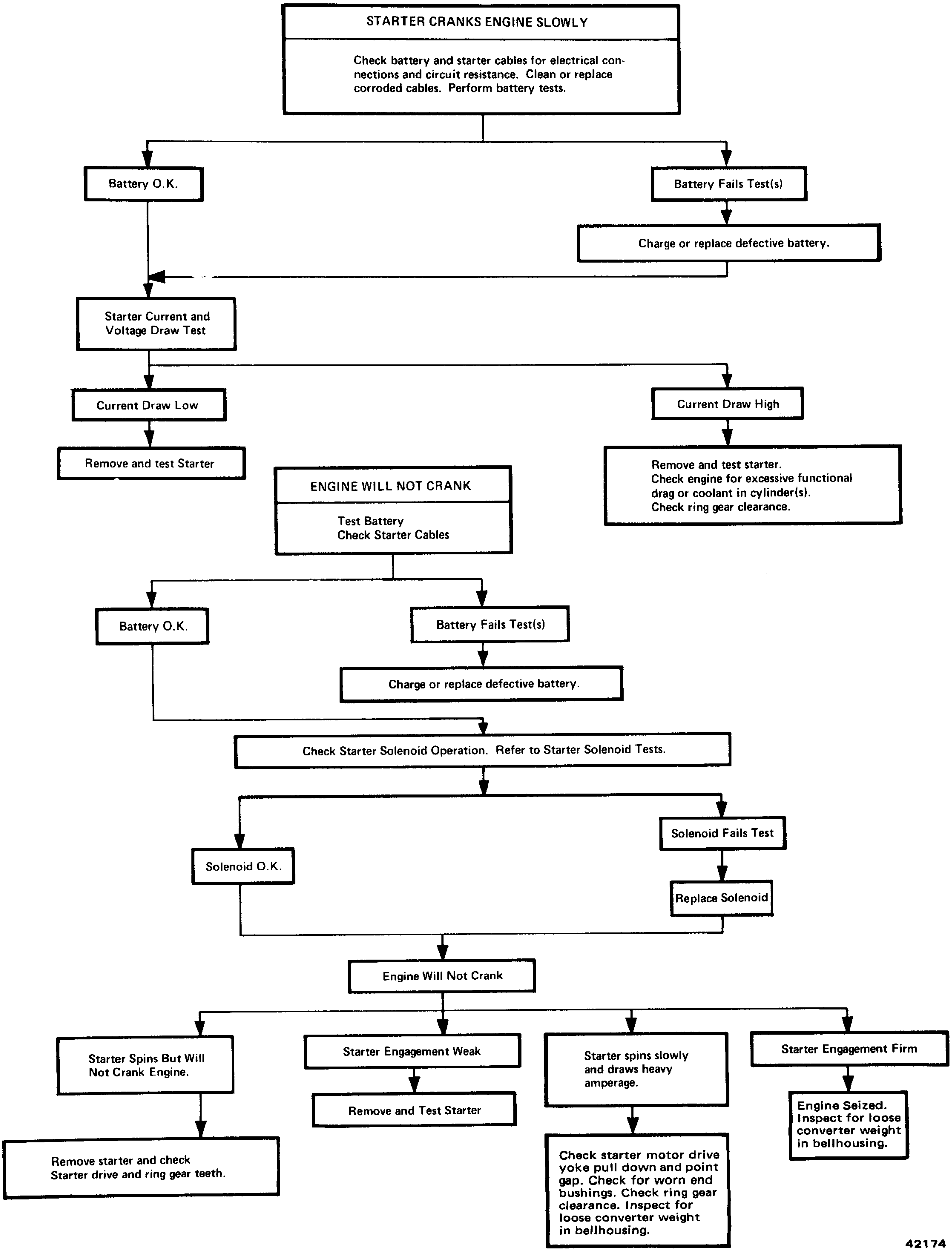
(3) Insert a piece of paper between solenoid points. Starter is now ready for testing (fig. 3-44).

(4) Connect one test prod to terminal screw and the other prod to starter frame. Test lamp should not light. If lamp lights, field windings are shorted and must be replaced.

NOTE: *Check for a loose rivet on solenoid point assembly which could also cause a short to ground.*

(5) Touch one prod to terminal and the other prod to brushes (not single ground brush). Test lamp should light. If lamp does not light, check for poor or broken connections.

Starter Motor Diagnosis Guide



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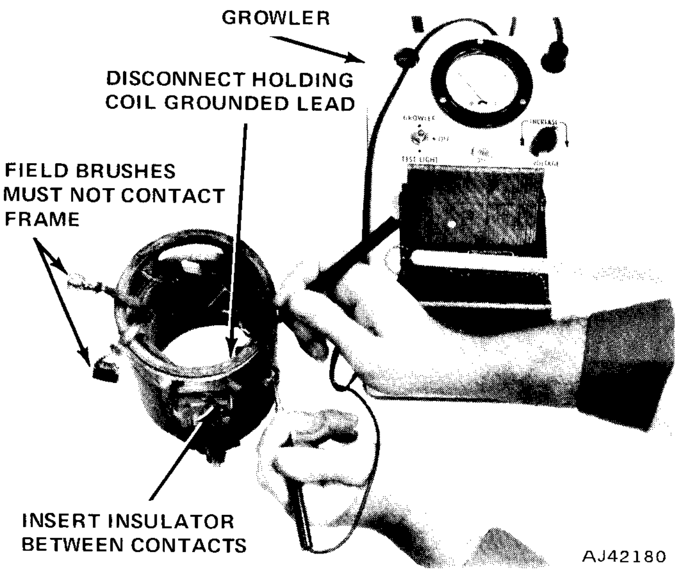

Fig. 3-44 Field Grounded Circuit Test

Field Coil Replacement

(1) Remove retaining screw and ground brushes from starter frame.

(2) Straighten tabs of solenoid coil retaining sleeve and remove sleeve.

(3) Remove three field coil retaining screws using Tool J-22516 and an arbor press.

(4) Unsolder field coil leads at terminal screw and at solenoid connection.

NOTE: *A considerable amount of heat is required to unsolder the leads. A heavy-duty soldering iron or a propane torch with a small flame is recommended.*

(5) Remove field coils and pole shoes from starter frame.

(6) Cut insulated brush leads as close to field coil connection as possible.

NOTE: *The solenoid point assembly need not be removed unless defective.*

(7) Solder new insulated brush lead clip to field coil connecting strap (use rosin core solder).

(8) Position field coils in starter frame, install retaining screws and tighten securely using Tool J-22516 and an arbor press.

(9) Solder field coil leads to starter terminal screw and solenoid connection (use rosin core solder).

(10) Install lower ground brush lead as close to threaded terminal block as possible.

(11) Place unthreaded terminal of replacement ground brush under threaded terminal of solenoid ground lead and install longer retaining screw contained in the brush kit.

(12) Install solenoid coil retaining sleeve and bend tabs to properly secure coil.

Solenoid Contact Assembly Replacement

To replace the contact assembly with the replacement kit, proceed as follows. Refer to figure 3-45 for parts identification.

(1) Unsolder contact post from field coil connecting strap.

NOTE: *A considerable amount of heat is required to unsolder leads. A heavy-duty soldering iron or a propane torch with a small flame is recommended.*

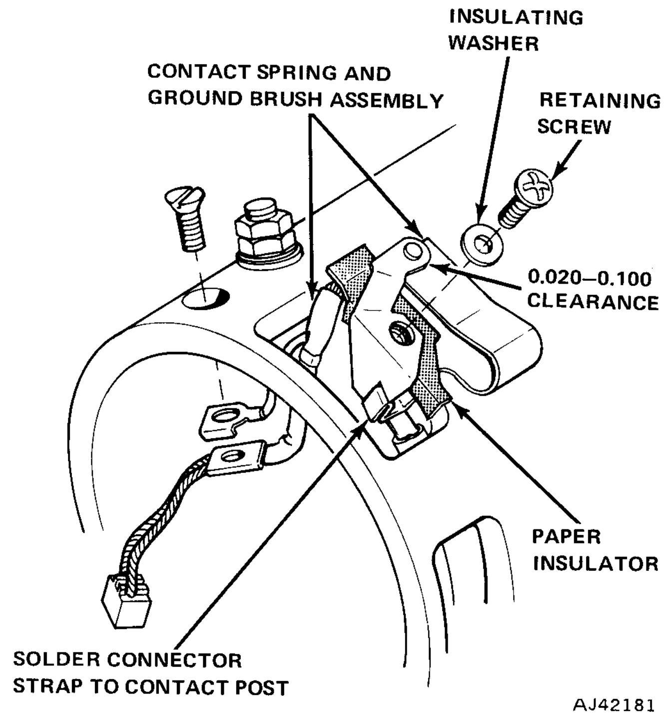

Fig. 3-45 Starter Motor Contact Kit

(2) Cut off head of contact spring retaining rivet with small, sharp chisel and discard contact spring. Use an 8-32 thread tap to cut threads in rivet hole.

(3) Remove contact post retaining screw and insulating washer. Discard contact post and paper insulator.

(4) Place new contact spring and ground brush assembly, paper insulator, and contact post into position on starter frame.

(5) Install insulating washer and retaining screw. Center contact points and tighten retaining screw.

(6) Stake threaded end of screw from inside starter frame.

(7) Clean end of field connecting strap and slotted area of contact post with fine sandpaper to ensure good solder joint.

(8) Insert end of field connector strap through slot of contact post. Bend and crimp end of connector strap against cleaned surface of contact post.

(9) Solder connection using rosin core solder.

(10) Remove upper ground brush retaining screw and discard brush.

(11) Place field ground lead terminal and new ground brush terminal block together and install original retaining screw.

(12) Install armature and drive assembly, drive yoke and drive yoke pivot pin. Apply a few drops of 10W-30 motor oil to both ends of armature.

(13) Slide stop ring retainer into place on armature shaft.

(14) Position drive yoke return spring in drive end housing and install housing to starter frame.

(15) Install end plate.

(16) Install through-bolts and tighten.

(17) Insert brushes into their holders.

(18) Press down firmly on starter drive yoke until movable pole shoe is bottomed and check clearance between new contact points. Bend upper contact post, if required, to obtain a minimum 0.020-inch to a maximum 0.100-inch clearance (0.508 to 2.54mm).

(19) Install a protective tape over brush openings of starter frame.

(20) Install drive yoke cover, gasket, and brush cover band.

(21) Tighten brush cover band retaining screw.

Armature Test Procedure

The armature should be tested for grounds, shorts, and balance whenever the starter motor is overhauled. Follow the test equipment manufacturer's procedure or the following.

Ground Test

(1) Place armature in growler jaws.

(2) Turn power switch to test position.

(3) Touch one test lead to armature core and other lead to each commutator bar one at a time and observe the test lamp. Test lamp should not glow. If test lamp glows on any bar, armature is grounded and must be replaced (fig. 3-46).

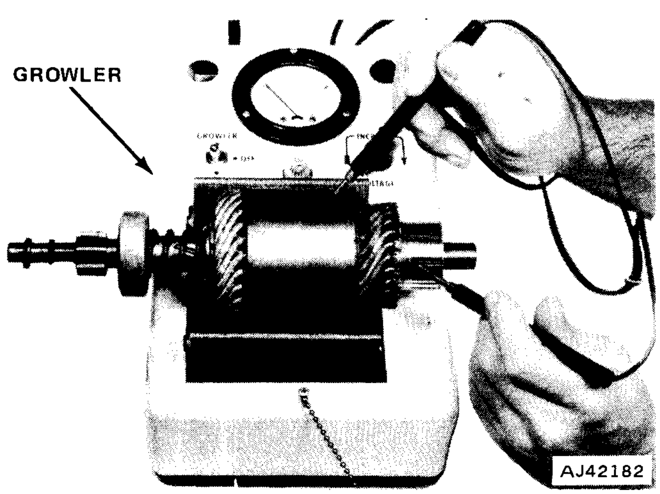

Fig. 3-46 Armature Ground Test

Short Test

CAUTION: *Never operate the growler in the test position without an armature in the jaws.*

(1) Place armature in growler jaws.

(2) Turn power switch to growler position.

(3) Using steel blade, hold blade parallel with and touching armature core. Slowly rotate armature one or more revolutions in growler jaws. If steel blade vibrates on any position of core, area is shorted and armature must be replaced (fig. 3-47).

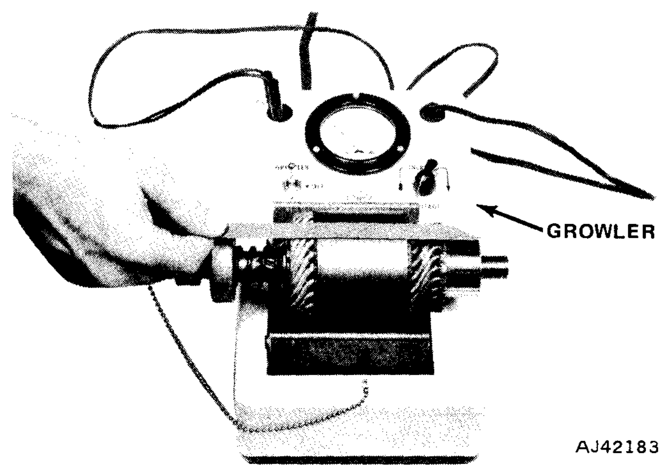

Fig. 3-47 Armature Short Test

Balance Test

(1) Place armature in growler jaws.

(2) Turn power switch to growler position.

(3) Place contact fingers of meter test cable across adjacent commutator bars at side of commutator.

(4) Adjust voltage control until needle is at highest reading on scale.

(5) Test each commutator bar with adjacent bar until all bars have been checked. A reading of zero indicates an open circuit in that particular pair (fig. 3-48).

Assembly

Refer to figure 3-41 for parts identification.

Bushing Replacement

Drive End

(1) Support drive end housing.

(2) Drive out seal from the inside of the housing.

(3) Drive out original bushing from housing after the seal has been removed.

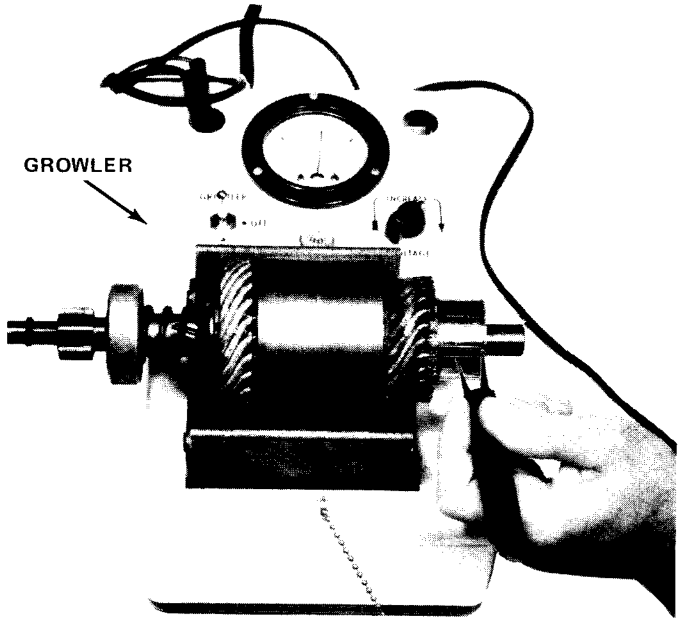

Fig. 3-48 Armature Balance Test

(4) Install new bushing using a suitable tool.

NOTE: *Do not install drive end housing seal at this time.*

Commutator End

(5) Remove old bushing by threading through bushing cavity with suitable size tap.

(6) Secure tap in vise and separate end frame from bushing.

(7) Press new bushing into place using suitable bushing installer.

Drive Assembly Replacement

(1) Pry stop ring off and remove starter drive from armature shaft.

NOTE: *The service replacement drive assembly is prelubricated. Apply a few drops of 10W-30 motor oil to the armature shaft and end bushings.*

(2) Apply thin coating of Dow Corning 33 Silicone Lubricant (or equivalent) on armature shaft splines.

(3) When installing drive assembly, check snap ring for tight fit on shaft. Slide drive assembly over shaft and install stop ring and original retainer.

Drive End, Armature, End Plate Installation

(1) Position fiber thrust washer on commutator end of armature shaft.

(2) Apply a few drops of 10W-30 motor oil to both bearing surfaces of shaft.

(3) Insert armature into starter frame and install starter drive yoke and pivot pin.

NOTE: *The drive yoke must engage the starter drive assembly.*

(4) All brushes should be out of their retainers and hanging outside of the starter frame before installing the armature.

(5) Place starter drive yoke return spring into recess of drive end housing and install housing to starter frame.

(6) Install brush end plate with end plate boss aligned with starter frame slot.

(7) Install through-bolts and tighten.

NOTE: *Be sure snap ring retainer is properly seated in drive end housing.*

(8) Use hook to pull back on brush springs and insert brushes into holders.

(9) Cover brush openings with waterproof tape and install drive yoke cover and gasket.

(10) Install brush cover band and tighten retaining screw.

(11) Apply a generous amount of Lubriplate to drive end of armature shaft and install drive end housing seal using a socket or other suitable tool. Dent seal slightly in center to expand it.

(12) Connect starter to battery and check operation (refer to No-Load Test in this section).

STARTER SOLENOID TEST (ON VEHICLE)

Engine Will Not Crank

(1) Verify battery and cable conditions as outlined under Battery Maintenance to assure correct cranking voltage.

(2) Inspect and tighten battery and starter cable connections at starter relay.

(3) Disconnect wire at solenoid S-terminal.

CAUTION: *Place transmission in Neutral or Park position and apply parking brake prior to conducting solenoid test.*

(4) Connect jumper wire from battery positive post to solenoid S-terminal. If engine cranks, solenoid is not defective.

(5) If engine does not crank, connect another jumper wire from battery negative terminal to solenoid mount bracket. Be sure a good connection is made. If solenoid now can be made to operate, relay was not properly grounded. Remove rust or corrosion and attach solenoid to fender with cadimum-plated screws.

(6) If engine does not crank, remove two jumper wires and connect a heavy jumper cable between battery and starter motor terminals of solenoid. If engine cranks, solenoid is defective and must be replaced.

(7) If engine does not crank, solenoid is not defective. Check starter motor.

STARTER CABLE TEST (VOLTAGE DROP)

General

The starter cable tests will determine if there is excessive resistance in the circuit (fig. 3-49). When performing these tests, it is important that the voltmeter be connected to the terminals that the cables are connected to instead of to just the cables. For example, when checking from the battery to the solenoid, the voltmeter probes must be touching the battery post and the solenoid threaded stud.

Before performing tests:

(1) Remove coil secondary wire from distributor and ground coil wire.

(2) Place transmission in Neutral or Park and apply parking brake.

(3) Be sure battery is fully charged.

Battery to Starter Motor Voltage Drop Tests (V-1, fig. 3-49)

(1) Connect voltmeter positive lead to battery positive post.

(2) Connect voltmeter negative lead to starter motor terminal.

(3) Crank engine and note voltmeter reading while cranking (V-1). Reading should be 0.5 volt or less. If reading is more than 0.5 volt, move test lead to starter cable at the starter and retest. If voltage reading is 0.5 or less, remove cable from starter and clean connections. If reading is more than 0.5 volt, perform tests on each cable and the solenoid to locate problem area.

Battery-to-Solenoid Voltage Drop Tests (V-2, fig. 3-49)

(1) Connect voltmeter positive lead to battery positive post.

(2) Connect voltmeter negative lead to battery terminal (threaded stud) of solenoid.

(3) Crank engine and note voltmeter reading while cranking. Reading should be 0.2 volt or less. If reading is above 0.2 volts, remove cable, clean connections, and retest. If reading is still above 0.2 volt, replace cable.

Solenoid Voltage Drop Test (V-3, fig. 3-49)

(1) Connect voltmeter positive lead to battery positive post.

(2) Connect voltmeter negative lead to starter cable at solenoid.

(3) Crank engine and note voltmeter reading while cranking. Reading should be less than 0.3 volt.

(4) If reading is over 0.3 volt, move voltmeter connections from cable connections to solenoid starter terminal and retest. If voltage drop is now 0.3 or less, remove cables and clean connections. If voltage drop is still in excess of 0.3 volt, replace solenoid.

(5) If battery to starter circuit voltage drop was more than 0.5 volt but battery through solenoid voltage drop is 0.3 volt or less, replace solenoid to starter cable.

Starter Motor Ground Voltage Drop Test (V-4, Fig. 3-49)

(1) Connect voltmeter negative lead to starter motor housing.

(2) Connect voltmeter positive lead to battery negative post.

(3) Crank engine and note voltmeter reading while cranking. Reading should be 0.2 volt or less.

(4) If reading is more than 0.2 volt, move positive voltmeter lead to ground cable attaching bolt at engine and retest.

(5) If voltmeter is less than 0.2 volt when checking at battery ground cable, check starter motor for loose mounting bolts, corrosion, or dirt on the mounting surface.

(6) If voltage drop is more than 0.2 volt when checking at ground cable, connect voltmeter leads to ground cable leads and retest.

(7) If voltage drop is now less than 0.2 volt, clean connections between engine block and cable. If voltage drop is more than 0.2 volt, move voltmeter negative lead to battery negative post clamp and retest. If more than 0.1 volt, clean terminals. If 0.1 volt or less, replace ground cable.

Starter Motor Solenoid Pull-In Winding Test

This test determines if solenoid pull-in winding is shorted or open.

(1) Remove S-terminal wire from solenoid.

(2) Connect one ohmmeter lead to S-terminal.

(3) Connect remaining ohmmeter lead to solenoid case or mounting bracket—ohmmeter should indicate 3 to 5 ohms. If solenoid is not within these limits, replace solenoid.

NOTE: *A poor solenoid ground can be determined by moving one ohmmeter lead to the battery negative terminal. If an increase in resistance is shown, the solenoid has a poor ground.*

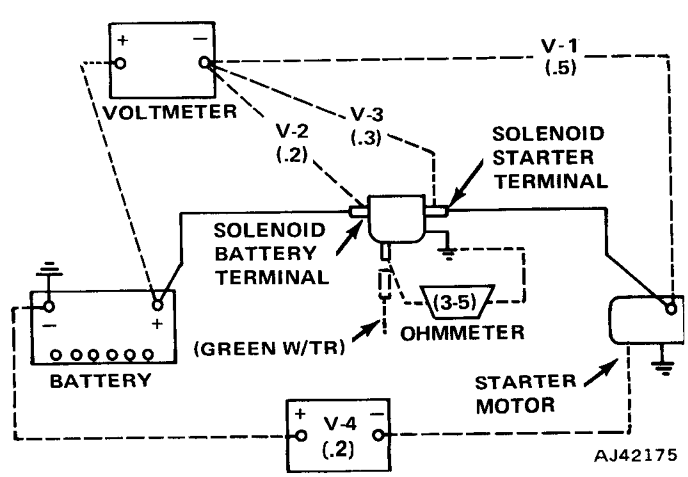

Fig. 3-49 Starter Cranking Circuit Test

IGNITION SYSTEM

GENERAL

The ignition spark must occur at the correct time and with sufficient intensity to ignite the compressed fuel-air mixture. All components of the ignition system must function properly for satisfactory and economical operation.

The coil must be able to transform the low primary voltage to a secondary voltage high enough to supply sufficient spark for all conditions of load and speed. The ignition distributor must perform two functions. It must distribute the high tension secondary voltage to the spark plugs in proper sequence. It must also give the electronic control unit a signal to operate the coil primary so the coil can fire the spark at just the right instant for the engine to develop full power.

At high speeds, the spark must occur at the plug earlier in the compression stroke in order to give the fuel-air mixture ample time to ignite, burn, and apply its power to the piston as it starts down on the power stroke. Spark timing must vary in relation to changes in engine speed. This is accomplished by the centrifugal advance mechanism of the distributor.

During part throttle operation or cruising speed, the fuel mixture is drawn into the cylinder through a restricted opening in the carburetor and is less dense. The less dense mixture will burn slower and additional advance is necessary for maximum economy. This additional advance is furnished by the vacuum advance unit and operates in relation to throttle position and engine load. The vacuum advance unit is controlled by carburetor ported vacuum. The centrifugal advance will advance engine timing with increases in engine speed.

IGNITION SYSTEM DIAGNOSIS

To determine an ignition system fault other than spark knock, refer to Ignition System Diagnosis Guide.

Engine Spark Knock (Ping)

Spark knock in some engines can be attributed to a number of causes. The most common is the intermittent spark knock which is a result of climatic factors such as temperature, air density, and humidity.

- Underhood temperatures are increased by the use of air conditioning (especially during long periods of idling), overloading (trailer pulling, operating in too high a gear), and the installation of accessories that restrict airflow.
- Air density increases as barometric pressure rises and as temperature drops. A dense mixture of air and fuel drawn into the cylinder has the same effect as raising the compression ratio which in turn increases the possibility of spark knock.
- Low humidity also increases the tendency to spark knock. High humidity decreases spark knock.

Other Causes of Spark Knock

- **Fuel Octane Rating**—All engines are designed to operate on unleaded fuels. (The required octane rating varies with each model year vehicle.) Fuels of equivalent research octane rating may vary in their knocking characteristics in a given engine. It may be necessary to reduce initial timing (not more than 2 degrees from specifications) or select an alternate source of fuel.
- **Ignition Timing**—Ignition timing should be checked to be sure it is set within specifications.

NOTE: *The white paint mark on the timing degree scale represents the specified spark setting at idle speed, not TDC (Top Dead Center).*

- **Combustion Chamber Deposits** — An excessive buildup of deposits in the combustion chamber may be caused by not using recommended fuels and lubricants, prolonged engine idling, or continuous low speed operation. The occasional use of Carburetor and Combustion Area Cleaner, Part Number 8992352 or its equivalent (Group 15.410), or operating the car at turnpike speeds will reduce these deposits.
- **Distributor Advance Mechanism**—The centrifugal and vacuum advance units should be checked to be sure they are operating freely.

Ignition System Diagnosis Guide

Condition	Possible Cause	Correction
MOMENTARY INTERRUPTION OF IGNITION	(1) Excessive resistance in ignition feed circuit.	(1) Perform checks outlined in Ignition System Tests. Repair as needed.
	(2) Excessive resistance in coil primary circuit.	(2) Perform checks outlined in Ignition System Tests. Repair as needed.
	(3) Excessive resistance in coil secondary circuit.	(3) Perform checks outlined in Ignition System Tests. Repair as needed.
	(4) Excessive resistance in sensor circuit.	(4) Perform checks outlined in Ignition System Tests. Replace sensor and modify connector terminals as needed.
	(5) Electronic Control Unit Faulty.	(5) Replace ECU and modify connector terminals as outlined in Ignition System Tests.
ENGINE FAILS TO START (NO SPARK AT PLUGS)	(1) No voltage to ignition system.	(1) Check battery, ignition switch and wiring. Repair as needed.
	(2) Electronic Control Unit ground lead open, loose or corroded.	(2) Clean, tighten, or repair as needed.
	(3) Excessive resistance in primary ignition circuit.	(3) Perform checks as outlined in Ignition System Tests. Repair as needed.
	(4) Ignition coil open or shorted.	(4) Test coil. Replace if faulty.
	(5) Electronic Control Unit Faulty.	(5) Replace Electronic Control Unit and modify connector terminals as outlined in Ignition System Tests.
	(6) Control Unit 4-wire connector corroded or loose.	(6) Clean with Jeep fabric cleaner and modify connector terminals as outlined in Ignition System Tests.
	(7) Faulty sensor.	(7) Check resistance of sensor circuit as outlined in Ignition System Tests. Replace if faulty.
ENGINE BACKFIRES BUT FAILS TO START	(1) Incorrect ignition timing.	(1) Check timing. Adjust as needed.
	(2) Moisture in distributor cap.	(2) Dry cap and rotor.

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Ignition System Diagnosis Guide (Continued)

Condition	Possible Cause	Correction
ENGINE BACKFIRES BUT FAILS TO START (Continued)	(3) Distributor cap faulty (shorting out).	(3) Check cap for loose terminals, cracks and dirt. Clean or replace as needed.
	(4) Wires not in correct firing order.	(4) Connect wires in proper firing order.
ENGINE DOES NOT OPERATE SMOOTHLY AND/OR ENGINE MISFIRES AT HIGH SPEED	(1) Spark plugs fouled or faulty.	(1) Clean and regap plugs. Replace if needed.
	(2) Spark plug cables faulty.	(2) Check cables. Replace if needed.
	(3) Spark advances system(s) faulty.	(3) Check operation of advance system(s). Repair as needed.
EXCESSIVE FUEL CONSUMPTION	(1) Incorrect ignition timing.	(1) Check timing. Adjust as needed. Refer to Section 4A.
	(2) Spark advance system(s) faulty.	(2) Check operation of advance system(s). Repair as needed.
ERRATIC TIMING ADVANCE	(1) Faulty vacuum advance assembly.	(1) Check operation of advance diaphragm and replace if needed.
	(2) Misadjusted, weak or damaged mechanical advance springs.	(2) Readjust or replace springs as needed.
BASIC TIMING NOT AFFECTED WHEN VACUUM HOSE IS DISCONNECTED	(1) Vacuum hose(s) leaking.	(1) Inspect hose and replace if needed.
	(2) Improper hose connections at spark CTO switch.	(2) Correct connections at spark CTO. Refer to Section 4A.
	(3) Faulty vacuum advance unit.	(3) Check operation of advance diaphragm and replace if needed.
DISTRIBUTOR CAP BLOWS OFF	(1) Housing not vented.	(1) Open blocked holes in nose of distributor or drill new holes (1/8 inch).

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- **Exhaust Manifold Heat Valve** — The exhaust manifold heat valve should be checked for free operation. If it sticks in the closed position, the intake manifold is heated excessively and ping results.

IGNITION SYSTEM COMPONENTS

The Breakerless Inductive System (BID) Ignition System consists of five major components: an electronic ignition control unit, an ignition coil, a distributor, high tension wires, and spark plugs.

Control Unit

The electronic control unit is a solid-state, moisture-resistant module. The component parts are permanently sealed in a potting material to resist vibration and environmental conditions. All connections are warerproof. The unit has built-in current regulation, reverse polarity protection and transient voltage protection.

Because the control unit has built-in current regulation, there is no resistance wire or ballast resistor used in the primary circuit. Battery voltage is present at the ignition coil positive terminal whenever the ignition key is in the ON or START position; therefore, there is no need for an ignition system bypass during cranking. The primary (low voltage) coil current is electronically regulated by the control unit.

NOTE: *This unit is not repairable and must be serviced as a unit.*

Ignition Coil

The ignition coil is an oil-filled, hermetically-sealed unit (standard construction). Ignition coils do not require special service other than keeping terminals and connections clean and tight. For correct polarity, the coil positive terminal should be connected to the battery ignition feed. The ignition coil has two windings on a soft iron core; the primary winding which consists of a comparatively few turns of heavy wire and the secondary winding which consists of many turns of very fine wire.

The function of the ignition coil in the BID ignition system is to transform battery voltage in the primary winding to a high voltage for the secondary system.

When an ignition coil is suspected of being defective, it should be checked on the car. A coil may break down after it has reached operating temperature; **it is important that the coil be at operating temperature when tests are made.** Perform the tests following the instructions of the Test Equipment Manufacturer.

Distributor

The distributor is conventional except that a sensor and trigger wheel replace the usual contact points, condenser, and distributor cam.

The distributor uses two spark advance systems (mechanical and vacuum) to establish the optimum spark timing setting required for various engine speed and load conditions. The two systems operate independently, yet work together to provide proper spark advance.

The mechanical (centrifugal) advance system is built internally into the distributor and consists of two flyweights which pivot on long-life, low-friction bearings and are controlled by calibrated springs which tend to hold the weights in the no-advance position. The flyweights respond to changes in engine (distributor shaft) speed, and rotate the trigger wheel with respect to the distributor shaft to advance the spark as engine speed increases and retard the spark as engine speed decreases. Mechanical advance characteristics can be adjusted by bending the hardened spring tabs to alter the spring tension.

The vacuum advance system incorporates a vacuum diaphragm unit which moves the distributor sensor in response to the changes in carburetor throttle bore vacuum.

Sensor/Trigger Wheel

The sensor (a component of the distributor) is a small coil, wound of fine wire, which receives an alternating current signal from the electronic control unit.

The sensor develops an electromagnetic field which is used to detect the presence of metal. The sensor detects the edges of the metal in the teeth of the trigger wheel. When a leading edge of a trigger wheel tooth aligns with the center of the sensor coil, a signal is sent to the control unit to open the coil primary circuit.

