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.*

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, Wagoneer and 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 high-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 temperature and fuel gauges.

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

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.

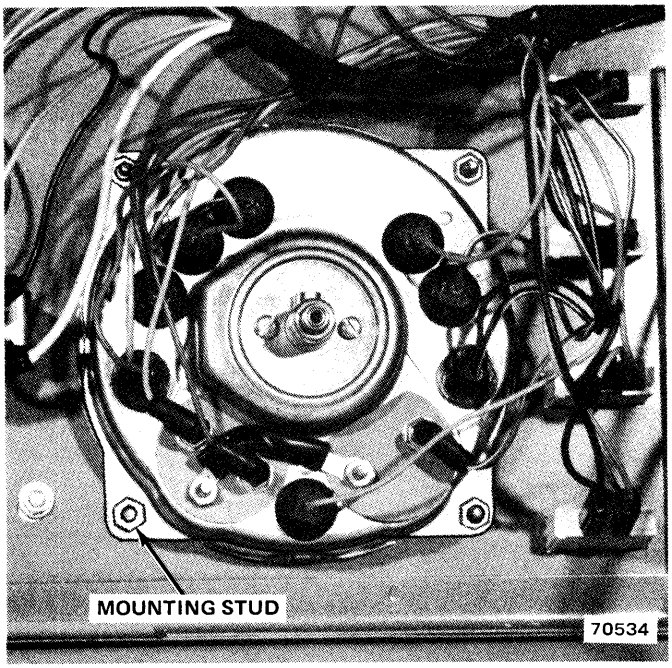

Fig. 3-1 Instrument Cluster Ground—CJ Models

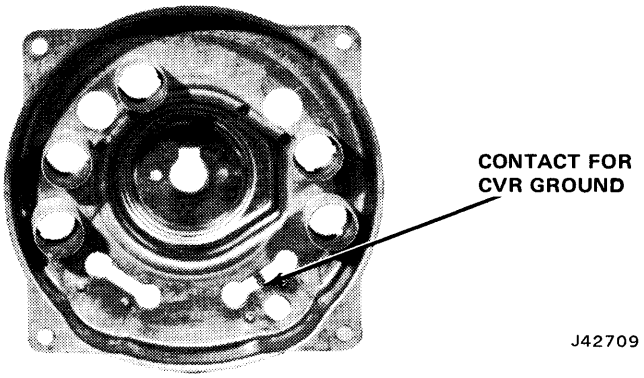

Fig. 3-2 Constant Voltage Regulator Ground—CJ Models

MAIN HARNESS CONNECTOR

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

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.*

On Cherokee, Wagoneer and Truck models, the connector for the frame harness and elecrical tailgate window is located near the left upper corner of the main harness connector. 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)
5459881	50	75	290
5459885	60	95	385
5459882	70	110	410

70498

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 accompanying high voltage, a fast charger must not be used for booster starting. Before connecting jumper cables to a discharged battery, remove the vent caps 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 vehicle is being jump-started by a battery in another vehicle, the vehicles 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.

Connect one end of the second jumper cable to the negative terminal of the booster battery. **Do not connect the other end of the second 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).

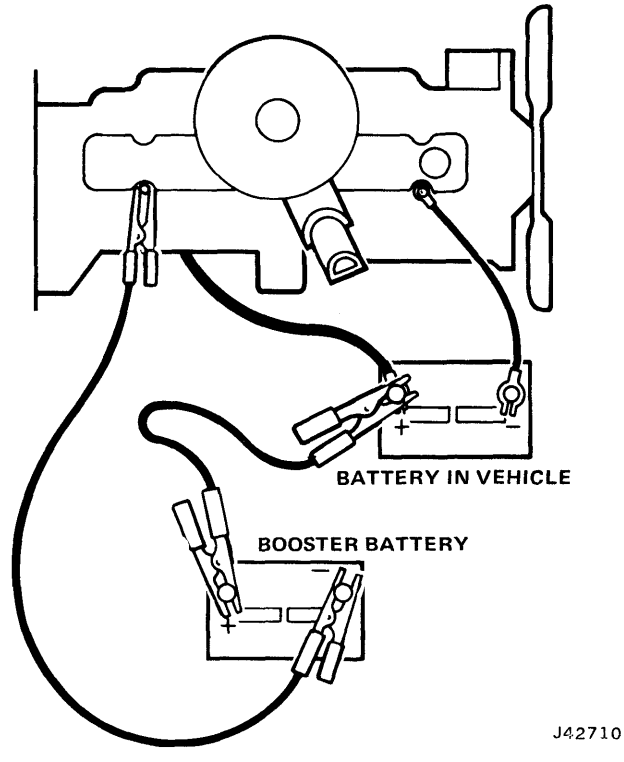

Fig. 3-3 Battery Jumper Cable Connections

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

Discard the cloth used to cover the cap openings as it has 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.

Fast Charge

Always disconnect one battery cable before using a fast charger on a battery installed in a vehicle.

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. Then, it will 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. **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. 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
1.270	– 84°F
1.250	– 62°F
1.200	– 16°F
1.150	+ 05°F
1.100	+ 19°F

60339

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.**

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 vehicle is delivered.

The continual operation of a partially charged battery could shorten its life and require premature replacement.

Fluid level in the battery should be checked periodically and replenished with distilled water, if possible.

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 so that the battery case is 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. Then flush with clean water. Care must be taken to keep vent caps 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 baking 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 DARS Chart.

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.

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

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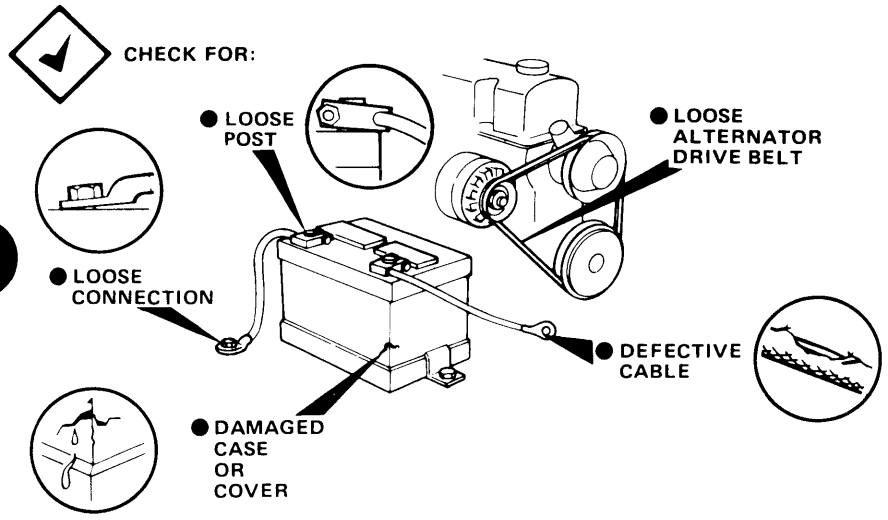
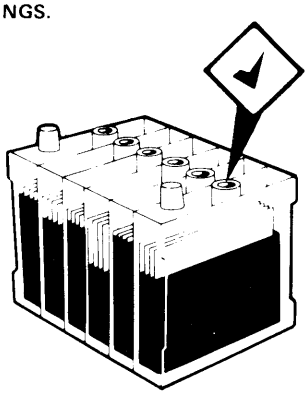
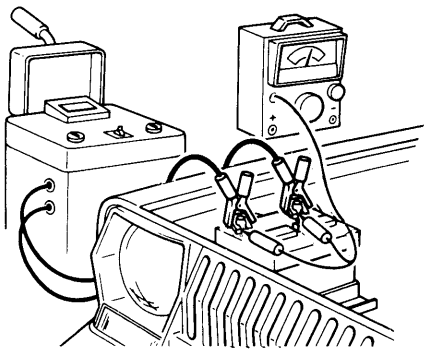
Hydrometer Test

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.

BATTERY DIAGNOSIS AND REPAIR SIMPLIFICATION (DARS) CHART

PROBLEM: ENGINE WILL NOT CRANK

Chart 1

STEP	SEQUENCE	RESULT
1	CHECK FOR: ● LOOSE POST ● LOOSE ALTERNATOR DRIVE BELT ● LOOSE CONNECTION ● DEFECTIVE CABLE ● DAMAGED CASE OR COVER 	REPAIR OR REPLACE IF NECESSARY → 2
2	● CHECK ELECTROLYTE LEVEL AND SPECIFIC GRAVITY IN EACH CELL AND RECORD READINGS. 	ELECTROLYTE LEVEL TOO LOW FOR SPECIFIC TEST–ADD WATER. CHARGE BATTERY FOR 10 MIN. AT 20 AMPS. MEASURE SPECIFIC GRAVITY. OK → 5 AVERAVE SPECIFIC GRAVITY 1.225 OR MORE CELL READINGS EQUAL WITHIN .050 NOT OK → REPLACE BATTERY → 6 AVERAGE SPECIFIC GRAVITY 1.225 OR MORE BUT CELL READINGS VARY .050 OR MORE NOT OK → 3 AVERAGE SPECIFIC GRAVITY BELOW 1.225
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 → 4 VOLTAGE IS 15.5 OR LESS NOT OK → SLOW CHARGE BATTERY AT 3 TO 4 AMPS FOR 48 TO 72 HOURS → 5 VOLTAGE ABOVE 15.5

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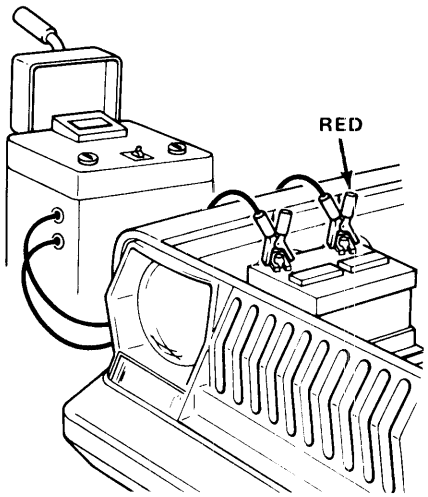
STEP **SEQUENCE** **RESULT**

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 → **5**

AVERAGE SPECIFIC GRAVITY 1.225 OR MORE
CELL READINGS EQUAL WITHIN .050

OK → REPLACE BATTERY → **6**

AVERAGE SPECIFIC GRAVITY 1.225 OR MORE
BUT CELL READINGS VARY .050 OR MORE

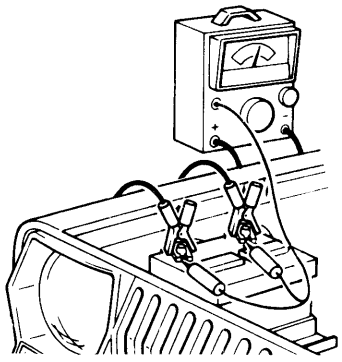
5

- CLEAN BATTERY POST AND CABLE ENDS
- CONNECT HEAVY LOAD TESTER
- DETERMINE AMP-HOUR READING FROM CHART
- ADJUST LOAD TO 3 TIMES THE BATTERY AMP-HOUR RATING
- HOLD LOAD FOR 15 SECONDS
- READ VOLTMETER

HEAVY LOAD OUTPUT TEST

AMP-HOUR IDENTIFICATION

PART NUMBER	RESERVE CAPACITY	COLD CRANK (AMPS)	AMP HOUR
5459881 5459884	75	290	50
5459885	95	385	60
5459882 5459883	110	410	70



- VOLTAGE READING 9.6 OR MORE → **6**
- VOLTAGE READING LESS THAN 9.6 → REPLACE BATTERY → **6**

6

OK → ENGINE CRANKS → STOP

OK → ENGINE DOES NOT CRANK → PERFORM STARTER DIAGNOSIS IN STARTER SECTION

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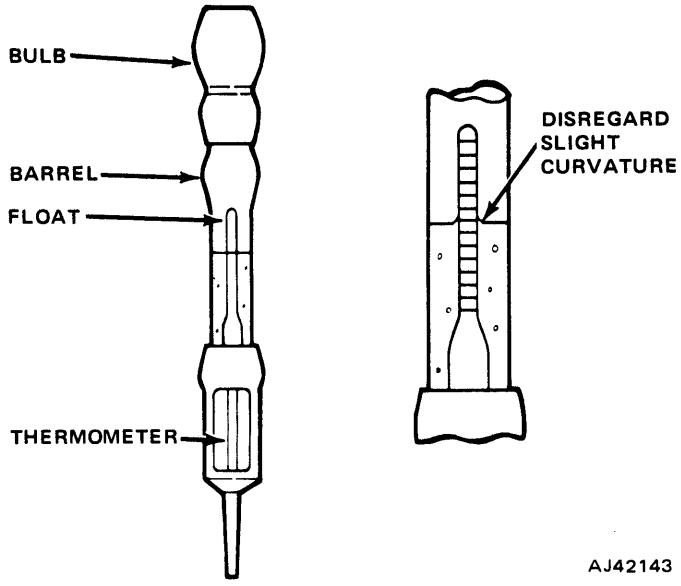

Fig. 3-4 Hydrometer and Proper Method of Reading

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 80°F, add 4 points. For each 10°F below 80°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 degrees above or below 80°F equals 70° (80° minus 10°).

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 temperature correction is subtracted.

Specific Gravity Reading

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

60340

Temperature-corrected specific gravity: 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, 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 vehicle for further testing.

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.

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 caps.

(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.

(3) Apply 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). If not, 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 is significantly lower in gravity, and its electrolyte when drawn into the hydrometer is discolored with the remaining cells relatively clear, 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, check the alternator to determine if it has sufficient output to satisfy the electrical demands of that particular vehicle. Install higher capacity size battery, if possible.*

(c) If all cells show a more than slight increase in **temperature-corrected** gravities, variation between cells is within 50 points, and all cells 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.

(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 batteries
- 180 amperes for 60 amp hour batteries

(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.

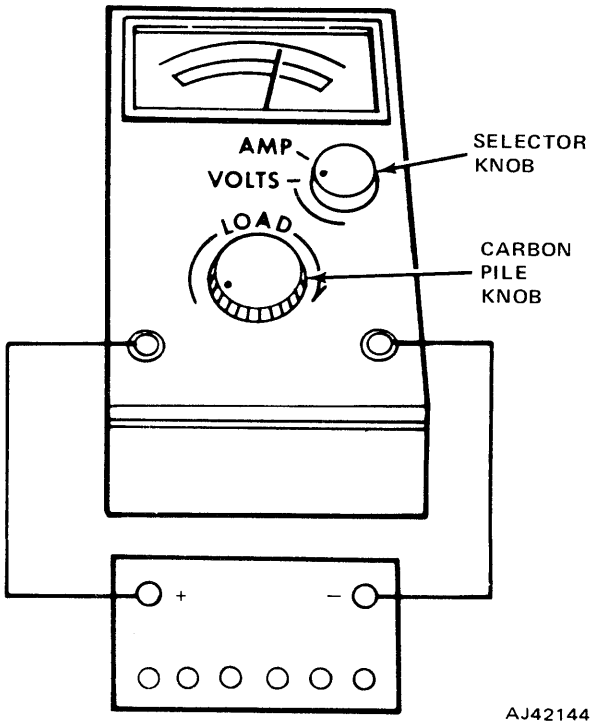

Fig. 3-5 Heavy Load Test

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 flows 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).