NOTE: *There are no wearing surfaces between the trigger wheel and sensor, dwell angle remains constant and requires no adjustment. The dwell angle is determined by the control unit and the angle between the trigger wheel teeth.*

OPERATION

With the ignition switch in the START or RUN position, the control unit is activated (fig. 3-50). At this time, an oscillator, contained in the control unit, excites the sensor which is contained in the distributor. When the sensor is excited, it develops an electromagnetic field. As the leading edge of a tooth of the trigger wheel enters the sensor field, the tooth reduces the strength of oscillation in the sensor. As the oscillator strength is reduced to a predetermined level, the demodulator circuit switches. The demodulator switching signal controls a power transistor which is in series with the coil primary circuit. The power transistor switches the coil primary circuit off, thereby inducing the high voltage in the

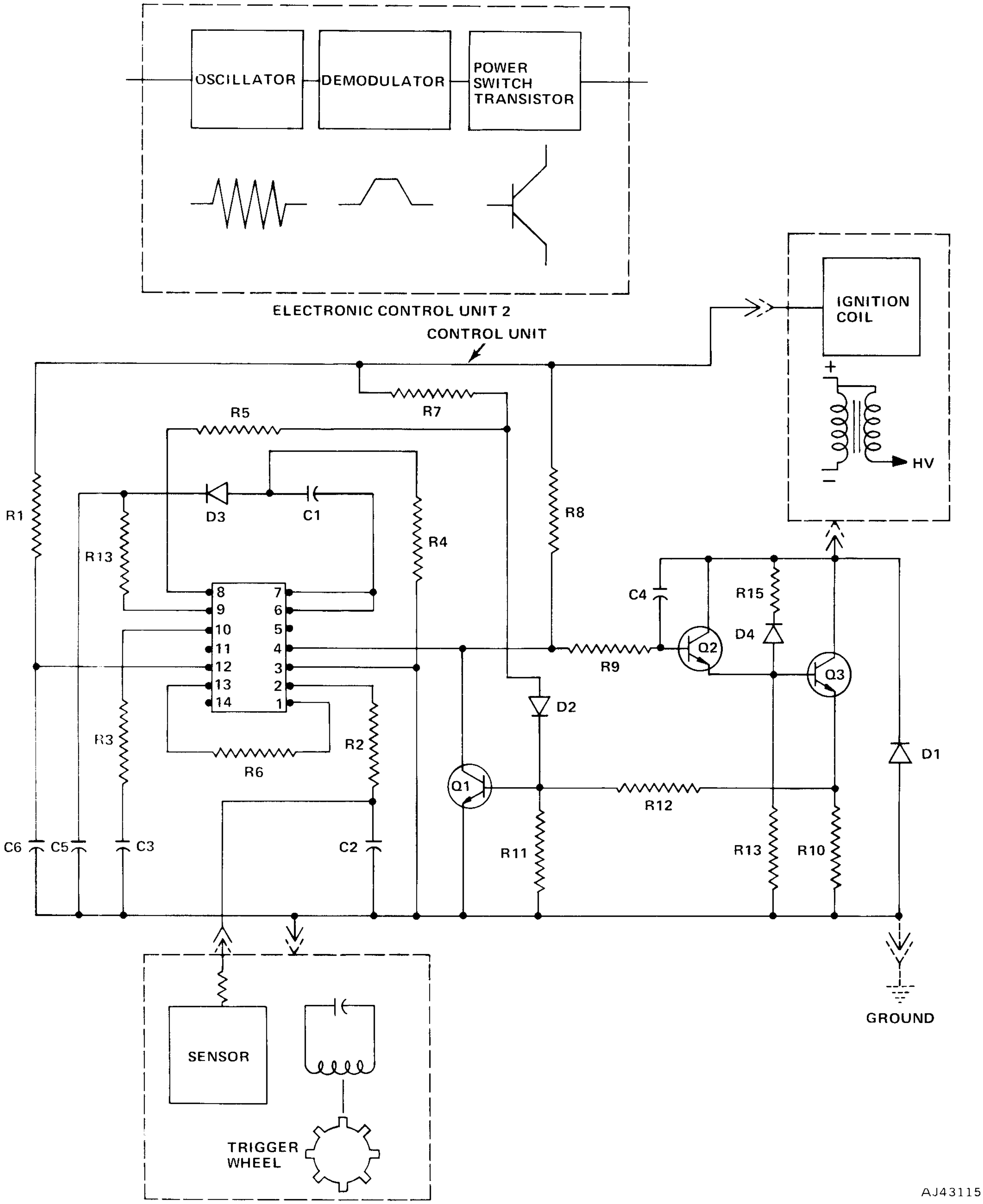


Fig. 3-50 Ignition System Schematic

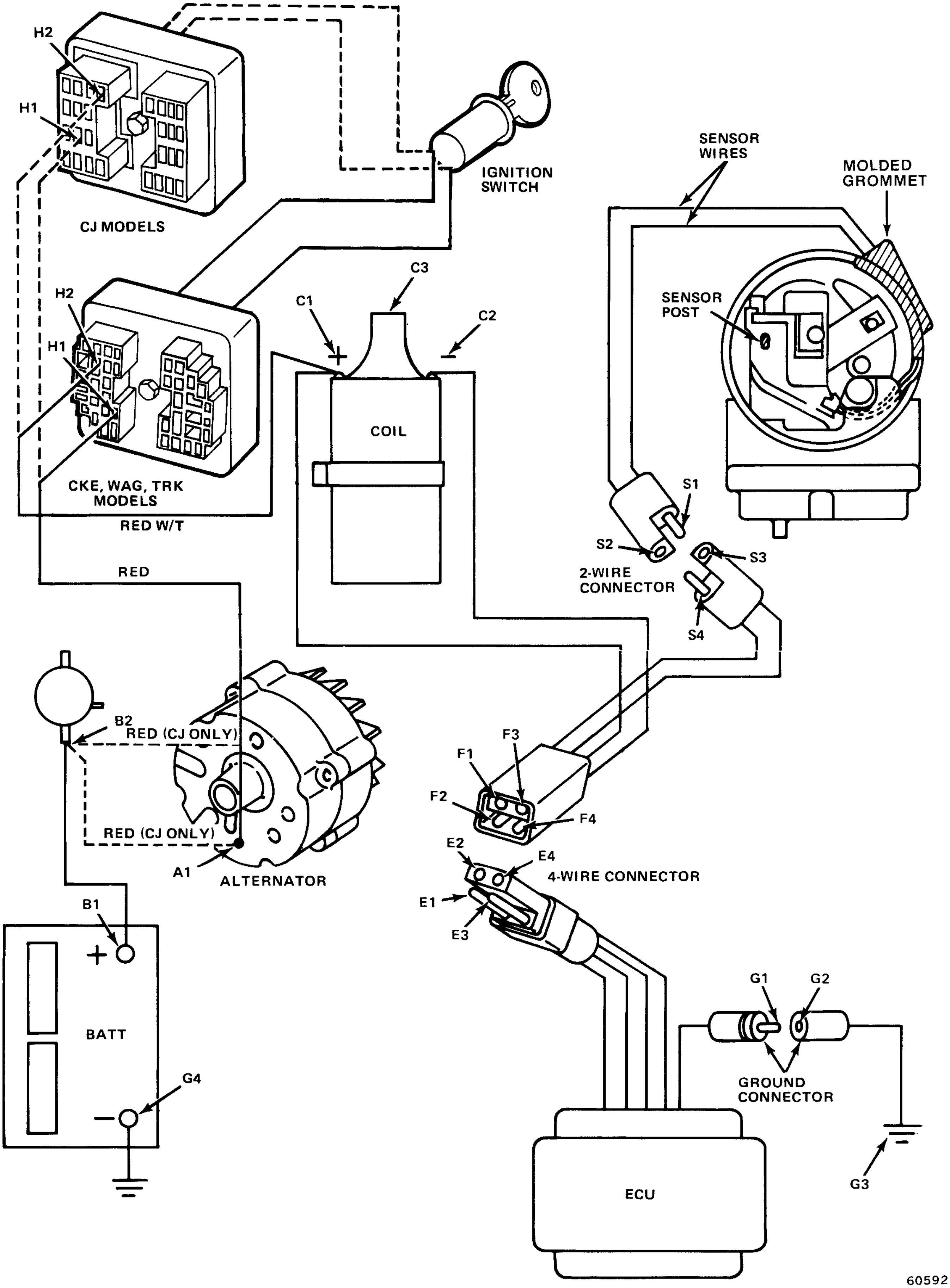


Fig. 3-51 Ignition System Tests

coil secondary winding. High voltage is then distributed to the spark plugs by the distributor cap, rotor, and ignition wires.

TROUBLESHOOTING

Ignition System Test

The following tools and materials are required for testing.

- Electronic Ignition Pulse Simulator J-25331
- Ohmmeter
- Small wire brush
- Jeep Fabric Cleaner, Part Number 8990968
- Petroleum jelly

(1) Disconnect Electronic Control Unit (ECU) ground and 4-wire connectors. Use small wire brush and fabric cleaner to clean and rinse terminals identified E1, E2, E3, E4, F1, F2, F3, F4, G1 and G2 in figure 3-51. Do not connect 4-wire and ground connectors.

(2) Disconnect battery cables from battery (disconnect negative cable first). Move ignition switch to START and hold momentarily before allowing it to return to ON position.

(3) Measure resistance of complete ignition feed circuit by connecting ohmmeter to battery positive cable (B1) and to F3 terminal in 4-wire connector (fig. 3-51).

(a) If resistance is less than 1 ohm, tighten main harness connector attaching screw to fully seat connector.

(b) If resistance is 1 ohm or more, isolate the problem area by connecting the ohmmeter and measuring the resistance of each segment of the ignition feed circuit (fig. 3-51): B1, B2; B2, A1; A1, H1; F3, C1; C1, H2; H1, H2; dash connector. Clean, tighten or reposition circuit connectors if needed. Tighten main harness connector attaching screw to fully seat connector.

(4) Inspect coil primary connections for looseness an proper assembly sequence (fig. 3-52). Wire terminal(s) must be between channel washer and nut. Channel washer tabs must be up. Reposition and tighten if required.

(5) Measure coil primary circuit resistance by connecting ohmmeter to F3 and F4 at 4-wire connector (fig. 3-51).

(a) If resistance is 1 to 2 ohms, proceed to step (6).

(b) If resistance is less than 1 ohm, replace coil and proceed to step (7).

(c) If resistance is more than 2 ohms, isolate problem area by connecting ohmmeter and measuring resistance at each segment (fig. 3-51): C1, C2—1 to 2 ohms; F3, C1—0 ohm; F4, C2—0 ohm. Replace coil or repair segment as needed and proceed to step (6). If coil was replaced, proceed to step (7).

(6) Measure coil secondary resistance by removing coil secondary wire from coil and connecting ohmmeter to coil positive terminal and coil secondary terminal (C1 and C3; fig. 3-51).

NOTE: *Be sure to recalibrate ohmmeter to 1,000 ohm scale before testing secondary resistance.*

(a) If resistance is 9,000 to 15,000 ohms, install coil secondary wire into coil and proceed to step (7).

(b) If resistance is less than 9,000 ohms or more than 15,000 ohms, replace coil, install coil secondary wire into coil, and proceed to step (7).

(7) Remove distributor cap, rotor and dust cover. Measure sensor circuit resistance and integrity by connecting ohmmeter to F1 and F2 at 4-wire connector (fig. 3-51) and observing ohmmeter while:

- Wiggling, flexing, and lightly pulling sensor wires and 2-wire connector.
- Firmly massaging molded sensor wire grommet at distributor (see shaded area in figure 3-51).
- Applying firm side-to-side pressure to sensor post.

Resistance should be 1.6 to 2.4 ohms. Ohmmeter needle should not waver of fluctuate when the wires, connector, grommet and sensor post are wiggled, pulled, flexed, massaged, and pressed.

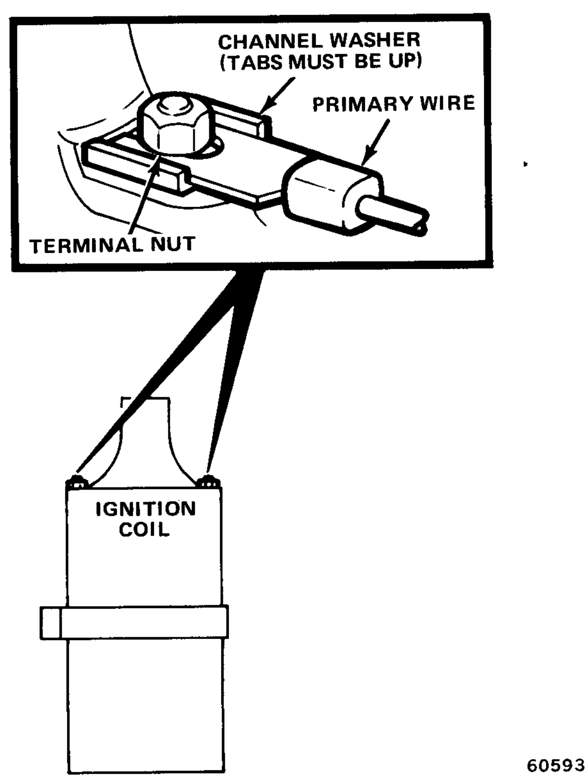


Fig. 3-52 Coil Primary Connections

(a) If resistance is 1.6 to 2.4 ohms and steady, disconnect 2-wire connector and proceed to step (9).

(b) If resistance is too high or too low, or if needle wavers or fluctuates, proceed to step (8).

(8) Disconnect 2-wire connector. Measure sensor resistance and integrity by connecting ohmmeter to S1 and S2 (fig. 3-51) and observing ohmmeter while:

- Wiggling, pulling, and flexing sensor wires.
- Firmly massaging molded sensor wire grommet at distributor (see shaded area in figure 3-51).
- Applying firm side-to-side pressure to sensor post.

Ohmmeter should indicate 1.6 to 2.4 ohms. Ohmmeter needle should not waver or fluctuate when the wires, grommet and sensor post are wiggled, pulled, flexed, massaged, and pressed.

(a) If resistance is 1.6 to 2.4 ohms and steady, proceed to step (9).

(b) If resistance is too high or too low, or if needle wavers or fluctuates, replace sensor and proceed to step (9).

(9) Use small wire brush and fabric cleaner to clean and rinse terminals identified S1, S2, S3, S4 (fig. 3-51). Proceed to step (10).

(10) Measure resistance of ECU ground circuit by connecting ohmmeter to G2 (fig. 3-51) and battery negative cable (G4). Resistance should be 0 ohms. Clean and tighten connections if needed and proceed to step (11).

(11) Before connecting the 4-wire and ground connectors, use pliers to squeeze terminals E1, E2, E3, E4, and G1 until terminals have a distant oval shape. This assures a tight interference fit when connected. Refer to figure 3-53 for desired terminal shape.

(12) Apply a film of petroleum jelly to all male terminals in 4-wire and ground connectors and around outer edge of terminal end of ECU 4-wire connector. Connect 4-wire and ground connectors and proceed to step (13).

(13) Connect Pulse Simulator Tool No. J-25331 to control unit side of 2-wire connector (fig. 3-54). Connect battery cables to battery (connect positive cable first). Remove coil secondary wire from distributor cap, and place wire end 1/2 inch from any good ground (fig. 3-54). With ignition switch ON, operate simulator and observe for spark across 1/2-inch gap.

(a) If spark jumps 1/2-inch gap, proceed to step (15).

(b) If spark does not jump 1/2-inch gap, proceed to step (14).

(14) Disconnect wire from coil negative terminal. Connect one pulse simulator clip to coil negative terminal. Connect remaining clip to ground (fig. 3-55). Place coil secondary wire end 1/2 inch from any good

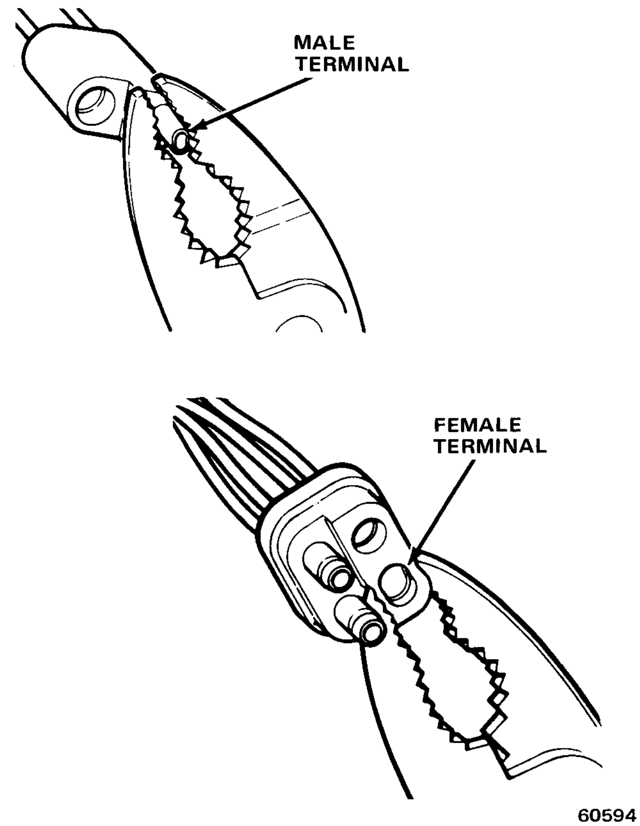


Fig. 3-53 Modifying Connector Terminals

ground. With ignition switch ON, operate pulse simulator and observe for spark across 1/2-inch gap when button is released.

(a) If spark jumps 1/2-inch gap, replace ECU and proceed to step (15).

NOTE: *Be sure to squeeze and lubricate the terminals and connectors of the new ECU as described in steps (11) and (12).*

(b) If spark does not jump 1/2-inch gap, replace coil and proceed to step (15).

(15) Disconnect pulse simulator. Before connecting 2-wire connector, squeeze terminals S1, S2, S3, and S4 until terminals have a distinct oval shape to assure tight interference fit (fig. 3-53). Apply a film of petroleum jelly to male terminals and connect 2-wire connector. Connect coil negative wire. Inspect distributor cap for cracks and carbon tracks and replace if necessary. Install dust cover, rotor, distributor cap and coil secondary wire.

(16) Inspect the catalytic converter for external evidence of overheating (e.g., top and bottom bulged) and replace converter(s) if damaged. Such damage is rare, but can occur as a result of extreme amounts of unburned fuel going into the converter.

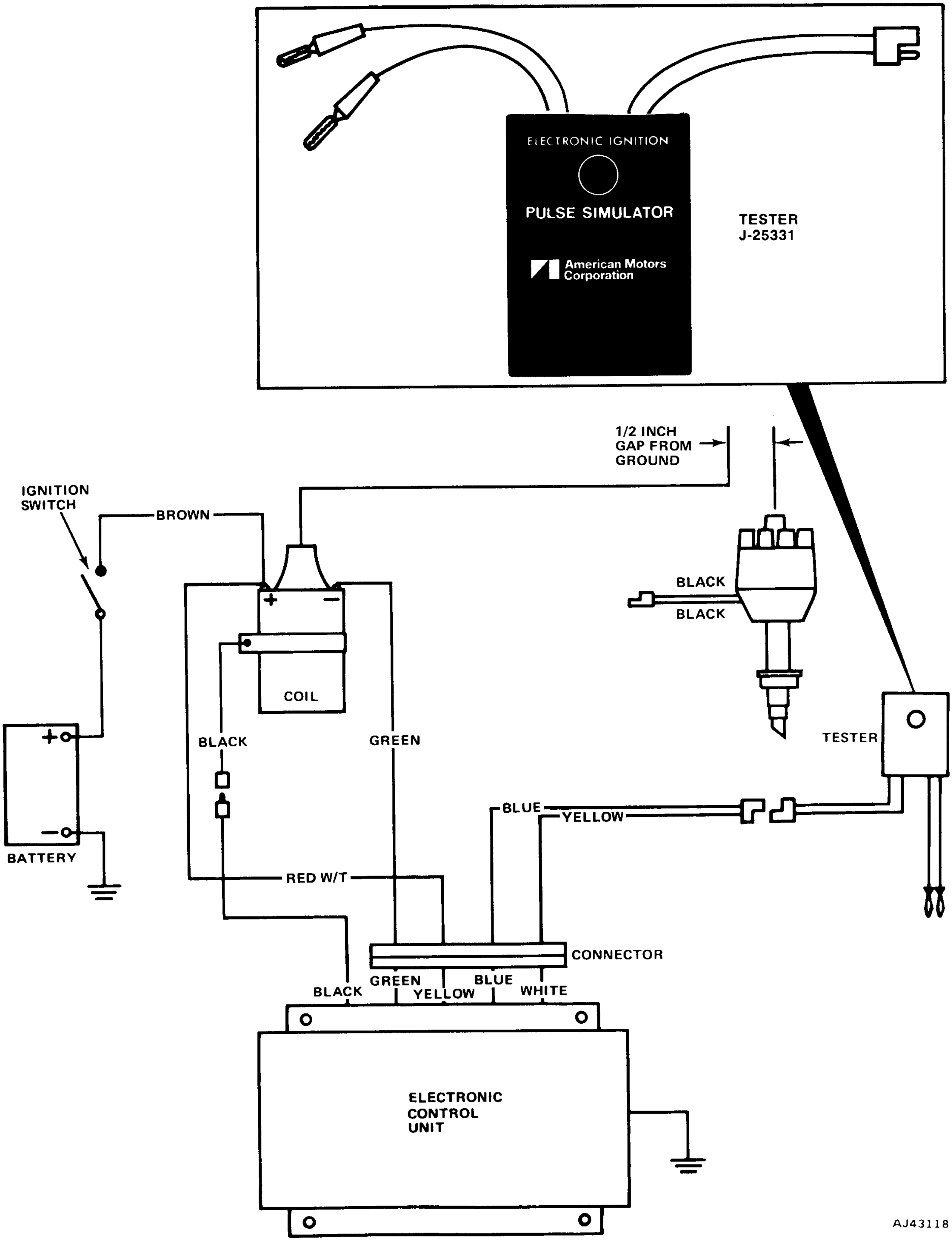


Fig. 3-54 Tester Connected to 2-Wire Connector

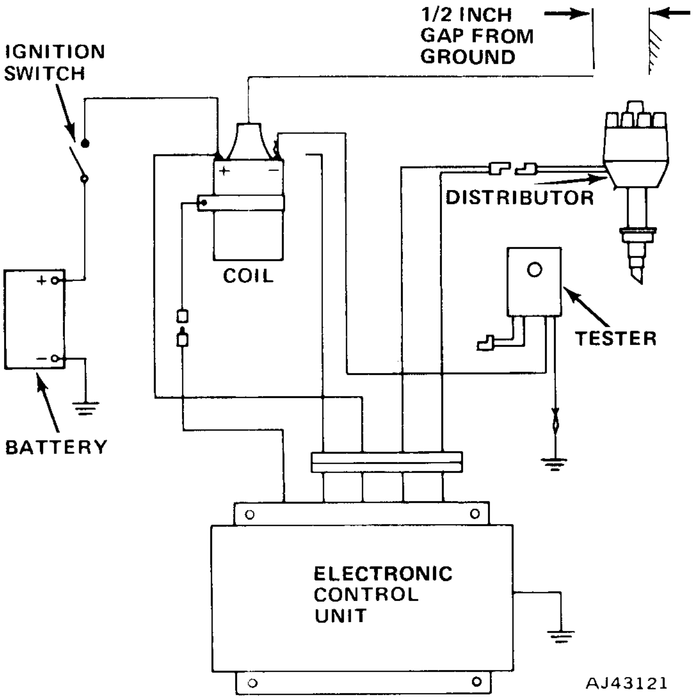


Fig. 3-55 Tester Connected to Coil Negative Terminal

NOTE: *Ignition system should now operate correctly. If an intermittent ignition interruption occurs after this procedure has been performed, disconnect 4-wire connector and measure sensor circuit and integrity (repeat only step (7)). If sensor circuit resistance and integrity are O.K., replace ECU. If sensor circuit resistance is too high or too low, or if needle fluctuates, replace sensor. Be sure to squeeze and lubricate the terminals and connectors of new ECU or sensor as described in steps (11), (12), and (15).*

DISTRIBUTOR SERVICE

General

When replacing the sensor or vacuum chamber on six-cylinder and V-8 engines, the distributor may be removed from the engine or remain installed.

Test Equipment

The following equipment is required to perform proper distributor service:

- Small Gear Puller
- Sensor Locking Screw Removal Tool (Special Driver Bit) J-25097.
- Sensor Positioning Gauge
- 0.050 Gauge Wire.

Removal—Six-Cylinder and V-8

(1) Unfasten distributor cap retaining clips. Remove distributor cap with high tension cables and position it out of the way.

(2) Disconnect vacuum hose from distributor vacuum advance unit.

(3) Disconnect distributor primary wiring connector.

(4) Scribe a mark on distributor housing in line with tip of rotor (fig. 3-56) and note position of rotor and distributor housing in relation to surrounding engine parts as reference points for installing distributor.

(5) Remove distributor holddown bolt and clamp.

(6) Withdraw distributor carefully from engine.

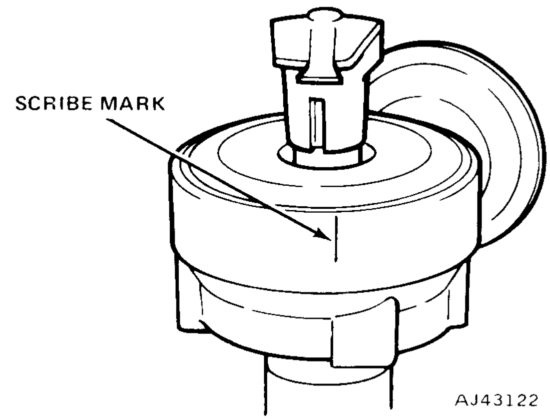


Fig. 3-56 Rotor Position Reference Mark

Component Replacement

(1) Place distributor in suitable holding device.

(2) Remove rotor and dust shield (fig. 3-57).

(3) Remove trigger wheel using a small gear puller (fig. 3-58). Be sure the puller jaws are gripping the inner shoulder of the trigger wheel or the trigger wheel may be damaged during removal. Use a thick flat washer or nut as a spacer. Do not press against the small center shaft.

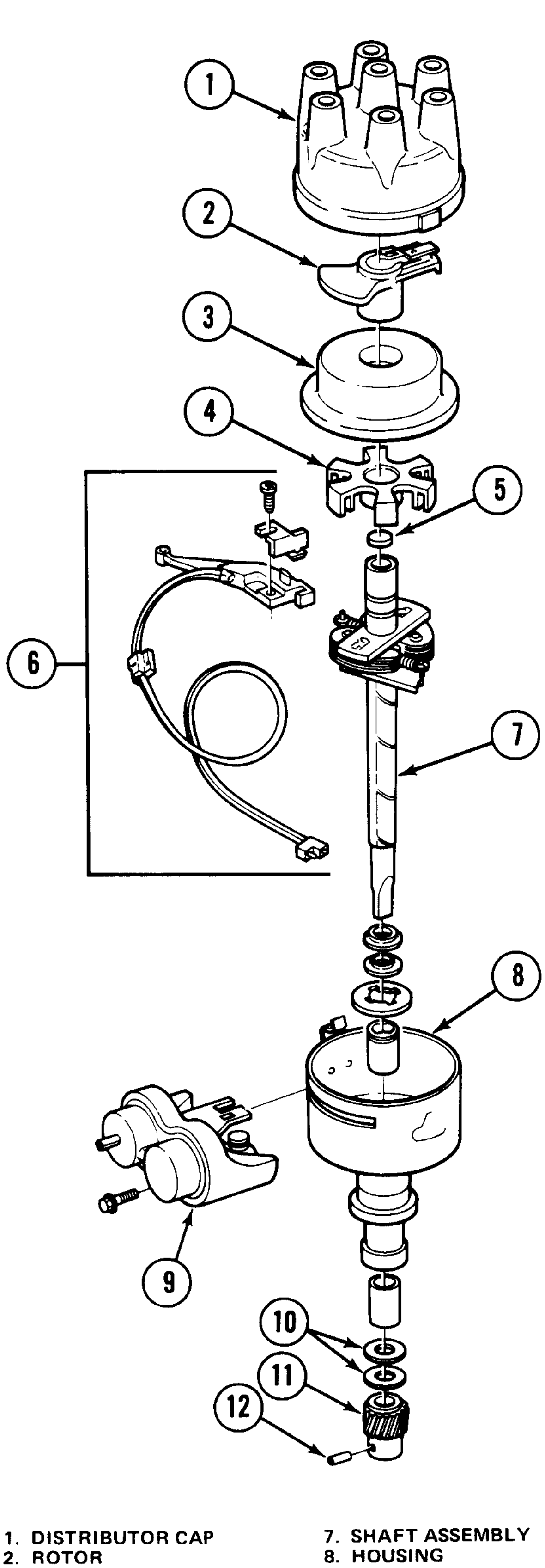
(4) Loosen sensor locking screw about three turns.

NOTE: *The sensor locking screw has a tamper proof head design which requires Special Driver Bit Tool J-25097. If a driver bit is not available, use small needlenose pliers to remove screw. The service sensor has a standard slotted head screw.*

Lift the sensor lead grommet out of the distributor bowl. Pull sensor leads out of the slot around sensor spring pivot pin (fig. 3-59). Lift and release sensor spring, making sure it clears the leads, then slide the sensor off bracket.

(5) If the vacuum chamber is to be replaced, remove the retaining screw and slide the vacuum chamber out of the distributor. **DO NOT** remove the vacuum chamber unless replacement is required.

(6) Clean dirt or grease off of the vacuum chamber bracket. Clean and dry sensor and bracket. The material used for sensor and vacuum chamber requires no lubrication.



1. DISTRIBUTOR CAP
2. ROTOR
3. DUST SHIELD
4. TRIGGER WHEEL
5. FELT PAD
6. SENSOR ASSEMBLY
7. SHAFT ASSEMBLY
8. HOUSING
9. VACUUM CONTROL
10. SHIM
11. DRIVE GEAR
12. PIN

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Fig. 3-57 Distributor—Disassembled View

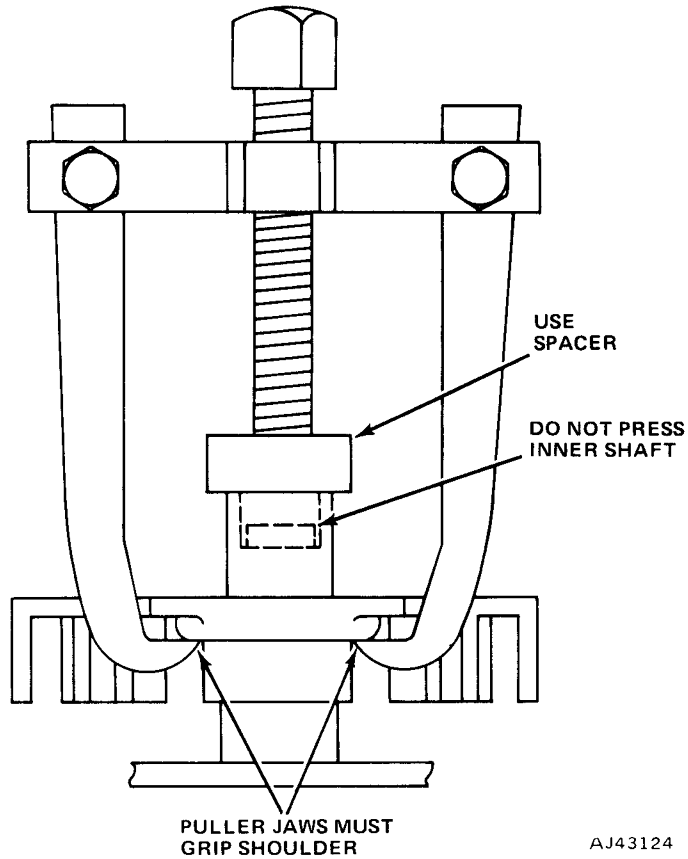

Fig. 3-58 Trigger Wheel Removal

(7) With the vacuum chamber installed, assemble sensor, sensor guide, flat washer, and retaining screw. Install retaining screw only far enough to hold assembly together and be sure it does not project beyond the bottom of sensor.

(8) If the vacuum chamber has been replaced and the original sensor is being used, substitute new screw for original special head screw to facilitate sensor positioning. Use existing flat washer.

(9) Install sensor assembly on vacuum chamber bracket, making certain that the tip of the sensor is located properly in summing bar (fig. 3-59).

(10) Place sensor spring in its proper position on sensor, then route sensor leads around spring pivot pin. Install sensor lead grommet in distributor bowl, then make certain the leads are positioned so they cannot be caught by the trigger wheel.

(11) Place sensor positioning gauge over yoke (be sure gauge is against flat of shaft) and move sensor sideways until the gauge can be positioned (fig. 3-60). With the gauge in place, use a small blade screwdriver to snug down retaining screw. Check sensor position by removing and installing gauge. When properly positioned, it should be possible to remove and replace gauge without any sensor side movement. Tighten the retaining screw to 5 to 10 oz.-in., then recheck the sensor position as before.

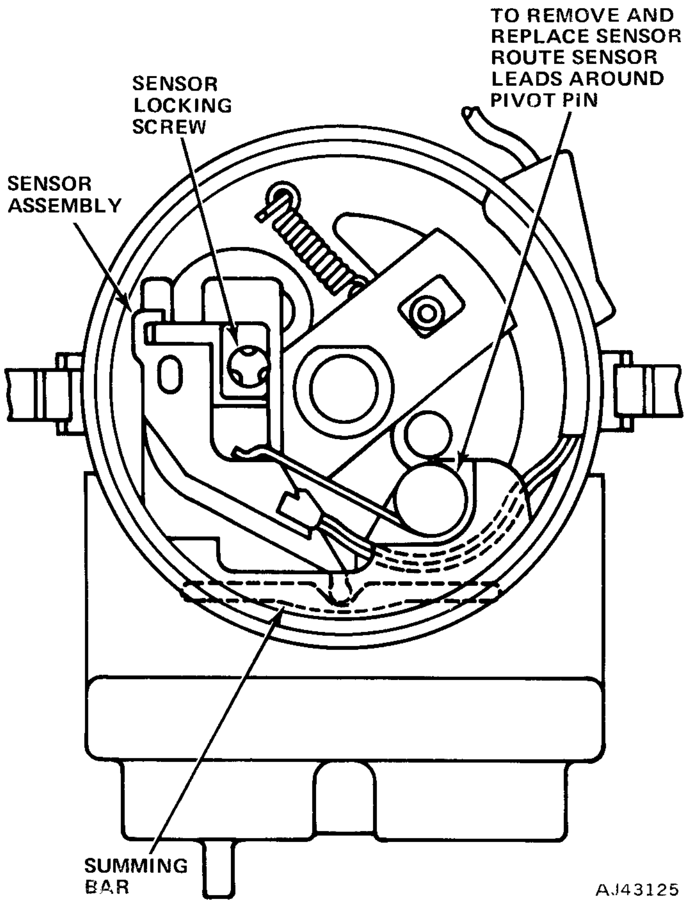

Fig. 3-59 Removal and Installation of Sensor Assembly

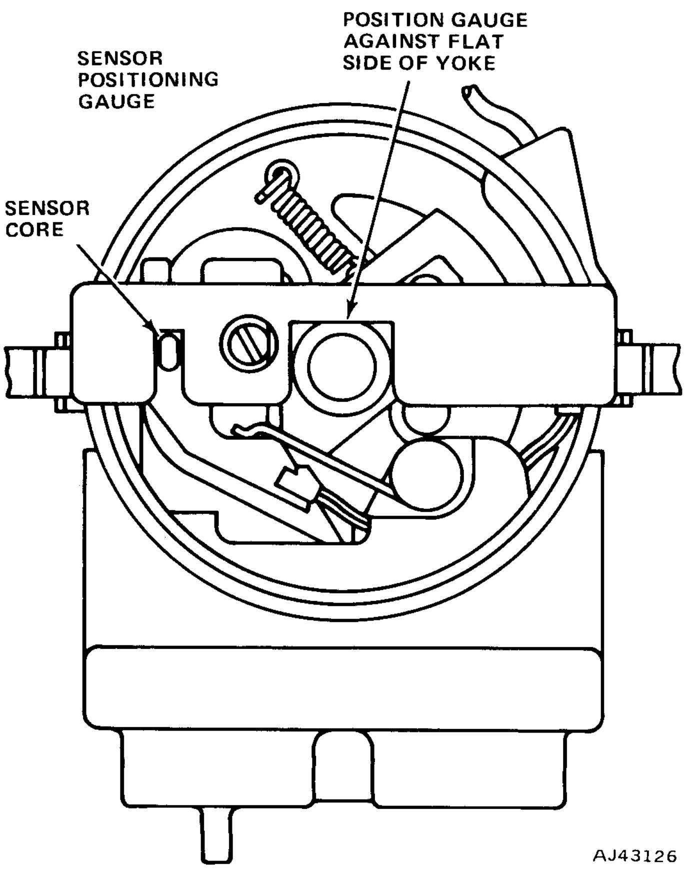

Fig. 3-60 Positioning Sensor

(12) Remove gauge and set trigger wheel in place on yoke. Visually check to make certain the sensor core is positioned approximately in the center of trigger wheel legs and that trigger wheel legs cannot touch sensor core.

(13) Support distributor shaft and press trigger wheel onto yoke. Using 0.050 gauge wire, bend wire gauge to the dimension shown in figure 3-61. Use gauge to measure the distance between trigger wheel legs and the sensor base (fig. 3-61). Install trigger wheel until it just touches the gauge.

(14) Add about 3 to 5 drops of SAE 20 oil to the felt wick in the top of the yoke.

(15) Install dust shield and rotor. Distributor is ready for installation. Install the distributor and time the engine to specification.

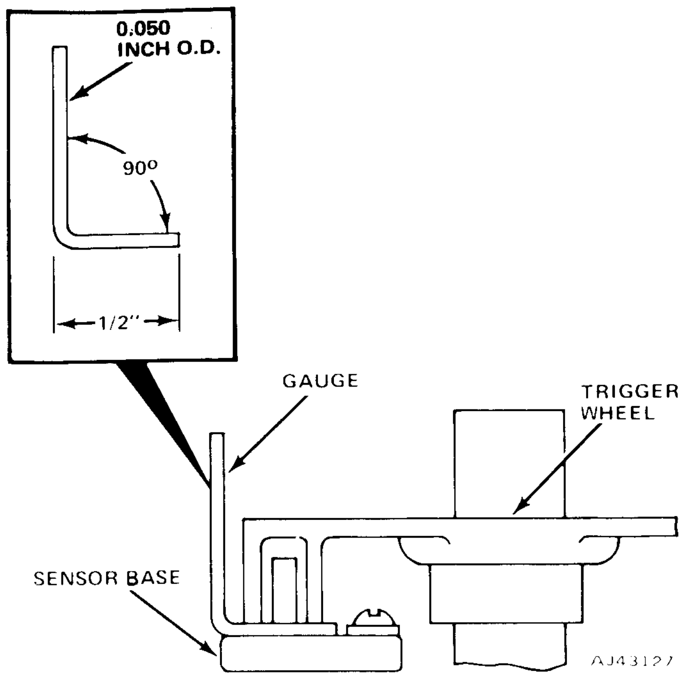

Fig. 3-61 Measuring Distance Between Trigger Wheel and Sensor Base

Installation—Six-Cylinder and V-8

(1) Clean distributor mounting area of engine block.

(2) Install a new distributor mounting gasket in counterbore of engine block.

(3) Position distributor in engine: If engine was not rotated while distributor was removed:

(a) Align rotor tip with mark scribed on distributor housing during removal. Turn rotor approximately 1/8-turn counterclockwise past scribed mark.

(b) Slide distributor down into engine and position distributor vacuum advance housing in approximately the same location (in relation to surrounding engine parts) as when removed.

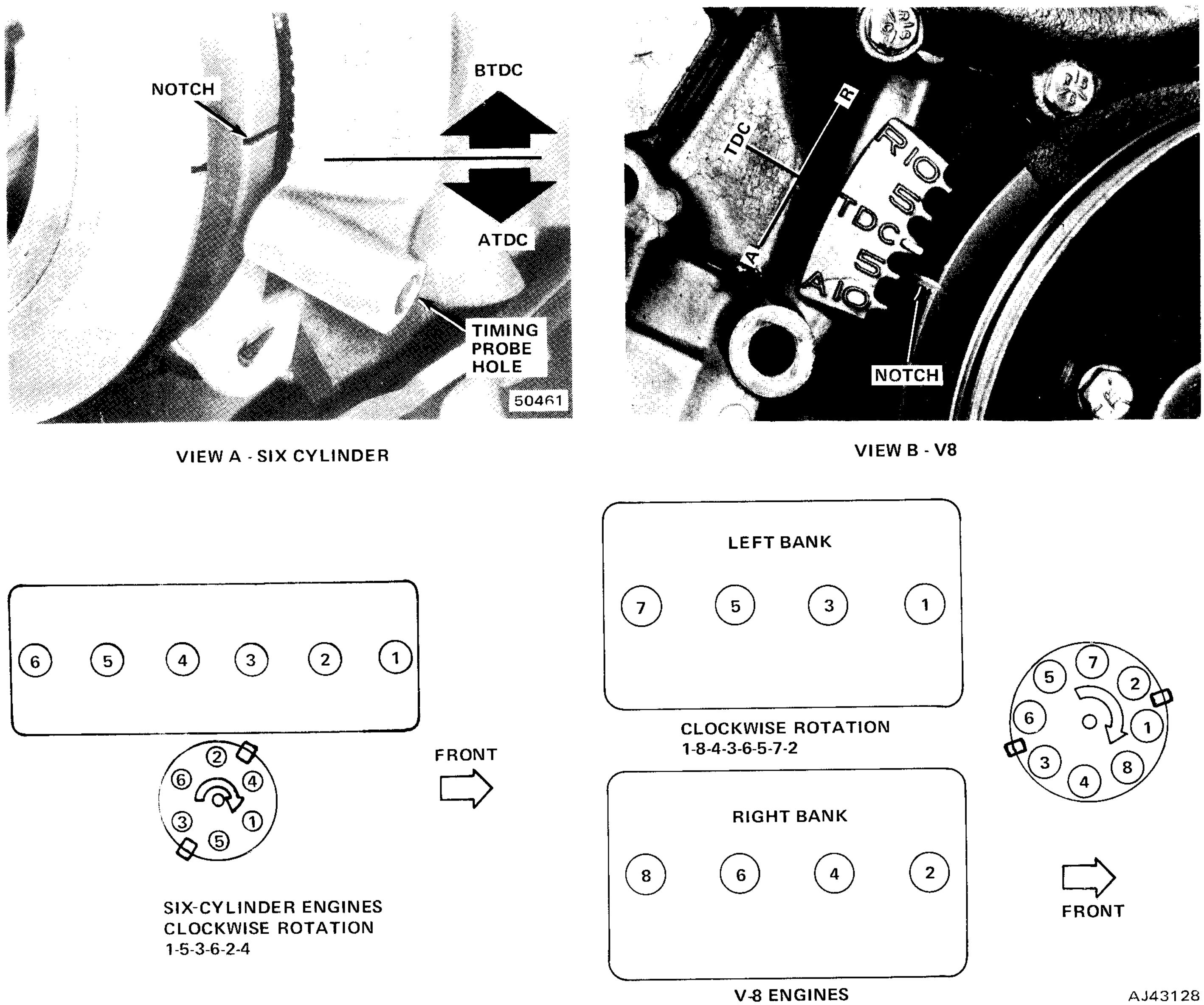

Fig. 3-62 Timing Mark Location and Firing Order

NOTE: *It may be necessary to move rotor and shaft slightly to start gear into mesh with camshaft gear and to engage oil pump drive tang, but rotor should align with scribed mark when distributor is down in place.*

(c) Install distributor holddown clamp, bolt and lockwasher, but do not tighten bolt.

(4) If engine was cranked while distributor was removed, it will be necessary to re-establish timing as follows:

(a) Remove No. 1 spark plug. Hold finger over spark plug hole and rotate engine until compression pressure is felt. Slowly continue to rotate engine until timing mark on crankshaft pulley lines up with top dead center (0) mark on timing quadrant (fig. 3-62). Always rotate engine in direction of normal rotation. Do not back engine to align timing marks.

(b) Turn distributor shaft until rotor tip points in the direction of the No. 1 terminal in the distributor cap. Turn rotor 1/8-turn counterclockwise past the position of the No. 1 terminal.

(c) Slide distributor down into engine and position distributor vacuum advance housing in approximately the same location (in relation to surrounding engine parts) as when removed.

NOTE: *It may be necessary to move rotor and shaft slightly to start gear into mesh with camshaft gear and to engage oil pump drive tang, but rotor should align with the position of No. 1 terminal when distributor is down in place.*

(d) Install distributor holddown clamp, bolt and lockwasher, but do not tighten bolt.

(5) Install distributor cap (with high tension cables) on distributor housing, making sure tang on

distributor housing aligns with slots in distributor cap and that cap fits down snug on distributor housing.

NOTE: *If distributor cap is incorrectly positioned on distributor housing, cap or rotor may be damaged when engine is cranked.*

(6) Connect distributor primary wiring connector.

(7) Connect timing light to No. 1 spark plug.

CAUTION: *Do not puncture high tension cables or boots to make contact. Use proper adapters.*

NOTE: *A hole is provided in the timing case cover for the use of a magnetic timing probe. The probe is inserted through the hole until it contacts the vibration damper. Eccentricity of the damper spaces the probe tip away from the damper while the engine is running. The magnetic probe is calibrated to compensate for the timing case cover hole location which is 9.5° after the TDC mark on damper.*

(8) Operate engine at 500 rpm and observe timing marks with timing light. Rotate distributor housing as needed to align timing mark on crankshaft pulley with mark on timing quadrant. See Specifications. When timing is correct, tighten distributor holddown bolt and recheck timing to be sure it did not change.

(9) Disconnect timing light and connect vacuum hose to distributor advance unit.

INSTRUMENT CLUSTER AND INSTRUMENT PANEL COMPONENTS

INSTRUMENT CLUSTER

CJ Models

The instrument cluster is composed of the speedometer housing, cluster lighting bulbs, hi-beam indicator, turn signal indicators, brake failure/parking brake warning indicator, Emergency Drive indicator, temperature gauge, combination fuel gauge and constant voltage regulator (CVR) (fig. 3-63).

The voltmeter, oil pressure gauge, clock, and tachometer are separate from the instrument cluster. Refer to figure 3-63 for location on the instrument panel.

Removal and Installation

(1) Disconnect battery negative cable.

(2) Separate speedometer cable from speedometer head.

(3) Remove voltmeter as outlined under Voltmeter Replacement.

(4) Remove four attaching nuts and pull cluster off of mounting studs.

(5) Remove gauge wires and cluster lamps and remove cluster assembly.

(6) After installing cluster and voltmeter, connect battery cable and check all lights and gauges for proper operation.

NOTE: *The connector link (fig. 3-64) is not serviced. In the event a connector link has to be replaced, manufacture a connector out of 16 gauge (or larger) insulated wire.*

Cherokee-Wagoneer-Truck

The instrument cluster (fig. 3-65) is composed of the instrument cluster case (speedometer housing), panel lighting bulbs, hi-beam indicator, turn signal indicators, ammeter, oil pressure gauge, temperature and fuel gauges, constant voltage regulator (CVR) (part of the temperature gauge), brake failure warning bulb, Emergency Drive warning bulb (Quadra-Trac), heater control lights, wiper-washer and heater control lights, and the blower motor fan switch.

Removal

(1) Disconnect battery.

(2) Remove six cluster retaining screws.

(3) Disconnect speedometer cable at cluster.

(4) Disconnect cluster pin terminal plug by pulling straight away from cluster.

(5) Disconnect four-terminal plug.

(6) Disconnect fan switch connector plug.

(7) Disconnect vacuum hoses from heater control.

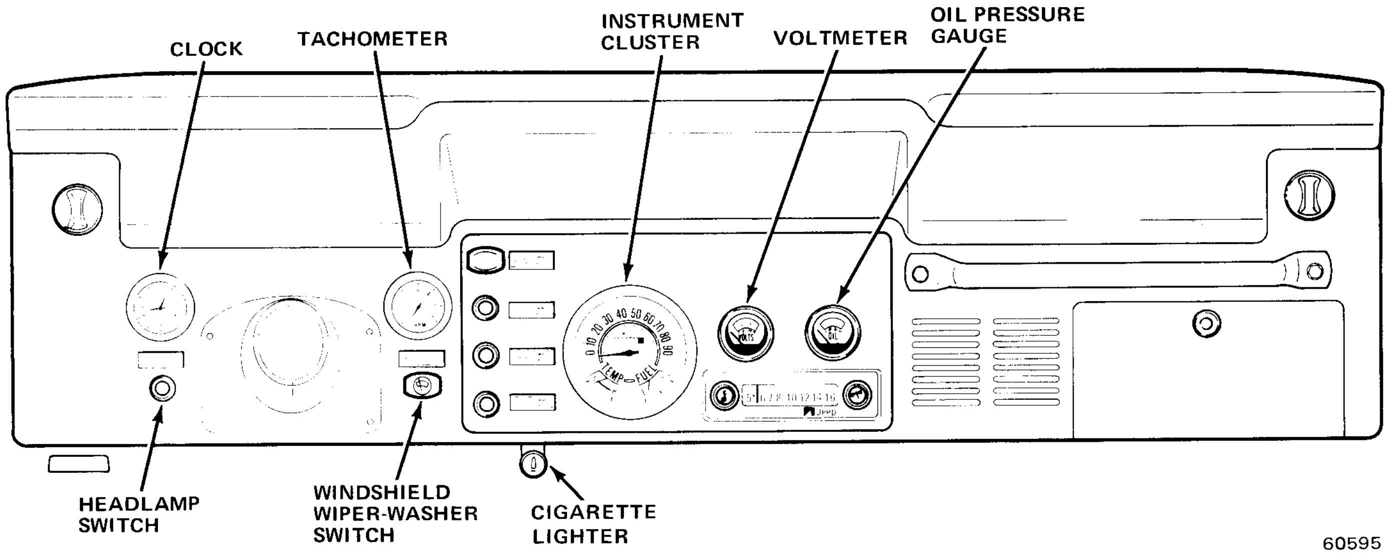

Fig. 3-63 Instrument Panel—CJ Models

NOTE: *Tag each hose according to its numbered location to ensure the proper connection when installing the cluster.*

(8) Remove two heater control panel lights.

(9) Disconnect temperature control wire from lever.

(10) Remove cluster assembly.

Installation

(1) Connect harness plugs and heater control identification bulbs.

(2) Connect temperature control wire to operating lever.

(3) Connect vacuum hoses.

(4) Install cluster.

(5) Connect speedometer cable.

(6) Connect battery cable.

(7) Check all gauges, controls, and lights.

COMPONENT TESTS AND REPLACEMENT

Printed Circuit Test

(1) Remove instrument cluster. Do not disassemble cluster.

(2) Remove all bulbs.

NOTE: *An ohmmeter or Test Lamp J-21008 should be used. When using an ohmmeter, use low scale and adjust meter to 0 reading.*

NOTE: *Refer to figure 3-66 for component identification.*

(3) Connect test lamp or ohmmeter lead to correct pin plug terminal for circuit to be tested. Follow each circuit from pin to each uncoated position up to bulb of indicator in that circuit. Bulb should light or ohmmeter should read 0 resistance at these positions.

(4) Check all uncoated positions on opposite side of bulb or indicator circuit. Circuit must go to either a pin terminal or a grounding screw. Bulb shoulb light or ohmmeter should indicate 0 resistance.

(5) Connect test lamp or ohmmeter lead to ground pin terminal and other lead to cluster metal case.

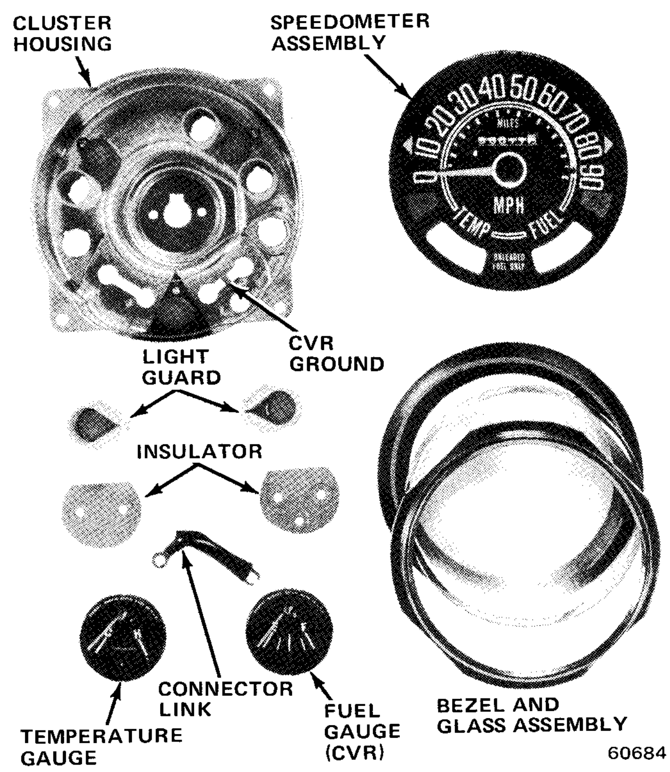

Fig. 3-64 Instrument Cluster Assembly—CJ Models

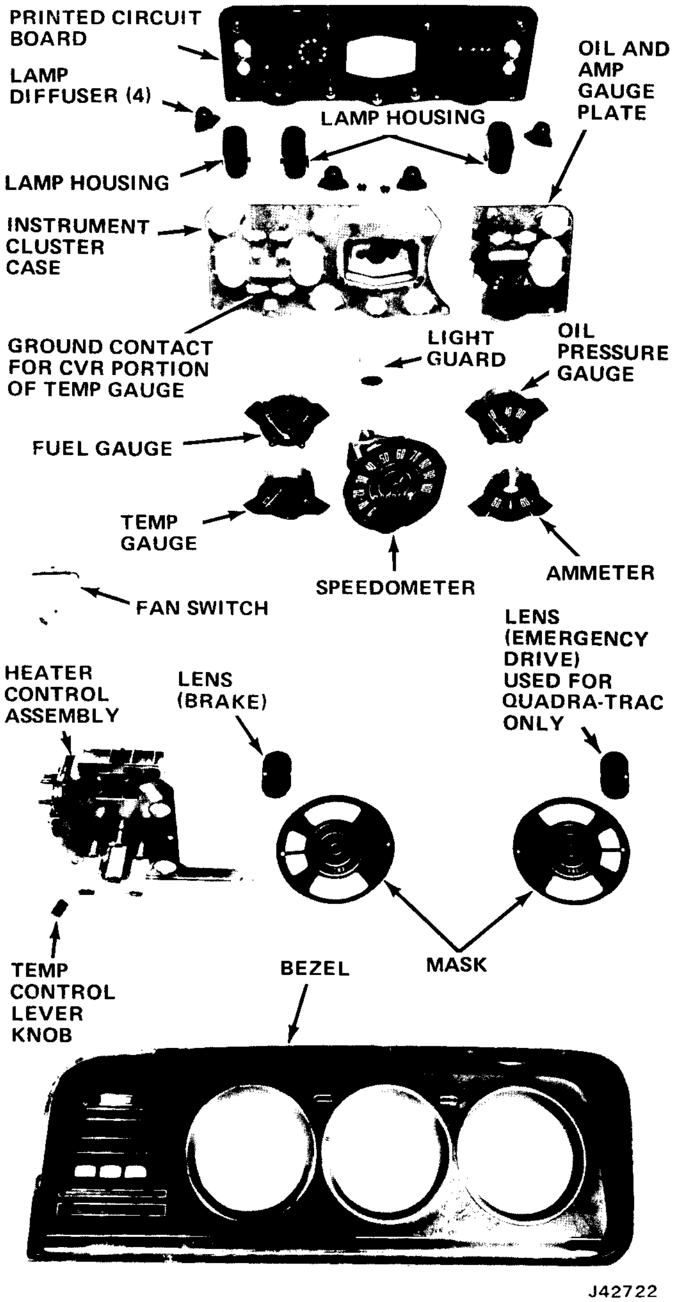

Fig. 3-65 Instrument Cluster—Cherokee-Wagoneer-Truck

Bulb should light or the ohmmeter should indicate 0 resistance. When bulb fails to light or ohmmeter reads resistance on any test, replace printed circuit.

(6) Check for shorting between circuits. With a lead connected to correct pin for circuit to be tested, move other lead to all other pin terminals in cluster. There should be no light or resistance indication between circuits.

Instrument Illumination

CJ Models

Three bulbs in the intrument cluster, six molded lamps in the instrument panel, and one bulb each in the voltmeter and oil gauge provide instrument panel illumination. Protection for the panel bulbs and lamps is provided by the 3-amp fuse located in the fuse panel. The 3-amp fuse is fed from the headlamp switch through a rheostat.

Do not pull on the bulb wires to remove the bulb socket; grasp the socket and pull straight out.

To remove the molded lamps, remove the wire connectors. Squeeze the lamp together at the top and bottom to release the small retaining tabs. Push the lamp through the panel (toward the steering wheel). To install the molded lamps, push into the panel until the retaining tabs snap into place.

Cherokee-Wagoneer-Truck

Four bulbs provide lighting for the instrument cluster and two bulbs illuminate the heater control panel. Panel lights are fed from the fuse panel through an adjustable headlamp switch rheostat. To replace instrument cluster bulbs, reach up behind the cluster, twist the bulb socket counterclockwise (viewed from the rear) and pull out. To replace the heater control panel bulb, pry the bulb socket down until the spring clip which attached the socket to the panel is free.

Voltmeter

The voltmeter (fig. 3-67) registers regulated voltage which provides an indication of the charging systems ability to keep the battery charged. Continuous readings in either the high or low red voltage bands can indicate improper voltage regulation, broken or slipping alternator belt, shorted alternator diode or defective battery. Low readings in the green band are normal with the engine idling or for short periods after long engine cranking. However, continuous readings in the low green area can indicate faulty operation.

The voltmeter gauge needle may indicate voltage when the ignition is turned off after engine operation. This is characteristic of magnetic-type gauges.

NOTE: *When replacing the voltmeter lamp bulb, the radio has to be removed on vehicles so equipped in order to seat the bulb socket.*

Replacement

(1) Disconnect battery negative cable.
(2) Remove radio, if equipped.
(3) Disconnect voltmeter wiring.
(4) Remove voltmeter retaining bracket and remove voltmeter.
(5) Install voltmeter in instrument panel and install retaining bracket.
(6) Connect voltmeter wiring.
(7) Install radio, if removed.
(8) Connect battery negative cable.

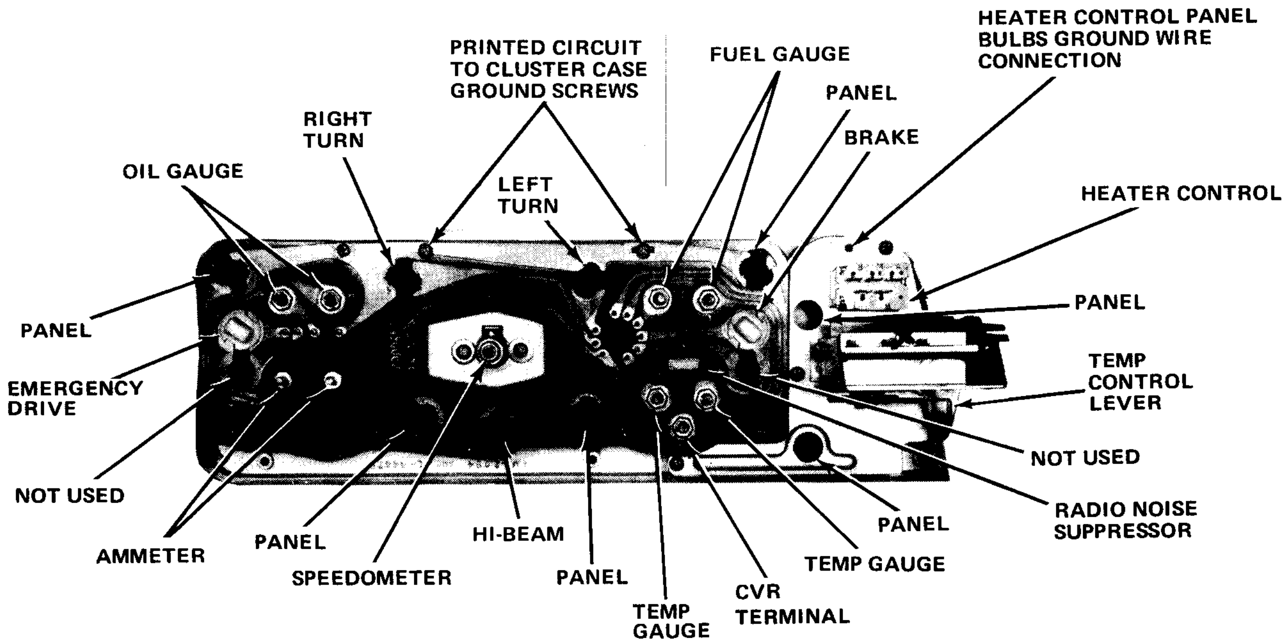

Fig. 3-66 Instrument Cluster—Rear View—Cherokee-Wagoneer-Truck

Oil Pressure Gauge and Sending Unit Test

To test the accuracy of the oil pressure gauge and the sending unit, the following procedure may be used.

Equipment Required: Tester J-24538, direct reading oil gauge and tee fitting (Automatic Transmission Gauge W-320 can be used).

Gauge Test

(1) Disconnect wire from sending unit located on engine.

(2) Turn ignition switch to the on position.

(3) Connect one lead of tester to a good ground and other lead to sending unit wire. Refer to the Oil Pressure Gauge Calibration Chart.

Oil Pressure Gauge Calibrations

Oil Pressure (PSI)	Resistance (Ohms)	
	CJ Models	Cke.–Wag.–Trk.
0	57-63	69-77
10	–	35-38
40	19-21	–
60	–	13-15
80	9.5-10.5	9.5-10.5

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Check all circuit connections before replacing the gauge.

NOTE: *On CJ models, the oil pressure gauge needle will indicate operating pressure when the ignition switch is turned off. When the ignition switch is turned on and the engine is stopped, the needle will return to zero.*

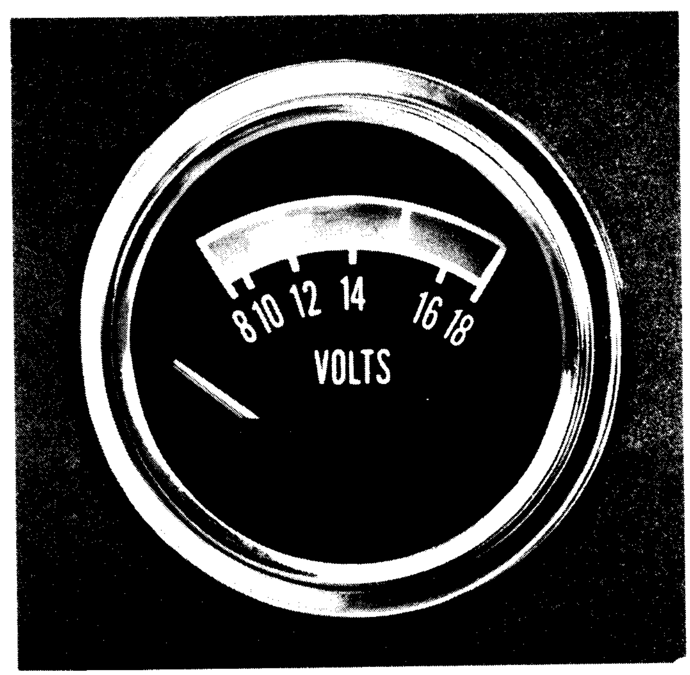


Fig. 3-67 Voltmeter—CJ Models

Sending Unit Test

After verifying a proper operating gauge, remove the oil sending unit and install a tee fitting, between the block and the sender. Connect a direct reading oil pressure gauge to the tee fitting. Connect the sending unit wires; start the engine and compare the readings between the two gauges. Replace sending unit if defective.

Oil Pressure Gauge Replacement

The oil pressure gauge in CJ models can be serviced by removing the two nuts which secure the retaining bracket to the gauge studs. The gauge can be slipped out of the instrument panel opening after removal of the retaining bracket.

The oil pressure gauge on Cherokee—Wagoneer—Truck models can be serviced by following the procedures outlined under Fuel and Temperature Gauge Replacement.

Temperature Gauge and Sending Unit

The temperature gauge circuit is comprised of a sending unit, connecting wiring, and gauge. On the Cherokee, Wagoneer, and Truck, it also includes the instrument cluster printed circuit.

The sending unit is threaded into the cylinder head on six-cylinder engines and into the intake manifold coolant crossover on V-8 engines. The indicator, located in the instrument cluster, is grounded through the variable resistance of the sending unit.

Changes in the coolant temperature vary the resistance of the sending unit, thereby increasing or decreasing the temperature indication.

Fuel Gauge and Sending Unit

The fuel level gauge circuit is comprised of a sending unit, connecting wiring, and gauge. On the Cherokee, Wagoneer, and Truck, it also includes the instrument cluster printed circuit.

The sending unit is located in the fuel tank and the gauge in the instrument cluster. The gauge is grounded through the variable resistance of the sending unit.

A float attached to a slide rheostat follows the level of the fuel. Changes in the fuel level vary the slide rheostat resistance, thereby increasing or decreasing the fuel level indication.

Attitude of the body of the vehicle while parked or making starts and stops will affect the fuel indication.

The fuel gauge on CJ models is a combination gauge and constant voltage regulator (CVR). This CVR provides approximately 5 volts to both the fuel and temperature gauges.

the temperature gauge on the Cherokee, Wagoneer, and Truck is also a combination gauge and CVR. It provides approximately 5 volts to the fuel gauge.

Fuel or Temperature Gauge Tests

The use of Universal Gauge Tester J-24538 is recommended for gauge testing. The tester is to be used on the ground side of a gauge to simulate the operation of a sending unit.

Sending Unit Test—All Models

(1) Disconnect sending wire at sending unit.

(2) Connect one lead of tester to disconnected wire and the other lead to a known good ground.

(3) Turn ignition switch to on position.

(4) Turn tester controls to select each ohm value listed on chart and observe gauge.

(5) If gauge reading is accurate for each ohm value selected, the trouble is in sending unit or sending unit ground circuit (includes sending unit-to-body ground connections).

(6) After verifying a good sending unit ground connection, replace sending unit if gauge is accurate.

(7) If gauge reading is not accurate for each ohm value selected, no gauge reading is obtained or gauge needle reading is pegged above the full or hot position.

(a) Disconnect test leads and connect sending unit wire.

(b) Proceed to Testing at the Instrument Cluster.

Temperature Gauge Calibration—All Models

C (COLD)	130°–73 ohms
Beginning of Band	171°–36 ohms
Top of Band	242°–13 ohms
H (HOT)	270°– 9 ohms

60597

Fuel Gauge Calibration—All Models

Indication	Empty	1/2	Full
Ohms	73	23	10

60598

NOTE: *Fuel and temperature gauges are 5 percent meters; that is, they must be accurate within 5 percent of a specific ohm value.*

Example: 5 percent of 60 ohms is 3 ohms or 60 (±3 ohms).

Testing at the Instrument Cluster—CJ Models

CAUTION: *Be sure tester leads are properly connected before turning ignition switch on.*

Refer to figure 3-68.

(1) Disconnect sender unit wire (output terminal) from terminal.

(2) Connect one tester lead to output terminal of gauge and other lead to a known good ground (T-1).

(3) Turn ignition switch on. Observe gauge reading while selecting ohm values listed in appropriate gauge calibration chart.

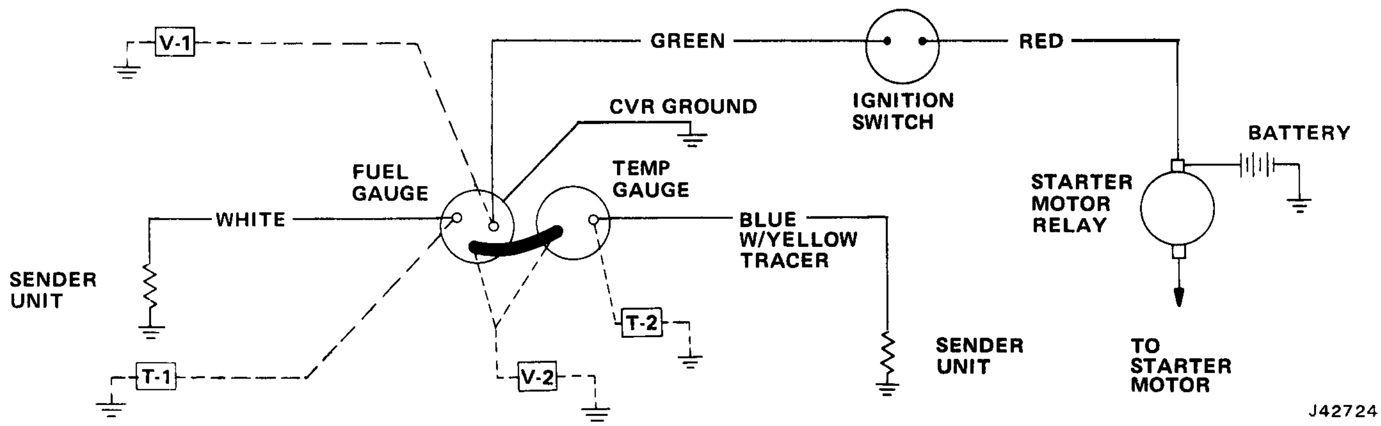


Fig. 3-68 Fuel and Temperature Gauge Circuitry—CJ Models

(4) If gauge reads correctly, wire leading to sender unit or the sender unit is defective. If the gaage reads correctly, disconnect the sender unit wire at the sender unit. Repeat the test from sender unit wire to ground. If the gauge is still inaccurate, replace the sender unit wire. If the gauge is accurate, the sender unit is defective or the fuel tank has a poor ground. A poor ground gives low readings on the gauge.

(5) If no reading is obtained, check input voltage to gauge (I-terminal) with test light or voltmeter (fig. 3-68).

(6) When checking input voltage, check fuel gauge first. The I-terminal of the fuel gauge is fed battery voltage. This terminal voltage can be checked by placing the positive lead of a voltmeter on the I-terminal and contacting a known good ground with the negative lead (V-1).

(7) If no voltage or a drop of more than 0.2 volt (as compared to battery voltage) is indicated, check connections at the ignition switch and red wire back to starter motor relay for loose connections, corrosion, or broken wires.

NOTE: *I-terminal voltage at the fuel gauge is regulated internally to approximately 5 volts.*

(8) To check this voltage, attach voltmeter, V-2, to CVR terminal as shown. The voltmeter should pulsate about one every second or less.

(9) A steady reading of battery voltage indicates that the CVR is defective or does not have a ground.

(10) No reading at all indicates a defective CVR. The CVR and fuel gauge are integral. The entire fuel gauge must be replaced if the CVR is defective.

The fuel gauge CVR terminal feeds the temperature gauge. A defective CVR will cause **both** gauges to read too high, too low, or not at all.

If the fuel gauge operation is satisfactory, check the temperature gauge by connecting the gauge tester (T-2) as shown in figure 3-79.

The gauge now reads correctly, the wire leading to the sender unit is defective.

Refer to the CJ Fuel and Temperature Gauge Diagnosis Guide.

NOTE: *Do not test gauges removed from the instrument cluster unless the fuel gauge is grounded by an extra ground wire attached to the gauge housing.*

Testing at the Instrument Cluster—Cherokee-Wagoneer-Truck

(1) Disconnect battery negative cable.

(2) Remove instrument cluster and disconnect all electrical connections.

(3) Connect a jumper wire from cluster ground terminal to known good ground (fig. 3-69).

CAUTION: *Do not attempt to test gauges with printed circuit removed from the cluster housing, as this would remove the ground for the CVR, resulting in high voltage to the gauges.*

(4) Connect an ignition feed wire, protected by a 3-amp fuse, to E-pin terminal. This applies voltage through radio noise suppressor to I-terminal of temperature gauge.

NOTE: *Be sure there are no open circuits between the E-terminal and the temperature gauge I-terminal.*

(5) Ground one lead of Gauge Tester J-24538 to known good ground.

(6) Connect battery and turn ignition on.

(7) To check fuel gauge, touch remaining lead of Gauge Tester to L-terminal.

(8) To check temperature gauge, touch C-terminal.

(9) Dial resistance required as shown in the appropriate gauge calibration Chart and observe gauge.

(10) Check full range of gauge. If gauge is not correct through entire range, it should be replaced.

NOTE: *Make sure the battery is fully charged.*

(11) If both gauges read too high through entire range, check for good contact between temperature gauge and cluster case.