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 output 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

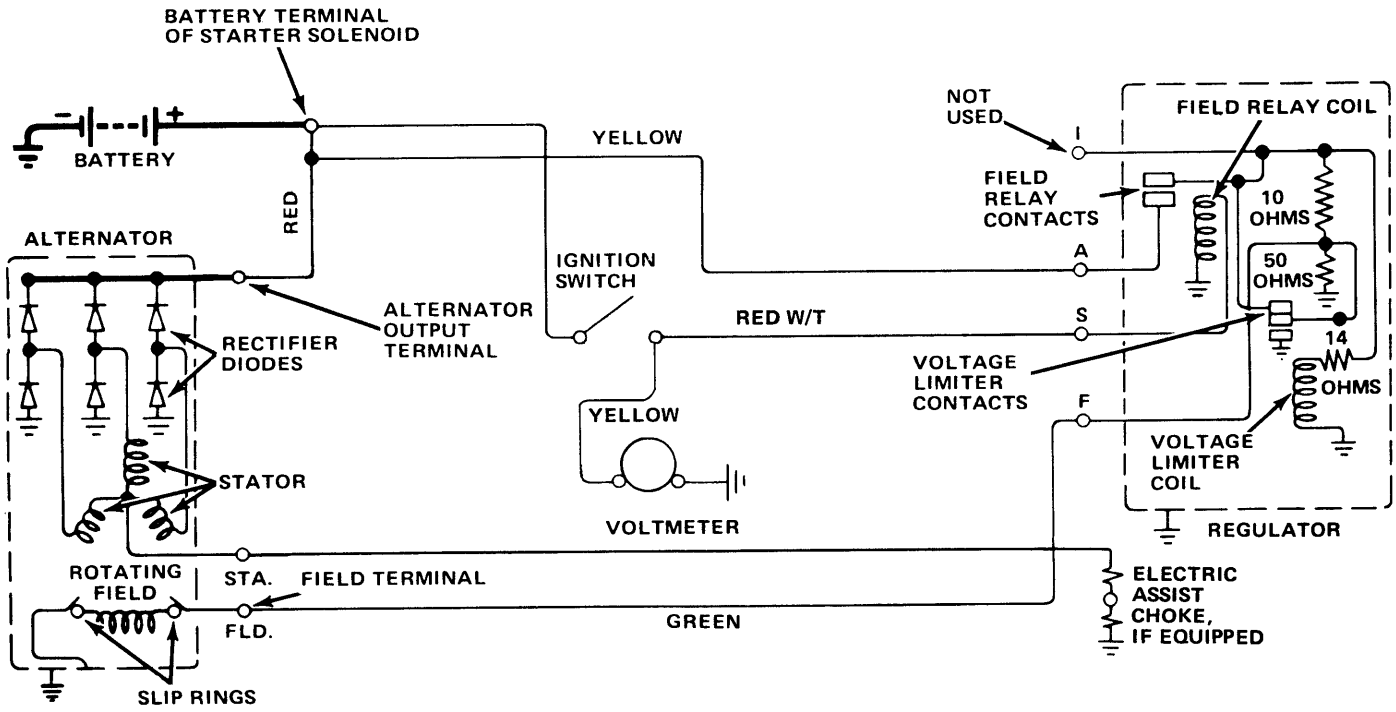

Fig. 3-6 Charging System Schematic—CJ Models with V-8 Engine

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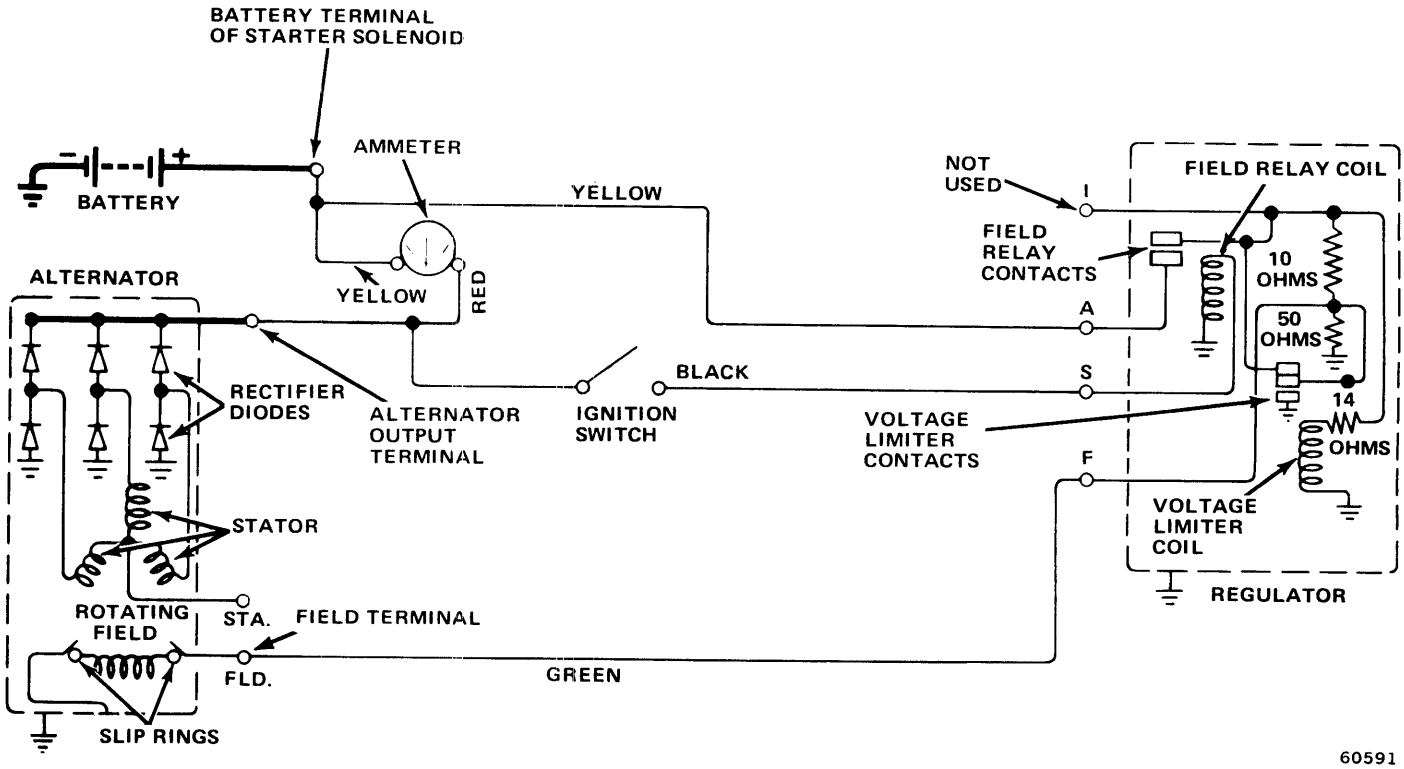

Fig. 3-7 Charging System Schematic—Cherokee—Wagoneer—Truck with V-8 Engine

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 magnetic field. The strength of this field is determined by the amount of current provided by the regulator. The magnetic field acts on the windings of the stator to produce alternating current through electro-magnetic 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 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 electric assist choke, operating current is obtained from the alternator STA terminal. The STA terminal passes approximately 7 volts to the heating element in the cover (fig. 3-6).*

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 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.*

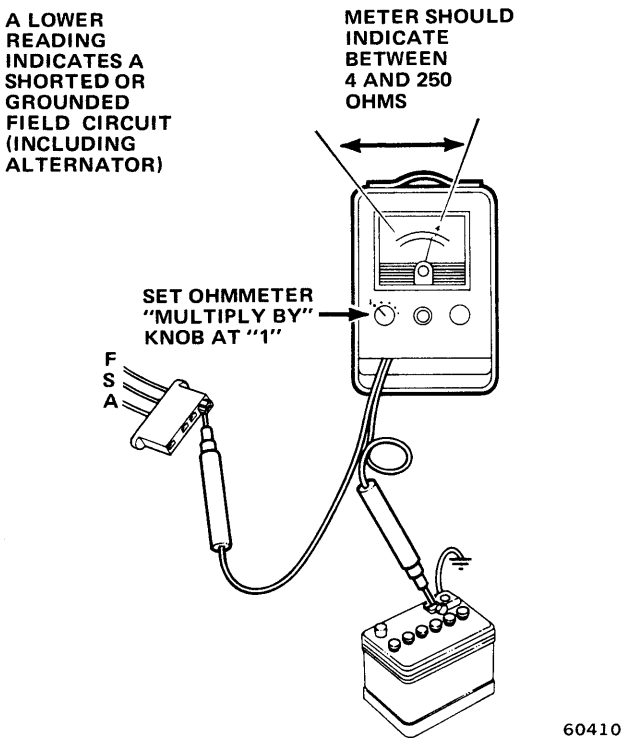


Fig. 3-8 Grounded Field Circuit Test

(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 (6) 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.

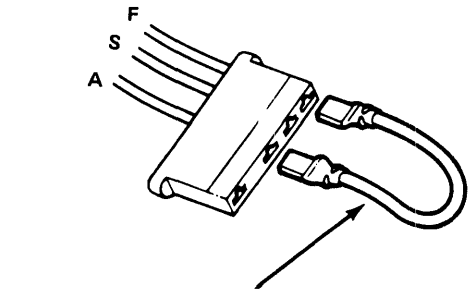


Fig. 3-9 Regulator Connector Jumper Wire Connections (Regulator Bypassed)

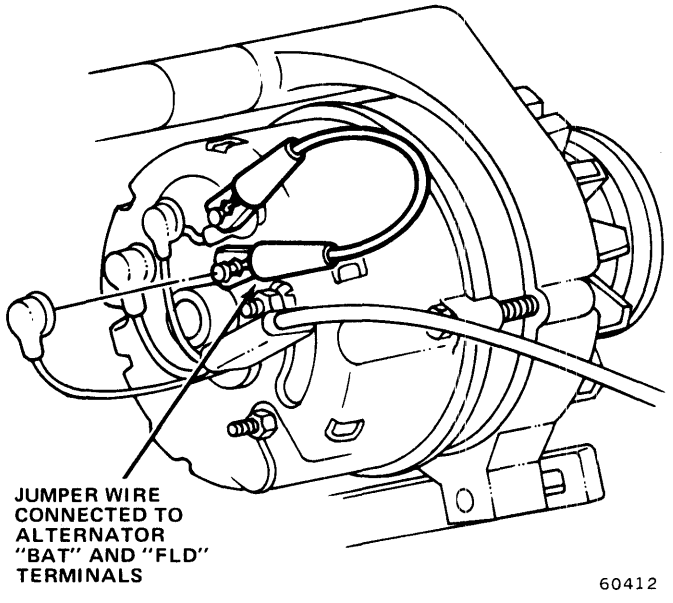


Fig. 3-10 Alternator Jumper Wire Connections

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 lead to 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 infinite (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)

Infinite (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.

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.

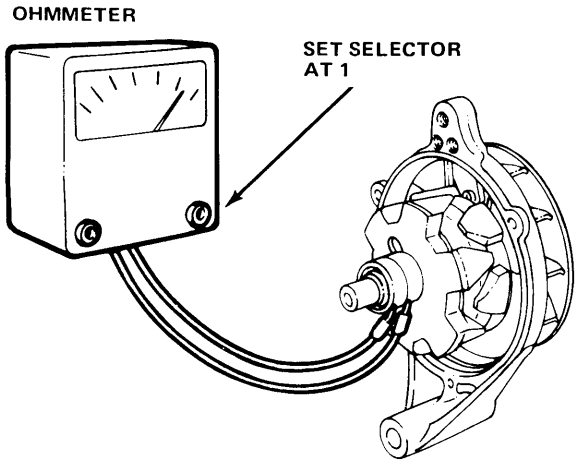


Fig. 3-11 Rotor Continuity Test

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 the Rotor Ground Test 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).

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

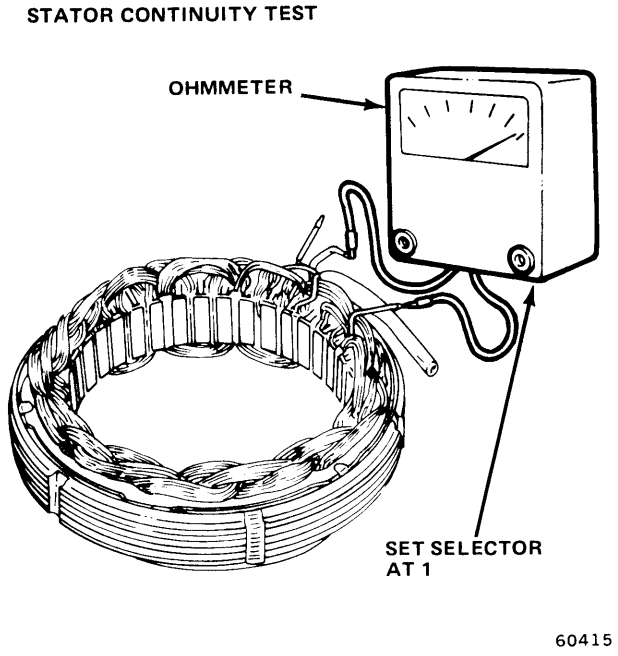


Fig. 3-12 Stator Continuity Test

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.

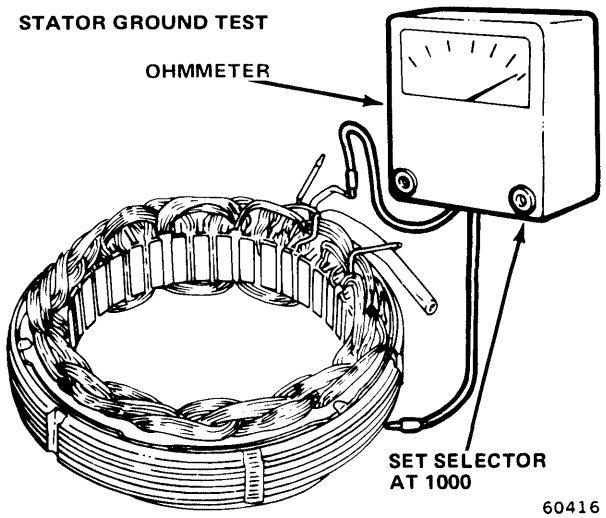


Fig. 3-13 Stator Ground Test

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).
(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.

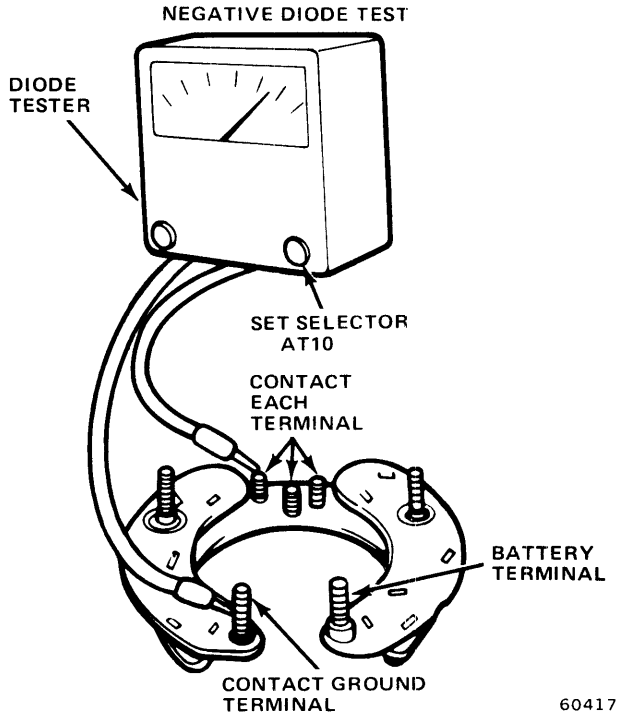


Fig. 3-14 Testing Negative Diodes

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.

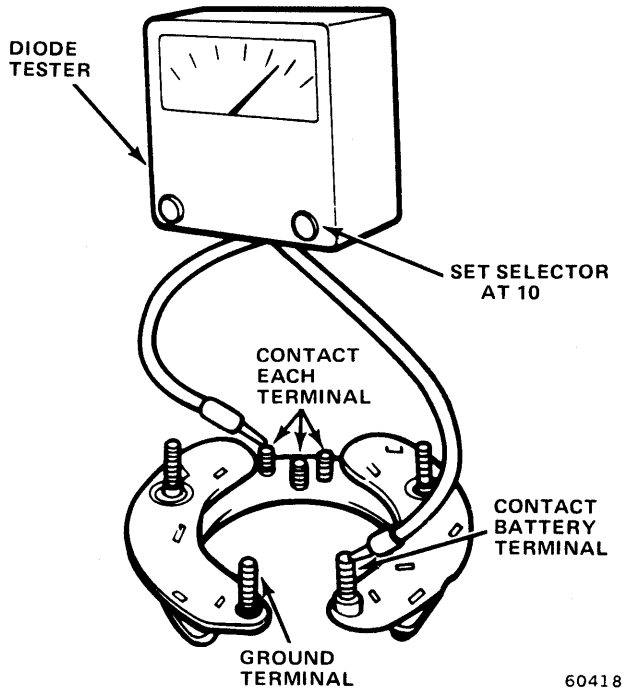


Fig. 3-15 Testing Positive Diodes

(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.

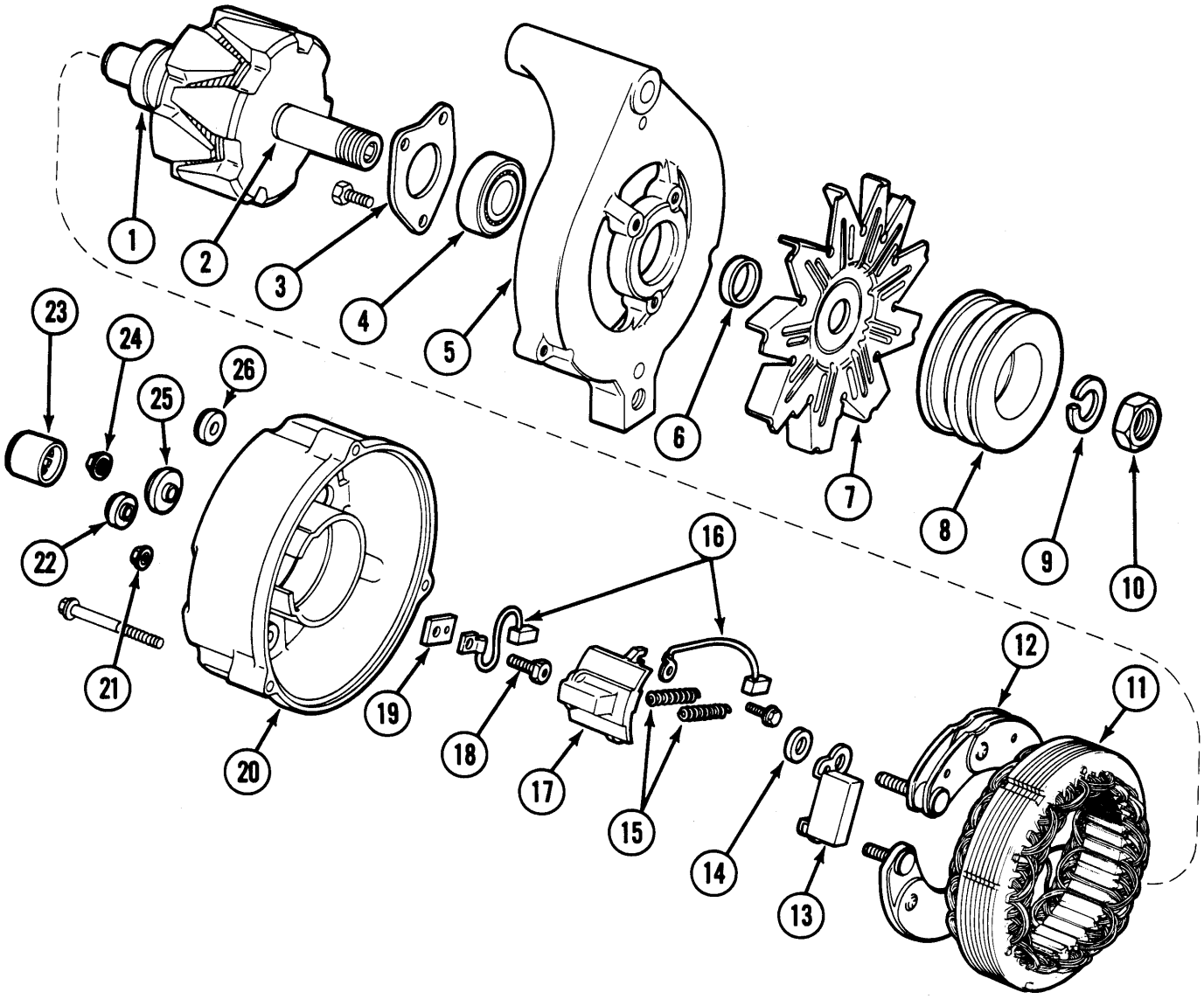
Installation

(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.



1. ROTOR
2. STOP RING
3. FRONT BEARING RETAINER
4. FRONT BEARING
5. FRONT HOUSING
6. FRONT BEARING SPACER
7. FAN
8. PULLEY
9. LOCKWASHER
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

(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.

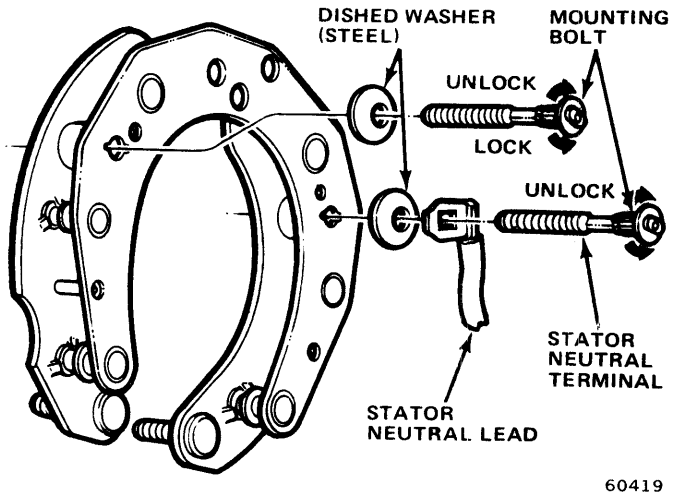

Fig. 3-17 Rectifier Assembly with Exposed Diodes

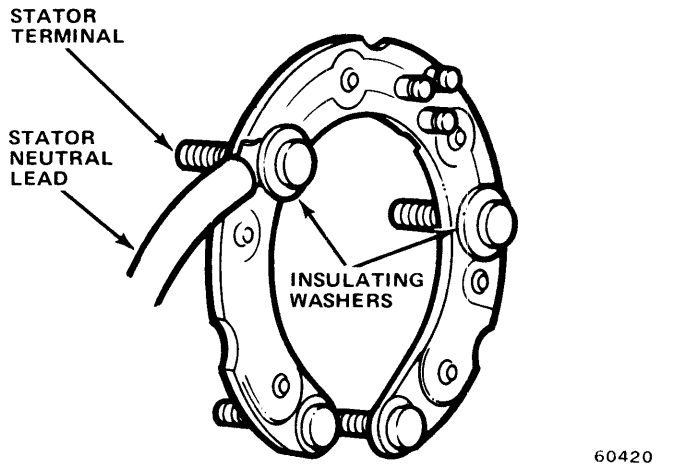

Fig. 3-18 Rectifier Assembly with Built-In Diodes

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.

Cleaning and Inspection

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

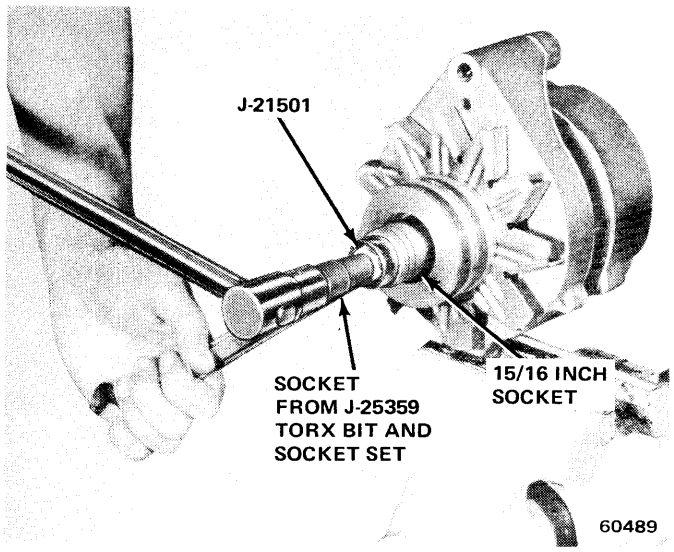

Fig. 3-19 Pulley Removal and Installation

(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 turing 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. Install bearing retainer. If stop ring on rotor drive shaft was damaged, install replacement stop ring. Push replacement ring on shaft and into groove. Do not open ring with a 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. 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 brush holder (fig. 3-20).

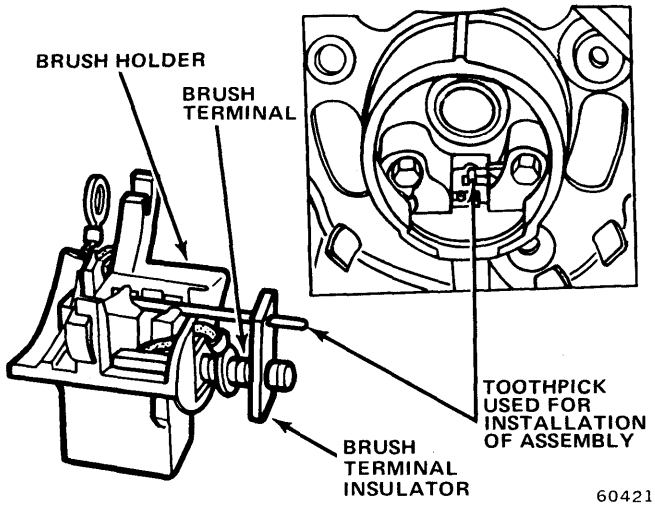

Fig. 3-20 Brush Holder Assembly Installation

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

(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. 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. Put a dab of waterproof cement over hole to seal it.

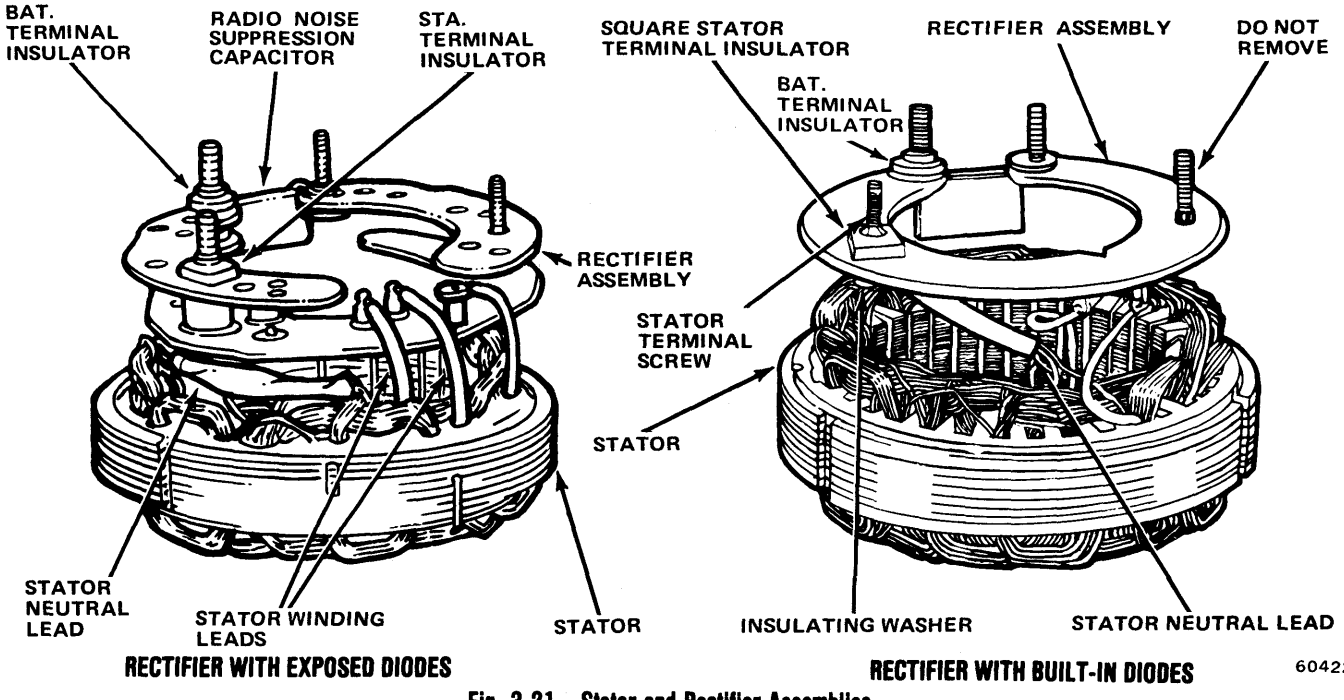

Fig. 3-21 Stator and Rectifier Assemblies

DELCO ALTERNATOR

GENERAL

The 10-SI Series Alternator (fig. 3-22) is 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. 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 are manufactured with adequate lubricant and do not require 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.

OPERATION

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

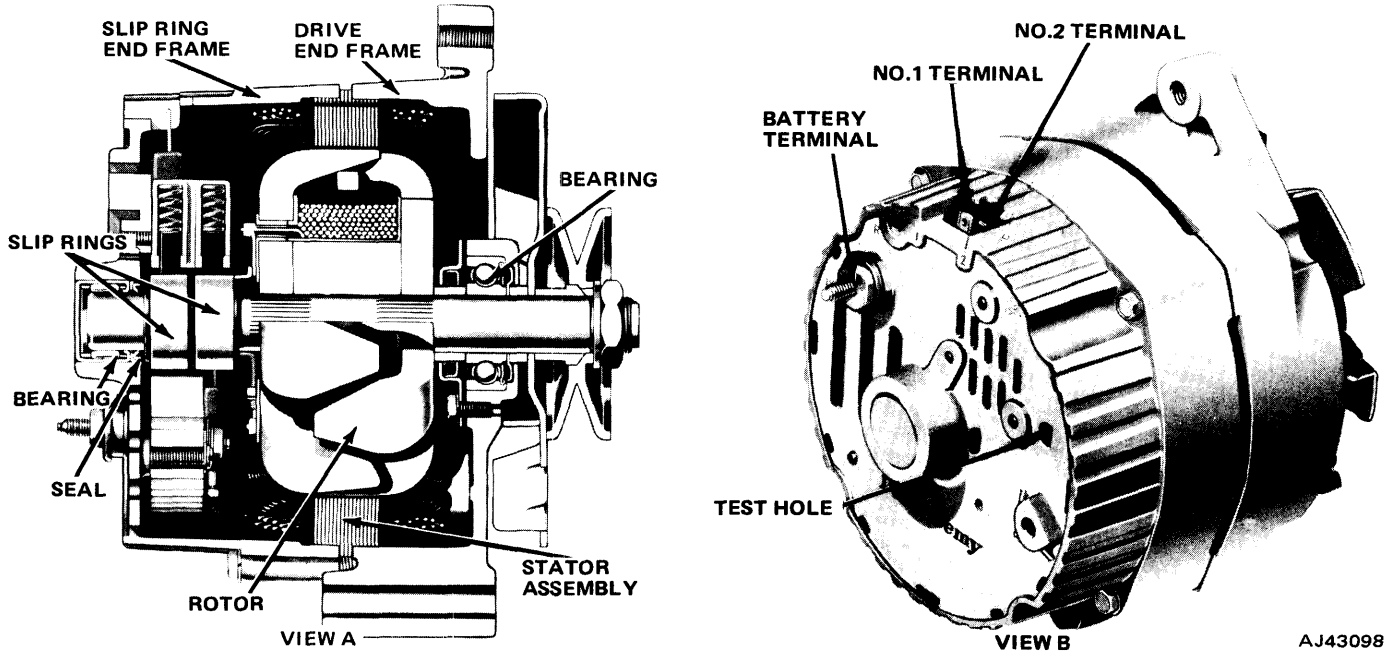

Fig. 3-22 Delco Alternator

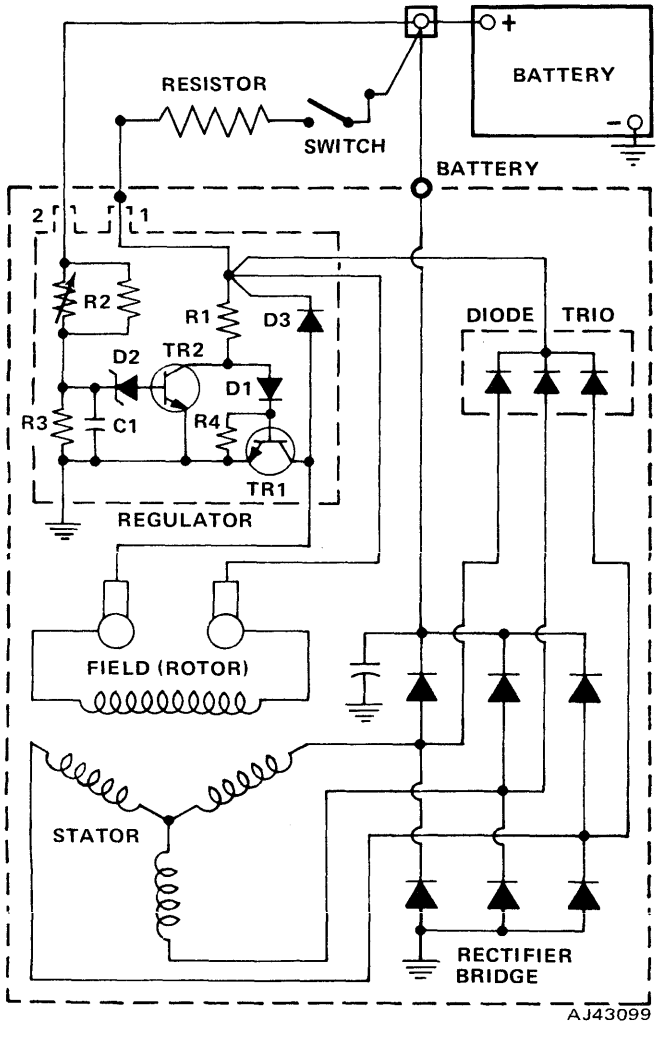

Fig. 3-23 10-SI Alternator Schematic—Typical

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.

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.

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, providing the optimum voltage for charging the battery.

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 3-24 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 and Truck. CJ Models use a voltmeter.*

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

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.

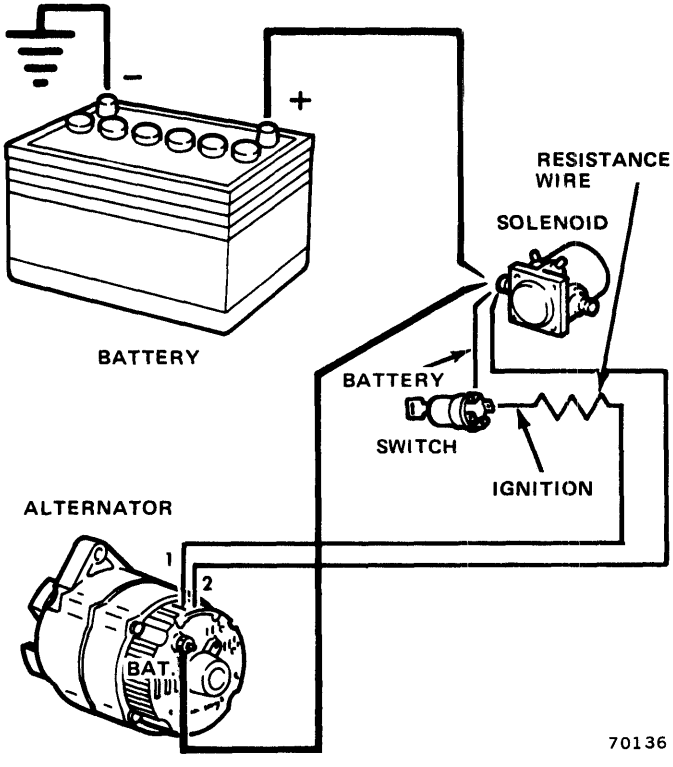

Fig. 3-24 Basic Lead Connections (Negative Ground Shown)

Faulty Ammeter or Voltmeter Operation

Check the ammeter or voltmeter for normal operation as outlined in the Instrument Cluster section. If the meter operates normally, proceed to Overcharged-Undercharged Battery Diagnosis Guide.