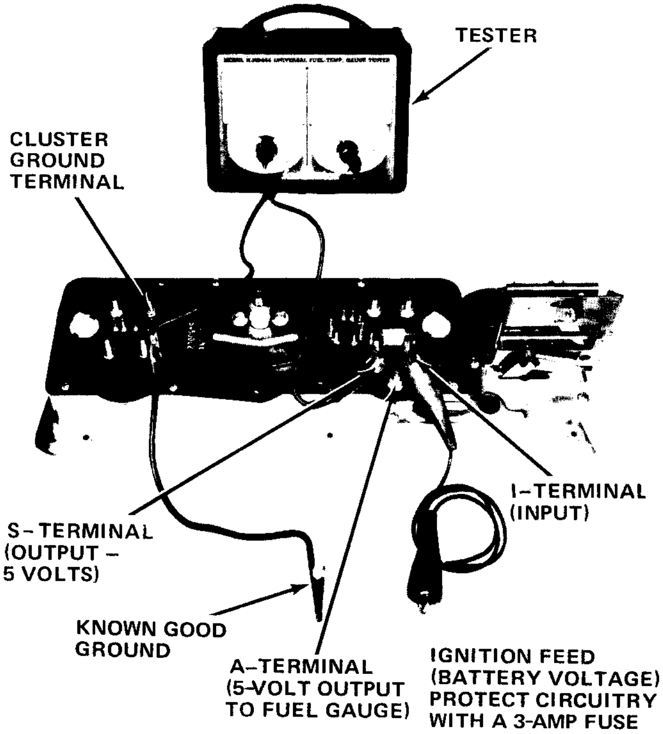


Fig. 3-69 Testing Temperature Gauge—Cherokee-Wagoneer-Truck

TEST RESULTS With Tester Connected as Shown in Figure 3-69	POSSIBLE LOCATION OF TROUBLE
Gauge reading satisfactory at each Ohm value selected (Gauge was defective as installed in vehicle)	Gauge output terminal to printed circuit connection. Printed circuit between gauge output terminal and gauge (indicator pin terminal). Sending wire or wire harness connections. Ignition terminal of instrument harness connector.
No gauge reading	Gauge terminals to printed circuit connections. Printed circuit between gauge input terminal and ignition pin terminal. Gauge.
Gauge reads Full or Hot at all Ohm values selected	Gauge or defective CVR.
Temperature and fuel gauges both read too low or too high	CVR unit. CVR case ground connection.
CAUTION: Upon completing tests, do not disconnect the ground jumper wire until the battery voltage source jumper wire has been disconnected and the ignition switch is in the OFF position.	

J42725

NOTE: *Be sure two printed circuit-to-cluster case ground screws are tight.*

(12) If all ground connections are good and both gauges still read too high or too low, replace the temperature gauge.

(13) If only one gauge reads high or low, replace just that gauge.

Fuel and Temperature Gauge Replacement (Cluster Removed)

All models require the cluster to be removed in order to service the fuel and temperature gauges.

CJ Models

(1) Carefully uncrimp lip of outer bezel and remove outer bezel, glass and glass retaining bezel.

(2) Remove two attaching screws from speedometer housing and remove housing and face plate.

(3) Either gauge can be removed by removing attaching nuts.

(4) When installing gauges, be sure gauges are properly centered in gauge openings in the face plate.

NOTE: *If fuel gauge is being replaced, burnish the metal to remove any corrosion at the contact (CVR) ground area.*

Cherokee-Wagoneer-Truck

NOTE: *This procedure can be used for oil pressure gauge replacement.*

(1) Remove six printed circuit retaining screws and remove instrument cluster case (fig. 3-65).

(2) Remove gauge mask.

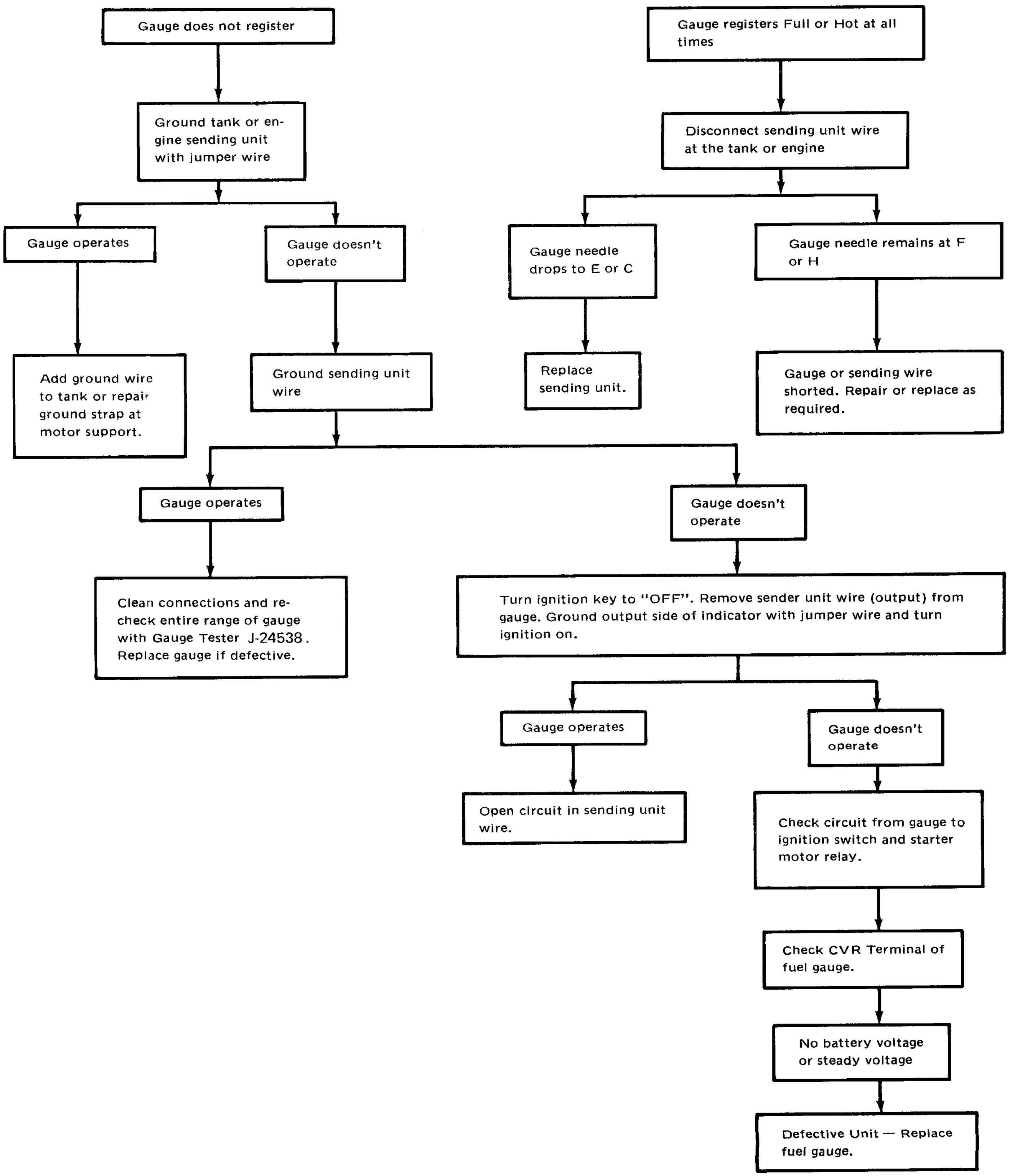
(3) Remove pal nuts (machine nuts on the ammeter) and remove gauge.

(4) When installing gauges, be sure gauges are centered. If installing the temperature gauge, be sure the CVR ground contact area is burnished clean (fig. 3-65). Be sure printed circuit ground screws are tight.

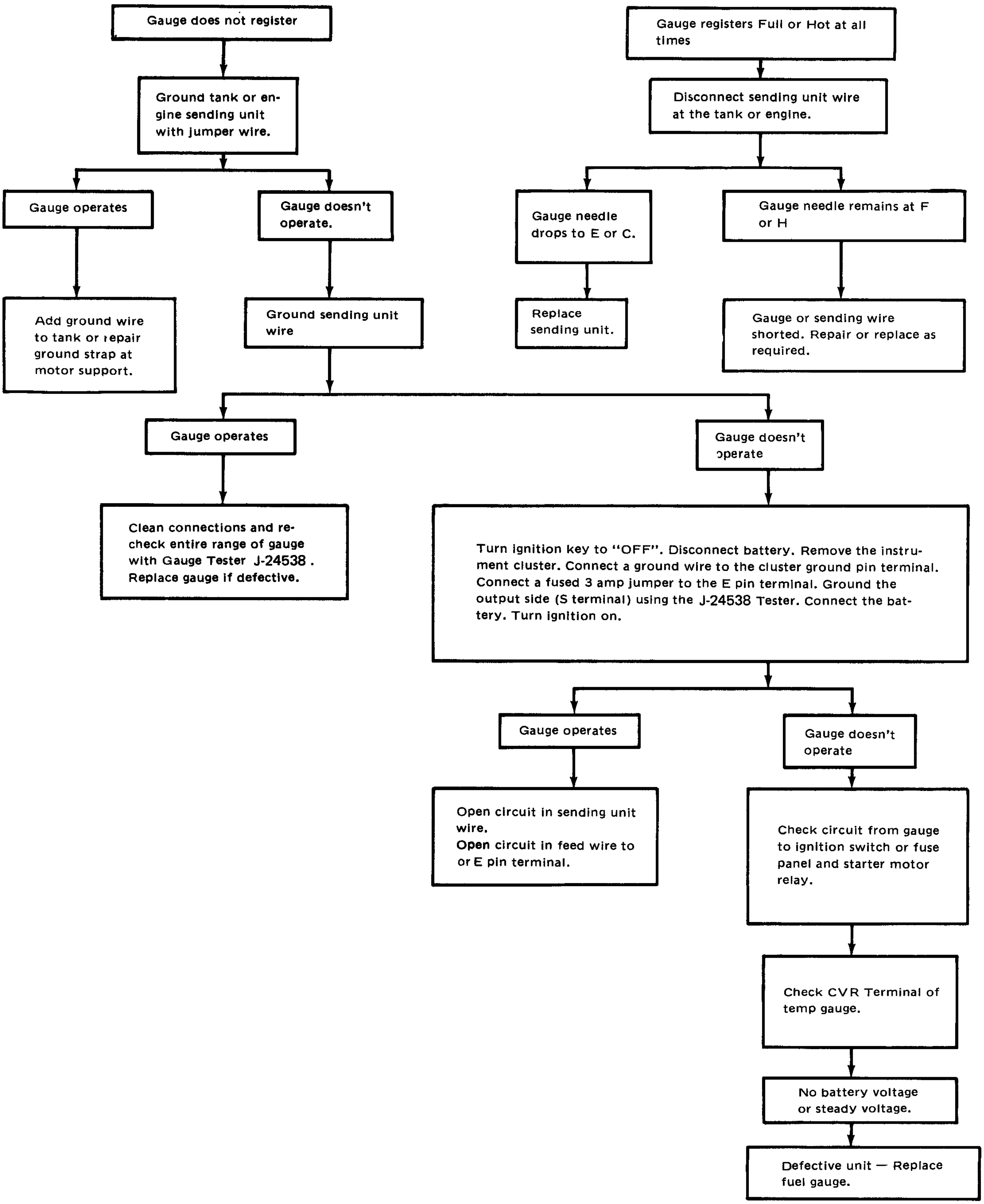
Fuel Tank Sender Unit Replacement

On all models, the fuel tank must be dropped down out of the mounting brackets in order to service the sender unit. Refer to the Fuel-Carburetor-Exhaust Section for fuel tank mounting information.

Fuel and Temperature Gauge Diagnosis Guide—CJ Models



Fuel and Temperature Gauge Diagnosis Guide— Cherokee-Wagoneer-Truck



SPEEDOMETER

A magnetic type speedometer is used on all models.

All speedometers are equipped with a ratchet device to prevent turning the odometer backward.

The following data is supplied for testing and calibrating the speedometer heads.

Speedometer Calibration

Shaft Speed (rpm)	Indication (mph)
167	9 to 11
500	30 to 32.5
1000	60 to 63
1500	90 to 94

60599

Speedometer Head Replacement

Speedometer head replacement includes resetting the replacment odometer to the same mileage as the one removed, unless such setting conflicts with local ordinances.

CJ Models

(1) Carefully uncrimp lip of outer bezel and remove glass and bezel.

(2) Remove two screws and separate speedometer head from housing.

(3) Unhook odometer retaining clip. Twist and push down to disengage clip.

(4) Remove odometer and set to proper mileage. Refer to Odometer Setting Procedures.

(5) Install odometer.

NOTE: *Check anti-backup spring for proper positioning.*

(6) Install retaining spring clip using needlenose pliers. Do not force clip against dial face.

(7) Install speedometer head into speedometer housing.

(8) Install bezel and glass assembly.

Cherokee-Wagoneer-Truck

(1) Remove printed circuit board attaching screws and separate cluster case from bezel.

(2) Remove two speedometer attaching screws and speedometer.

(3) Remove odometer retaining clip.

(4) Remove odometer.

(5) Install odometer assembly.

NOTE: *Check anti-backup spring for proper positioning.*

(6) Install retaining spring clip.

(7) Install speedometer head.

(8) Install printed circuit board.

Odometer Setting Procedure

This procedure applies with the odometer removed from the speedometer head.

Refer to figure 3-70.

Hold the fifth separator and rotate the last five numerals in their normal direction until the desired sixth digit is obtained. When the desired sixth digit is obtained, align the fourth separator in line with the fifth separator. Rotate the last four numerals, repeating the process until the desired total mileage is obtained. When installing the odometer, the separators must straddle a cross bar to maintain proper number alignment.

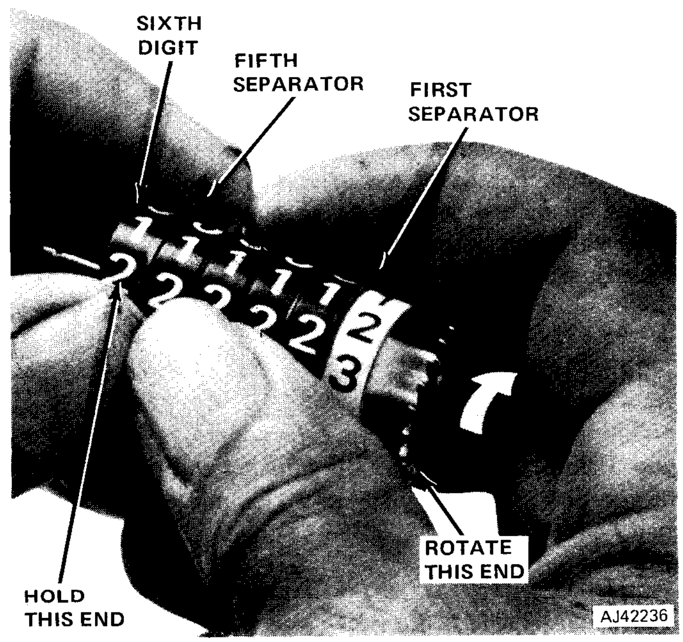


Fig. 3-70 Advancing Odometer Reading (for Replacement Only)

Speedometer Cable Inspection

Always inspect the speedometer cable and core for kinks or sharp bends.

Place the core on a flat surface in the form of an inverted U and then cross the open ends. Hold one end in the left hand, the other in the right hand.

Twist one end, applying light finger pressure to the other end. If the core is satisfactory, the turning action will be smooth.

On a damaged core, the turning action will be jerky and, in a severe case, the core will leap or jump.

The speedometer cable requires a graphite grease lubrication.

CLOCK

CJ Models

The clock is attached to the instrument by a retaining bracket secured with two screws. To reset the clock, pull out the adjustment knob. Hands of *fast running* clocks should be turned *backward*, and *slow running* clocks *forward*. Clock speed will then be corrected automatically after one or two adjustments.

Cherokee-Wagoneer-Truck

The clock is attached to the instrument panel with two nuts.

If the vehicle is not equipped with air conditioning, the clock may be removed by reaching behind the instrument panel and removing the nuts.

If the vehicle is equipped with air conditioning, access to the clock can be obtained by removing the glove box liner attaching screws and pulling down the top portion.

To reset the hands of the clock, pull out the adjustment knob. Hands of a *fast-running* clock should be turned *backward*, *slow-running* clocks *forward*. Clock speed will then be corrected automatically after one or two adjustments.

TACHOMETER—CJ MODELS

The tachometer used in CJ models is an in-line type. Primary current for the ignition coil passes from the ignition switch through the tachometer to the coil positive terminal.

Tachometer Replacement

The tachometer is attached to the instrument panel by a plastic retaining cup secured to the tachometer case by a screw. The tachometer wiring cannot be disconnected at the tachometer. Disconnect the wiring at the fuse panel, ignition switch, and instrument panel ground.

CIGAR LIGHTER

The cigar lighter is mounted to the instrument panel on all models.

The lighter can be removed by removing the battery feed wire (and ground wire on CJ models) and unscrewing the shell that surrounds the lighter.

All models protect the lighter circuit with a 20-amp fuse located at the fuse panel.

IGNITION SWITCH

The ignition switch is mounted on the lower section of the steering column on all models. It is connected to the key lock assembly by a remote lock rod.

The ignition switch has five positions: (1) accessory, (2) off-lock, (3) off, (4) on, and (5) start.

In accessory position, current is available to those loads connected to the accessory terminals on the fuse panel and to the electric tailgate switch mounted on the instrument panel.

In off-LOCK and off position, no current flows through the switch.

In on position, current is available to all accessories, the primary ignition system, and the instrument cluster.

In start position, all accessories are disconnected. The wire connected to the solenoid S-terminal is energized and the brake warning light grounds through the ignition switch ground (bulb check) terminal.

Two different types of ignition switches are used, one for standard columns and one for Adjust-O-Tilt columns (referred to hereafter as Tilt column). The actuator rod moves down on the standard column and up (toward the steering wheel) on the Tilt column when the ignition key is turned to start position.

(1) To make sure that switch is in its correct position, install ignition key in off position. Turn switch body until key is straight up and down.

(2) Remove key an push on main switch body so that notched bezel can be installed freely with notches in line with notch pins.

(3) Turn bezel clockwise to lock in position. The word **Starter** should be on top when correctly assembled.

Removal

(1) Place key in off-lock position and remove two switch mounting screws.

(2) Disconnect switch from remote rod.

(3) Remove harness connector and remove switch.

Installation

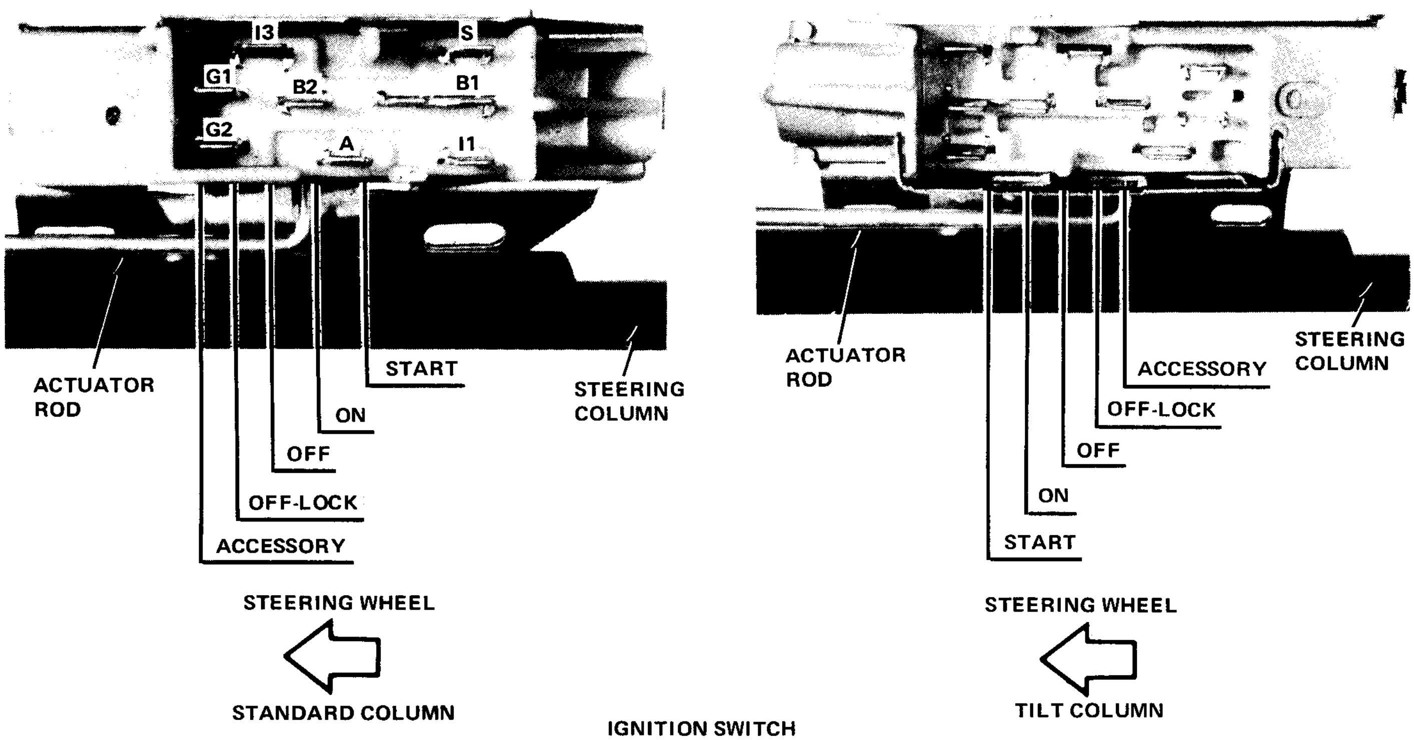
(1) With actuator rod disconnected, position switch as shown in figure 3-71.

(2) Move slider to extreme left (accessory position).

NOTE: *The left side of the ignition switch is toward the steering wheel.*

(3) Position actuator rod in slider hole and install switch to steering column, being careful not to move slider out of detent.

(4) Tighten retaining screws securely.



IGNITION SWITCH

POSITION	CIRCUIT	
START	I-1, B-1 & S G-1, G-2	CONNECTED GROUNDED
ON	I-1 & B-1 A & B-2 1-3 & B-3	CONNECTED CONNECTED CONNECTED
OFF	OPEN	
OFF-LOCK	OPEN	
ACCESSORY	A & B-2	CONNECTED

B-1, B-2 & B-3 (COMMON CONNECTION)

A42215

Fig. 3-71 Ignition Switch Positions

Tilt Column

(1) With actuator rod disconnected, position switch as shown in figure 3-82.

(2) Move slider to extreme left (accessory position).

NOTE: *The right side of the ignition switch is downward from the steering wheel.*

(3) Position actuator rod in slider hole.

(4) Install switch to steering column but do not tighten retaining screws.

(5) Lightly push switch down column (away from steering wheel) to remove lash in actuator rod. Be careful not to move slider out of detent.

(6) Tighten retaining screws securely.

Cylinder Service

For ignition switch cylinder service, refer to Section 11—Steering.

Ignition Switch Test

The ignition switch terminals are shown in figure 3-71.

Although an ohmmeter can be used to check continuity between common connections, a better method is to place a load across the switch (heater, ignition, etc.) which will heat the switch and show it under normal operation. Insert paper clip into the ignition feed wire connector at the back of the switch. Insert another paper clip into any other terminal that is carrying the load. Connect a voltmeter to the two paper clips and note the reading. The maximum voltage drop (the voltage indicated on the voltmeter) is 0.0125 (12.5 millivolts) volt per amp. This means that a 10-amp load would allow 10 x 0.0125 volt to appear on the scale. A reading of 0.2 (two tenths) volt, for example, would mean that the switch is defective.

The ignition switch slide bar positions can be easily identified by first locating the alignment hole in the flat portion of the switch adjacent to the terminals.

LIGHTING SYSTEMS—DIRECTIONAL SIGNAL SWITCH—HORNS

LIGHTING SYSTEMS

The wiring of the lighting systems is shown in the wiring diagrams, which indicate the various units in relation to their positions in the vehicle. The wires in the various circuits are different colors or are marked by tracers.

All models have a 20-amp circuit breaker built into the switch for light system protection.

The upper and lower headlamp beams are controlled by a foot switch located on the toeboard.

HEADLAMPS

All models are equipped with a single headlamp system.

The type 2 headlamp used with the single system is identified by the number 2 embossed on the sealed beam face. The lamp contains two elements: one low beam and one high beam.

Headlamp Aiming Procedure

Lamps must be aimed on the low beam. They may be aimed either with mechanical aimers or by using a screen. If Mechanical Aimers C-3674 are used, follow instructions supplied by the aiming equipment. If a screen is to be used, preparation for aiming is as follows:

(1) Locate vehicle in a darkened area with a level floor and with a screen (wall) having a nonreflecting white surface.

(2) A reference line should be marked on floor 25 feet away from and parallel to the screen.

(3) Position vehicle perpendicular to screen and with front headlamps directly over reference line.

(4) Locate middle tape on screen so it is aligned with centerline of vehicle.

(5) Equalize all tire pressures.

(6) Rock vehicle from side to side to equalize springs and shock absorbers.

(7) Measure distance between vehicle headlamp centers.

(8) Position marker tapes vertically on screen to right and left of middle tape at half this distance.

(9) Measure distance from center of each lamp to surface on which vehicle rests.

(10) Position marker tape horizontally on screen to cross vertical tapes at measured height of each lamp center respectively.

(11) Remove headlamp doors.

(12) Clean headlamps.

(13) Turn headlamps on low beam.

NOTE: *Cover the lamp not being aimed. Be sure to use the horizontal reference line on the screen that is the same dimension as the vehicle lamp height.*

(14) Turn vertical aiming screw counterclockwise until lamp beam is considerably lower than horizontal reference line on screw (fig. 3-72).

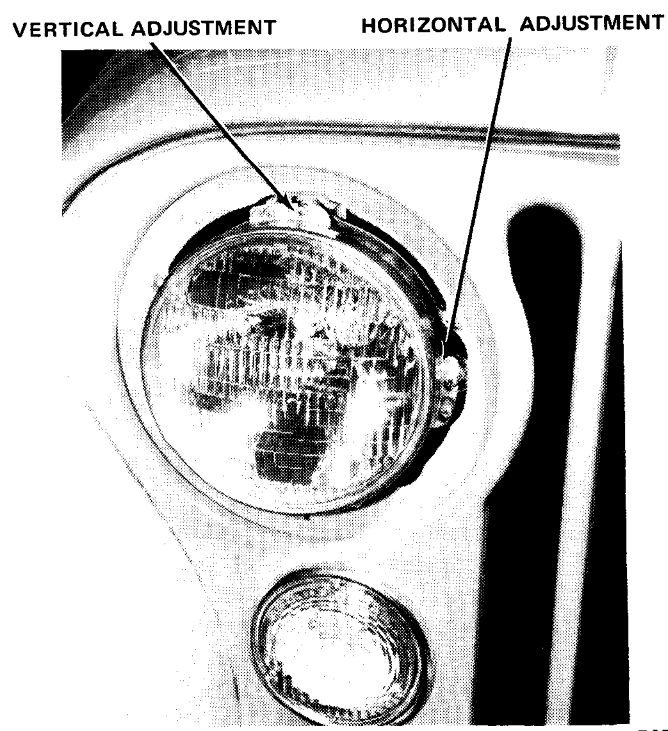


Fig. 3-72 Headlamp Adjustment

(15) Turn screw clockwise until top edge of high intensity area is even with horizontal line.

(16) Turn horizontal aiming screw counterclockwise until beam is off centering tape.

(17) Turn same screw clockwise until left edge of high intensity area is 2 inches to right of lamp centerline (fig. 3-73).

(18) Cover lamp that has been aimed and aim other lamp using same procedure.

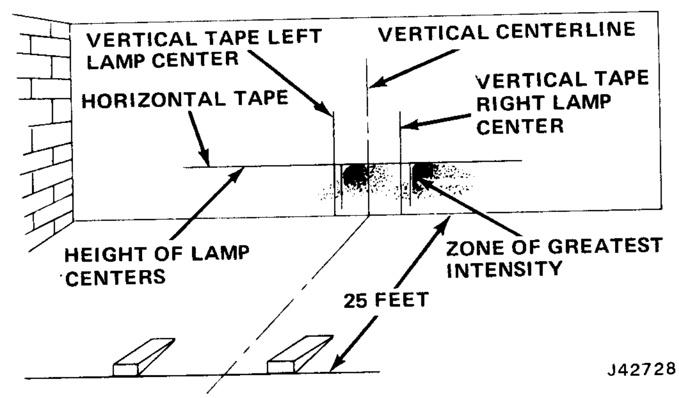


Fig. 3-73 Headlamp Aiming Chart

Headlamp Replacement

Each sealed beam headlamp can be replaced only as a complete unit.

NOTE: *Headlamps have a number 2 molded into the glass at the top of the lens.*

The only difference in the replacement procedure between models is the removal of the headlamp door. The remainder of the headlamp assembly is the same as for all models.

To remove the door on the CJ models, remove the one lower attaching screw. Pull the door out slightly at the bottom and push up to disengage upper retaining tab. Cherokee-Wagoneer-Truck models have three screws retaining headlamp door.

(1) Remove screws and remove door.

(2) Remove three screws in retaining ring.

(3) Pull headlamp out and disconnect wire harness.

(4) Install headlamp with the number 2 at the top of the lamp.

(5) Check lamp aim following procedures under Headlamp Aiming Procedure when replacing headlamps.

Headlamp Switch

The switch is a two-position switch containing a rheostat for controlling instrument panel light brightness (fig. 3-74). Rotating the knob clockwise dims the panel lights. Rotating the knob fully counterclockwise turns on the dome and courtesy lamps.

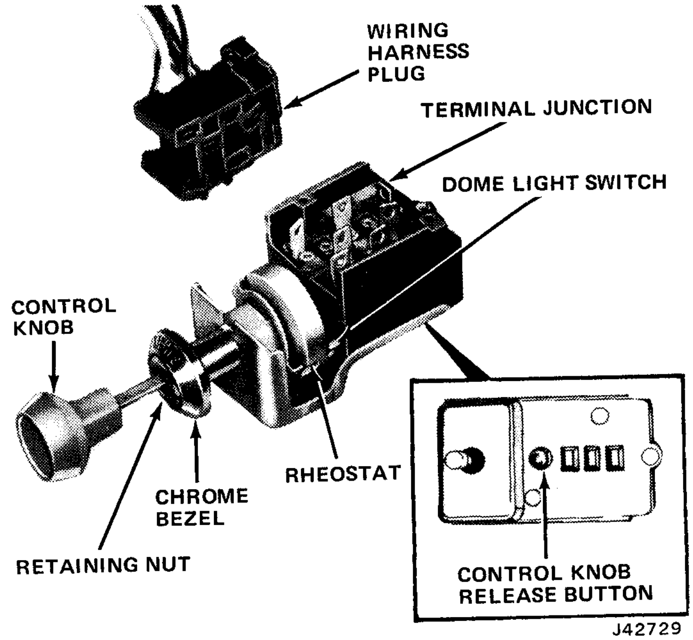


Fig. 3-74 Headlamp Switch

(1) To remove switch, first disconnect wire connector plug from switch.

(2) Pull control knob out to second position.

(3) From behind instrument panel, depress knob release button (as shown in figure 3-74 inset) and pull knob out of switch.

(4) Remove retaining nut and bezel.

(5) Remove switch through rear of instrument panel.

(6) When replacing switch, make sure wire terminal plug on switch is tight on connections.

Dimmer Switch Replacement

Refer to figure 3-75.

(1) Remove wire plug from switch.

(2) Remove two capscrews that hold dimmer switch to floorboard.

(3) Remove plug.

(4) Check operation of dimmer switch with a test lamp. A circuit across two different pairs of contacts (one to headlamps, the other to the high-beam indicator light) should alternately light test lamp when switch is operated.

PARKING, SIDE MARKER, AND DIRECTIONAL LAMPS

CJ Models

The parking lamps are mounted in the radiator guard panel just below the headlamps (fig. 3-76). The lamps are on when headlamp switch knob is pulled out.

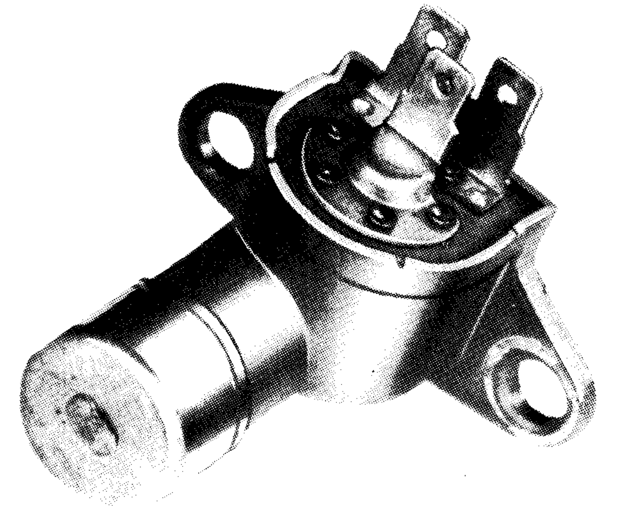


Fig. 3-75 Headlamp Dimmer Switch

(1) Remove three screws, allowing lens to be removed.

(2) Replace lamp.

If the complete parking lamp assembly is to be removed for service or replacement, remove the headlamp assembly to gain access to the rear of the parking lamp.

(1) Disconnect wire connector from harness.

(2) Remove nuts and lockwashers securing parking lamp assembly.

(3) Remove through the front of panel.

To replace front side marker bulbs, reach under the fender and pull down on the socket assembly. To install the bulb and socket assembly, line up the retaining tabs on the socket with the openings on the marker lamp. Push the assembly in and twist the socket 1/4-turn. The bulb is an edge-base type. Pull straight out to remove.

Cherokee-Wagoneer-Truck

The Cherokee and Truck models have the parking lamps mounted in the headlamp panel just above the bumper (fig. 3-77).

The Wagoneer has the parking lamps mounted in the radiator grille panel (fig. 3-78).

The front side marker lamp will flash in unison with the front turn indicator bulb when the headlamps are not on. When the headlamps are on, the side marker flashes alternately with the front turn signal lamp. Side marker and parking lamps come on when the headlamp switch is pulled out to any position.