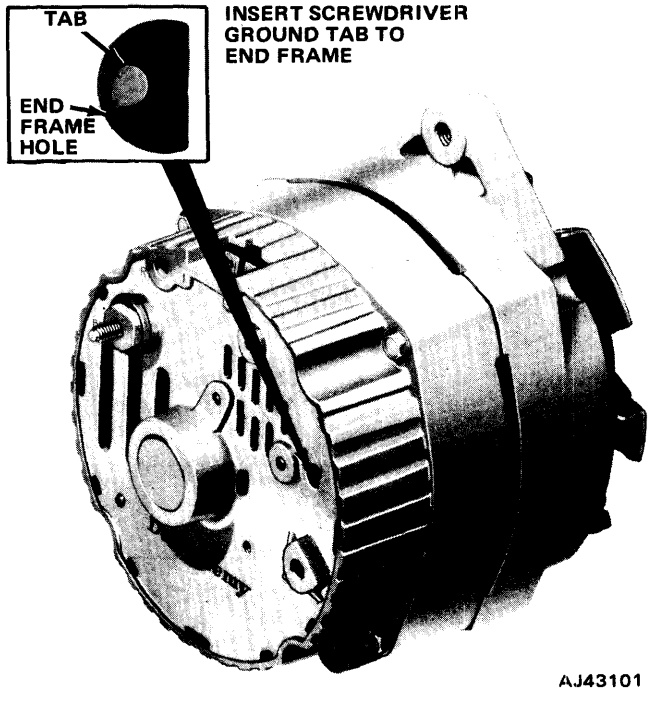

Fig. 3-25 Grounding Alternator Field Windings (Wiring Connections not Shown)

Overcharged-Undercharged Battery

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

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 atlernator 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. 3-26).

(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. 3-27).

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

(3) Install alternator drive belt.

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. 3-25)**. 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 **Fig. 3-31, 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. 3-34)**, 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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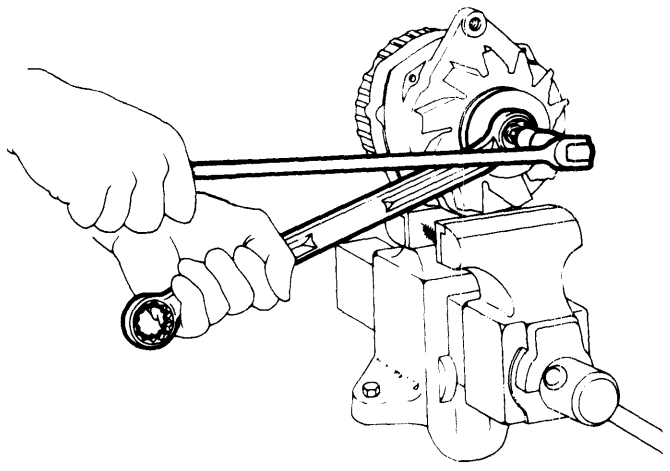

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Fig. 3-26 Pulley Removal

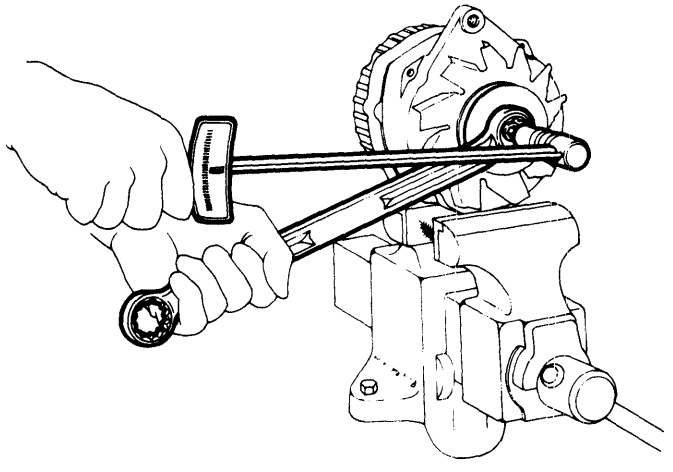

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Fig. 3-27 Tightening Pulley Nut

(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.

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 assembly reference.

(2) Remove four through-bolts, connecting slip ring and end frame and drive end frame (fig. 3-28).

(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 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.

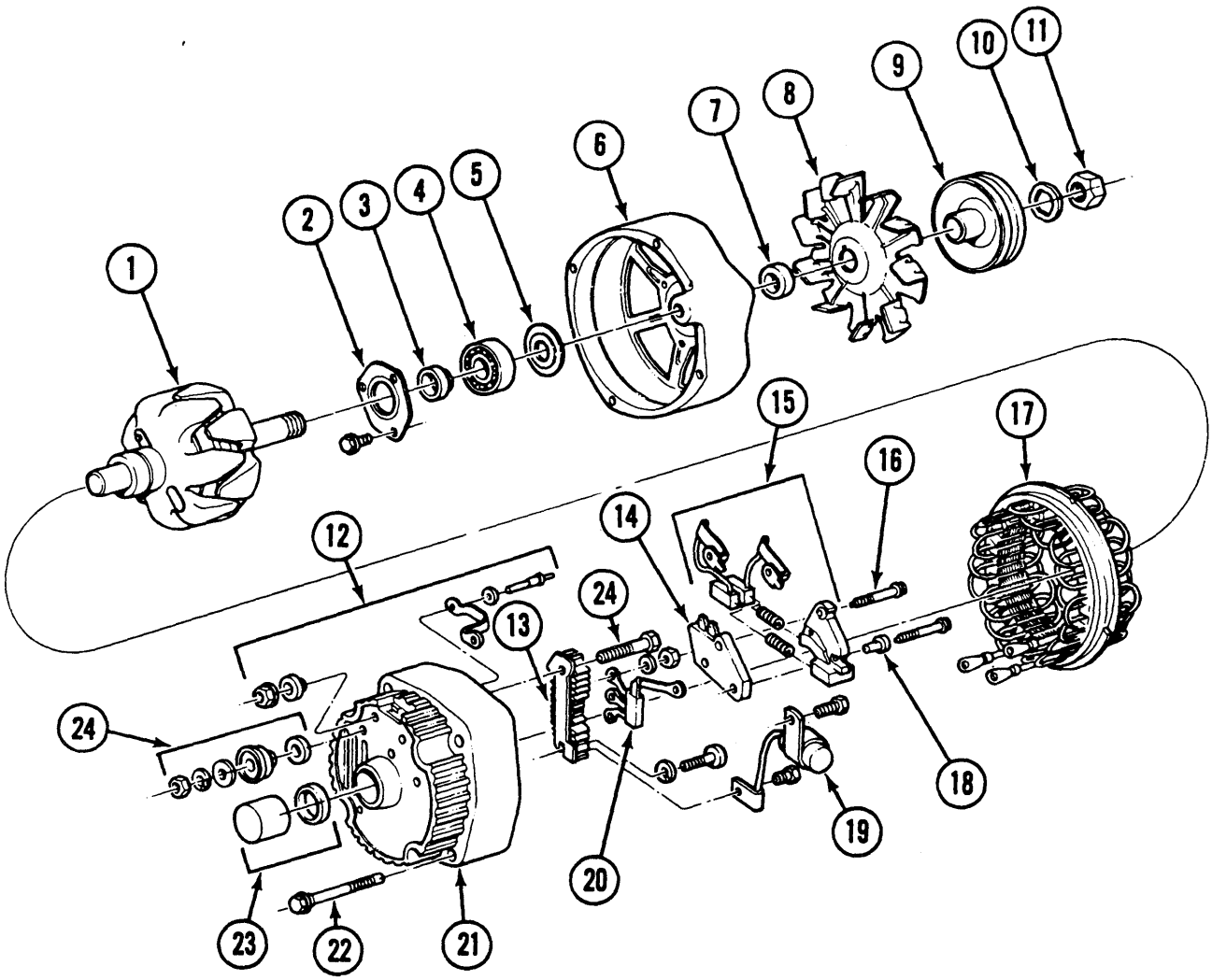
(1) Check for ground by connecting a 110-volt test lamp or ohmmeter from either slip ring to rotor shaft or to rotor poles. If lamp lights or ohmmeter reading is low, the field winding is grounded (fig. 3-29).

(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. 3-29).

(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. 3-45). 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.



1. ROTOR
2. FRONT BEARING RETAINER
3. COLLAR (INNER)
4. BEARING
5. WASHER
6. FRONT HOUSING
7. COLLAR (OUTER)
8. FAN
9. PULLEY
10. LOCKWASHER
11. PULLEY NUT
12. TERMINAL ASSEMBLY
13. RECTIFIER BRIDGE
14. REGULATOR
15. BRUSH ASSEMBLY
16. SCREW
17. STATOR
18. INSULATING WASHER
19. CAPACITOR
20. DIODE TRIO
21. REAR HOUSING
22. THROUGH-BOLT
23. BEARING AND SEAL ASSEMBLY
24. TERMINAL ASSEMBLY

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Fig. 3-28 Delco Alternator

(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 grit 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.

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.

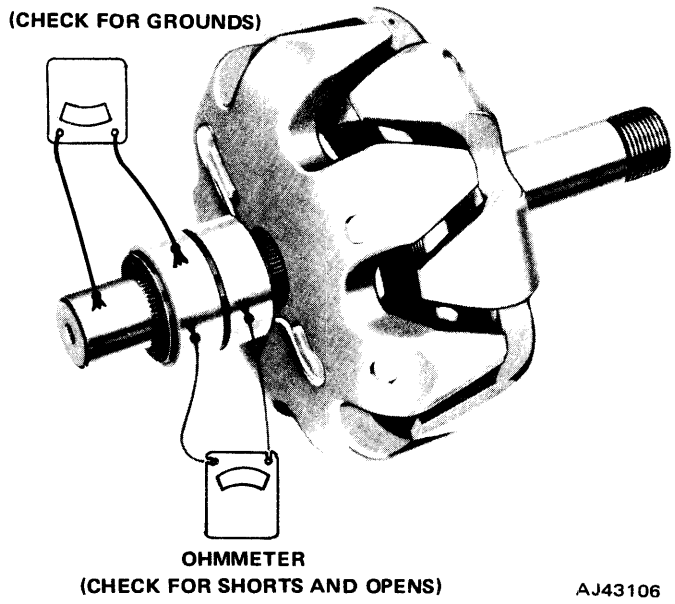

Fig. 3-29 Checking Rotor

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.

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

Testing

The stator windings may be checked with a 110-volt test lamp or ohmmeter as follows:

(1) 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. 3-30).

(2) Test for opens by successively connecting test lamp or ohmmeter between stator leads. If lamp fails to light or ohmmeter reading is high, there is an open in stator windings (fig. 3-30).

(3) 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.*

(4) Replace stator which fails above test.

CAUTION: *Do not clean in solvent.*

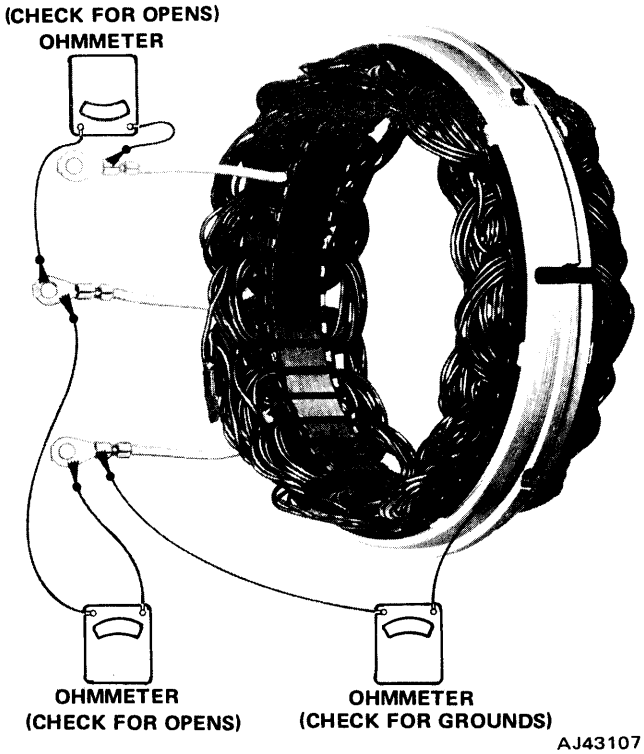

Fig. 3-30 Checking Stator

Assembly

(1) Position stator frame and end frame together.

(2) 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. 3-31).

(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. 3-31).

(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.

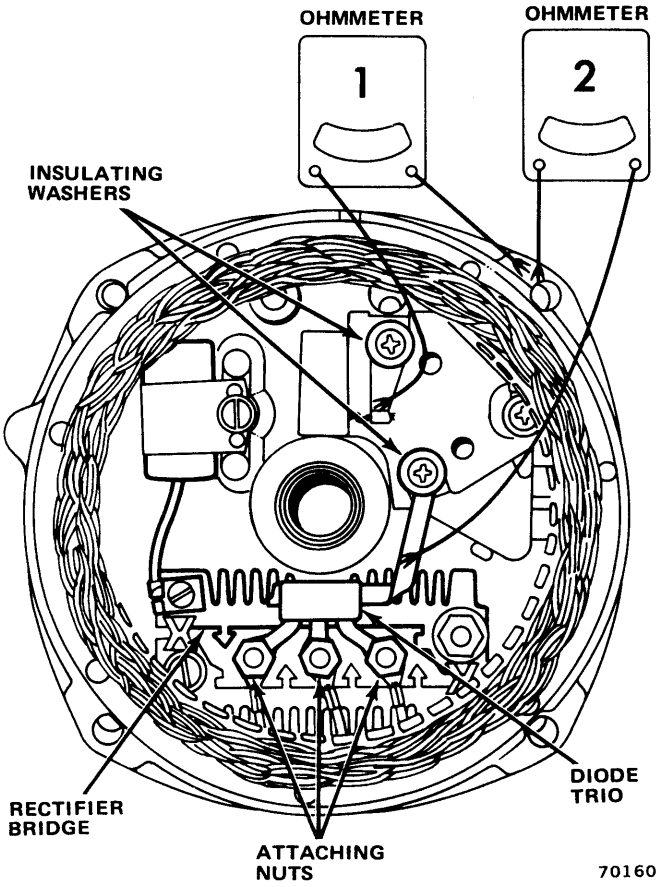

Fig. 3-31 Slip Ring End Frame Assembly

(3) Remove stator.

(4) 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.

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. 3-32). 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.

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 stator and attach leads to rectifier bridge terminals. Secure with washers and nuts.

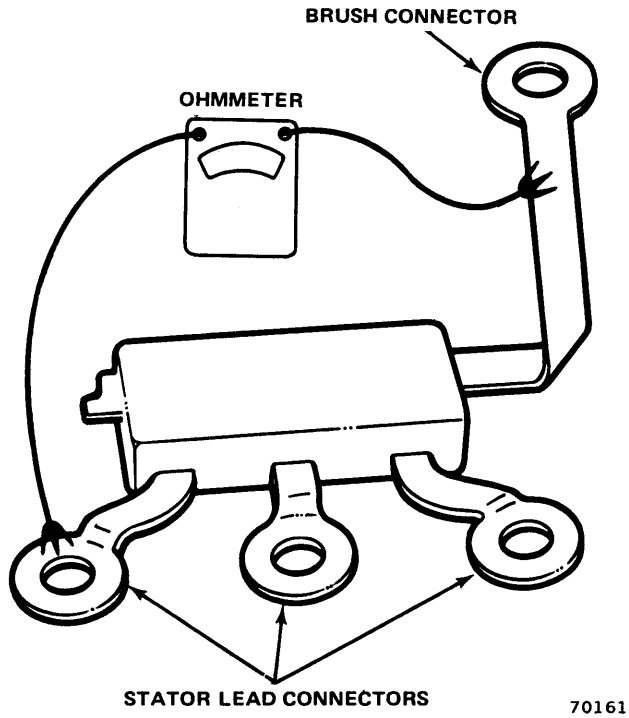

Fig. 3-32 Checking Diode Trio

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. 3-33). 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.