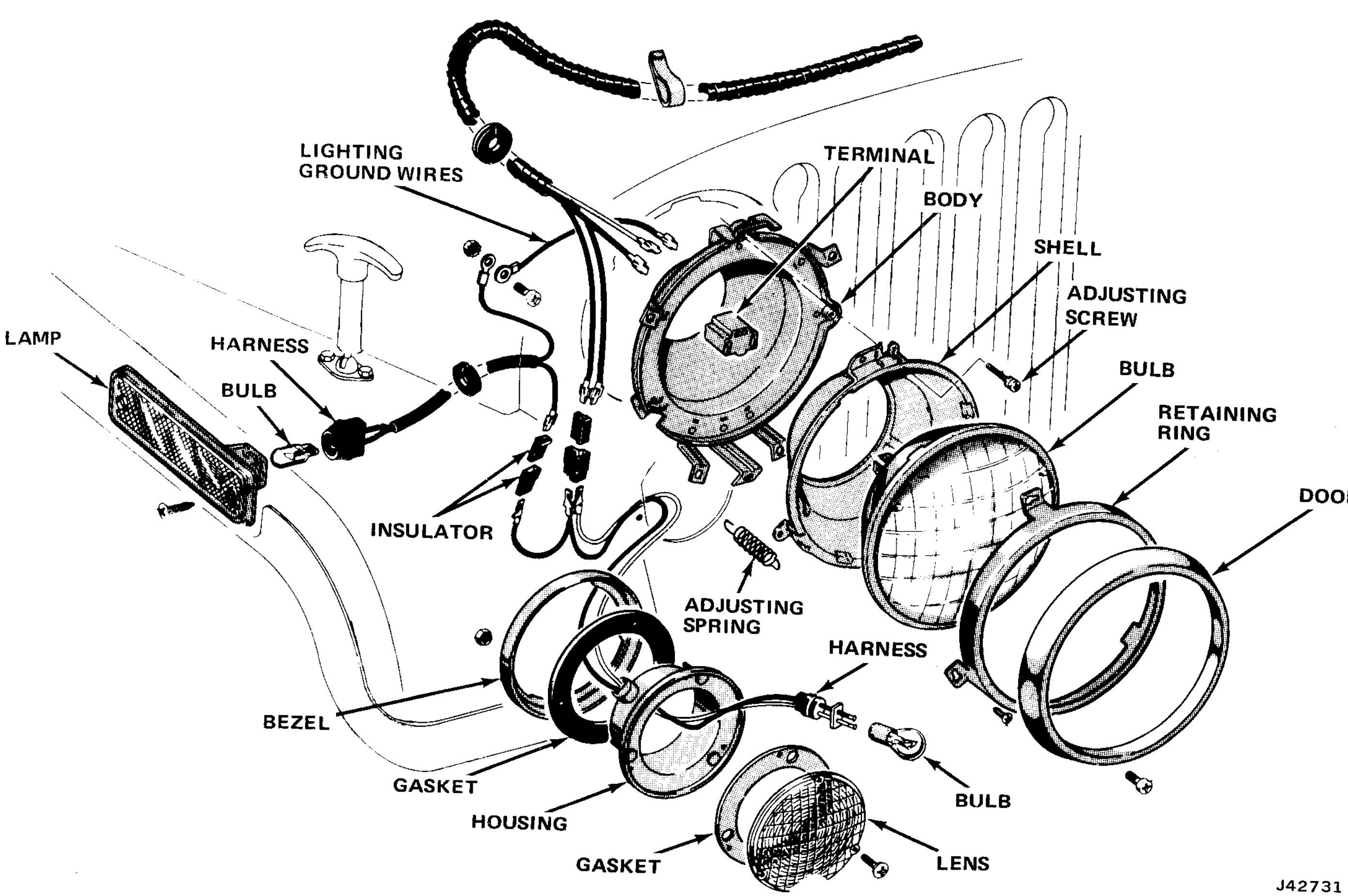


Fig. 3-76 Headlamp, Parking, Directional and Side Marker Lamps—CJ Models

To replace parking lamp bulbs on the Wagoneer, remove the parking lamp lens.

To replace parking lamp bulbs on Cherokee and Truck models, remove the lens and colored relector.

To remove the entire parking lamp assembly, remove the lamp lens. Insert a narrow blade screwdriver or a putty knife between the lamp and the body sheet metal. Pry the sheet metal away from the lamp assembly until the spring clip on the side is disengaged. Pull out the lamp assembly to disconnect the wires. Before installing the lamp assembly, bend the retaining sheet metal lip back to its original position.

To replace side marker lamps, remove the lamp assembly. Twist the socket 1/4-turn to remove. Remove the bulb by pulling it straight out from the socket.

REAR DIRECTIONAL, SIDE MARKER, STOP AND TAILLAMPS

CJ Models

Refer to figure 3-79 for parts identification.

Taillamp Bulb Replacement

Remove lens screws, lens, and gasket. Clean lens and reflector before installing.

Taillamp Housing Replacement

Disconnect wiring, remove taillamp lens, and remove the three screws securing taillamp assembly body and remove from rear of body.

Side Marker Bulb Replacement

Turn the bulb socket 1/4-turn counterclockwise and remove the bulb and socket.

Cherokee

Refer to figure 3-80 for parts identification.

Taillamp Bulb Replacement

Remove the taillamp lens and remove the bulb. Clean the lens and housing before installing lens.

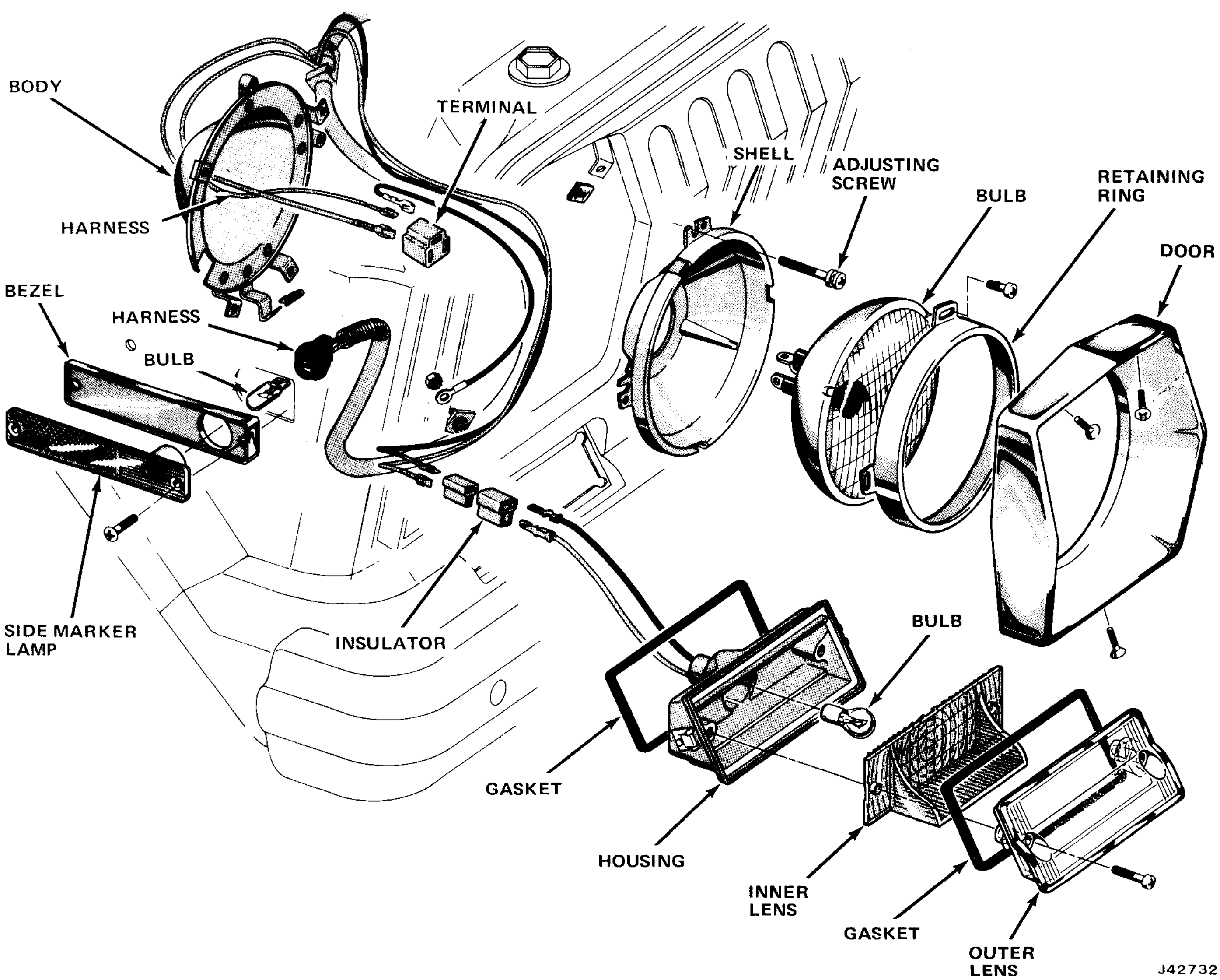


Fig. 3-77 Headlamp, Parking, Directional, and Side Marker Lamps— Cherokee-Truck

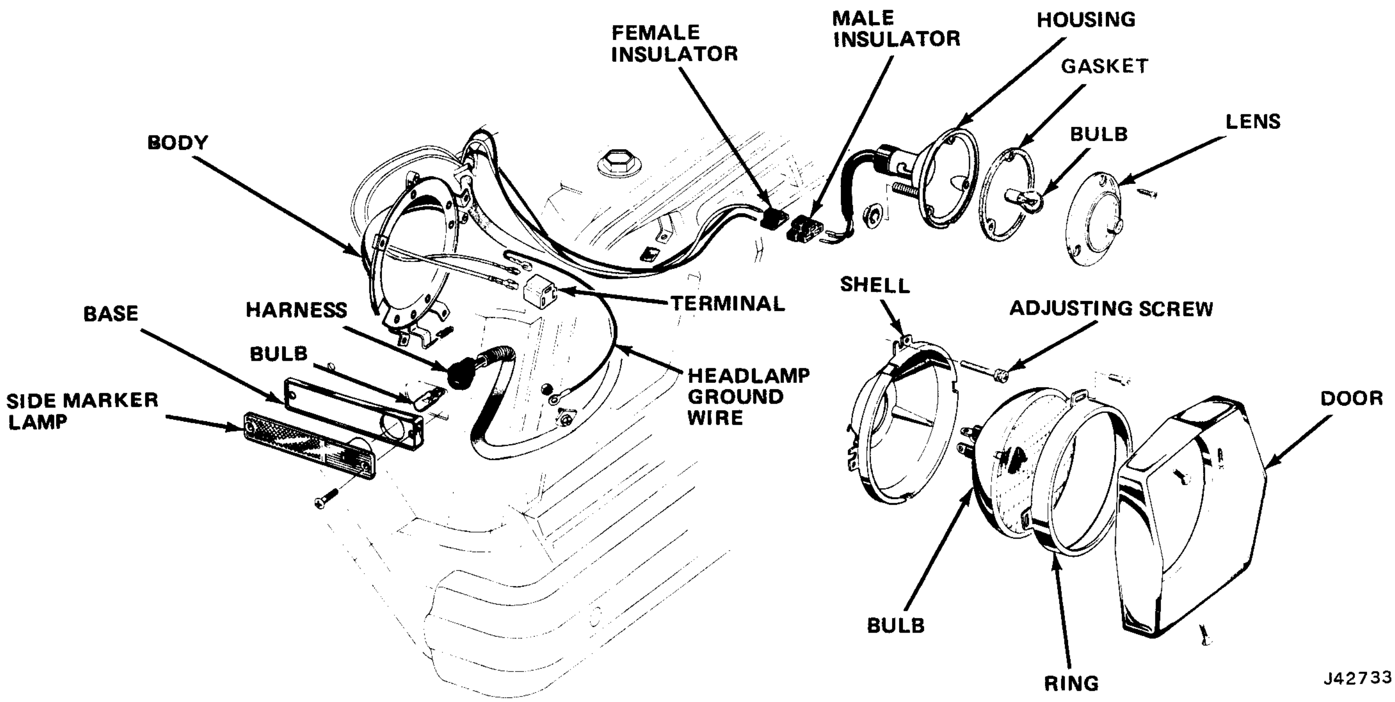


Fig. 3-78 Headlamp, Parking, Directional and Side Marker Lamps—Wagoneer

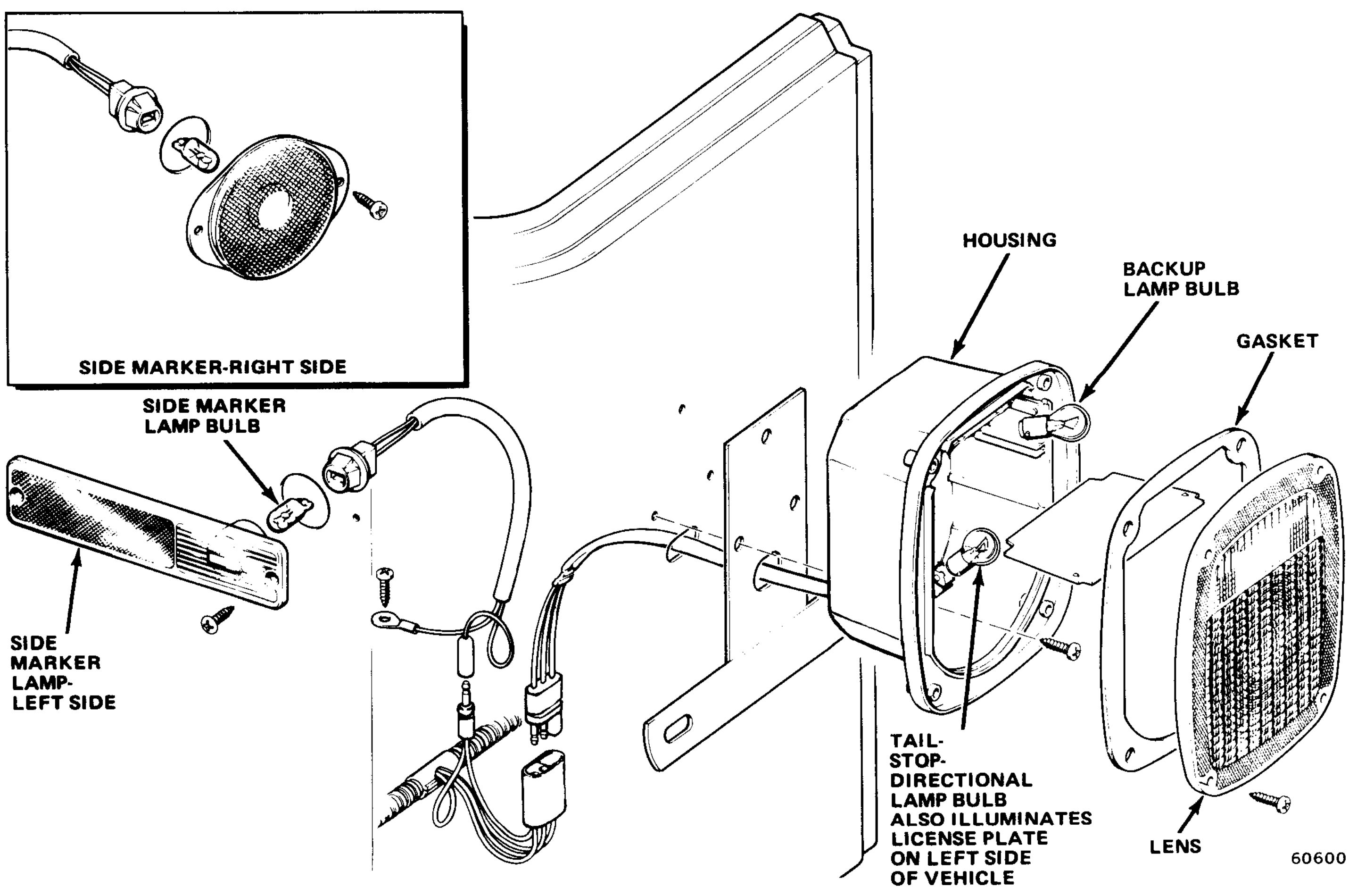


Fig. 3-79 Rear Directional, Stop, Backup, Taillamps and Side Marker Lamps—CJ Models

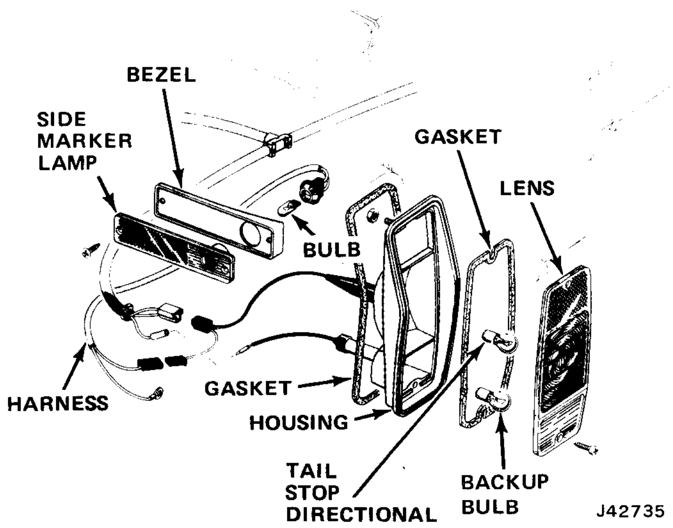


Fig. 3-80 Rear Directional, Stop, Backup and Taillamps—Cherokee

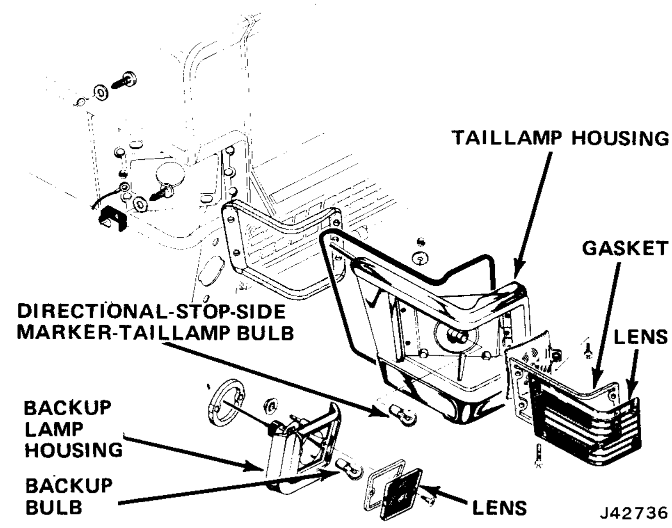


Fig. 3-81 Rear Directional, Stop, Backup and Taillamps—Wagoneer

Taillamp Housing Replacement

(1) Remove interior rear quarter trim panel. On right side, pull panel out at top and remove (this section of body contains jack and tire wrench). On left side, trim panel is held by expandable clips. Use care in prying these clips out of their recesses so panel is not bent or damaged.

(2) Disconnect taillamp harness connections.

(3) Remove four attaching nuts and push housing out from corner posts.

Wagoneer

Refer to figure 3-81 for parts identification.

Taillamp Bulb Replacement

Remove four screws and remove the lens. The white reflector is held in position by one capscrew which, when removed with the reflector, allows the bulb to be removed and replaced. Clean lens and reflector before installing.

Taillamp Housing Replacement

Refer to figure 3-81 and follow the housing replacement procedure as outlined for Cherokee models.

Truck—Except Townside Model

On these vehicles, the lamp is mounted to brackets located on the outside rear of the pickup box side panel .

Taillamp Bulb Replacement

Remove lens and remove the bulb. Clean lens and reflector before installing.

Taillamp Housing Replacement

(1) Disconnect lamp harness.

(2) Remove attaching nuts.

Truck—Townside Model

On these vehilces, the lamp assemblies are mounted in the pickup box end caps (fig. 3-82).

Taillamp Bulb Replacement

Remove lens and remove bulb. Clean lens and reflector before installing.

Taillamp Housing

(1) Remove lens.

(2) Remove two 1/4-20 screws.

(3) Remove housing and disconnect lamp harness.

License Plate Lamp

CJ Models

The left taillamp illuminates the license plate. Refer to figure 3-79.

NOTE: *When installing a rear step bumper on CJ models, the lamp wiring from the step bumper must be spliced into the taillamp harness.*

Cherokee and Wagoneer

The license plate lamp is attached to the tailgate and is a sealed unit. The lamp is removed by removing the lamp attaching screws and disconnecting the attaching wire.

Truck

The license plate lamp is attached to the rear frame crossmember. Bulb replacement is accomplished by removing the bulb lens. The ground for the license plate bulb depends upon metal-to-metal contact between the bulb bracket, license plate bracket, and the frame (fig. 3-82).

When equipped with step bumper, the lamp wiring must be disconnected from the original lamp and connected to the step bumper license lamp extension wire.

Backup Lamps and Switches

To replace a bulb, remove the backup lamp or taillamps lens, as required.

Switch Adjustment and Replacement—Manual Transmission

The backup lamp switch is threaded into the right rear corner of the transmission cover housing. The backup lamp switch is actuated by the reverse shift rail.

The backup lamp switch is not serviceable or adjustable and must be replaced as a unit.

NOTE: *Jumper wires are used at the neutral safety switch connector and the automatic transmission backup lamp switch connector to complete the circuit on vehicles equipped with manual transmission.*

Switch Adjustment and Replacement—Automatic Transmission

A combination backup and neutral safety switch is mounted on the steering column. This switch is adjustable. If defective, the switch must be replaced.

To adjust the backup lamp switch, place the transmission shift lever in the R position. Loosen (do not remove) the two switch attaching screws. Turn the ignition switch to the on position. Rotate the switch one direction or the other until the backup lamps operate. Tighten the attaching screws. Check the switch for an engine start in the N and P positions. The engine must not start in R, D, 2, or 1 position.

As an aid to adjusting the backup lamp switch, install a test lamp to the lamp side of the switch and ground one side of a test lamp. When the test lamp lights, the backup lamps are operating.

Courtesy and Dome Lamps

CJ Models

The courtesy lamps are located beneath each end of the instrument panel and are operated by rotating the headlamp switch knob counterclockwise to the stop.

Current passes from the headlamp switch through the lamp and back to ground at the headlamp switch. No door switches are used.

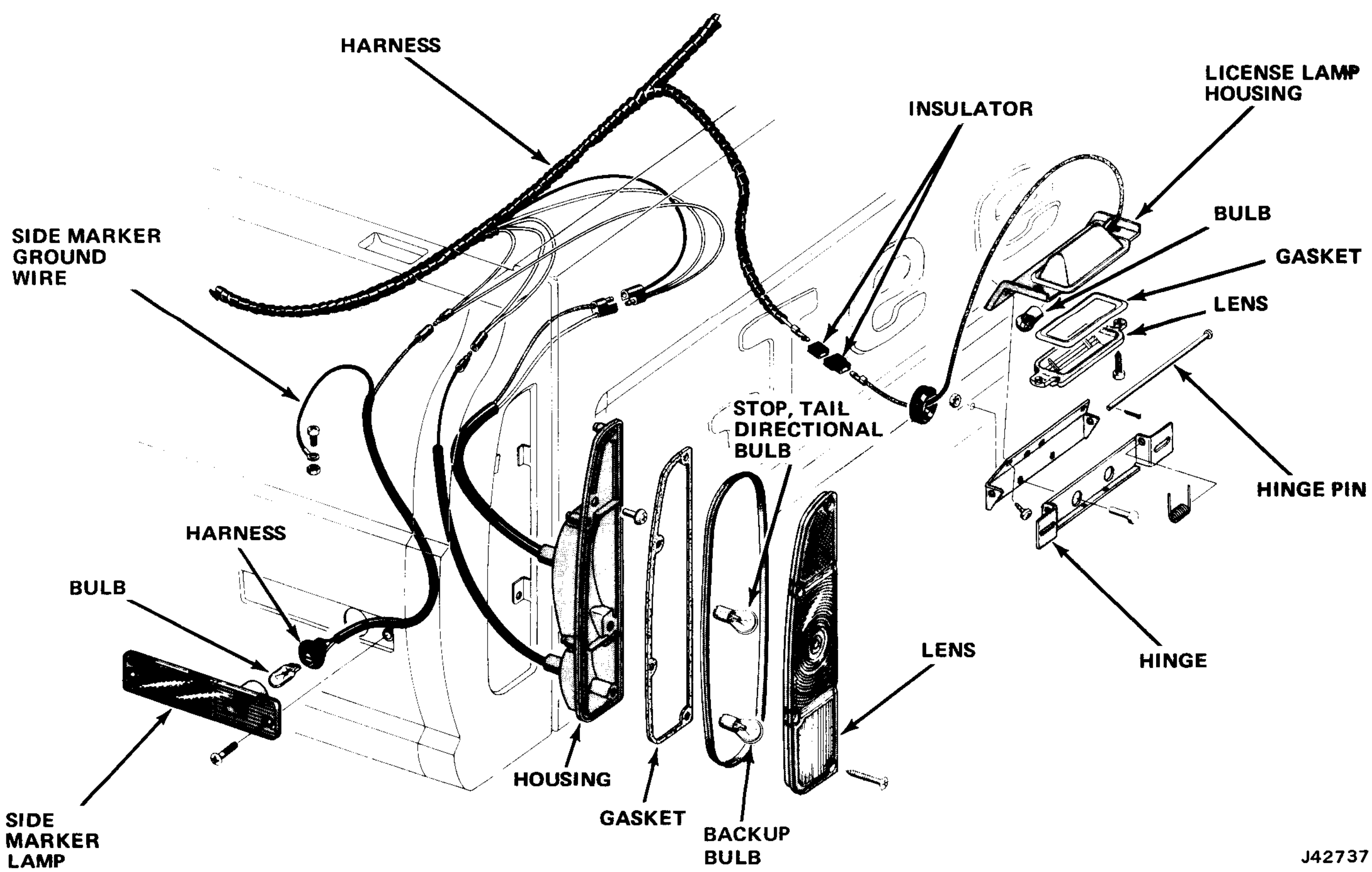


Fig. 3-82 Rear Directional, Stop, Backup, Taillamps and Side Marker—Truck

Cherokee-Wagoneer-Truck

The courtesy and dome lamps operate when the front doors are opened, being actuated by the door pillar switch which provides a ground for the circuit.

Battery feed is from the headlamp switch through a rheostat. When the doors are closed, the dome and courtesy lamps are operated by rotating the headlamp switch knob counterclockwise to the stop. The ground for the lamps is then through the headlamp switch. The dome lamp lens can be removed by squeezing the lens together to disengage the retaining tab (fig. 3-83).

A cargo lamp is offered on some Truck models (fig. 3-84). The cargo lamp bulb is replaced by removing the outer lens.

The lamp assembly can be removed after removing two attaching screws. The dome lamp bracket in the cab of Truck body styles is centrally located above the rear window.

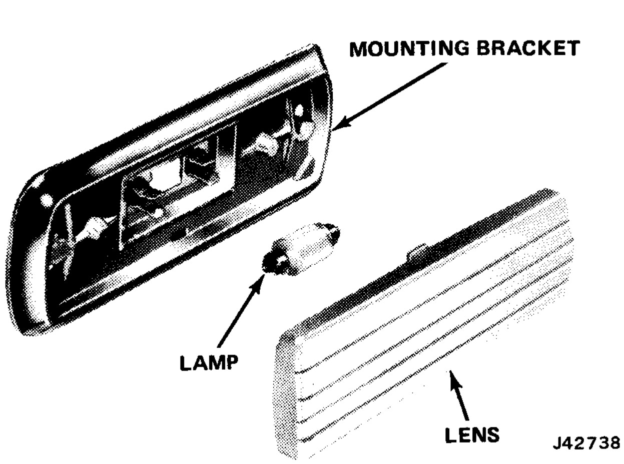


Fig. 3-83 Dome Lamp

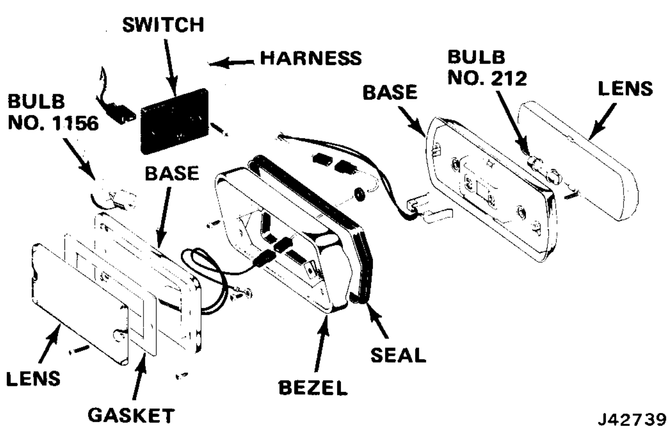


Fig. 3-84 Cargo Lamp—Truck

DIRECTIONAL SIGNAL SWITCH

The most frequent causes of failure in the directional signal system are loose connections and burned out bulbs. A flashing rate approximately twice the normal rate usually indicates a shorted out bulb in the circuit.

If a three-lamp flasher is installed in a vehicle having only two lamp bulbs per side, the lamps will light but will not flash. Conversely, if a two-lamp flasher is used on a vehicle having three lamps, the too-high current draw will cause the lamps to flash too fast.

If there is no signal at any front, rear, or indicator lamp, check the fuse.

If fuse checks okay, next eliminate flasher unit by substituting a known good flasher. If a new flasher does not cure trouble, check signal system wiring connections at fuse and at steering column connector.

NOTE: *If brake stoplamps function properly, rear signal lamp bulbs are okay.*

The directional flasher is mounted directly to the fuse panel. Refer to the wiring diagram at the rear of the manual for circuitry.

Switch Removal

(1) Disconnect battery negative cable.

(2) Remove horn contact trim cover by loosening bottom attaching screws.

(3) Disconnect horn wire from switch in steering wheel cavity by gently pulling quick-disconnect connector.

(4) Remove steering wheel nut. Note alignment of steering wheel to steering shaft index marks for later installation.

(5) Remove steering wheel with Steering Wheel Puller J-21232-01.

(6) Loosen anti-theft cover retaining screws and lift cover from column. It is not necessary to completely remove these screws as they are held on the cover by plastic retainers.

(7) Use Lock Plate Compressor Tool J-23653 to depress lock plate (fig. 3-85).

(8) Once lock plate is depressed, pry round wire snap ring from steering shaft groove.

(9) Remove Lock Plate Compressor Tool, snap ring, lock plate, directional signal canceling cam, upper bearing preload spring and thrust washer from steering shaft.

(10) Place directional signal actuating lever in right turn position and remove lever.

(11) Depress hazard warning light switch, located on right side of column adjacent to the key lock, and remove button by turning in a counterclockwise direction.

(12) Remove directional signal wire harness connector block from its mounting bracket on right side of lower column.

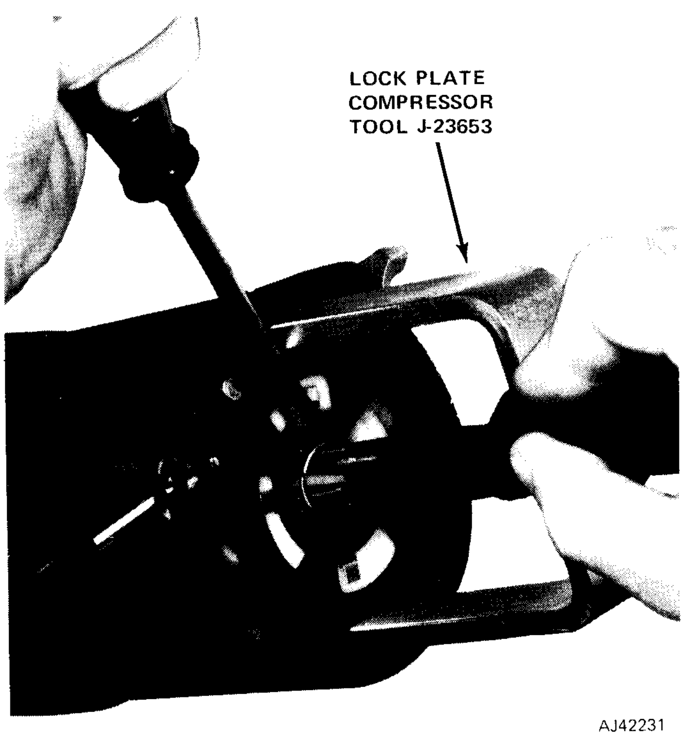


Fig. 3-85 Lock Plate Snap Ring Removal

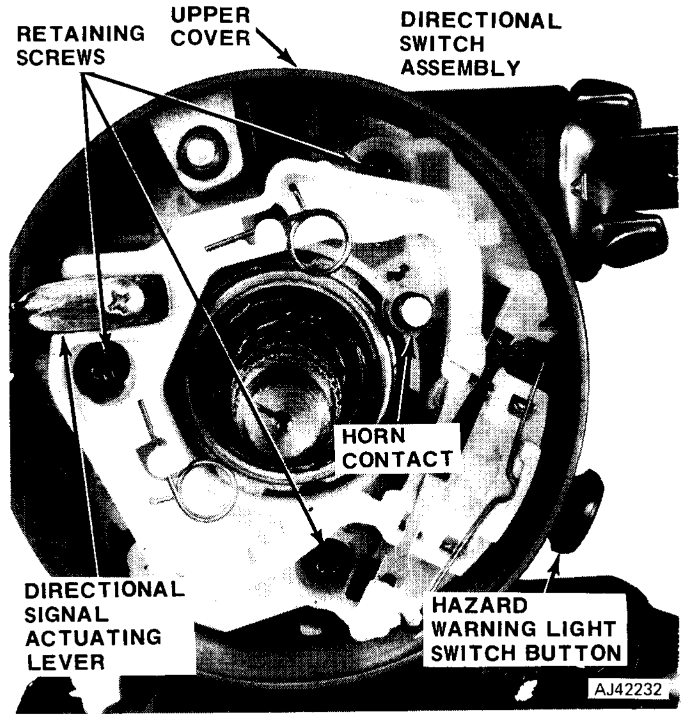


Fig. 3-86 Directional Switch

NOTE: *On vehicles equipped with automatic transmission, use a stiff wire, such as a paper clip, to depress the lock tab which retains the shift quadrant lamp wire in the connector block.*

(13) Remove directional signal switch retaining screws and pull directional signal switch and wire harness from column (fig. 3-86).

Switch Installation

(1) Guide wire harness into position and carefully align switch assembly.

NOTE: *Assure that actuating lever pivot is correctly aligned and seated in the upper housing pivot boss prior to installing the retaining screws.*

(2) Install directional signal lever and actuate directional signal switch to assure correction operation.

(3) Place thrust washer, spring, and directional signal canceling cam on upper end of steering shaft.

(4) Align lock plate splines with steering shaft splines and place lock plate in position with directional signal canceling cam shaft protruding through dogleg opening in lock plate.

(5) Install snap ring.

(6) Install anti-theft cover.

4-WAY EMERGENCY FLASHER (HAZARD WARNING)

All models are equipped with a four-way emergency flasher system. With the switch activated, the two front and two rear turn signal lights flash on and off simultaneously as do both turn signal indicator lights on the instrument clusters.

This system makes use of the regular turn signal wiring and bulbs, but has a separate supply wire, flasher unit, and off-on switch. This makes it possible when leaving a vehicle with the 4-way flasher operating, to lock the ignition switch and car doors. When the 4-way flasher is turned on, the normal directional signal supply is disconnected at the directional signal switch and a new supply circuit is connected into the switch directly from the battery. This 4-way flasher circuit comes through a special heavy-duty flasher. Since the 4-way warning flasher is of the heavy-duty type, it will flash from one to six bulbs at a constant rate. Therefore, flashing indicator lights do not necessarily mean that *all* signal bulbs are flashing.

The 4-way emergency flasher switch is a part of the directional signal switch.

To operate the system, push in the switch button. The 4-way flasher can be canceled by pulling out on the flasher switch.

As the 4-way flasher switch is part of the directional signal switch assembly, refer to Directional Signal Switch for removal or replacement procedure.

The battery feed for the 4-way flasher system is from the fuse panel.

HORNS AND HORN RELAY

The horn circuit for all Jeep vehicles consists of the horn(s), horn relay, horn contacts, and the battery.

The horn relay, located under the instrument panel, obtains current from an unfused battery source. It reduces the amount of current passing through the horn contacts in the steering column and closes the horn feed circuit when the horn contacts are closed by pressing the horn ring. The relay is encased in plastic and hangs freely from the wire harness at the left side of the instrument panel.