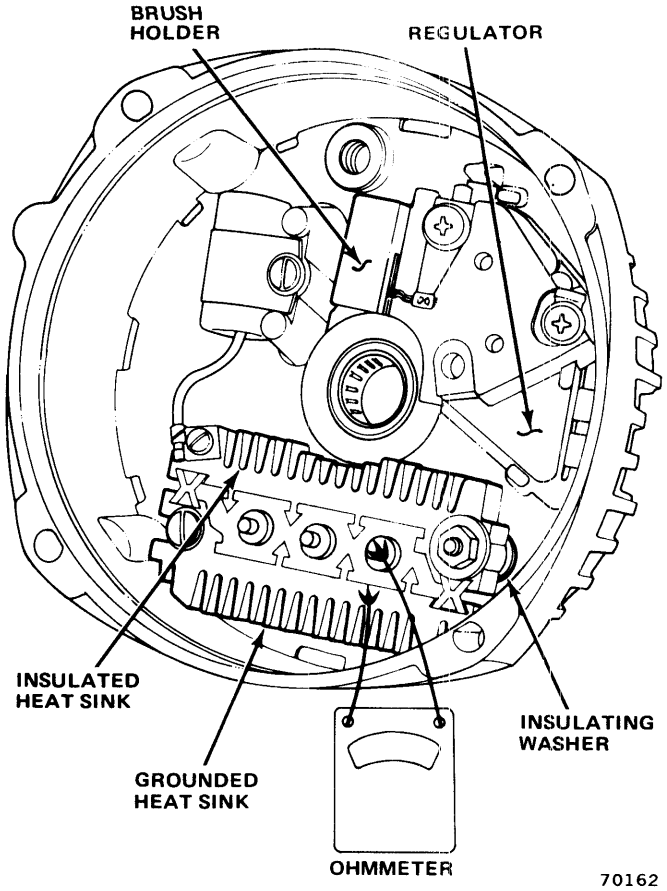

Fig.3-33 Rectifier Bridge Check

Disassembly

(1) Remove capacitor lead attaching screw.
(2) Disconnect capacitor lead from rectifier bridge.
(3) Remove rectifier bridge attaching screws and battery terminal screw.
(4) Remove rectifier bridge. Note insulator between insulated heat sink and end frame (fig. 3-33).

Assembly

(1) Position rectifier bridge to end frame with insulator between insulated heat sink and end frame.
(2) Install rectifier bridge attaching screw and battery terminal screw.
(3) 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. 3-34).
(2) Inspect brush holder screws for broken or cracked insulation.
(3) Remove brush holder and brushes. Carefully note stack-up of parts for assembly.

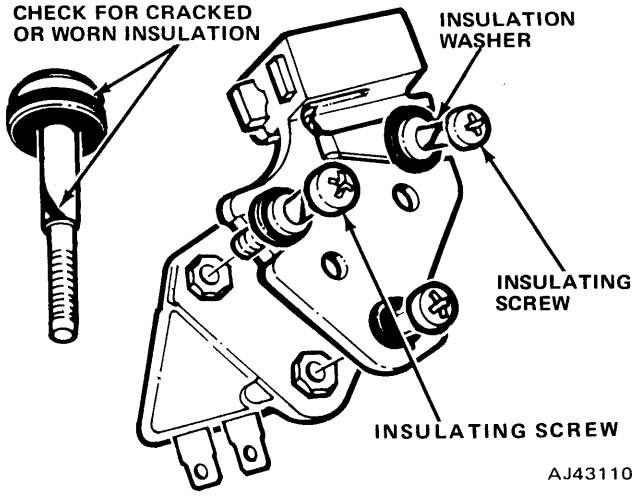

Fig. 3-34 Brush Holders

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.

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.
(3) Install voltage regulator.
(4) Attach brush holder into end frame, noting stack-up of parts (fig. 3-34). Allow wooden or plastic toothpick to protrude through hole in end frame.
(5) Install diode trio lead strap attaching screw and washer.
(6) Securely tighten remaining two brush holder screws.

Bearing Replacement and Lubrication

Drive End Frame Disassembly

(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 Disassembly

(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.*

Drive End Frame Assembly

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. 3-35).

(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 replacement retainer plate be installed if the felt seal in the retainer plate is hardened.*

(3) Install retaining plate and screws.

Slip Ring End Frame Assembly

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

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

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

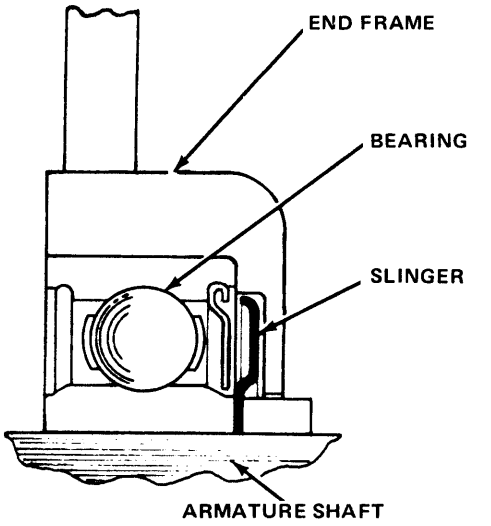

Fig. 3-35 Drive End Bearing Assembly

NOTE: *If the seal is separated from the bearing, install a replacement seal 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 slip ring frame and drive ring frame together, aligning 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 used on all Jeep vehicles consists of a positive engagement starter motor, a starter solenoid, a starter switch (integral with the ignition switch), starter circuits protected by fusible links, and the vehicle's battery. Vehicles equipped with automatic transmission also have a neutral start switch. The starter motor uses a moveable pole shoe and appropriate linkage to engage the drive mechanism. Inside the drive

assembly, an overrunning clutch protects the starter motor in case of a false start.

COMPONENTS

Starter Motor

Identification

At the time of manufacture, the starter motor identification code is stamped on the frame adjacent to the Jeep Part Number.

Example: 7 A A

- Year (6—1976, 7—1977)
- Month (A—Jan., B—Feb.)
- Week (A—first week in month, B—second week)

Field Coils

Four field coils are used. Each is wrapped around an iron pole shoe which acts to concentrate the magnetic field created when current flows through the field coil. Three of the field coils have fixed pole shoes, while the fourth coil has a moveable pole shoe. This fourth coil, mounted at the top of the starter motor, has an additional, smaller coil wrapped inside. This is called the hold-in coil.

Drive Assembly

A pinion gear, driven by the starter motor armature, is slid into mesh with the engine ring gear when the starter is activated. The sliding motion is accomplished by the action of the moveable pole shoe and its drive yoke (fig. 3-36). As long as the ignition key is held in the START position, the drive pinion remains in mesh with the engine ring gear. An overrunning clutch in the drive assembly permits the starter motor to drive the engine ring gear. After the engine starts, it prevents the engine from driving the starter motor before the key is returned to the RUN position.

Neutral Safety Switch

On automatic transmission models, a combination neutral safety—back-up lamp switch is mounted on the steering column. The neutral safety switch permits current to pass only when the transmission selector is in PARK or NEUTRAL. Vehicles with manual transmission have a jumper bar across the neutral safety switch connector, resulting in a direct connection between the ignition switch and the starter motor relay S-terminal.

Starter Solenoid

Current flows from the ignition switch, through the neutral safety switch (or jumper bar) to the S-terminal of the starter solenoid and energizes the solenoid pull-in coil. The pull-in circuit grounds through the solenoid mounting bracket.

When the solenoid coil is energized, the contact disc is pulled into the closed position. The disc strikes two contacts in the solenoid, completing the circuit between the battery and the starter motor.

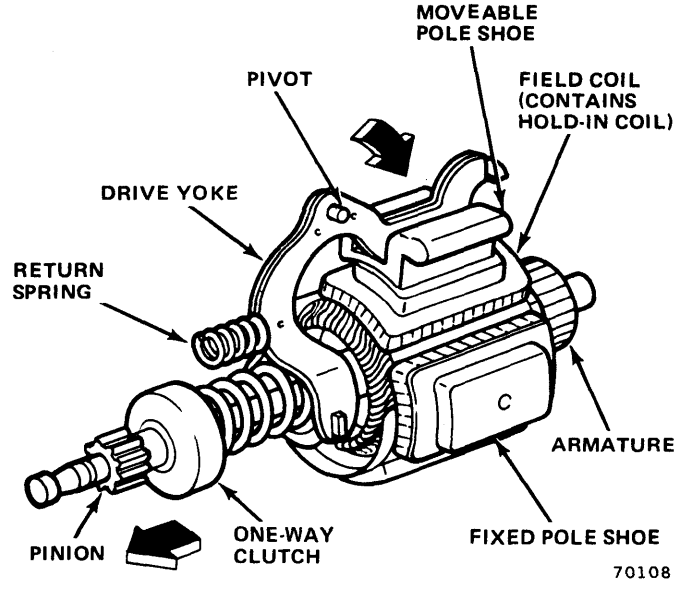

Fig. 3-36 Moveable Pole Shoe Operation

Starter System Circuits

The starting system operates on two circuits, a low current circuit and a high current circuit (fig. 3-37).

The low current circuit is the control circuit. It includes the connections and wires from the ignition switch, through the neutral safety switch to the S-terminal of the starter solenoid.

The high current circuit runs from the battery through the starter solenoid to the starter motor to ground. This circuit uses heavy cables because of the heavy current draw of the starter motor.

Fusible Links

Current is carried from the battery by cable to the starter solenoid battery terminal. From this terminal, current is distributed to all parts of the vehicle. A 14-gauge fusible link joins the battery terminal to the main body harness. This fusible link protects the complete wiring system of the vehicle.

Fusible links are covered with a special non-flammable insulation. Each link is manufactured with a specific load rating and is intended for a specific circuit. Replacement links are listed in the Parts Catalog.

OPERATION

The starting circuit begins at the ignition switch (fig. 3-37). The ignition switch supplies battery voltage to the starter solenoid S-terminal when the ignition key is in the START position. This voltage energizes the solenoid pull-in coil. The circuit between the battery and the starter motor is completed at the solenoid. The starter motor is energized and begins cranking the engine.

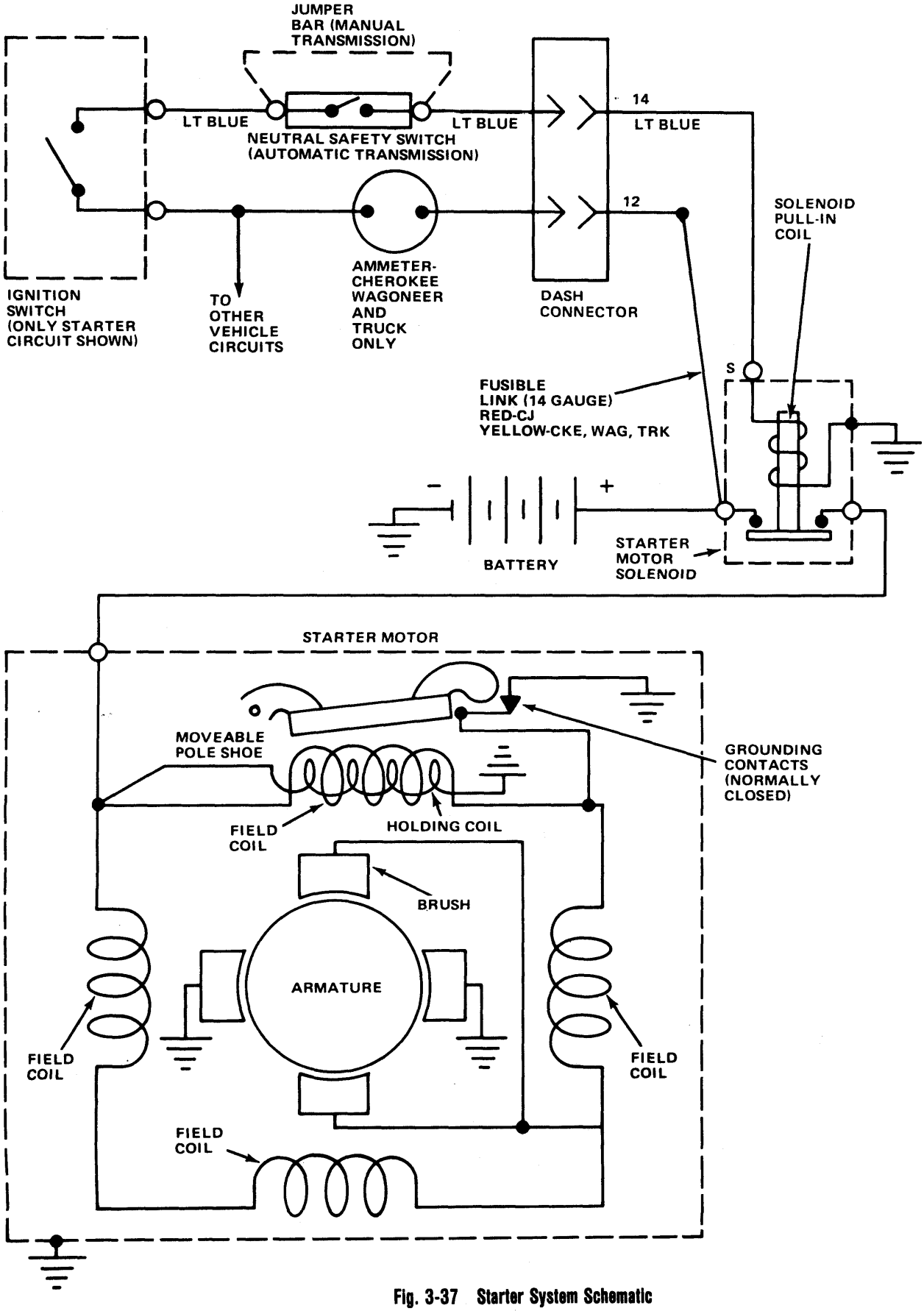

Fig. 3-37 Starter System Schematic

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TROUBLESHOOTING

The Starter Motor Service Diagnosis Chart may be used to trace the source of the problem when the starter cranks the engine slowly, will not crank the engine, or has abnormal drive engagement.

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

ON-VEHICLE TESTING

Engine Will Not Crank

(1) Verify battery and cable condition as outlined in Batteries in this chapter to assure correct cranking voltage.

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

(3) Disconnect wire at the solenoid S-terminal.

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

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

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

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

Starter Motor Solenoid Pull-In Winding Test

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

(1) Remove S-terminal wire from solenoid.

(2) Connect ohmmeter leads (fig. 3-38).

(3) If solenoid fails any one of ohmmeter checks, replace solenoid.

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

Starter Cable and Ground Cable Tests (Voltage Drop)

The voltage drop tests will determine if there is excessive resistance in the high current circuit. Refer to Starter Voltage Drop Tests DARS Chart. When performing these tests, it is important that the voltmeter be connected to the terminals that the cables are connected to instead of to the cables. For example, when checking between battery and solenoid, the voltmeter probes must touch the battery post and the solenoid threaded stud.

Before Performing Tests

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

(2) Place transmission in NEUTRAL or PARK and apply parking brake.

(3) Be sure battery is fully charged.

Test Procedure

Follow the steps as outlined in the Starter Voltage Drop Test DARS Charts.

Current Draw Test

(1) Prior to performing current draw test, battery must be fully charged as described in Batteries in this chapter.

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

(2) Disconnect and ground ignition coil secondary wire.

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

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

(5) Turn remote control starter switch off.

(6) Turn load control knob toward INCREASE (clockwise) until voltmeter reading is exactly the same as it was when starter was cranking engine.

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 within 180 to 220 amperes at room temperature, remove the starter motor from the engine for bench testing.

NOTE: *Do not consider the initial amperage draw that is required to begin engine cranking. A very hot or very cold engine may draw 400 to 600 amperes for the first few revolutions. Take an amperage draw reading after the starter has obtained its maximum rpm.*

Service Diagnosis

Condition	Possible Cause	Correction
STARTER CRANKS ENGINE SLOWLY	(1) Battery low or defective.	(1) Charge or replace battery.
	(2) Poor circuit between battery and starter motor.	(2) Clean and tighten, or replace cables.
	(3) Current draw low.	(3) Bench-test starter motor. Look for worn brushes and weak brush springs.
	(4) Current draw high.	(4) Bench-test starter. Check engine for functional drag or coolant in cylinders. Check ring gear clearance to starter motor.
STARTER WILL NOT CRANK ENGINE	(1) Battery low or defective.	(1) Charge or replace battery.
	(2) Faulty solenoid.	(2) Check solenoid ground. Repair or replace as necessary.
	(3) Damaged drive pinion gear or ring gear.	(3) Replace damaged gear(s).
	(4) Starter engagement weak.	(4) Bench-test starter.
	(5) Starter spins slowly and draws high current.	(5) Check drive yoke pull-down and point gap, check for worn end bushings, check ring gear clearance.
	(6) Engine siezed.	(6) Repair engine.
STARTER DRIVE WILL NOT ENGAGE (SOLENOID KNOWN TO BE GOOD)	(1) Defective point assembly.	(1) Repair or replace point assembly.
	(2) Poor point assembly ground.	(2) Repair connection at ground screw.
	(3) Defective pull-in coil.	(3) Replace field coil set.
STARTER DRIVE WILL NOT DISENGAGE	(1) Starter motor loose on bellhousing.	(1) Tighten mounting bolts.
	(2) Worn drive end bushing.	(2) Replace bushing.
	(3) Damaged ring gear teeth.	(3) Replace ring gear.
	(4) Drive yoke return spring broken or missing.	(4) Replace spring.
	(5) Defective starter drive.	(5) Replace starter drive.
	(6) Ignition Switch adjusted wrong.	(6) Reposition switch.
	(7) Foreign object in dash connector.	(7) Remove foreign object.
STARTER MOTOR DRIVE DISENGAGES PREMATURELY	(1) Weak drive assembly thrust spring.	(1) Replace drive assembly.
	(2) Weak hold-in coil.	(2) Replace field coil set.
LOW CURRENT DRAW	(1) Worn brushes.	(1) Replace brushes.
	(2) Weak brush springs.	(2) Replace springs.