Testing

If the horn does not operate, check for battery voltage to the red wire with tracer connected to the horn relay No. 1 terminal. If voltage is not present, refer to the wiring diagram and trace the red wire with tracer back to the voltage source.

If voltage is present at the relay No. 1 terminal, disconnect the wire from the horn and touch the horn terminal with the hot wire. If the horn does not blow, it is defective or has a bad ground.

If the horn blows, connect all the wires and ground the horn button wire (No. 2 terminal). If the horn does not blow, the relay is defective.

If the horn blows, there is an open circuit to the horn button.

Ground the horn wire at the steering column connector. If the horn operates, the open circuit is in the steering column. If the horn does not operate, the open circuit is between the horn relay and the steering column connector.

RADIOS

GENERAL

Jeep radios are transistorized. They operate with the ignition in the ON or ACCESSORY position. All models use nonadjustable, whip-stype antennas.

AM radios are available on all Jeep models. Station selection is controlled manually on CJ models (fig. 3-87) while Cherokee, Wagoneer, and Truck models have pushbutton or manual tuning (fig. 3-88). A single speaker mounted in the instrument panel is used on all models.

AM/FM stereo radios are available on Cherokee, Wagoneer, and Truck models (fig. 3-88). A slide switch, located in the center of the radio, controls AM or FM band selection. A stereo indicator lamp, located at the right end of the station dial, lights when the radio is tuned to an FM stereo broadcast. A left-to-right balance control is located behind the tuning control knob.

Cherokee S and Wagoneer models use four speakers with the stereo radio. A speaker is mounted in each front door and rear quarter trim panel. A front-to-rear speaker fader control is used with the 4-speaker system. It is separate from the radio and mounted on the instrument panel.

Cherokee (except S models) and Truck models use a 2-speaker system with the stereo radio. A speaker is mounted in each front door.

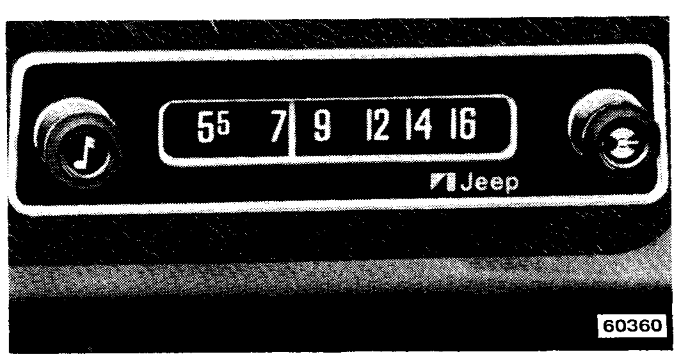


Fig. 3-87 AM Radio—CJ Models

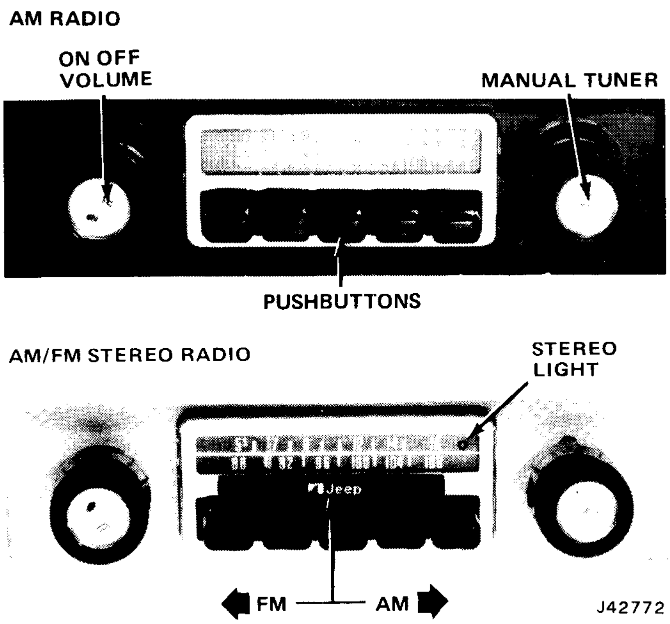


Fig. 3-88 AM and AM-FM Stereo Radio—Cherokee-Wagoneer-Truck

Antenna Trimmer Adjustment

An antenna trimmer adjustment is necessary to match the radio to the antenna. The adjustment always must be made after installation of a radio and antenna, or after any repairs to a radio.

The adjustment should also be checked whenever radio reception is unsatisfactory.

The antenna trimmer adjustment for CJ models is at the upper right corner at the rear of the radio. The trimmer adjustment is located just above the tuning control on radios in Cherokee, Wagoneer, and Truck models.

The trimmer adjustment may be made anywhere. It is not necessary to be able to receive an understandable station. The object is to obtain the most amount of noise possible while the volume control is left in a medium volume setting. Adjust the trimmer as follows:

(1) Remove inner and outer tuning control knobs.

NOTE: *AM/FM stereo radios must be switched to the AM position.*

(2) Turn on radio and allow it to warm up for several seconds.

(3) Turn tuning control knob to 1400 KC range and obtain a signal (a station or just plain static). Turn volume control to medium level.

(4) Insert a common blade screwdriver through small hole above tuning control.

(5) Turn screw left or right until most volume is obtained (*without touching volume control*).

(6) Install inner and outer tuning control knob.

Setting Pushbuttons

(1) Move vehicle outside and away from high tension power lines.

(2) Pull button out (approximately one-half inch) to unlock tuner.

(3) Select station with tuning knob. Tune for clearest reception.

(4) Push button in as far as possible (to lock tuner) and release. This station is now set for automatic tuning.

(5) Follow same procedure for remaining buttons.

Radio Polarity

When servicing the radio, the A (Red) lead must be connected to the positive side of the power source. If connected otherwise, the receiver will not operate and damage will result.

The radio is grounded internally. The ground return circuit is completed by grounding the chassis to the instrument panel. When bench testing, a ground jumper wire must be attached between the radio chassis and the negative terminal of a 12-volt battery to complete the power circuit.

DEFINITIONS OF FREQUENTLY USED TERMS

AM (Amplitude Modulation): Common system of radio broadcasting (520 to 1610 kHz).

Antenna: Device used for transmitting and receiving radio signals.

Circular Polarization: A technique of transmitting radio signals to minimize the affects of fading.

Distortion: False reproduction of the original transmitted signal.

FM (Frequency Modulation): Another system of radio broadcasting (88 to 108 mHz) with the added advantage of wider audio frequency response.

Fading: Variation of intensity of received radio signals.

Flutter: Momentary loss of received radio station; sometimes referred to as picket fencing.

Hertz: Current term of cycles per second.

Ignition Noise: Undesirable radio signals or noise that interfere with the reception of desired radio signal. Examples include the adjacent channel interference, cross-modulation, and intermodulation.

Monaural: A system utilizing a single signal on a single radio frequency (station) as distinquished from a dual channel system (FM stereo).

Multipath Reception: Signal loss or reduction due to a direct signal and a reflected signal arriving at the antenna simultaneously.

Selectivity: The ability of a radio receiver to accept the signal of one station while rejecting signals of undesirable adjacent stations.

Sensitivity: The ability of the radio receiver to receive weak stations.

RADIO RECEPTION CHARACTERISTICS

AM and FM stereo have different reception characteristiscs. The following information will help explain the normal operational characteristics of these radios.

Signal Transmission

The range of a normal hearing is approximately 30 Hz (cycles per second) to 14,000 Hz. AM has a range of 50 to 5000 Hz; FM on the other hand, covers the entire range of normal hearing. Both AM and FM are received on a regular radio as a monaural (single) signal.

FM stereo receivers are capable of receiving both monaural and FM stereophonic broadcasts. These broadcasts are sometimes referred to as multiplex.

Fading

Fading is not usually a problem with AM because of its long distance reception capability (fig. 3-89). FM, on the other hand, is limited to line-of-sight reception (25 to 40 miles) under average conditions of terrain and transmitted power (fig. 3-90). The area of good

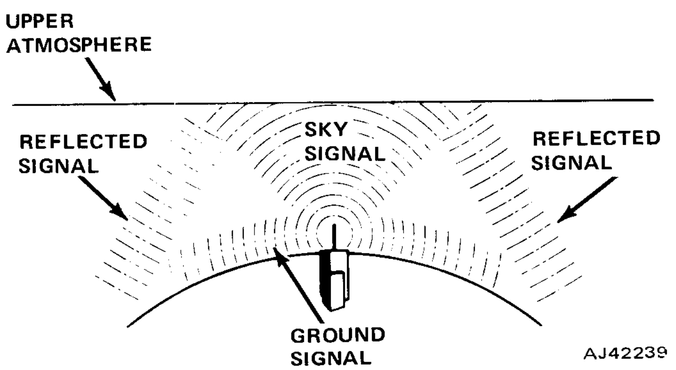


Fig. 3-89 AM Reception—Long Distance, Follows Curvature of Earth and Is Reflected by Upper Atmosphere

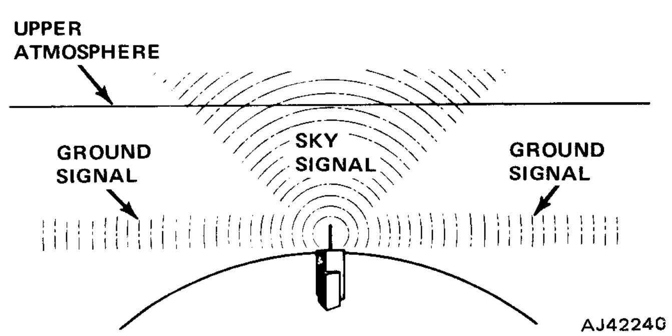


Fig. 3-90 FM Reception—Shorter Distance, Does Not Follow Curvature of Earth and Is Not Reflected by Upper Atmosphere

FM stereo reception may be even slightly less than that of regular FM because of stronger signal requirements. Figure 3-91 illustrates fading of an FM signal due to differences in terrain. Reception behind hills may be noisy (hissing, popping, etc.). This noisy reception is sometimes called "flutter" or "picket fencing."

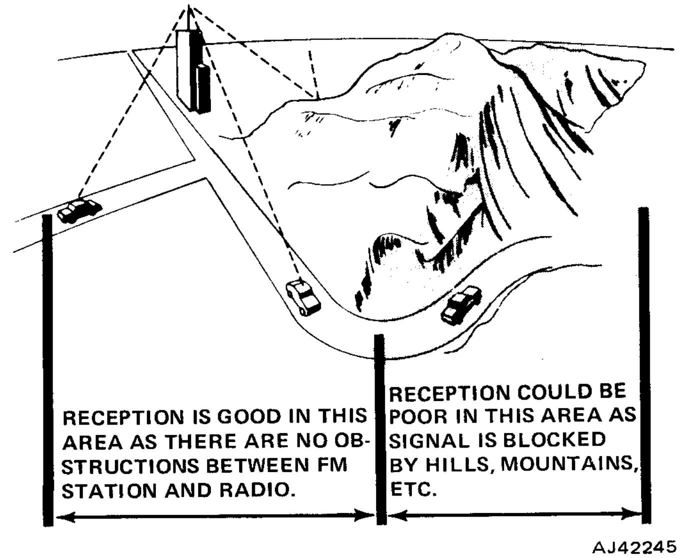


Fig. 3-91 FM Fading

Metropolitan Reception

Transmitted FM signals are easily reflected by solid objects such as buildings. This is why FM can be received under bridges and between tall buildings, whereas AM reception under the same conditions would either be reduced or nonexistent.

Multipath Reception

The fact that FM can be received quite well between tall buildings can unfortunately cause a detrimental side effect, namely multipath reception (fig. 3-92). It is caused by a direct signal and a reflected one arriving at the vehicle's antenna causing distortion, partial or complete loss of the station, or poor FM stereo reception. This type of interference is usually of short duration since the area of interference is usually only a few inches or feet across. It is mostly encountered in downtown areas.

Some FM stations use a technique known as circular or vertical polarization. This technique can improve radio performance in areas encountering multipath reception.

AM Interference

Interference and Ignition Noise

AM reception is susceptible to certain types of electrical interference. These include power lines,

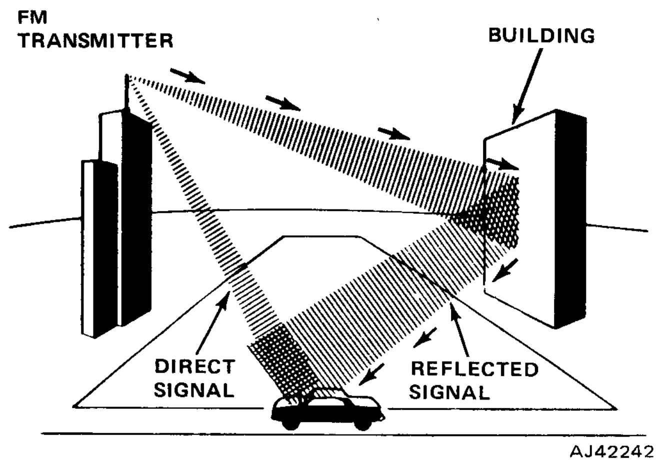


Fig. 3-92 Multipath Reception

thunderstorms, and other situations where electrical charges in the air cause disturbances resulting in buzzing and static. AM, however, does not usually suffer from ignition interference of nearby vehicles, because suppression equipment installed on the vehicle (resistive ignition wire, noise suppression capacitors, etc.) prevents ignition noise in the radio.

FM Interference

Ignition Noise Interference

FM usually does not suffer from the electrical disturbances that affect an AM receiver. FM is slightly sensitive to ignition noise generated by engines of adjacent vehicles, especially those not containing radio suppression equipment. This ignition noise is more prevalent when listening to a weaker station while driving in heavy traffic. The noise will also occur if the radio is tuned off-station slightly. To improve reception, make sure the radio is tuned for minimum noise.

Other FM Interference

Occasionally when listening to a station while driving in the vicinity of another station, especially a strong station, the possibility of receiving both stations simultaneously exists. The phenomenon is called adjacent channel interference or cross-modulation (fig. 3-92).

Using Controls Effectively

Always fine-tune the radio manually for clearest sound and minimum noise.

Weak FM stereo signals are inherently noisier than monaural ones when received on an FM stereo radio. To prevent this type of noise from being heard, the FM stereo radio automatically switches from stereo to the monaural mode. This Stereo-Indicator light will go out, both speakers will still operate, but without the stereo effect. When the signal strength increases to a noise-free level, the receiver will switch back to the stereo mode. This action is automatic and requires no adjustment by the customer.

Occasionally, conditions will be such that noise-free reception simply cannot be attained. If this occurs, set the tone control to the bass (counterclockwise) position to reduce the noise level. Later, when out of the noisy area, set the control back to its normal position.

RADIO INTERFERENCE DIAGNOSIS

The object of this diagnosis is to present a systematic approach to troubleshoot noise problems:

- Determine if the noise is normal (refer to Radio Reception Characteristics)
- Determine point of entry
- Eliminate the noise

Determine Point of Entry

There are five different ways for noise to enter a radio:

1. Antenna
2. A-line (battery feed wire to the radio)
3. Speaker leads (by themselves or from noise radiated from the other car wires)
4. Defective radio
5. Enter directly into the radio

Antenna

Disconnect the antenna. If this causes the noise to stop, the problem is reduced to three possibilities:

- A defective antenna (refer to Radio Antenna Ohmmeter Tests).
- Noise radiated upward from the dash.
- Noise radiated from the engine compartment.

Noise Radiated Upward from Dash: Can be determined by improvising a tool made from a piece of aluminum or copper screen approximately 36 inches by 12 inches (fig. 3-93).

Lay the screen across the top of the dash and attach the clips to good body ground.

To determine exactly where the noise source is, another useful tool can be improvised from an antenna lead-in cable.

To make the tool, cut or remove the lead-in from the antenna at the antenna. Remove approximately 2 inches of the outer plastic covering and the woven shield (fig. 3-94).

(1) Disconnect original antenna lead-in and plug-in test probe.

(2) Turn radio on and use probe to discover the hot spot. Do not touch end of probe with your hand,

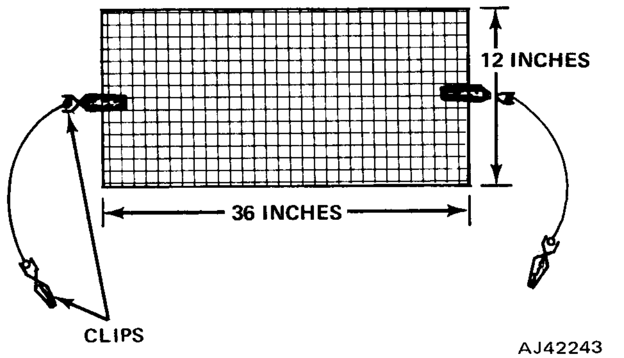


Fig. 3-93 Noise Suppression Tool

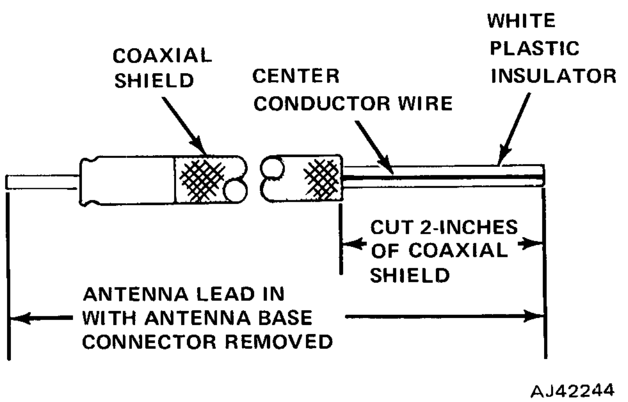


Fig. 3-94 Noise Probe

as this will give a wrong indication. As probe comes closer to noise source, loudness of noise will increase.

(3) If source is found to be a switch, connect a 0.5 mfd capacitor from battery feed side of switch to a good chassis ground.

(4) Gauges and sender units generally can be silenced by installing 0.5 mfd capacitors at their terminals.

(5) If source is found to be a wire, try rerouting wire. If this is not successful, a 0.5 mfd capacitor can be connected from wire to ground or wrap a piece of screen around wire or harness and attach one or more ground leads to screen. It also may be possible to screen off the area found to be radiating noise and ground screen.

(6) If noise is found to be a motor, install a 0.25 mfd coaxial (feed-through) capacitor.

Noise Radiated from the Engine Compartment:

These noises can be separated into three areas:

- Primary Ignition Noise
- Secondary Ignition Noise
- Alternator Whine (Antenna)

Primary Ignition Noise: Generally affects the AM band and usually appears as:

- Frequency varying with rpm
- Loudness varying with rpm

It stops instantly when ignition key is shut off and turned to accessory position.

The first two classifications are usually the result of a poor ground on the control unit or a control unit wire routing problem.

Cleaning of the control unit ground may solve the problem.

An extra long antenna lead-in may be prepared as shown in figure 3-94 and used as a hot-spot probe.

Remove the ignition coil and its mounting bracket. Clean the paint off the bracket and the engine block, then reassemble tightly (fig. 3-95). In many cases, this helps reduce the amount of interference radiated from the ignition system.

Be sure to check the coil polarity. The distributor must be connected to the negative side of the coil.

Secondary Ignition Noise: Will always affect FM but, if severe, it may also affect AM. Normally one of the following conditions will be found in the radio:

- Motor noise across FM band (and possibly on AM)
- Motor noise (loud) off station but not on a strong station

NOTE: *When these conditions exists in the radio, the problem is more than likely a result of:*

- Distributor cap carbon ball eroded away or cracked, or loose cap
- A rotor with a burned carbon contact spot
- A secondary wire not seated in the coil or distributor
- A defective coil
- An oily film on some of the lead terminals
- Copper core secondary wiring
- Defective or improper spark plugs

If a wire was found not seated, remove the wire and check for a carboned end. It is not advisable to repair an end terminal on carbon core wire, replace the entire cable.

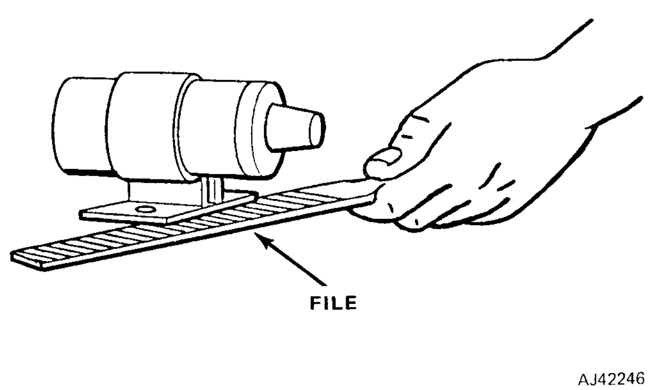


Fig. 3-95 Cleaning Coil Bracket

A tuneup may cure most of the problems.

If the noise in question sounds like one or two cylinders and definitely not all of them, then the problem is after the coil. Once again, use the probe which plugs into the radio. Have someone sit in the vehicle and listen to the radio while going from plug to plug with the probe. The person in the vehicle should notice an appreciable increase in the plug noise when the defective plug is reached.

Install resistor spark plugs when experiencing spark plug noise. The resistor equivalent of the Champion N-12Y plug is the XN-12Y or RN-12Y plug. If the vehicle has copper core secondary wiring, these wires should be replaced with carbon core resistor wire.

Alternator Whine: Can be described as an annoying, high-pitched whistle or squeal that increases and decreases with engine rpm. Methods of getting rid of alternator whine are:

(1) Provide a good fender ground (fig. 3-96).

(2) Install good grounding strap.

(3) Run offending wire through a shielded (grounded) cable.

(4) Clean slip rings and make sure brushes are making good contact.

(5) Align hood to keep fender-to-hood gap as close as possible.

(6) Install a 0.5 mfd coaxial capacitor at the alternator output terminal. Be sure it is rated to handle the maximum alternator current.

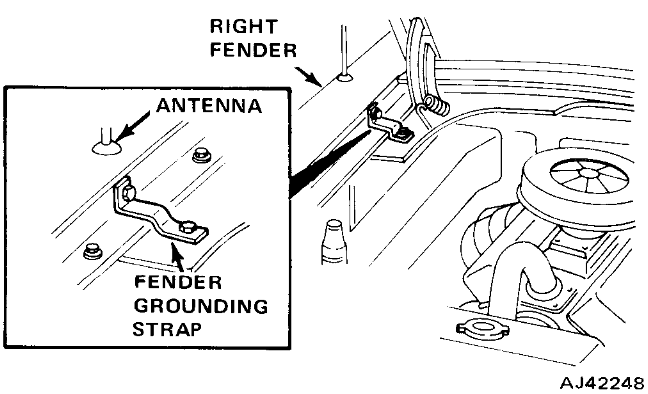


Fig. 3-96 Typical Fender Ground Strap Installation

A-Line (Battery Feed Wire to Radio)

If disconnecting the antenna did not rid the radio of the noise, the noise is probably on the A-line.

Motor noise on the A-line is usually the result of voltage spikes on this line being so large that the input filter circuit in the radio cannot handle them. There are two ways to handle this problem.

- Find out what is causing the noise on the line and eliminate it.
- Add external filters to reduce the spikes to a point where the radio filter can handle the spikes.

A grounded capacitor touched to all hot electrical connections will often identify the offenders (fig. 3-97). The antenna probe (fig. 3-93) also can be used to find hot spots.

In general, any adjacent metal parts which are separated by mastic or paint must be connected together electrically.

Effective bonding requires more than physically clean surfaces and self-tapping screws. Tooth-type lockwasher must be used to cut into the surface layers of metal. Grounding straps must be as short and heavy as possible.

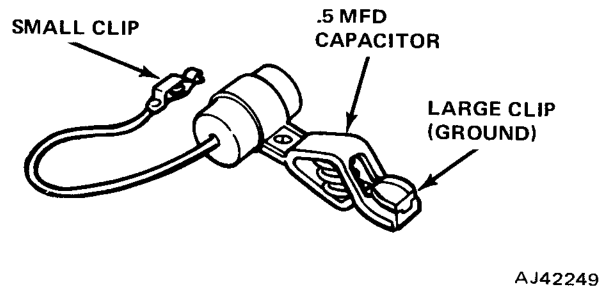


Fig. 3-97 Noise Eliminator Test Device

A-line noise is normally the result of:

- Alternator whine
- Wiring harness too close to ignition wiring
- Radio noise suppressor
- Poor radio ground

Alternator Whine: Does not stop instantly when the key is turned quickly to the accessory position at fast idle. It is a high-pitched whine which increases with rpm. Correct alternator whine as follows:

(1) Install 0.5 to a 2 mfd bypass capacitor from alternator output terminal to ground (fig. 3-98).

(2) Install coaxial capacitor in alternator output wire (fig. 3-98).

(3) Install noise suppressor kit (part no. 8121771).

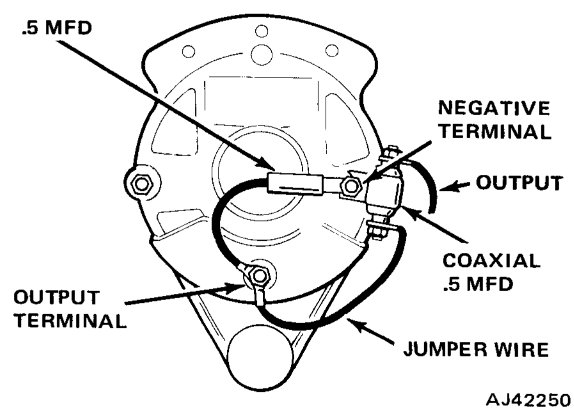


Fig. 3-98 Alternator Noise Suppression

(4) Replace alternator diodes.

(5) Install a 0.5 mfd coaxial capacitor in alternator brush feed wire.

Wiring Harness: Noise normally can be corrected as follows:

(1) Relocate wiring away from ignition wires.

(2) Install 0.5 mfd capacitors on each fuse panel lead. Be sure capacitor is grounded (fig. 3-99).

(3) Relocate wiring away from tachometer and ammeter wiring.

(4) Remove loops from harness wires.

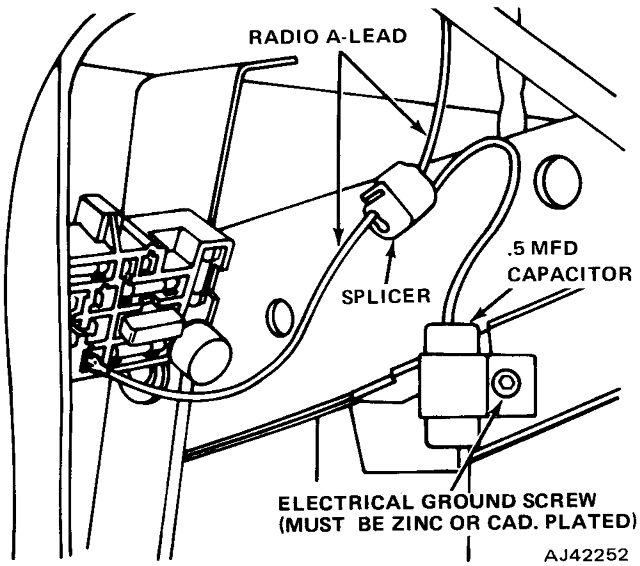


Fig. 3-99 Wiring Harness Noise Suppression

Radio Noise Suppressor: A noise suppressor must be installed on every Cherokee, Wagoneer, or Truck equipped with a radio. This suppressor (choke) is plugged into the back of the printed circuit board. Be sure the choke has not been installed over the copper strip that is installed on the vehicles not originally equipped with a radio.

Tap on the dash with the ignition on and in the accessory position. If noise only occurs in the on position:

(1) Remove radio choke.

(2) Remove plastic covering.

(3) Unsolder one end of coil wire and remove approximately 6-1/2 inches of wire.

(4) Resolder wire end.

(5) Wrap coil with several turns of electrician tape and install choke.

Poor Radio Ground: To check for a poor ground, attach a jumper wire to the radio case and ground to a good chassis ground. If there is no change in radio noise, the radio has a good ground. Check for loose mounting screws.

Speaker Leads

To determine if speaker leads are inducing or picking up noise, perform one or both of the following:

(1) Separate the speaker coil wires by installing a loom over each wire.

(2) Install a 0.002 mfd thumbnail type capacitor across the speaker.

Speaker-induced noise normally will not occur on front mounted one or two speaker systems. It will more likely occur on four speaker systems and when the fader control is in the midposition.

Defective Radio

Exchange with a known good radio to determine if the radio is defective.

Enter Directly into the Radio

(1) Be sure radio has good ground.

(2) Tighten all radio chassis screws.

(3) Center punch cover to make good electrical contact with front of case (fig. 3-100).

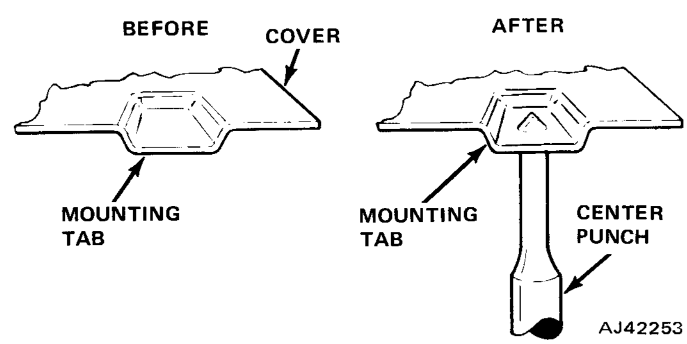


Fig. 3-100 Center Punching Covers

Wheel and Tire Static

Wheel static is another source of interference. This is a running noise most likely to be encountered when the vehicle is in motion, on a hard, dry surface road. The noise will remain when the vehicle is coasting with the engine and all electrical equipment turned off. The static occurs in the front wheels due to insulating film produced by the lubricant in the wheel bearings. The remedy is to install collector springs to dissipate the static (fig. 3-101).

In some instances, static discharges take place between the tire and the road surface, which cannot be eliminated with collector springs. An anti-static powder kit is available from radio supply houses which applies conducting material to the inside surface of the tire to eliminate noise from this source. Tire static can be checked by washing the tire with water. The water provides a conduction path to ground for the discharge. Tire static is most likely to be encountered during hot and dry seasons.

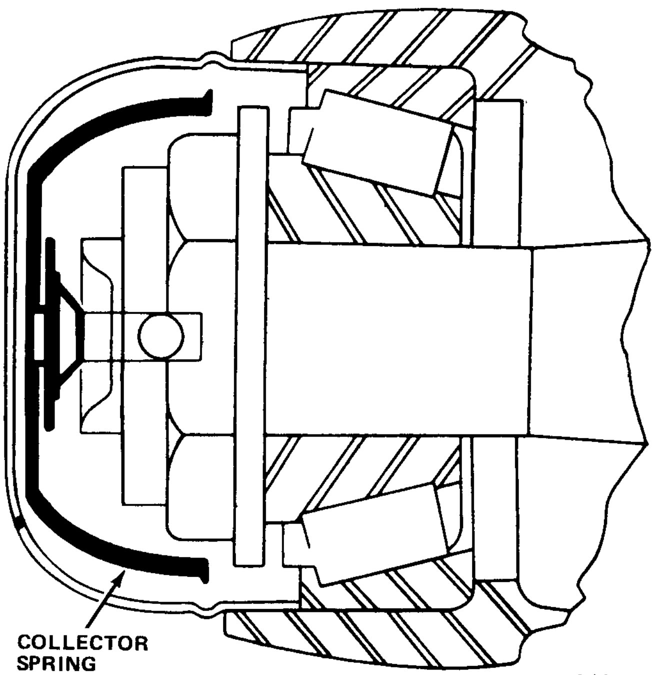


Fig. 3-101 Collector Springs

Turn and Stop Signals

The flasher in the turn signals and the switch in the stop signal may cause popping noises in the radio. In most cases, the noises are interference due to arcing at the contacts. The cure is a 0.5 mfd bypass capacitor installed at the battery connection of the switch or the flasher. It is less likely, but possible, that the low frequency components of the interruptions are reaching the audio stages of the radio. The test is to check if the noise is present with the volume control turned down. If so, install a 1000-mfd capacitor.

Horn Noise

The diagnosis and cure for a growling noise in the radio when the horn is operated is a 0.5 or 0.25 mfd capacitor. Be sure the capacitor case is grounded. The suppressor capacitors are installed at the point where the battery lead feeds the horn relay.

Accessories

Electric windshield wipers, blowers or fans, window openers, or any brush-type motors generally can be suppressed by installing 0.25 mfd capacitors at their terminals.

RADIO REPLACEMENT

CJ Models

(1) Disconnect negative battery cable.
(2) Remove radio control knobs, attaching nuts, and bezel.
(3) Disconnect radio support bracket.
(4) Remove defroster hose.
(5) Remove radio by tilting it downward.
(6) Disconnect antenna lead, speaker wires, and feed wire.
(7) Connect antenna lead, speaker wires, and feed wire to replacement radio.
(8) Install radio in instrument panel.
(9) Connect radio support bracket.
(10) Install radio bezel, attaching nuts, and control knobs.
(11) Install defroster hose.
(12) Connect battery negative cable.

Cherokee—Wagoneer—Truck

(1) Open glove box door and remove glove box liner and lock striker.
(2) Remove antenna lead.
(3) Disconnect feed wire from fuse panel.
(4) Disconnect rear support bracket from radio.
(5) Remove radio control knobs and attaching nuts.
(6) Push radio back to clear instrument panel and remove it through glove box opening.
(7) Install radio in instrument panel.
(8) Install radio attaching nuts and control knobs.
(9) Connect rear support bracket.
(10) Connect feed wire to fuse panel.
(11) Connect antenna lead.
(12) Install glove box liner and lock striker.

RADIO BULB REPLACEMENT

All Models

(1) Remove radio.
(2) Remove radio dial cover retainers and cover.
(3) Rotate manual tuning control to move pointer to extreme left or right.
(4) Remove dial light deflector clips and deflector.
(5) Remove bulb and bulb diffuser.
(6) Install diffuser on bulb and install bulb.
(7) Install dial light deflector.
(8) Install dial cover.
(9) Install radio.

RADIO ANTENNA

All antennas must have good ground to eliminate static noises. The mast of the antenna is not grounded except through the radio. The base of the antenna is grounded to the vehicle sheet metal. The coaxial shield (the wire mesh) surrounding the center conductor wire of the antenna lead-in cable is grounded to the radio and the antenna base.

Tests

There are three antenna tests to be made with the use of an ohmmeter:

- Mast to ground

- Tip of mast to tip of conductor
- Body ground to battery ground

Refer to figure 3-102.

Mast-to-Ground Test

This test verifies that the antenna is making electrical contact with the radio and that the mast is insulated from the base.

(1) Touch one ohmmeter prod to tip of antenna mast and other prod to antenna base (0-1). With antenna installed in radio, there should be continuity (approximately 15 ohms).

(2) Disconnect antenna from radio and repeat step (1). There should not be any continuity with antenna disconnected from radio.

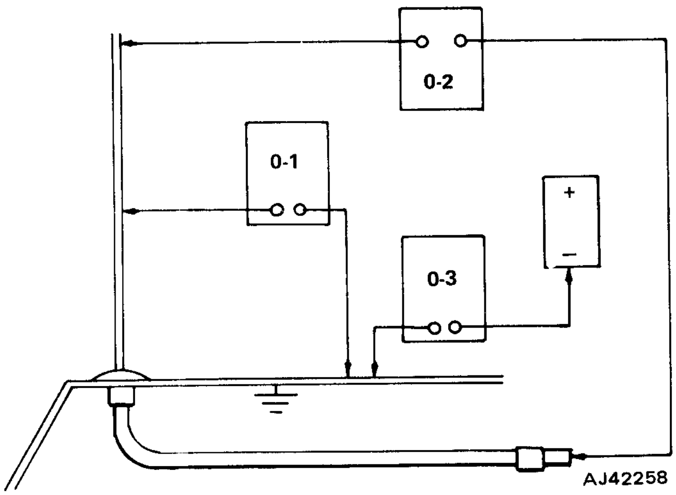


Fig. 3-102 Antenna Ohmmeter Test

Tip of Mast-to-Tip of Conductor Test

This test verifies that the antenna does not have an open circuit.

(1) Disconnect antenna from radio.

(2) Touch one ohmmeter prod to mast tip and other prod to tip of lead-in (part inserted into the radio) (0-2). There should be continuity (fraction of an ohm).

Body Ground-to-Battery Ground Test

This test verifies that the antenna base has a good ground. Touch one ohmmeter lead to the fender and the remaining prod to the battery post (0-3). The resistance should be extremely low (less than one ohm).

RADIO SPEAKERS

Speakers have an impedance of either 3.2 or 8 ohms. A speaker should be replaced with the proper part number speaker. If the exact replacement is not available, select a speaker which matches the ohm value stamped on the radio chassis with a black ink stamp.

AM/FM stereo radios are more critical in the selection of a speaker than are AM radios. A noticeable deterioration in sound will be noticed if the correct speaker is not used.

Stereo speakers are paired together for a truer stereo sound, right front with right rear, left front with left rear.

Speaker Repairs

A speaker, once it has been damaged, is usually not repairable and should be replaced with a new unit. Defective speakers usually have one or more of the following symptoms:

- Loose mounting.
- Screws or other objects stuck to back of magnet.
- Audio distortion, particularly on the low frequency notes and at high volume.
- Rattles and buzzes caused by foreign material hitting or rubbing against the speaker cone.
- Raspy noises caused by foreign matter inside the speaker restricting free movement of the speaker cone.
- Muffled sound caused by speaker opening obstruction.

Use a light to check the speaker opening(s).

If the entire speaker is not visible through the speaker grille openings, remove the obstruction as follows:

Front Door Speakers

(1) Remove door trim panel lower screws.

(2) Carefully lift the door trim panel away from door to expose speaker.

(3) Cut out excess water dam paper around speaker.

(4) Install door trim panel lower screws.

NOTE: *Be sure the speaker mounting screws are tightened securely.*

SPEAKER HARNESS TEST

Ground Condition

(1) Disconnect speaker feed wires at radio connector and each individual speaker.

NOTE: *When reconnecting the speaker harness to the radio, be sure the antenna lead-in cable is fully engaged in the radio socket.*

(2) Connect one lead of an ohmmeter to the speaker feed wire and the other

The speaker is located to the right of the radio. lead to a good ground. An infinity reading should be indicated. Check each individual speaker wire in this manner.

(1) If resistance is indicated on the ohmmeter, the wire being checked is grounded.

NOTE: *Grounded speaker harnesses are generally caused by screws pierced through wire harness.*

Short Condition

(1) Disconnect speaker feed wires at the radio connector and at each individual speaker.

(2) Connect ohmmeter leads to speaker feed wires at the radio connector.

(3) An infinity reading should be indicated.

(4) If resistance is indicated on ohmmeter, the feed wires being checked are shorted.

Speaker Test

Speakers may be isolated for grounds by testing the impedance with an ohmmeter. The specified value should match the ohm value stamped on the radio chassis.

Radio Speaker Replacement

CJ Models

To remove the speaker, remove the four attaching nuts from the mounting studs.

Cherokee-Wagoneer-Truck

The AM speaker is located above the radio. To remove the speaker, remove the radio, then remove the four attaching nuts from the speaker mounting studs.

On vehicles equipped with a stereo radio, interior trim panels must be removed for access to the speaker. Refer to Section 15 for trim panel service procedures.

TAILGATE WINDOW DEFOGGER

GENERAL

The electrically heated tailgate window grid consists of two vertical bus bars and horizontal rows of heating elements of silver bearing, ceramic enamel compound that is fused to the inside surface of the tailgate glass. A controls witch, pilot lamp, timer-relay, and wire harness complete the circuit.

Braided wire, soldered to each bus bar at 2-1/2-inch intervals, serves as the electrical feed and ground for the grid. The grid feed wire is attached to the timer-relay, mounted inside the tailgate. The feed to the relay is supplied by a wire attached to the fuse panel power tailgate terminal (fig. 3-103).

A separate control circuit, connected to the heater control switch, operates the relay and timer in the relay.

When the control switch, located on the instrument panel, is activated (with ignition switch on, the relay contacts will close. The timer in the relay will operate the defogger for about 8 to 12 minutes, depending on the ambient temperature, or until the control switch or ignition switch is turned off. The pilot lamp indicates system operation.

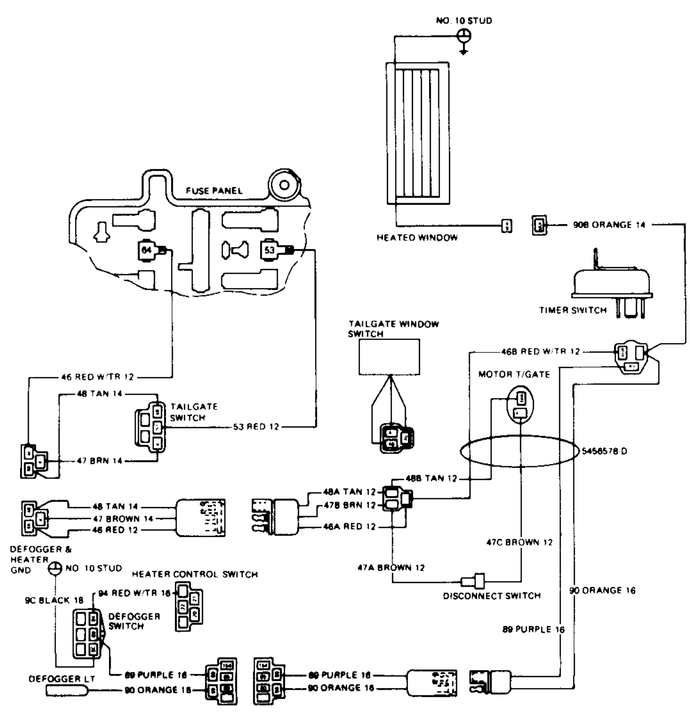


Fig. 3-103 Heated Rear Window Wiring Diagram

NOTE: *If the defogger switch must be replaced, both it and the electric tailgate window switch must be replaced since they are serviced as as an assembly.*

TESTING

Switch Test

(1) Turn ignition switch on and press defogger switch.

(2) Disconnect optional equipment wiring harness at connector under dash. Connect a 12-volt test lamp from purple wire (89) to a good ground (fig. 3-103). Test lamp should light.

(3) Shut off defogger switch and test lamp should not light.

(4) To test indicator light, disconnect orange wire from lamp. Connect a jumper wire from accessory terminal of fuse panel to orange wire. With ignition switch turned to ACC position, the lamp should light.

Relay Test

(1) Remove tailgate trim panel and access hole cover.

(2) Disconnect three-wire connector plug from timer-relay (fig. 3-103).

(3) Connect a jumper wire from fuse panel accessory terminal to X-terminal on timer-relay.

(4) Connect another jumper wire from fuse panel accessory terminal to red wire with tracer terminal of switch.

(5) Connect third jumper wire from purple wire terminal of switch to P-terminal of timer-relay.

(6) Connect a 12-volt test lamp from L-terminal of timer-relay to a good ground.

(7) Turn ignition switch to ACC position. Test lamp should not light.

(8) Press defogger switch. Test lamp should light and remain on for 8 to 12 minutes. This test should be performed with a fully charged battery. If switch or timer-relay does not function as described, replace individual unit. If timer-relay does not shut off when key is turned off, replace switch.

Grid Test (fig. 3-104)

When a grid is inoperable due to an open circuit, the area of glass normally cleared by that grid will remain fogged or iced until adequately warmed by the adjacent grids. Use the following procedure to locate a broken grid.

(1) With the engine running at idle, press the tailgate window defogger switch. The defogger lamp should glow, indicating defogger operation.

NOTE: *The feed wire is connected to the right side (passenger side) of the window and the ground connection is on the left side of the window.*

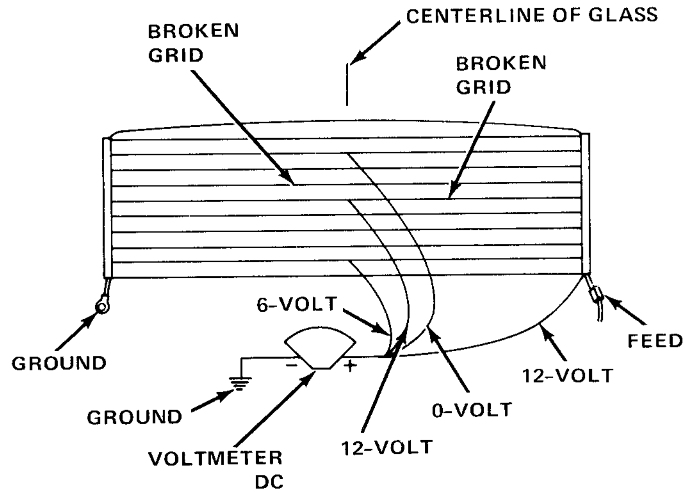


Fig. 3-104 Voltmeter Connections and Voltage Drop for Grid Continuity

(2) Use a 12-vdc voltmeter and contact the positive lead of the voltmeter to the right side (feed) vertical bus element on the inside surface of the glass and contact the negative lead to the left side (ground) bus element. Voltage drop indicated on the meter should be 11 to 13 volts. Connect the negative lead of the voltmeter to a good ground—the meter reading should remain the same.

(3) Keep the negative lead connected to ground. Use the positive lead and carefully contact each grid at approximate centerline of the window.

(4) A voltage drop of one-half the full amount, approximately six volts, indicates a good grid or closed circuit.

(5) A full voltage drop of 12 volts at the centerline indicates a break in the grid between the positive lead and ground.

(6) No voltage drop (0 volts) at the centerline indicates a break in the grid between the centerline and the voltage source or feed.

(7) The exact location of the break can then be pinpointed by moving the positive lead to the left or right along the grid until an abrupt change in the voltage reading is noticed.

GRID REPAIR

Once a broken or open grid is located, repairs can be accomplished using the grid repair kit in accordance with the following procedure.

(1) Using suitable marking pencil, mark location of broken or open grid on exterior surface of glass.

(2) Using fine steel wool, lightly rub area to be repaired (inside of tailgate window). Clean area with isopropyl alcohol (rubbing alcohol).

(3) Attach two strips of cellulose tape (inside of tailgate window) above and below break in grid as shown in figure 3-105.

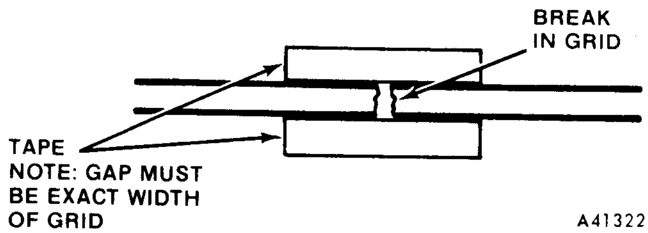


Fig. 3-105 Tailgate Window Defogger Grid Repair

(4) Mix repair coating until uniform in consistency, with silver particles mixed throughout fluid, and apply coating to break in grid with small brush furnished in kit. Apply a heavy coat of mixture, extending approximately 1/4 inch on either side of break.

(5) Start engine and press defogger switch. Run engine for one minute. Turn ignition switch off.

(6) Apply a second heavy coat of mixture to break in grid, extending about 1/4 inch on either side of break.

(7) Start engine and press defogger switch. Run engine until defogger completes cycle (pilot light goes off). Turn ignition switch off.

(8) Remove cellulose tape from inside of tailgate window.

(9) Check repaired area for continuity. Do not touch repaired area.

CAUTION: *Do not clean repaired area for 24 hours. Then clean inside of tailgate window with liquid window cleaner.*

(10) Clean pencil markings from exterior surface of glass.

ELECTRICALLY OPERATED TAILGATE WINDOW

GENERAL

An electrically operated tailgate window is offered on the Cherokee and Wagoneer Models. When checking for tailgate window motor operation, it is necessary to isolate the problem to one of the two operating circuits: (1) tailgate window operation from instrument panel switch and (2) tailgate window operation from tailgate window switch.

Operation

Instrument Panel Switch

Voltage is supplied from the ignition switch through a 30-amp circuit breaker in the fuse panel to instrument panel tailgate window switch (fig. 3-106).

NOTE: *If the vehicle is equipped with a tailgate window defogger, the defogger and tailgate switches are serviced as an assembly. They cannot be replaced separately. Both switches must be replaced when either is defective.*

Tailgate Window Switch

Voltage is supplied directly from the battery through a 30-amp circuit breaker in the fuse panel to the red (No. 46) wire of the tailgate window switch (fig. 3-107).

Testing

Instrument Panel Tailgate Window Switch

(1) Turn ignition switch to on position.

(2) Using a 12-vdc test lamp, connect one end of test lamp to ground and place probe to red (No. 53) wire of switch (fig. 3-106). If lamp lights, voltage is present at switch. If lamp does not light, repair problem in feed circuit before proceeding.

(3) Place test lamp probe to brown (No. 47) wire of switch. Move switch to up position. If lamp lights, proceed to step (4). If lamp does not light, replace switch.

(4) Place test lamp probe to tan (No. 48) wire of switch. Move switch to down position. If lamp lights, proceed to Tailgate Window Switch Test. If lamp does not light, replace switch.

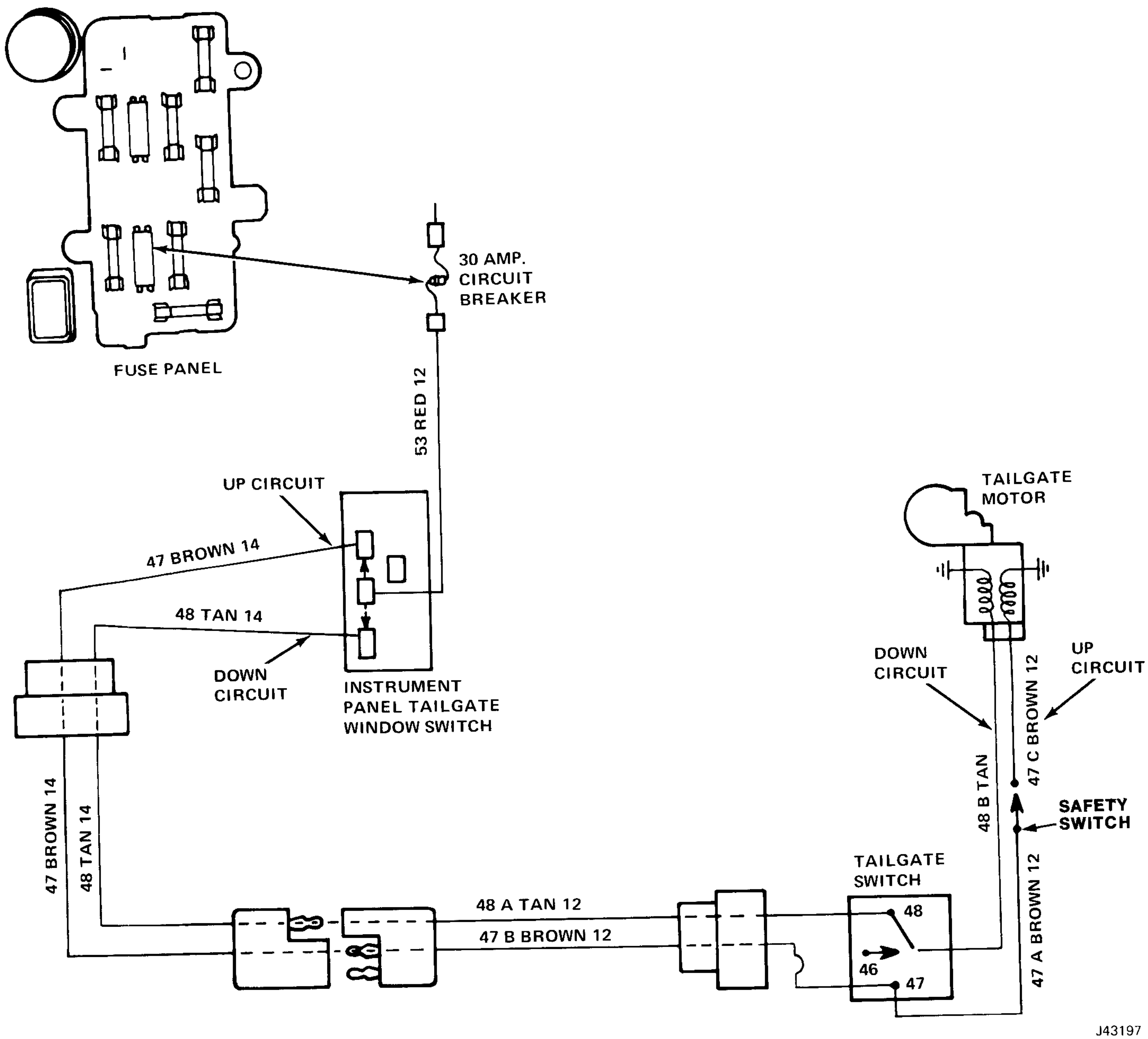


Fig. 3-106 Instrument Panel Tailgate Window Switch Circuitry— Cherokee-Wagoneer

Tailgate Window Switch

(1) Using a 12-vdc test lamp, connect one end of test lamp to ground and place probe to red (No. 46) wire of tailgate window switch (fig. 3-107). If lamp lights, proceed to step (2). If lamp does not light, repair problem in feed circuit before proceeding.

(2) Place test lamp probe to tan (No. 48A) wire of tailgate switch. Turn tailgate window switch key to down position. If lamp lights, proceed to step (3). If lamp does not light, replace switch.

(3) Place test lamp probe to brown (No. 47B) wire of tailgate switch. Turn tailgate window switch key to up position. If lamp lights, proceed to next test. If lamp does not light, replace switch.

Tailgate Window Safety Switch

(1) Using a 12-vdc test lamp, connect one end of test lamp to ground and place probe to brown (No. 47A) wire of safety switch (fig. 3-107). Turn tailgate window switch to up position. If lamp lights, voltage is present at switch. If lamp does not light, repair feed circuits as necessary.

(2) Place test lamp probe to brown (No. 47C) wire at switch. Turn tailgate window switch to up position

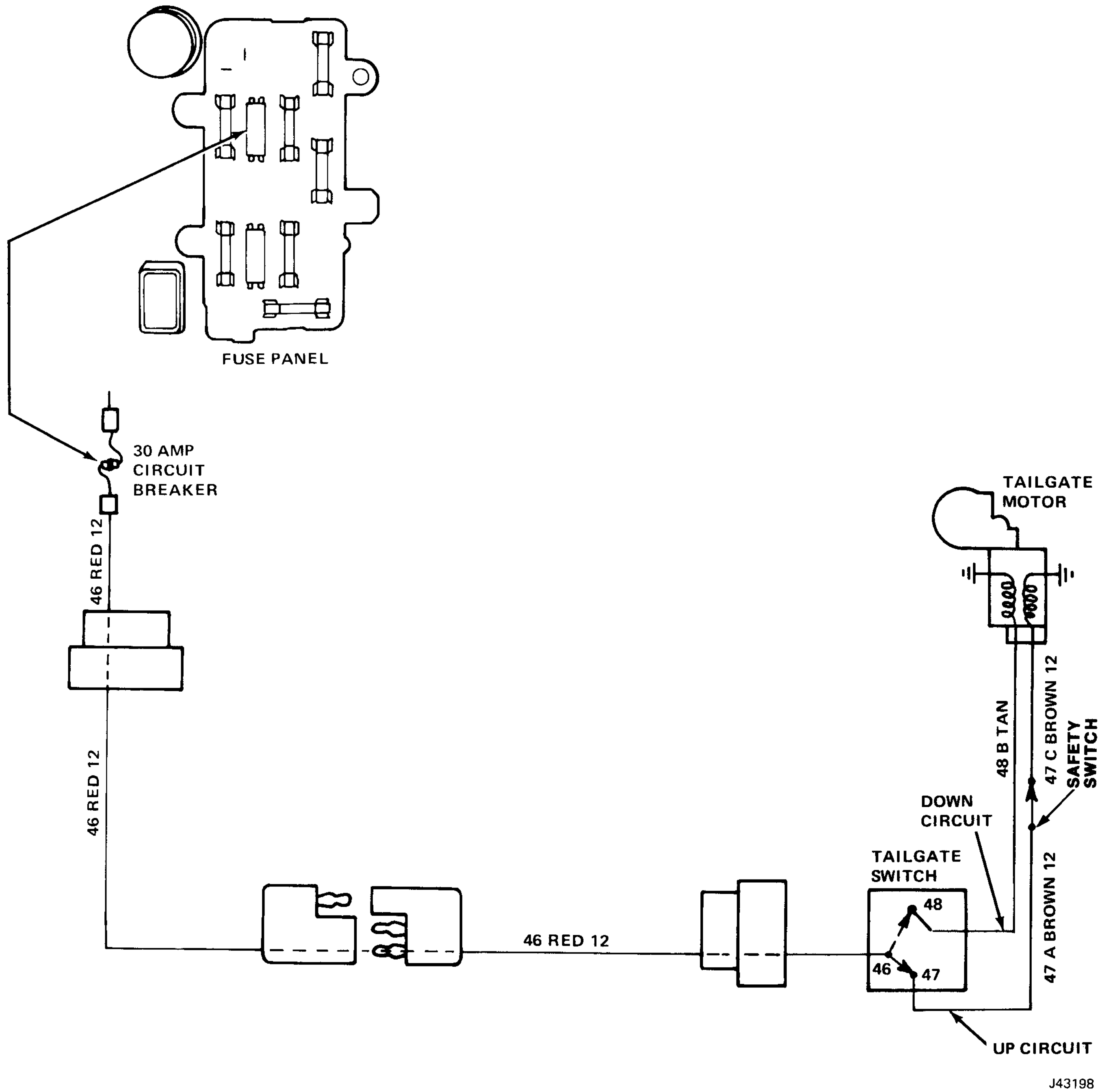


Fig. 3-107 Tailgate Window Switch Circuitry—Cherokee-Wagoner

and close safety switch. If lamp lights, proceed to next test. If lamp does not light, replace switch.

Tailgate Window Motor

NOTE: *Tailgate window motor must be grounded.*

(1) Using a 12-vdc test lamp, connect one end of test lamp to ground and place probe to tan (No. 48B) wire at electrical motor (fig. 3-107). Turn tailgate window switch to down position. If lamp lights and motor does not operate, replace motor. If lamp does not light, check feed circuit to motor and repair as necessary.

(2) Place test lamp probe to brown (No. 47C) wire at electric motor. Close safety switch. Turn tailgate window switch to up position. If lamp lights and motor does not operate, replace motor. If lamp does not light, check feed to motor and repair as necessary.

Electric Motor Removal and Installation

For electric tailgate removal, refer to Section 16 of this manual.

CRUISE COMMAND

GENERAL

Cruise Command automatic speed control senses car speed through the speedometer cable and uses engine intake manifold vacuum to regulate the accelerator and automatically maintain any preset cruising speed between 30 and 85 mph.

The Cruise Command control is an integral part of the directional switch lever and consists of two separate switches. The first is the OFF-ON and RES (resume) slide switch located on the directional switch lever. The second switch is a pushbutton switch located at the end of the directional switch lever.

To engage the speed control, move the slide switch to the ON position and accelerate to the desired speed. Press the pushbutton on the end of the directional switch lever and release. The speed control system will now maintain the selected speed. The system will automatically disengage when the brake pedal is lightly depressed.

The speed control can be re-engaged automatically to the previously selected speed by accelerating to 30 mph and moving the slide switch to the RES position and releasing the switch. When the RES function is used, the rate of acceleration is regulated by engine intake manifold vacuum; therefore, the rate of acceleration cannot be adjusted. On the large displacement V-8 engines, the acceleration rate will be firm.

WARNING: *Cruise Command should not be used when driving on slippery roads.*

NOTE: *When the ignition or slide switch is moved to the OFF position, the preset speed of the RES function is canceled and must be reset when the system is reactivated.*

The Cruise Command can be set at a higher speed than initially selected by accelerating to the desired speed and then depressing and releasing the pushbutton. A lower controlled speed can be achieved by lightly pressing the brake pedal, momentarily, allowing the car to slow to the desired speed and then pressing and releasing the pushbutton.

COMPONENTS

The system is comprised of five basic components: the regulator, the relay, the vacuum servo, the control switch, and the release switch.

Regulator

The regulator meters vacuum to the servo. It senses speed through the speedometer cable located between the transmission and regulator. The flyweight-type governor reacts to the cable speed and engages the low speed switch at approximately 30 mph. When the low speed switch is closed, the driver may engage the Cruise Command system.

The regulator is serviced as an assembly.

Relay

The relay, located beneath the instrument panel, is energized when the ignition switch is turned on and prevents a battery drain when the ignition is turned off.

Vacuum Servo

The vacuum servo, a neoprene bellows, receives the modulated vacuum and actuates the throttle to control the car speed.

Control Switch

The control switch, which is an integral part of the turn signal lever, when actuated, energizes either the solenoid valve or the coupling coil, or both, thereby controlling speed.

Release Switch

When the brake pedal is depressed slightly, the brake switch de-energizes the solenoid valve disengaging the speed control.

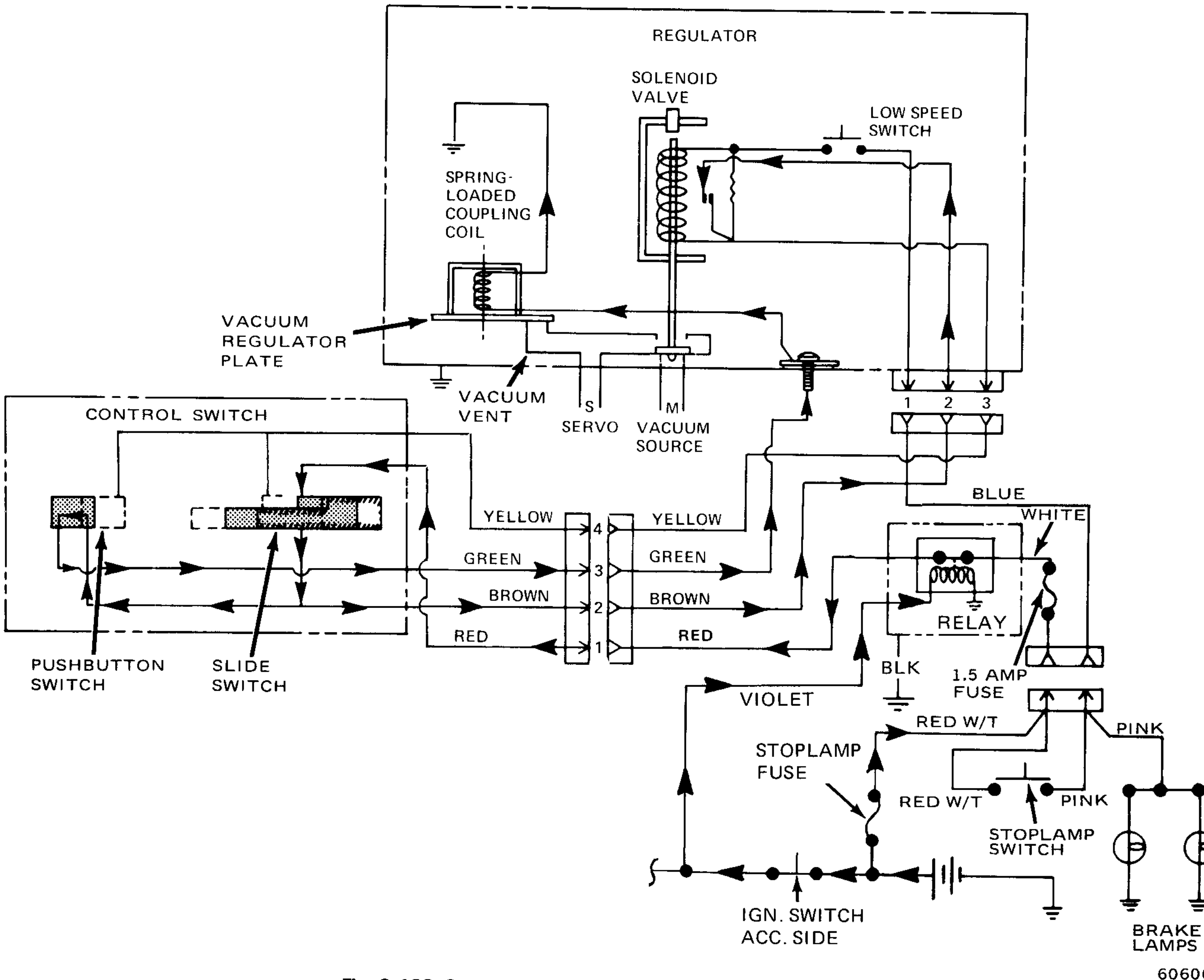


Fig. 3-108 Current Flow with Slide Switch in the ON Position

OPERATION

Once the vehicle has been started and the ignition turned to the ON position, the relay is energized and current is supplied to the control switch. The control switch now can be moved to the ON position, but the Cruise Command system will not operate until vehicle speed reaches about 30 mph (fig. 3-108). At this speed, the flyweights in the regulator have moved out far enough to close the low speed switch contacts. With the low speed switch closed, the current can be supplied to the solenoid valve coil.

The solenoid valve controls vacuum entering the regulator by sealing off the manifold vacuum port until the solenoid valve coil is energized.

With speed about 30 mph and the low speed switch closed, the solenoid valve coil can be energized by pressing the pushbutton. This passes current from the pushbutton switch to the solenoid valve coil. The current passes through the coil and the low speed switch and grounds at the brakelamps.

The current passing through the solenoid valve coil creates a magnetic field which draws a metal plunger in the center of the coil up to the top of the solenoid valve. This plunger opens the manifold vacuum port when it moves up into the solenoid valve and vacuum is applied to regulator passages.

In addition to opening the manifold vacuum port, the plunger completes the solenoid valve coil hold-in circuit. The metal plunger carries current supplied from the control switch when it is in the ON position. However, the current does not flow until the plunger moves up and contacts the solenoid valve metal mounting bracket. Then current flows from the plunger through the solenoid valve mounting bracket which is connected to one end of the solenoid valve coil. Current passes through coil and grounds at the brakelamps (fig. 3-109). In this way, the solenoid valve remains energized and the plunger is held off the manifold vacuum port.

NOTE: *The circuit completed through plunger and solenoid valve mounting bracket is illustrated in the circuitry diagrams as a pair of contacts to the right of the solenoid valve.*

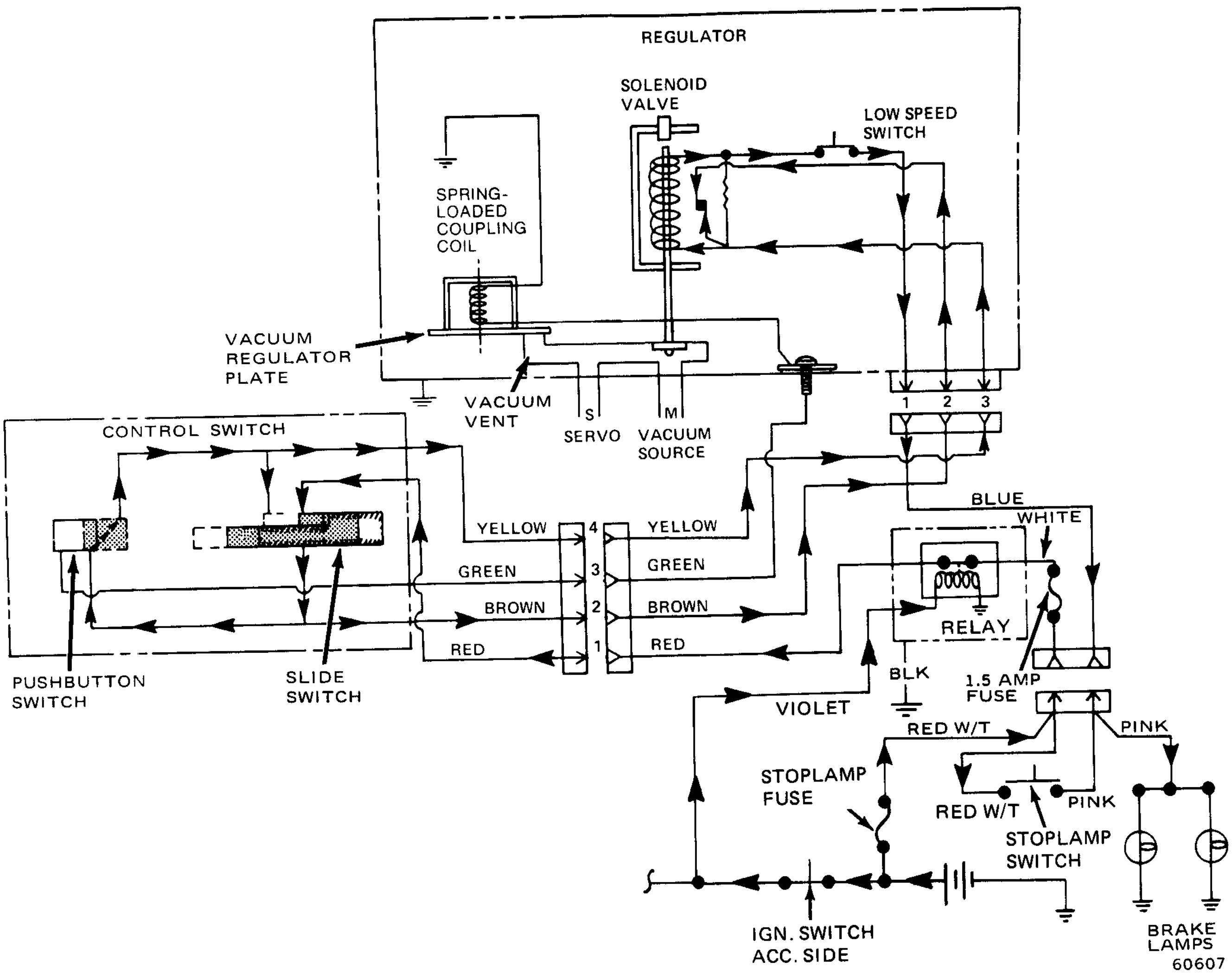


Fig. 3-109 Current Flow with Pushbutton Pressed

Once the pushbutton is released, vehicle speed is controlled by the coupling coil within the regulator. The coupling coil is connected to a pair of flyweights by the flyweight slide. The slide is moved back and forth by the flyweights which are driven by the speedometer cable. The flyweight slide causes the coupling coil to rotate clockwise or counterclockwise dependent upon whether the vehicle is accelerating or decelerating.