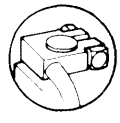
STARTER VOLTAGE DROP TEST DIAGNOSIS AND REPAIR SIMPLIFICATION (DARS) CHARTS

STARTER VOLTAGE DROP TESTS

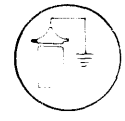
Chart 1

STEP | **SEQUENCE** | **RESULT**

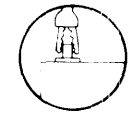
STARTER DRAW TEST



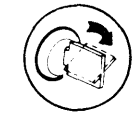
● CLEAN AND CONNECT BATTERY CABLES



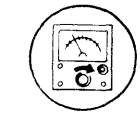
● REMOVE COIL WIRE FROM DISTRIBUTOR AND CONNECT TO GROUND



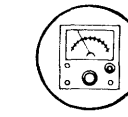
● CONNECT HEAVY LOAD TESTER



● CRANK ENGINE FOR THREE SECONDS

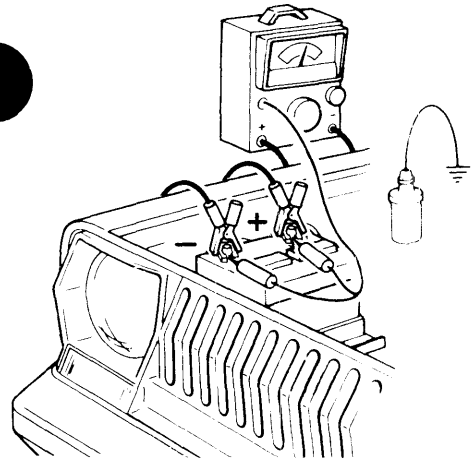


● TURN LOAD CONTROL UNTIL VOLTMETER SHOWS SAME VOLTAGE AS WHEN CRANKING



● READ AMMETER. NOTE READING FOR USE IN LATER STEPS

1



OK — 6 CYL. – 150-180 AMPS
8 CYL. – 160-210 AMPS → STOP

OK — 6 CYL. – ABOVE 180 AMPS
8 CYL. – ABOVE 210 AMPS

● BATTERY CABLES AND SOLENOID NOT TESTED → **2**

OR

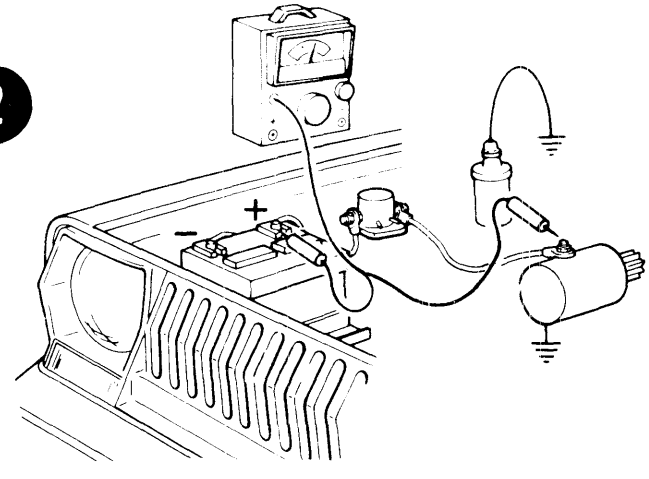
● BATTERY CABLE AND SOLENOID REPAIRS COMPLETED → REPAIR STARTER → STOP

VOLTAGE DROP TEST

● GROUND COIL WIRE
● CONNECT VOLTMETER
● CRANK ENGINE
● READ VOLTMETER
● NOTE AMMETER READING FROM STEP 1

MAXIMUM VOLTAGE DROP BY STARTER DRAW AMPERAGE				
AMPS	150-210	215-295	300-420	425-600
VOLTS	0.5 V	0.7 V	1.0 V	1.5 V

2



OK — VOLTAGE AT OR BELOW MAXIMUM → **5**

OK — VOLTAGE ABOVE MAXIMUM → **3**

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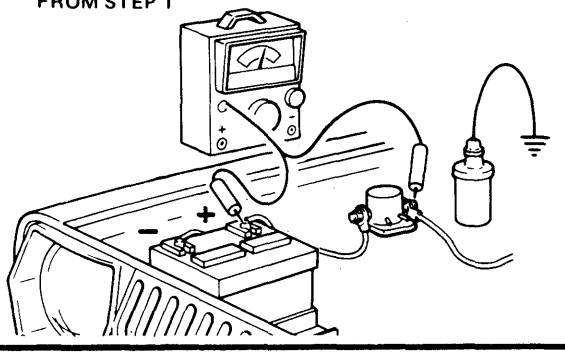
STEP	SEQUENCE	RESULT

3

VOLTAGE DROP TEST

- GROUND COIL WIRE
- CONNECT VOLTMETER
- CRANK ENGINE
- READ VOLTMETER
- NOTE AMMETER READING FROM STEP 1



MAXIMUM VOLTAGE DROP BY STARTER DRAW AMPERAGE				
AMPS	150-210	215-295	300-420	425-500
VOLTS	0.3 V	0.5 V	0.6 V	0.9 V

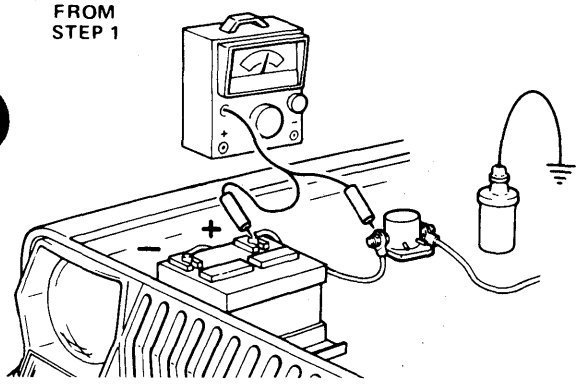
OK → VOLTAGE AT OR BELOW MAXIMUM → REPAIR SOLENOID-TO-STARTER CABLE → 5

OK → VOLTAGE ABOVE MAXIMUM → 4

4

VOLTAGE DROP TEST

- GROUND COIL WIRE
- CONNECT VOLTMETER
- CRANK ENGINE
- READ VOLTMETER
- NOTE AMMETER READING FROM STEP 1



MAXIMUM VOLTAGE DROP BY STARTER DRAW AMPERAGE				
AMPS	150-210	215-295	300-420	425-600
VOLTS	0.2V	0.3V	0.4V	0.5V

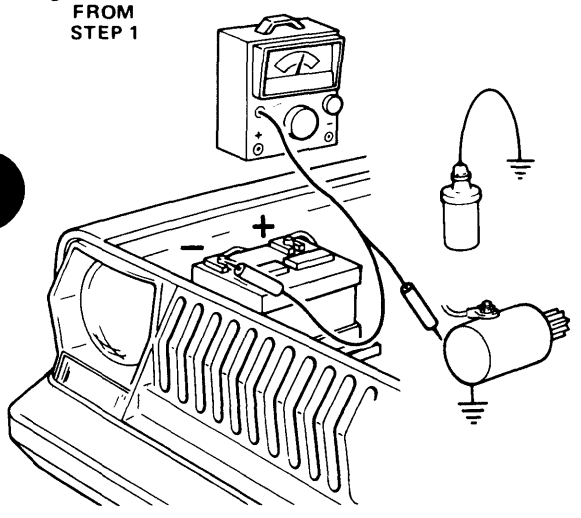
OK → VOLTAGE AT OR BELOW MAXIMUM → REPAIR SOLENOID → 5

OK → VOLTAGE ABOVE MAXIMUM → REPAIR BATTERY-TO-SOLENOID CABLE → 5

5

VOLTAGE DROP TEST

- GROUND COIL WIRE
- CONNECT VOLTMETER
- CRANK ENGINE
- READ VOLTMETER
- NOTE AMMETER READING FROM STEP 1



MAXIMUM VOLTAGE DROP BY STARTER DRAW AMPERAGE				
AMPS	150-210	215-295	300-420	425-600
VOLTS	0.2V	0.3V	0.4V	0.5V

OK → VOLTAGE AT OR BELOW MAXIMUM

- REPAIRS TO SOLENOID OR CABLES PERFORMED IN A PREVIOUS STEP → 1
- REPAIRS TO SOLENOID OR CABLES NOT REQUIRED IN A PREVIOUS STEP → REPAIR STARTER → STOP

OK → VOLTAGE ABOVE MAXIMUM → REPAIR ENGINE-TO-BATTERY CABLE → 1

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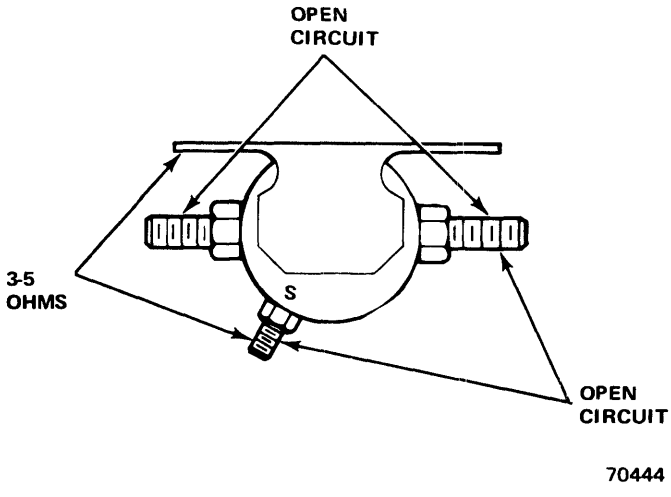


Fig. 3-38 Ohmmeter Check of Starter Solenoid

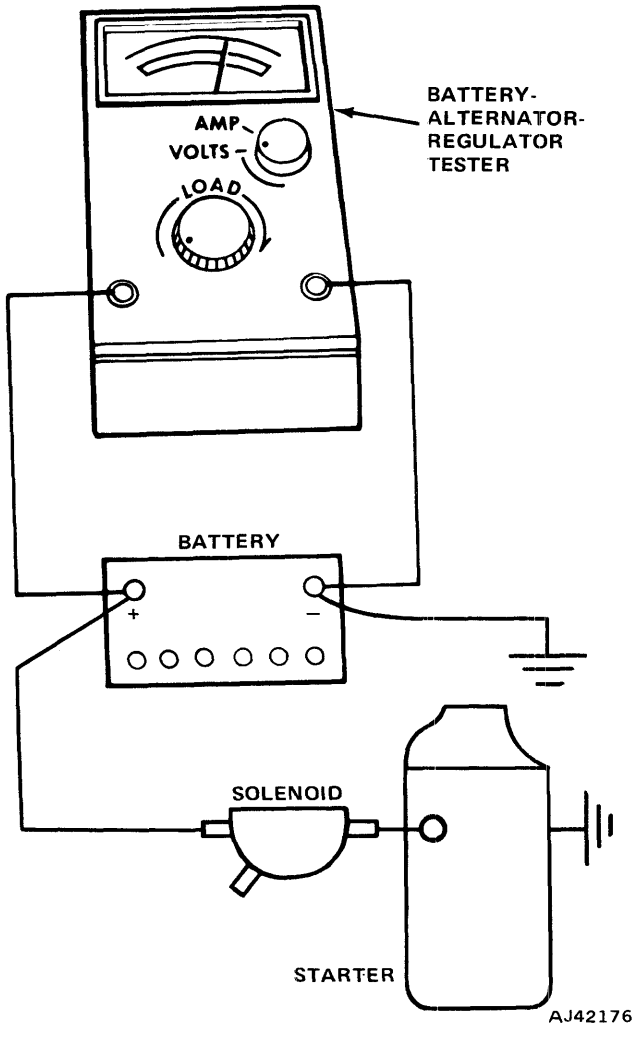


Fig. 3-39 Starter Motor Current Draw Test

Neutral Safety Switch Test

(1) Insert voltmeter leads into switch with all switch leads connected.

NOTE: *Probe-type tips are required on voltmeter leads. If not available, push cotter pins into switch connector to provide contacts for jaw-type voltmeter leads.*

(2) Turn ignition switch to START position.
(3) Voltmeter should indicate less than 0.1 volt.

OFF-VEHICLE TESTING

No-Load Test

The starter motor no-load test will indicate such faults as open or shorted windings, worn bushings (rubbing armature) or bent armature shaft.

NOTE: *The tester load control knob must be in the DECREASE (extreme counterclockwise) 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).

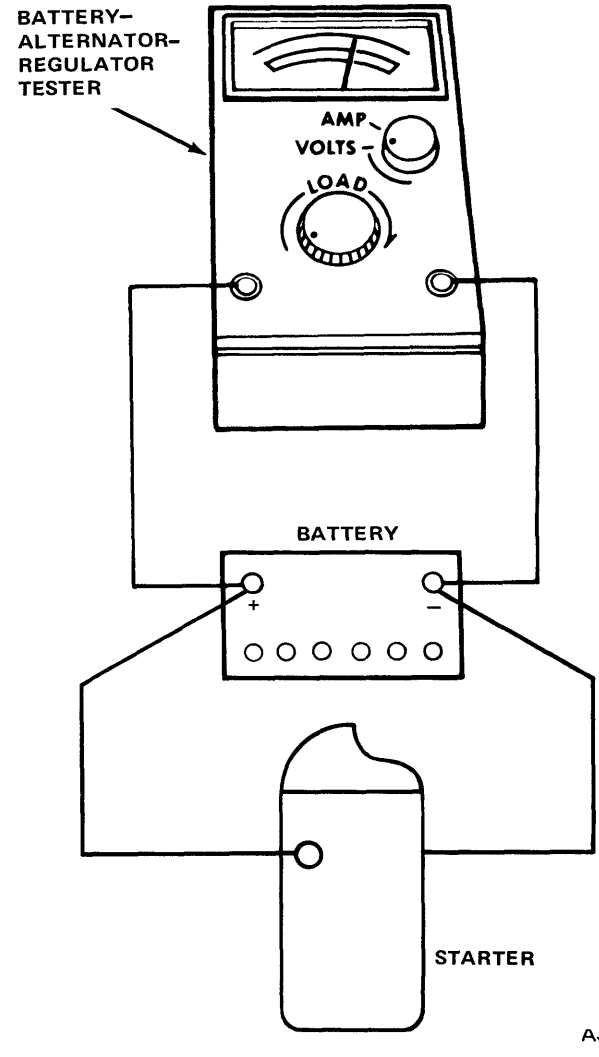


Fig. 3-40 Starter Motor No-Load Test

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

(3) Disconnect starter from battery.

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

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

If the ammeter reading is higher than specified and the starter rpm is less than 9000, the starter should be disassembled, cleaned, inspected and tested as outlined in the following paragraphs.

Field Grounded Circuit Test

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

(1) Place insulated brushes aside to prevent their touching any part of starter (fig. 3-41).

(2) Remove screw attaching solenoid point assembly brush lead to frame. **Do not** allow ground brush to contact starter.

(3) Connect one test probe to terminal screw and one test probe to starter frame. Test lamp should not light. If lamp lights, field windings are shorted and must be replaced. A loose rivet on solenoid point assembly could also cause a grounded circuit.

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

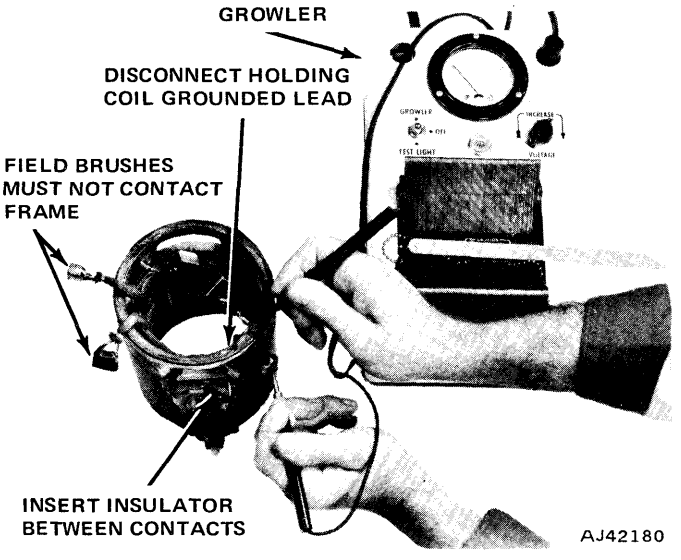


Fig. 3-41 Field Grounded Circuit Test

Armature Tests

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.

Armature Ground Test

(1) Place armature in growler jaws and turn power switch to TEST position (fig. 3-42).

(2) Touch one test lead to armature core, touch other lead to each commutator bar one at a time and observe the test light. The test light should not glow. If test light glows on any bar, the armature is grounded and must be replaced.

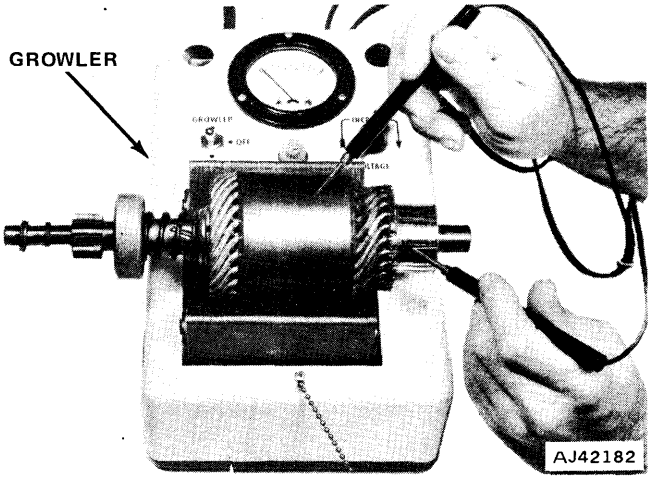


Fig. 3-42 Armature Ground Test

Armature Short Test

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

(1) Place armature in growler jaws and turn power switch to GROWLER position (fig. 3-43).

(2) Hold a steel blade parallel with and touching the armature core. Slowly rotate armature one or more revolutions in growler jaws. If steel blade vibrates at any area of core, area is shorted and armature must be replaced.

Armature Balance Test

(1) Place armature in growler jaws and turn power switch to GROWLER position (fig. 3-44).

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

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

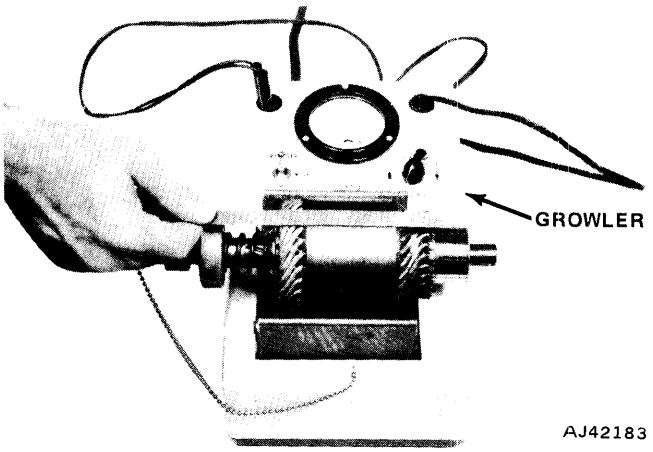


Fig. 3-43 Armature Short Test

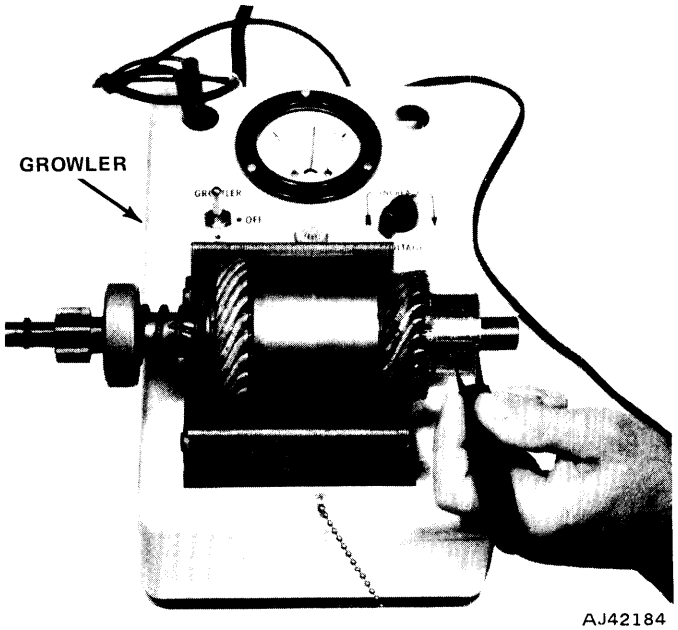


Fig. 3-44 Armature Balance Test

(4) Test each commutator bar with adjacent bar until all bars have been checked. A zero reading indicates an open circuit in the particular pair.

STARTER MOTOR REPLACEMENT

Removal

(1) Disconnect cable from starter motor terminal.
(2) Remove attaching screws and remove starter motor from bellhousing.

Installation

(1) Position starter motor to bellhousing.

NOTE: *Make sure mounting surfaces are free of burrs and debris.*

(2) Install mounting screws and tighten to 18 foot-pounds torque.
(3) Clean terminal stud on starter motor and terminal end of cable.
(4) Install cable to terminal. Install lockwasher and nut and tighten to 55 inch-pounds torque.

STARTER MOTOR OVERHAUL

Disassembly

(1) Remove brush cover band and protective tape, drive yoke cover, and gasket (fig. 3-45).
(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 brush or air to clean starter frame, field coils, armature, drive assembly, and drive end housing.
(2) Wash all other parts in solvent and dry parts.
(3) Inspect armature windings for broken or burned insulation and unsoldered connections.
(4) Inspect armature for open circuits and grounds as outlined in Armature Tests.
(5) Clean dirty commutator with No. 400 or finer sandpaper. **Never use emery cloth to clean commutator.**
(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 two bushings for scoring and excessive wear.
(8) Inspect drive assembly pinion gear for damage. An engine that has repeated starter motor pinion failures should be inspected for:

- Proper ring gear location (fig. 3-46). Inspect for missing or improper parts or misaligned bellhousing.
- Wobbling ring gear. Maximum allowable runout is 0.030. Inspect for broken welds or broken flex plate.
- Foreign object such as a converter balance weight in bellhousing.

NOTE: *The entire circumference of the ring gear must be inspected for damage when the teeth of the drive assembly pinion gear are damaged. A normal wear pattern will be found in three places on 6-cylinder engine ring gears and four places on 8-cylinder engine ring gears. The normal wear pattern extends approximately two inches along the circumference of the ring gear.*

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

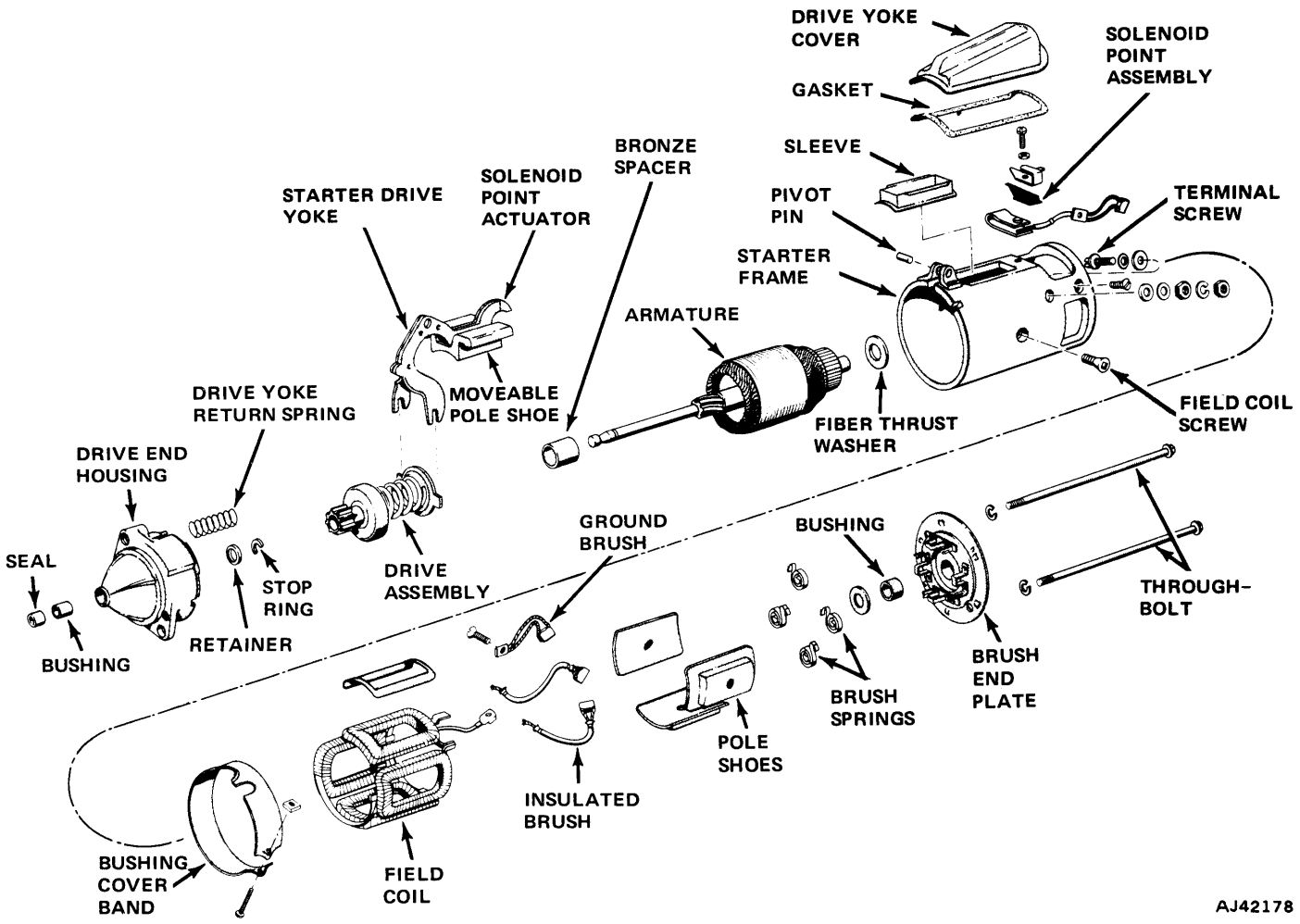
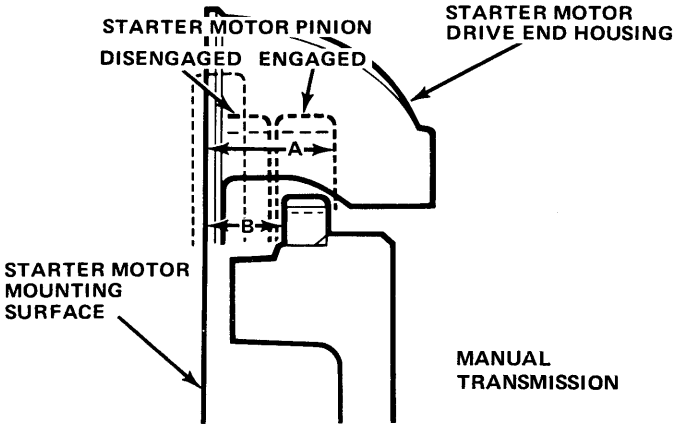
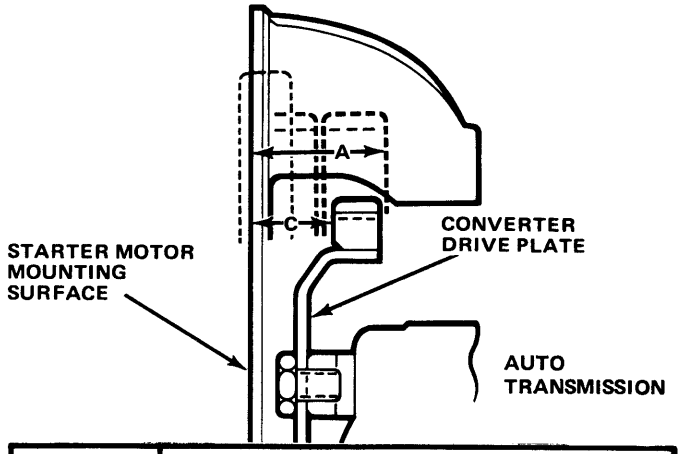


Fig. 3-45 Parts Identification



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

60137



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

60138

Fig. 3-46 Transmission Ring Gear Location

(10) Inspect 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 in length. Check brush spring tension. Replace springs if tension is not within 40 ounces maximum (fig. 3-47).

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

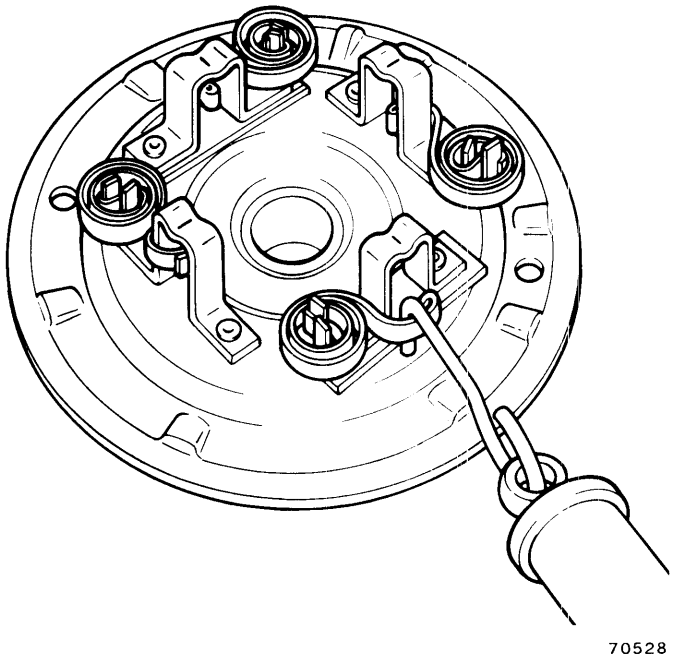


Fig. 3-47 Checking Brush Spring Tension

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. Arbor press should be used to prevent tool slippage.

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

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

(10) Install lower ground brush lead and retaining screw.

(11) Cut upper ground brush lead as close to threaded terminal block as possible. Place unthreaded terminal of replacement ground brush under threaded terminal of solenoid ground lead and install longer retaining screw contained in brush kit.

(12) Install solenoid coil retaining sleeve and bend tabs securing coil.

Solenoid Contact Assembly Replacement

To replace contact assembly with the replacement kit, proceed as follows:

(1) Unsolder contact post from field coil connecting strap. A heavy-duty soldering iron (at least 300 watts) or a propane torch with a small flame is recommended (fig. 3-48).

(2) Cut off head of contact spring retaining rivet with a small, sharp chisel and discard the 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) Position replacement contact spring and ground brush assembly, paper insulator, and contact post on starter frame.

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

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

(7) Clean end of the field connecting strap and slotted area of contact post with fine sandpaper to ensure a 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 the contact post. Solder connection using rosin core solder.

(9) Remove upper ground brush retaining screw and discard brush. Place field ground lead terminal and replacement ground brush terminal block together and install original retaining screw. Tighten screw securely.

Bushing Replacement

Drive End Bushing

(1) Support drive end housing and remove original bushing and seal.

(2) Install replacement bushing using armature and pinion as bushing driver. **Do not** install drive end housing seal at this time.

Commutator End Bushing

(1) Remove original bushing by threading through bushing cavity with a suitable size tap. Secure tap in vise and separate bushing from end plate.

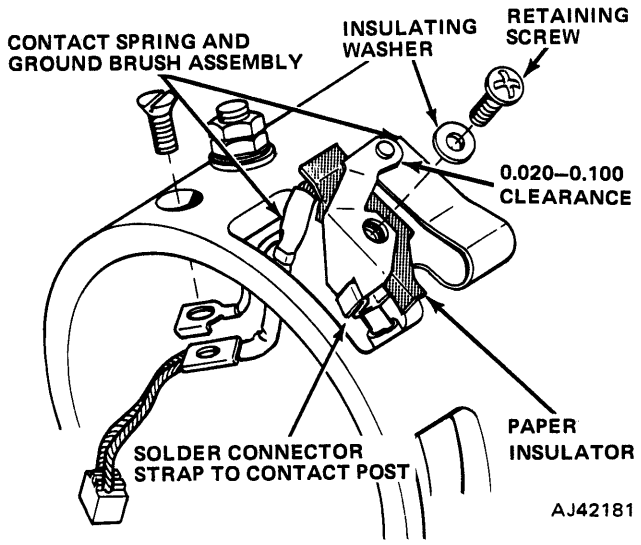


Fig. 3-48 Starter Motor Contact Kit

(2) Drive replacement bushing into end plate until seated, using suitable socket or bushing driver.

Drive Assembly Replacement

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

(2) Apply a few drops of 10W-30 motor oil to armature shaft and end bushings. Service replacement drive assembly is prelubricated.

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

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

Assembly

(1) Position fiber thrust washer on commutator end of armature shaft and apply a few drops of 10W-30 motor oil to bearing surfaces on both ends of shaft.

(2) Insert armature into starter frame and install starter drive yoke and pivot pin. Drive yoke must engage starter drive assembly.

NOTE: *All brushes should be out of their retainers and hanging outside of the starter frame before installing the armature.*

(3) Place starter drive yoke return spring into recess of drive end housing and install housing to starter frame. Install brush end plate with end plate boss aligned with starter frame slot.

(4) Install through-bolts and tighten to specified torque. Be sure that stop ring retainer is properly seated in drive end housing.

(5) Use a hook to pull back on the brush springs and insert brushes into their holders.

(6) Press down firmly on the starter drive yoke until moveable pole shoe is bottomed. Check clearance between contact points (fig. 3-48). Bend upper contact post, if required, to obtain a desired clearance of 0.060-inch, with an OK range of 0.020-inch to 0.10-inch.

(7) Cover brush openings in frame with waterproof tape and install drive yoke cover and gasket.

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

(9) Apply a generous amount of Lubriplate or eqivalent to drive end of armature shaft and install drive end housing seal using a socket or other suitable tool.

(10) Connect starter to a battery and check operation. Refer to No-Load Test.