Located beneath the coupling coil is a metal flat washer. Attached to the washer is a thin plastic plate. This plate is positioned over a port which is part of the regulator vacuum passages. The port is the vent for vacuum applied to the servo. The plate regulates vacuum bleed-off by covering or uncovering the vacuum vent (fig. 3-109).

The vacuum regulator plate works in combination with the coupling coil to control vacuum supplied to the servo which operates the engine throttle. The coupling coil creates a magnetic field when energized. This field attracts the metal washer of the vacuum regulator plate and locks the plate and washer to the coupling coil.

As mentioned previously, the coupling coil is rotated by the back-and-forth movement of the flyweight slide as the flyweights move outward as the speedometer cable speed increases and inward as cable speed decreases. When speed decreases as in ascending a hill, the coupling coil rotates counterclockwise. This moves the vacuum regulator plate counterclockwise which completely covers the vacuum vent. With the vent sealed, more manifold vacuum is applied to the servo which opens the throttle further causing the car to gain speed. The speed increases until the set speed is attained.

When speed increases as in descending a hill, the coupling coil is rotated clockwise by flyweight movement. This moves the vacuum regulator plate clockwise which opens the vacuum vent and causes more vacuum bleed-off. Less vacuum is applied to the servo, throttle opening is reduced, and speed is lowered.

Two features of the vacuum regulator plate cause the system to maintain the desired, constant cruising speed. The vacuum regulator plate is notched. When

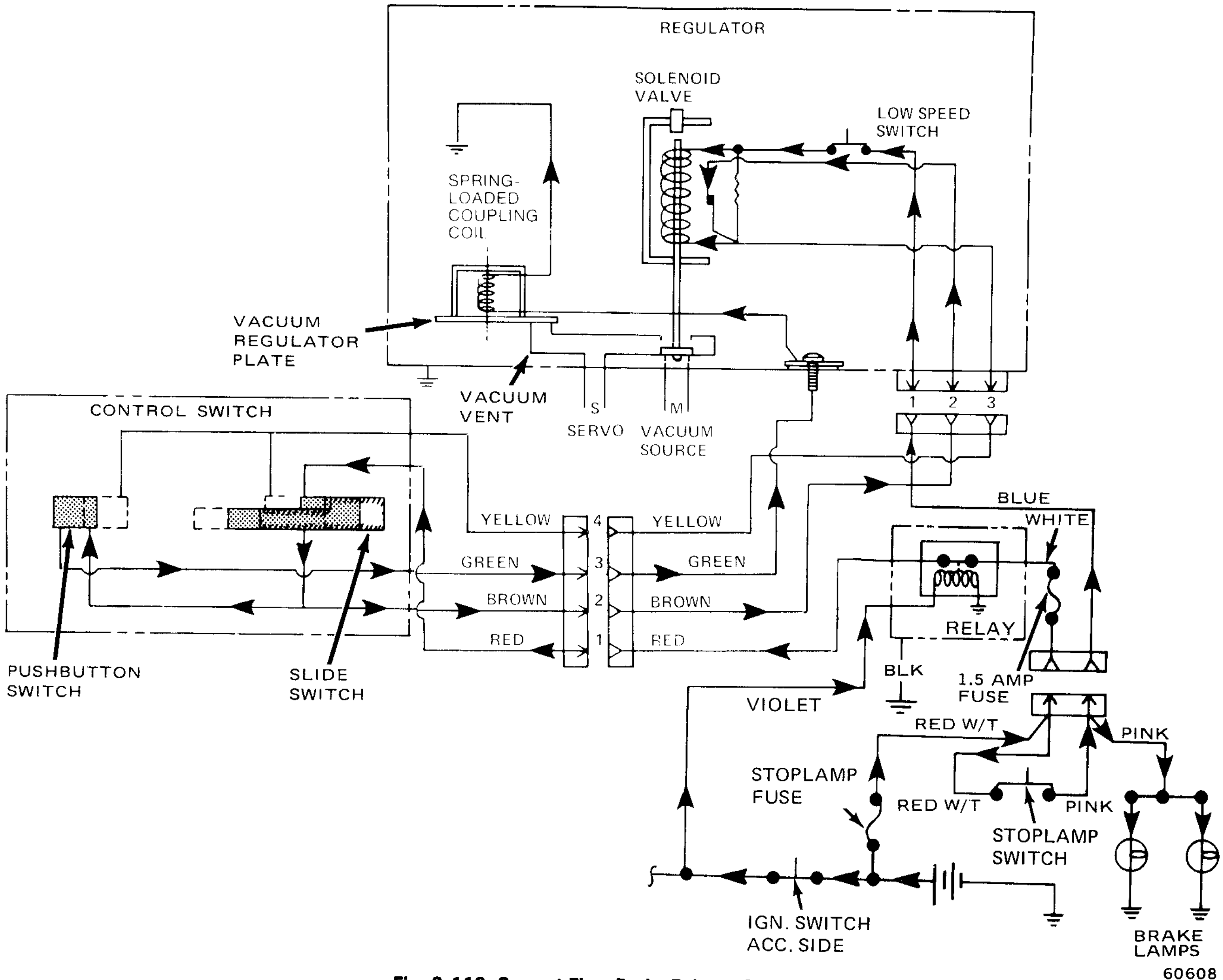


Fig. 3-110 Current Flow Brake Release Circuit

the plate is centered over the vacuum vent, the notch meters vacuum bleed-off.

The vacuum bleed-off is designed to be just enough to maintain a vacuum supply to the servo to overcome the throttle return spring and keep the throttle in a fixed position. The plate notch remains in a centered position due to spring wire attached to the plate. After accelerating or decelerating, the spring wire returns the plate to the centered position.

When the control switch is in the ON position, the coupling coil is energized through the pushbutton switch when it is not pressed. When the pushbutton is pressed (and car speed is above 30 mph), the pushbutton switch stops current flow to the coupling coil circuit and applies current to solenoid valve (fig. 3-109). With no current applied to the coupling coil, the vacuum regulator plate centers over the vacuum vent. Set speed is determined by the relationship of the coupling coil to the flyweight slide. When the pushbutton is released, the coupling coil is energized and the vacuum regulator plate and washer are locked to it. If speed increases, the plate decreases vacuum to the servo. If speed decreases, the plate increases vacuum to the servo. A constant speed is maintained since any change in flyweight speed rotates the coupling coil and vacuum regulator plate which increases or decreases vacuum to the servo.

When the brakes are applied, the solenoid valve is deenergized which seals off the manifold vacuum port and vacuum is lost in the system. The stoplamp switch applies voltage through the low speed switch to one end of the solenoid valve coil. This voltage opposes voltage already applied to the coil by the control switch (fig. 3-110). The opposing voltage causes current to stop flowing and the solenoid field collapses, allowing the plunger to drop and seal the manifold vacuum port.

The stoplamp switch does not affect the coupling coil. For this reason, the vehicle accelerates back to set speed when the control switch is moved to the RES or RESUME position after braking.

When the control switch is moved to the RESUME position, current flows from the control switch through the low speed switch to the solenoid valve coil. The solenoid valve is energized in the same way as when the pushbutton is pressed. The solenoid valve

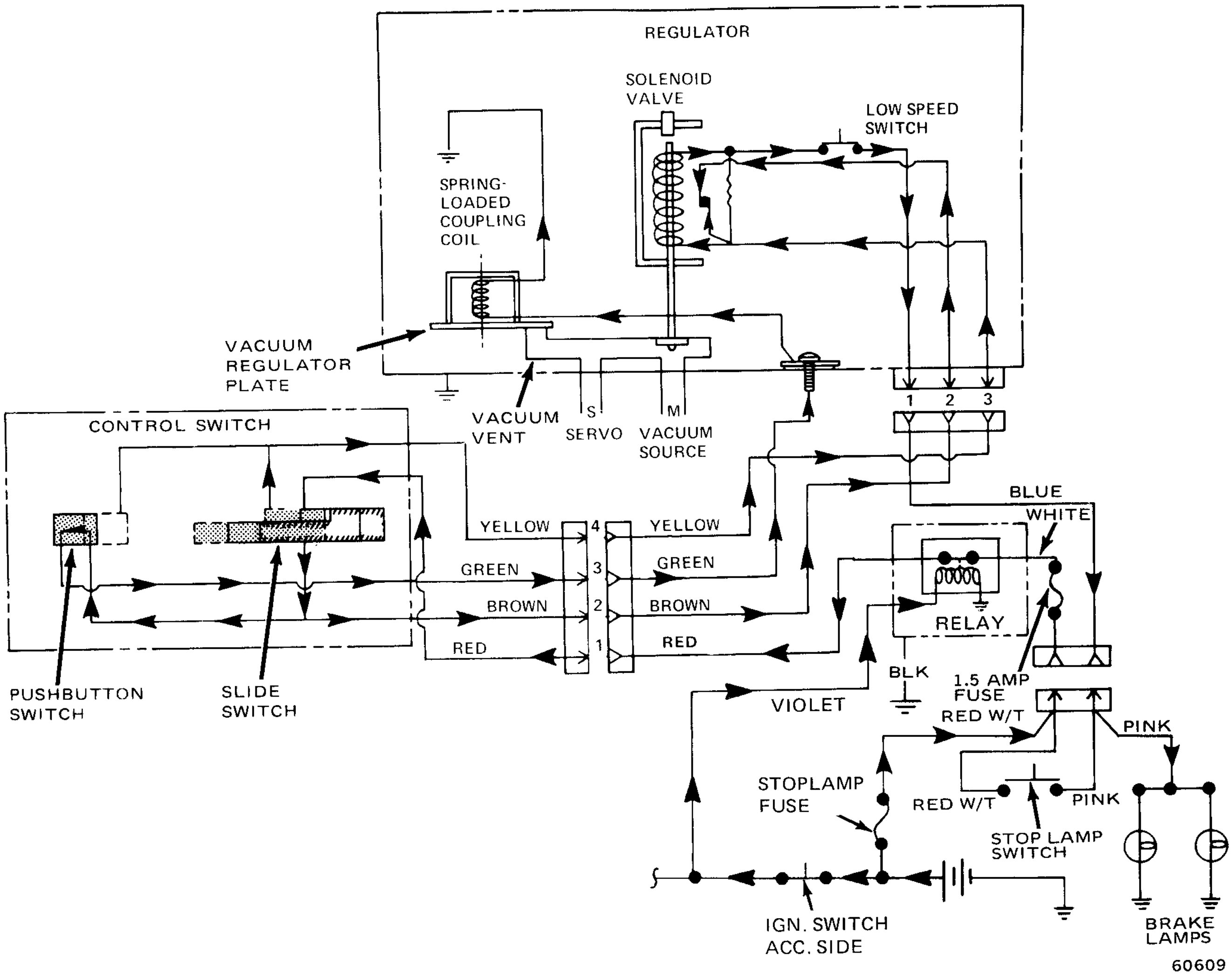


Fig. 3-111 Current Flow with Slide Switch in RESUME Position

lifts the solenoid plunger which completees the hold-in circuit and opens the manifold vacuum port (fig. 3-111).

Since the coupling coil is not de-energized during braking, the vehicle begins to accelerate once the solenoid valve is energized during resume mode. This occurs because of the decrease in speedometer cable speed due to braking, which causes the flyweights to move inward. The flyweight slide moves back and rotates the coupling coil counterclockwise. This moves the vacuum regulator plate over the vacuum vent which applied more vacuum to the servo and produces acceleration until set speed is attained. Then the vacuum regulator plate again maintains the constant set speed.

ADJUSTMENTS

Vacuum Servo Chain Linkage Adjustment

IMPORTANT: Prior to adjusting the servo chain, the carburetor throttle must be at idle position, throttle stop solenoid disconnected, and choke valve fully open.

To install the vacuum servo chain, insert the chain in the vacuum servo hook.

Stretch the chain linkage to the carburetor until the chain is fully extended, the clevis pin hole should align with the hole in the carburetor throttle lever. If it does not, adjust the chain at the servo hook, one ball at a time, until a free pin fit is obtained. When properly adjusted, the chain must be as tight as possible and still allow the throttle to return to an idle with the throttle stop solenoid (if equipped) disconnected.

After the servo chain has been properly adjusted, bend the servo hook tabs together. The chain must be free in the hook after bending the tabs.

Do not use any type of lubrication on the chain guide and pulley assembly.

Damaged Speedometer Cables and Gears

Refer to Speedometer section.

Centering Spring Adjustment

The Cruise Command system is designed to maintain, within 3 mph, the speed selected by the driver.

Check operation of the system at 50 mph. Adjustment is made by turning the centering spring adjustment screw.

If speed control holds speed three or more mph higher than selected speed, turn centering spring adjusting screw, "C" toward "S" 1/32 inch or less; if speed is three or more mph below selected speed, turn centering spring adjusting screw, toward "F", 1/32 inch or less (fig. 3-112).

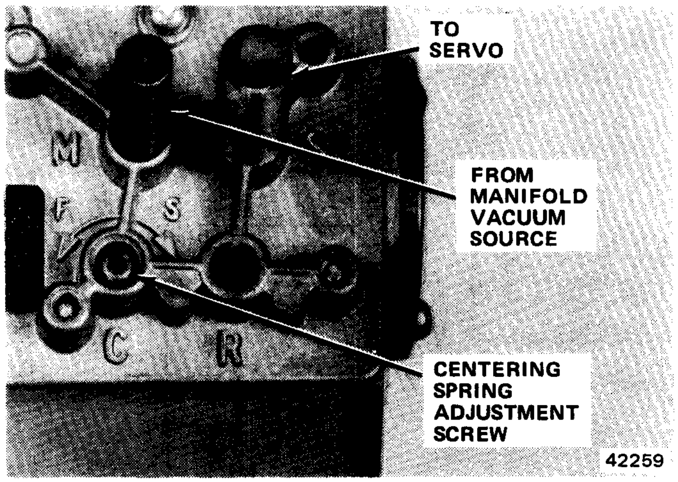


Fig. 3-112 Centering Spring Adjustment

NOTE: *The centering adjustment is extremely sensitive and must never be turned more than one-eight turn in either direction. If the centering adjustment is not correct, the "zero" starting point can be found as follows:*

(1) Remove regulator cover to view adjustment cam.

(2) Insert allen wrench in adjustment screw on outside of housing.

(3) Turn adjustment screw until pin on eccentric faces toward the center of housing.

(4) Install regulator cover.

TROUBLESHOOTING

For troubleshooting of the Cruise Command system, refer to the Cruise Command Diagnosis Guide.

TESTING

The following tests should be performed as part of the diagnosis to determine the cause of the malfunction and the correction required.

NOTE: *Whenever a unit is disconnected for testing, it should be reconnected before the next unit is tested.*

Control Switch Continuity Test

To test control switch operation, connect an ohmmeter or test lamp to the control switch wire harness connector at the steering column. Refer to the Control Switch Continuity Chart for wire connections and switch positions.

Control Switch Circuitry

Switch Wire Continuity	Slide Switch			Pushbutton Depressed Slide Switch On
	Off	On	Resume	
Red/Brown	Open	Closed	Closed	Closed
Red/Green	Open	Closed	Closed	Open
Red/Yellow	Open	Open	Closed	Closed

Note: Pushbutton cannot be depressed with slide switch in resume position.

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Circuitry Tests

It is not always necessary to remove the regulator in case of inoperative Cruise Command. The following checks should be performed as part of the diagnosis to determine the cause and correction of Cruise Command trouble. Refer to figure 3-113.

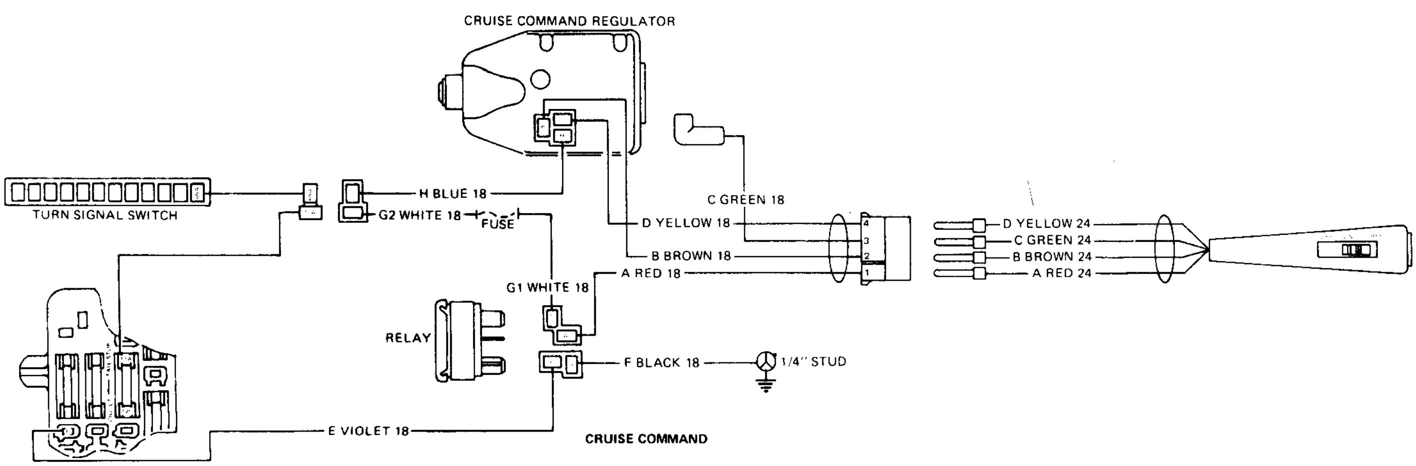

Fig. 3-113 Cruise Command Schematic

Cruise Command Diagnosis Guide

Condition	Possible Cause	Correction
BLOWING FUSES	(1) Short or ground in Cruise Command wiring circuit.	(1) Perform electrical checks.
CRUISE COMMAND DOES NOT ENGAGE	(1) Cruise Command harness fuse burned out.	(1) Check for cause. Replace fuse 1.5 amp only).
	(2) Faulty brake lamp switch.	(2) Replace brake lamp switch.
	(3) No current to brown wire.	(3) Check for loose connection or repair wiring harness.
	(4) Vacuum leak.	(4) Repair leak.
	(5) Bad regulator ground.	(5) Check regulator for ground (use ohmmeter—check from regulator to mounting bracket).
	(6) Faulty connections.	(6) Check connections, repair as necessary.
	(7) Brake lamp fuse burned out.	(7) Check for cause and repair, replace fuse.
	(8) Brake lamp bulb burned out.	(8) Replace bulb.
	(9) Control switch inoperative.	(9) See Circuitry Tests—steps (8) through (15).
	(10) Faulty regulator.	(10) After all electrical checks, replace regulator.
CRUISE COMMAND DOES NOT DISENGAGE WHEN BRAKE IS APPLIED	(1) Defective brake lamp switch (open).	(1) Replace brake lamp switch.
	(2) Collapsed hose from servo to regulator.	(2) Replace hose.
RE-ENGAGES WHEN BRAKE IS RELEASED	(1) Faulty control switch.	(1) Replace control switch.
	(2) Check wiring for proper location in connectors.	(2) Correct wiring location.
CARBURETOR DOES NOT RETURN TO NORMAL IDLE OR PULSATING ACCELERATOR PEDAL	(1) Improper throttle chain linkage adjustment.	(1) Adjust throttle chain linkage.
	(2) Speedometer cable or drive cable kinked or lack of lubrication.	(2) Lubricate cable, including tips, or replace cable if necessary.

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Cruise Command Diagnosis Guide (Continued)

Condition	Possible Cause	Correction
SPEEDOMETER INOPERATIVE AND CRUISE COMMAND OPERATES	(1) Speedometer cable not driving speedometer.	(1) Check for broken cable or loose connections.
	(2) Faulty regulator.	(2) Replace regulator as necessary.
NEITHER SPEEDOMETER NOR CRUISE COMMAND OPERATES	(1) Transmission cable not driving regulator.	(1) Check for broken cable or loose connections.
VEHICLE ACCELERATES OR DECELERATES MORE THAN 3 MPH AFTER PRESSING CONTROL SWITCH PUSHBUTTON	(1) Regulator out of adjustment.	(1) Refer to Centering Spring Adjustment.
	(2) Open in green to regulator.	(2) Check green wire from control switch to regulator.
	(3) Incorrect wiring.	(3) Refer to wiring diagram.
ENGINE ACCELERATES WHEN STARTED	(1) Vacuum hoses reversed at regulator.	(1) Check for proper connections.
SYSTEM DISENGAGES ON LEVEL ROAD WITHOUT APPLYING BRAKE	(1) Loose wiring connections or poor ground.	(1) Tighten connection and check ground.
	(2) Loose hoses.	(2) Check hose connections.
	(3) Servo linkage chain broken or throttle clevis slipped.	(3) Repair chain or install clevis.
ERRATIC OPERATION OF CRUISE COMMAND	(1) Check vacuum servo or vacuum hose.	(1) Replace servo or vacuum hose.
	(2) Faulty wiring.	(2) Perform circuitry tests.
	(3) Faulty regulator.	(3) Replace regulator as necessary.

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(1) Disconnect push-on connectors (single and triple) at regulator.

(2) Turn ignition switch to ACCESSORY position.

(3) Move slide switch to the ON position.

(4) Using a 12-volt test lamp, ground one test lamp lead and touch the other lead to the brown wire and then the green wire at the connectors. Test lamp should light. If test lamp does not light on brown wire, check fuse, automatic speed control relay, engagement switch, and connection at power source. If test lamp does not light on green wire, check engagement switch and connections at power source, automatic speed control relay and brake light switch.

(5) Push SET SPEED button all the way in and hold. Ground one test lamp lead and touch the other lead to each wire connector. Test lamp should light on the brown and yellow wires and should not light on the green or blue wire.

(6) Release SET SPEED switch button.

(7) Move slide switch to RES position and hold. Ground one test lamp lead and touch the other lead to each wire in the connector. Test bulb should light on all wires except the blue wire (blue connects to turn signal side of turn signal switch). To make an independent check of the engagement switch before removal from the car, disconnect switch from wiring

harness, at the multiple connector in passenger compartment, and make the following checks (omit steps (8) through (15) if steps (1) through (7) check out).

(8) Attach a jumper wire from a 12-volt power source to red lead of the engagement switch.

(9) Move slide switch to OFF position.

(10) Using test lamp, ground one test lamp lead and touch the other lead, in turn, to brown wire, green wire, and yellow wire. Test lamp should not light on any of these wires.

(11) Move slide switch to ON position.

(12) Touch test lamp lead to the brown wire and then green wire. Test lamp should light on each of these wires. Touch lead to the yellow wire. Lamp should not light.

(13) Push SET SPEED all the way in and hold. Test lamp should light on brown wire and on yellow wire. Test lamp should not light on green wire.

(14) Release SET SPEED switch button.

(15) Move slide switch to RES position and hold. Touch test lamp lead, in turn, to brown wire, yellow wire, and then to light green wire. Test lamp should light.

NOTE: *If steps (1) through (7) do not check out and steps (8) through (15) do check out, replace Cruise Command wire harness. If steps (8) through (15) do not check out, replace engagement switch.*

Brake Release Test

The brake release switch is part of the stoplamp switch. To test the brake release switch, observe the stoplamps. Stoplamps should light when brake pedal is pressed one-quarter inch or more.

NOTE: *If the Cruise Command is to disengage, when stepping on the brake, the stoplamp circuit must not be grounded. Correct any stoplamp problem before proceeding. Check for burned out bulbs, improper ground connections, open or grounded circuits in the brake release switch or wire harness.*

NOTE: *Use of Hazard Warning lights prevents Cruise Command system from engaging.*

(1) Test brake release switch at regulator.

(2) Check all harness connections for proper fit.

(3) Disconnect three-wire connector at regulator.

(4) Connect one side of test lamp to ground and other to blue wire. Test lamp should not light.

(5) Press brake pedal 1/4 inch. Test lamp should light. If test lamp does not light, check power source fuse, stoplamp switch, and wire harness to regulator to locate problem.

Automatic Speed Control Relay Test

The automatic speed control relay is located next to the steering column and near dash panel.

NOTE: *Check all connections prior to testing.*

(1) Turn ignition switch and slide switch to ON position.

(2) Using a test lamp, ground one lead and touch other lead to each individual connector at relay. Test lamp should light. If test lamp does not light on the red but lights on the white and violet connectors, replace relay. If test lamp does not light on the white and violet wires, check power source, fuse, and wire harness.

CONTROL SWITCH REPLACEMENT

The Cruise Command control switch is part of the turn signal lever. The switch is not repairable. The switch and harness are serviced only as a unit.

Removal

(1) Remove the following:

- Horn button insert
- Steering wheel
- Anti-theft cover
- Locking plate and horn contact

(2) Remove turn signal lever (allow handle to hang loose outside steering column).

(3) Remove four-way flasher knob.

(4) Remove holddown screws and turn signal switch.

(5) Remove trim piece from under steering column.

(6) Disconnect four-wire connector.

(7) *Tilt Column*—Remove harness from plastic connector. Tape two of the four wires back along the harness (to allow a smaller diameter) and tape a string to the harness.

(8) *Standard Column*—Tie or tape a string to the plastic connector.

(9) Remove lever and harness assembly from column.

Installation

(1) Check new Cruise Command control switch by connecting to plastic connector before installing in steering column. Refer to Control Switch and Harness Test.

NOTE: *When installing the harness, be sure to feed the harness through the turn signal lever opening as the handle will not fit through the opening.*

(2) *Tilt-Column*—Tape two of the leads back along the harness and tape the harness to the string that was attached to the original harness before removal.

(3) Pull replacement harness down through the steering column. On the Tilt Column, the harness must pass through the hole on the left side of the steering shaft.

(4) Install turn signal switch and four-way flasher knob.

(5) Install Cruise Command lever.

(6) Install horn contact, locking plate, and lockring anti-theft cover.

(7) Install steering wheel and horn button insert.

(8) Install trim on steering column.

TRAILER TOWING PACKAGES

GENERAL

The schematics for the light and heavy-duty towing packages are shown at the rear of this manual.

CAUTION: *If a trailer is equipped with a fully charged battery and the battery on the towing vehicle is dead, do not attempt to start the towing vehicle unless the trailer connector is disconnected. Attempting to use the trailer battery for starting will damage the trailer connector.*

Class 1 and 2 Package

The trailer connector is connected into the existing frame harness. This type of package requires the use of heavy-duty flashers for both turn and Hazard Warning flashers. The maximum amount of bulbs to be used on the trailer are:

- Four taillamp bulbs
- One license plate lamp bulb
- One set of directional signal lamp bulbs

All bulbs are to be the same size as the towing vehicle. The original equipment flashers must be installed when the trailer is not in use.

Class 3 and 4 Package

This type of package does not require the use of heavy-duty flashers. Three relays, fed through a 10-amp circuit breaker, carry the load to the trailer. The left and right turn and taillamp circuits are used only to trigger the relays and do not carry any of the trailer load.

Electrical Specifications

ALTERNATOR – V-8 ENGINES

Make	Motorcraft
Standard – All except Camper	40 amp
– Camper Truck	60 amp
Optional – Required with Heated Backlight, Air Conditioning, Cold Climate Group	60 amp
Rotation	CW @ Drive End
Field Current	2.5 - 3.0 amp
Pulley Size	2.62 inches

VOLTAGE REGULATOR – V-8 ENGINES

Make	Motorcraft
Type	Electro-mechanical
Adjustment	None

Regulator Temperature	Acceptable Voltage Range
0 - 50°F	14.8 - 14.1
50-100°F	14.5 - 13.7
100 - 150°F	14.2 - 13.4
150 - 200°F	13.8 - 13.1

ALTERNATOR – SIX-CYLINDER ENGINES

Make	Delco-Remy
Rating	
Standard	37 amp
A/C Optional – Required with Heated Backlight and Cold Climate Group	63 amp
Rotation Viewing Drive End	Clockwise
Field Current	4.0 - 4.5 amps at 12V, at 80°F
Pulley Size	2.62 inches

VOLTAGE REGULATOR – SIX-CYLINDER ENGINES

Make	Delco-Remy
Model	1116387
Type	Solid State
Adjustment	None

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Electrical Specifications (Continued)

IGNITION SYSTEM

Sensor

Resistance: 1.6 to 2.4 ohms at 77°F to 200°F. Use accurate ohmmeter and check across sensor lead terminals.

Coil

Primary Resistance	1 to 2 ohms
Secondary Resistance	9,000 to 15,000 ohms
Open Circuit Output	20 kv minimum

STARTER MOTOR

Brush Length	0.50 inch
Wear Limit	0.25 inch
Brush Spring Tension	40 oz
Free Speed (No Load Test)	
Volts	12.0
Amperes	65
RPM	9250 max
Lock Test - pounds (max)	
600 Amperes @ 3.4 Volts	13 foot-pounds min
Minimum Voltage to Seat Pole Shoe and Complete Pinion Engagement	7.2 volts
Contact Point Clearance	0.020 - 0.100 inch (0.060 desired)

FUSE CHART	CJ Models	Cherokee-Wagoneer-Truck
Air Conditioner/Heater	25	25 amp
Backup Lamps/Cigar Lighter	15	15 amp
Tail and Stop Lamps/Cruise Control	20 amp	20 amp
Cluster Feed/Brake Failure/Parking Brake Warning	3	3 amp
Directional Signal/Windshield Wiper-Washer	10 amp	10 amp
Electric Tailgate Window/Defogger	—	(2) Circuit Breaker (30 amp)
Headlamps	Circuit Breaker (25 amp)	Circuit Breaker (25 amp)
Panel Lights	3 amp	3 amp
Radio	10 amp (5 amp In Line)	10 amp (5 amp In Line)

BULB CHART	CJ Models	Cherokee-Wagoneer-Truck
Front Lamps		
Headlamp	6014	6014
Side Marker	194	194
Parking and Directional	1157	1157 (1157 NA-Wag.)
Rear Lamps		
Backup Lamp	1156	1156
License Lamp	—	(97-Truck Only)
Side Marker	194	194
Stop, Tail and Directional	1157	1157
Indicator Lamps		
Brake Failure/Parking Brake Warning	53	158
Directional Signals	53	158
High Beam	53	158
Quadra-Trac Emerg. Drive	53	158
Vehicle Interior		
Ammeter	—	158
Ashtray	—	1445
Clock	1816	1816
Column Light (Auto. Trans.)	1816	1816
Courtesy	89	89
Directional Signal Flasher (Tung Sol or equivalent)	224	224
Dome	—	212
Glove Box	—	1891
Hazard Warning Flasher (Tung Sol or equivalent)	552	552
Headlamps/Wiper-Washer	*	*
Heater Controls	*	1815
Instrument Cluster	53	158
Oil Pressure Gauge	1895	158
Radio	1893	1892
Tachometer	1895	—
Voltmeter	1895	—

*Replaced as unit

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Torque Specifications

Service Set-To Torques should be used when assembling components. Service In-Use Recheck Torques should be used for checking a pre-torqued item.

	Service Set-To Torques	Service In-Use Recheck Torques
Alternator Adjusting Bolt	28	20-35
Alternator Mounting Bracket Bolt to Engine	28	23-30
Alternator Pivot Bolt or Nut	18	15-20
Battery Holddown Bolt	60-70 in-lb	50-90 in-lb
Bolt, Fan (Alternator)	10-15	10-18
Directional Signal Switch Handle	20-30 in-lb	15-30 in-lb
Screw	10-15	10-18
Hazard Warning Knob Mounting Screws	2-5 in-lb	2-5 in-lb
Speedometer Cable to TCS Switch	120-130 in-lb	115-175 in-lb
Spark Plug	25-30	22-35
Starter Motor to Clutch or Converter Housing	18	13-25
Starter Motor Through Bolts	65 in-lb	55-75 in-lb
Starter Motor to Bell Housing	18	13-25
Starter Solenoid Terminal Nuts (5/16-inch Stud Nut)	50-60 in-lb	40-70 in-lb
Steering Wheel Nut	15-20	15-25

All torque values given in foot-pounds with dry fits unless otherwise specified.
Refer to the Standard Torque Specifications and Capscrew Markings Chart in Section A of this manual for any torque specifications not listed above.

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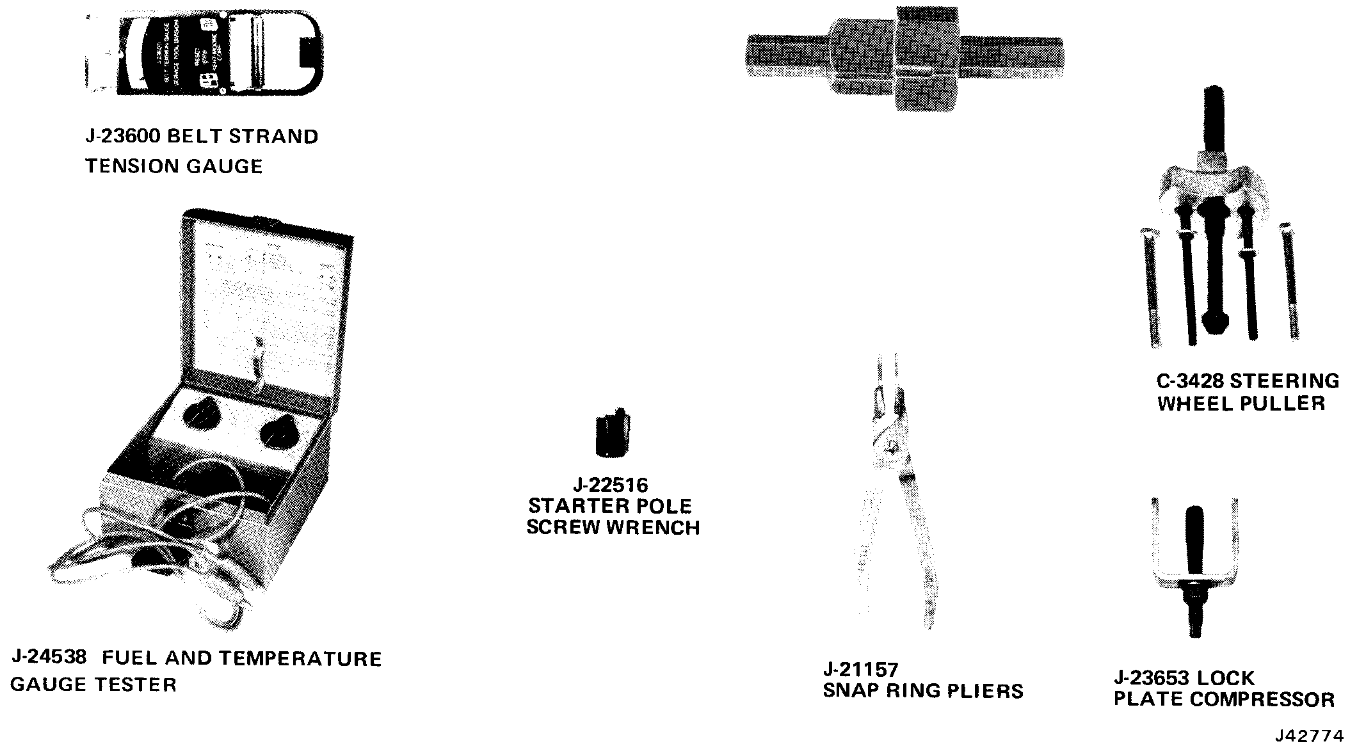

Special Tools

TECHNICAL BULLETIN REFERENCE

Date	TB No.	Subject	Changes Information on Page No.