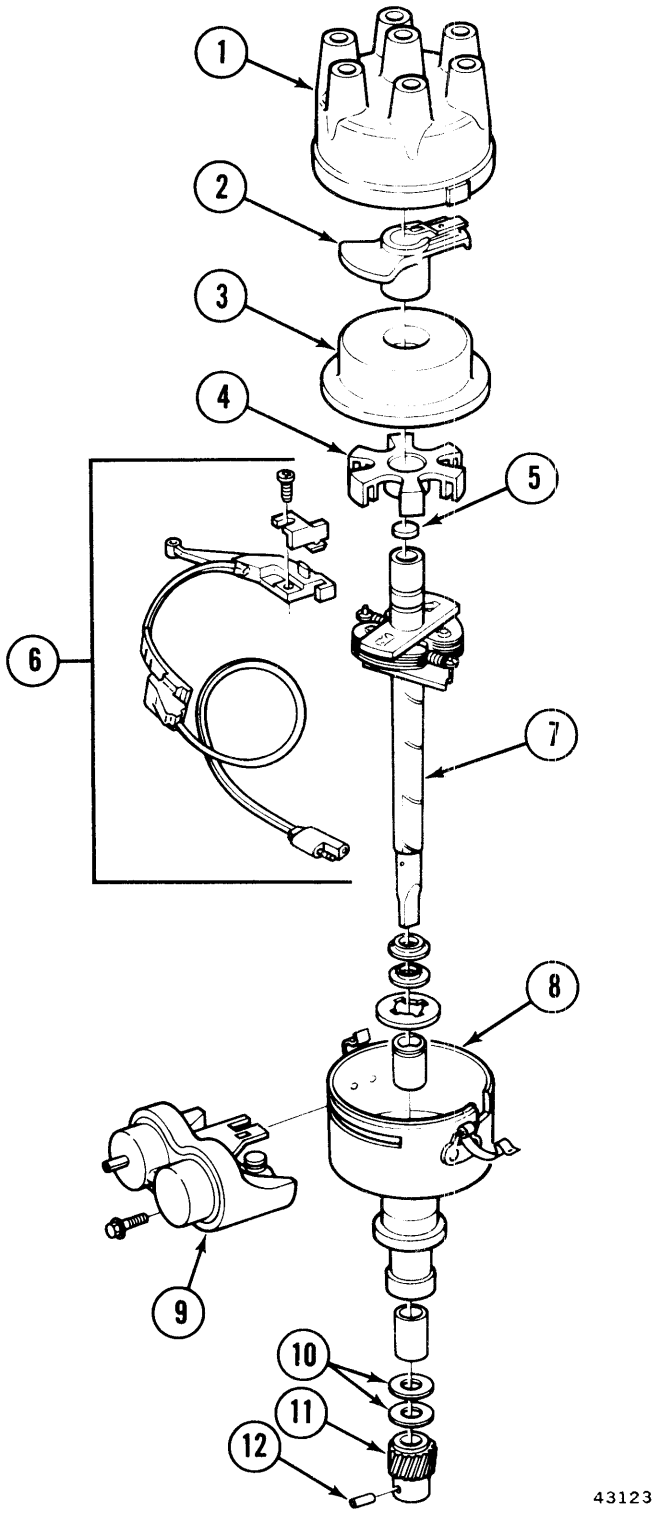
IGNITION SYSTEM

GENERAL

The Jeep Breakerless Inductive Discharge (BID) ignition system has no conventional breaker points, cam or condenser. These parts have been replaced by a trigger wheel, a sensor and an electronic control unit. The BID system retains conventional distributor drive assembly, advance mechanism, distributor cap and rotor (fig. 3-49).

COMPONENTS

The BID system consists of six major components: electronic ignition control unit, ignition coil, distributor, sensor and trigger wheel, ignition wires and spark plugs.



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

Fig. 3-49 Distributor Components

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 waterproof. 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. 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). The ignition coil does 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 consists of a comparatively few turns of heavy wire. The secondary winding consists of many turns of 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 inside the distributor and consists of two flyweights which pivot on long-life, low-friction bearings. The flyweights 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 lessen the spark advance 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 and Trigger Wheel

The sensor detects the signal that causes the electronic control unit to operate the coil primary. The sensor is a small coil, wound of fine wire, which receives an alternating current signal from the electronic control unit.

An electromagnetic field is developed which is sensitive to the presence of metal. The sensor detects the edges of the metal teeth of the trigger wheel. When the 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 contacting surfaces between the trigger wheel and sensor. Because there is no wear, 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.*

Ignition Wires and Spark Plugs

These components are of conventional design. Maintenance and replacement procedures are included in Section 4-A.

OPERATION

The control unit is activated with the ignition switch in the START or RUN position. An oscillator in the control unit excites the sensor in the distributor. When the sensor is excited, it develops an electromagnetic field. As the leading edge of each tooth of the trigger wheel enters the sensor field, the tooth reduces the strength of the oscillation in the sensor. As the oscillation 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, inducing high voltage in the coil secondary winding. High voltage is then distributed to the spark plugs by the rotor, distributor cap and ignition wires.

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 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 and vacuum advance mechanisms 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 burns slower. Additional advance, necessary for maximum economy, is furnished by the vacuum advance unit. Carburetor ported vacuum operates the vacuum advance unit in relation to throttle position and engine load.

TROUBLESHOOTING

Ignition System Diagnosis

To determine an ignition system fault other than spark knock, refer to the Service Diagnosis chart and the Ignition System DARS chart.

Engine Spark Knock (Ping)

Spark knock can be attributed to a number of factors. The most common are climatic factors such as temperature, air density, and humidity.

- **High Underhood Temperature**
  Underhood temperature is 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**
  Air density increases as barometric pressure rises or as temperature drops. A denser than normal mixture of air and fuel drawn into the cylinder has the same effect as raising the the compression ratio. This increases the possibility of spark knock.

- **Humidity**
  Low humidity increases the tendency to spark knock. High humidity decreases spark knock.

- **Fuel Octane Rating**
  All engines are designed to operate on unleaded fuels. 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).*

Service Diagnosis

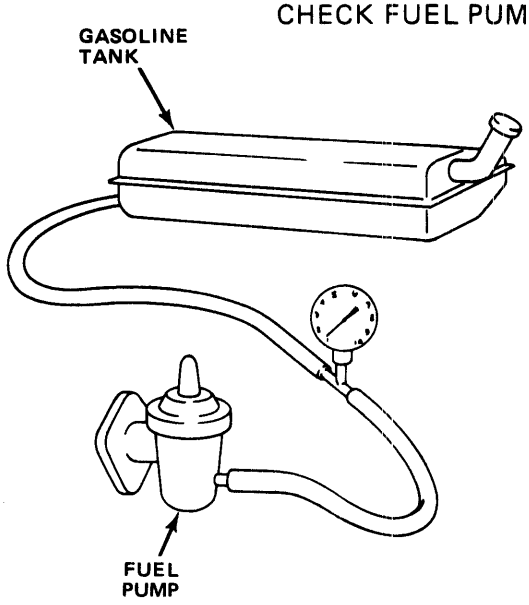
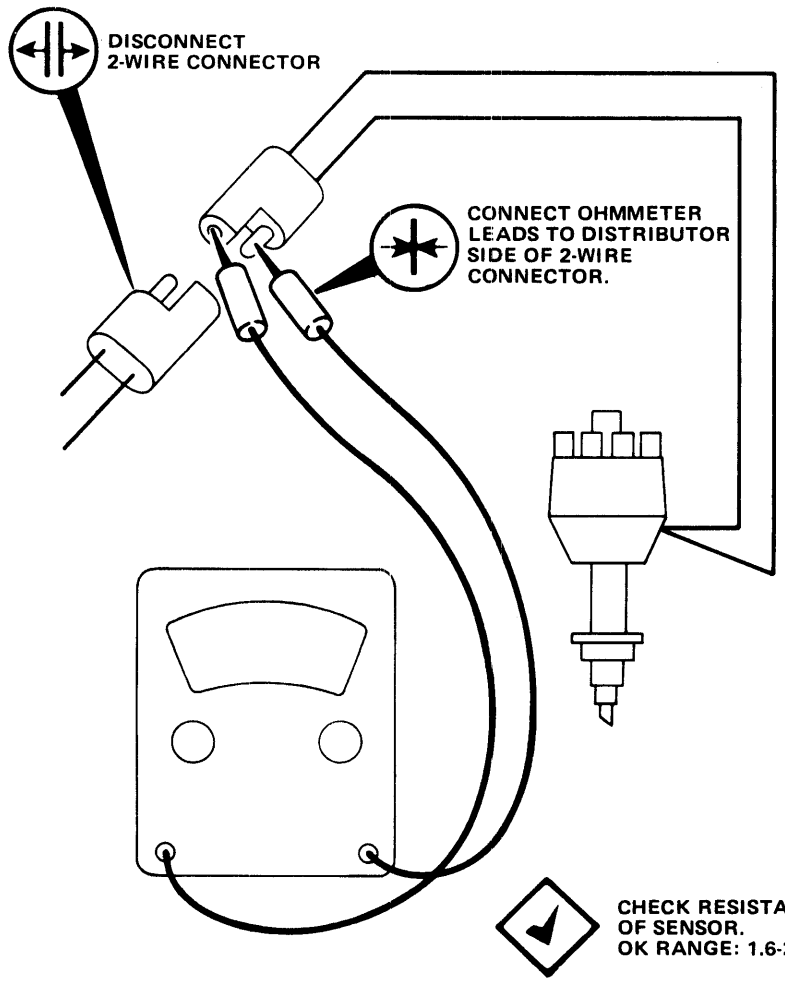
Condition	Possible Cause	Correction
ENGINE FAILS TO START (NO SPARK AT PLUGS).	(1) No voltage to ignition system.	(1) Check battery, ignition switch and wiring. Repair as needed.
	(2) Trigger wheel positioned too high.	(2) Position trigger wheel to 0.50-inch clearance.
	(3) Electronic Control Unit ground lead open, loose or corroded.	(3) Clean, tighten, or repair as needed.
	(4) Primary wiring connectors not fully engaged.	(4) Make sure connectors are clean and firmly seated.
	(5) Coil open or shorted.	(5) Test coil. Replace if faulty.
	(6) Damaged trigger wheel or sensor.	(6) Replace damaged part.
	(7) Electronic Control Unit faulty.	(7) Replace Electronic Control Unit.
	(8) Cracked distributor cap.	(8) Replace cap.
	(9) Defective rotor.	(9) Replace rotor.
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.
	(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) Reconnect in proper firing order.
ENGINE DOES NOT OPERATE SMOOTHLY	(1) Spark plugs fouled or faulty.	(1) Clean and regap plugs. Replace if needed.
AND/OR	(2) Spark plug cables faulty.	(2) Check cables. Replace if needed.
ENGINE MISFIRES AT HIGH SPEED.	(3) Spark advance 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. system(s). Repair as needed.
ERRATIC TIMING ADVANCE.	(1) Faulty vacuum advance assembly.	(1) Check operation of advance diaphragm and replace if needed.
BASIC TIMING NOT AFFECTED BY VACUUM (DISCONNECTED)	(1) Misadjusted, weak or damaged mechanical advance springs.	(1) Readjust or replace springs as needed.

IGNITION SYSTEM DIAGNOSIS AND REPAIR SIMPLIFICATION (DARS) CHARTS

PROBLEM: IGNITION FAILURE OR INTERMITTENT OPERATION

STEP	SEQUENCE	RESULT
1	IDENTIFY CONDITION VEHICLE TOWED IN — NO START OCCASIONAL "NO START" OR ON-THE-ROAD IGNITION FAILURE — INTERMITTENT IGNITION	2 3
2	VERIFY SPARK CHECK FOR SPARK AT SPARK PLUG WIRES SPARK CHECK FOR FUEL SYSTEM OR MECHANICAL ENGINE PROBLEMS CAUTION: DO NOT TOUCH ANY OTHER IGNITION SYSTEM WIRES NO SPARK	STOP 3
3	DISCONNECT 4-WIRE CONNECTOR (DO NOT DISTURB ANY OTHER IGNITION SYSTEM WIRES OR CONNECTORS) ELECTRONIC IGNITION CONTROL UNIT COIL 4-WIRE CONNECTOR WIRE HARNESS 2-WIRE CONNECTOR CONNECT OHMMETER LEADS TO SENSOR WIRE TERMINALS IN 4-WIRE CONNECTOR • OBSERVE OHMMETER READING • MASSAGE AND PRESS 2 - WIRE CONNECTOR • OBSERVE OHMMETER. NEEDLE FLUCTUATION INDICATES RESISTANCE BUILD-UP IN 2-WIRE CONNECTOR OK NEEDLE DOES NOT FLUCTUATE OK NEEDLE FLUCTUATES	4 5

70214A

STEP	SEQUENCE	RESULT
4	CHECK FUEL PUMP RUNNING VACUUM  INSERT VACUUM GAUGE USING "TEE" IN LINE FROM FUEL TANK TO FUEL PUMP SET CARBURETOR ON "FAST IDLE" RUN ENGINE FOR 3-5 MINUTES NOTE VACUUM READING ON GAUGE	2 INCHES OR MORE OF VACUUM → REPLACE IN-TANK FUEL FILTER → STOP LESS THAN 2 INCHES OF VACUUM → 6
5	 CHECK RESISTANCE OF SENSOR. OK RANGE: 1.6-2.4 OHMS.	OK → SENSOR AND WIRES OK → REPLACE HARNESS → 6 OK → SENSOR AND WIRES NOT OK → REPLACE SENSOR → 6

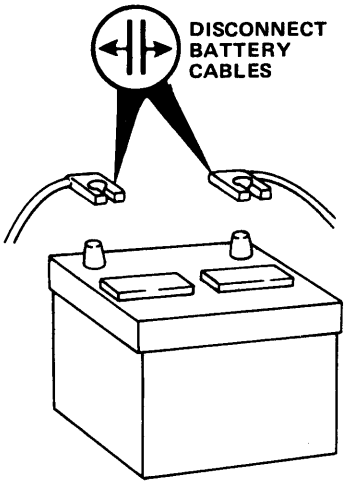
70214B

STEP	SEQUENCE	RESULT

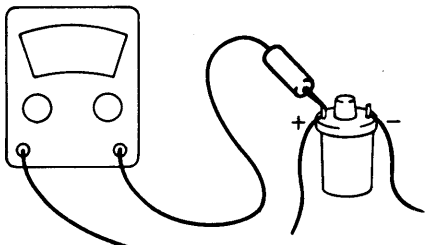
OHMMETER TESTS

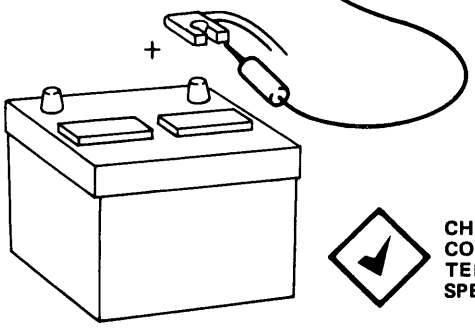
6

DISCONNECT BATTERY CABLES

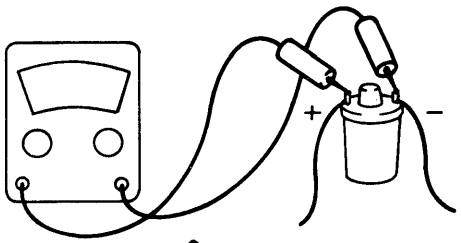


CHECK RESISTANCE OF IGNITION FEED-
BATTERY POSITIVE (+) CABLE TERMINAL
TO COIL POSITIVE (+) TERMINAL
IGNITION SWITCH TURNED ON
SPECIFICATION: 1 OHM

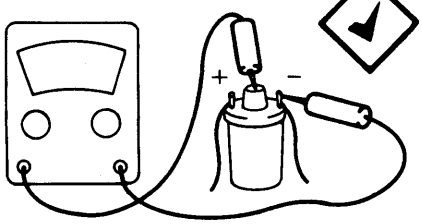




CHECK RESISTANCE OF COIL PRIMARY –
COIL POSITIVE (+) TO COIL NEGATIVE (–)
TERMINAL
SPECIFICATION: 1-2 OHMS



CHECK RESISTANCE OF COIL SECONDRY –
COIL NEGATIVE (–) TERMINAL TO COIL
SECONDARY TERMINAL
SPECIFICATION: 9,000 - 15,000 OHMS



REPLACE ANY
OUT-OF SPEC
COMPONENT
CLEAN AND
TIGHTEN
CIRCUIT
CONNECTORS
AS REQUIRED

STOP

70214C

- **Combustion Chamber Deposits**
  An excessive build-up of deposits in the combustion chamber may be caused by not using recommended fuels and lubricants, prolonged engine idling, or continuous low speed operation. These deposits may be reduced by the occasional use of Jeep Carburetor and Combustion Area Cleaner 8992352 or equivalent, or by operating the vehicle at turnpike speeds.
- **Distributor Advance Mechanism**
  The centrifugal and vacuum advance units should be checked to be sure they are operating freely.
- **Exhaust Manifold Heat Valve**
  If the heat valve sticks in the heat ON position, the intake manifold is heated excessively.
- **Cold Air Induction Hose**
  This hose brings cooler outside air into the air cleaner snorkel. Be sure it is properly connected and not cracked.

TESTING

Ignition System Test

The following procedure can be used to check operation of the components of the BID ignition system.

Electrical components of the ignition system (sensor, coil, and electronic control unit) are not repairable. If the operation test indicates that they are faulty, they must be replaced.

The following equipment is required to make this test:

- Ohmmeter
- DC Voltmeter
- Jumper Wire (12 to 18 inches long) with clip at each end
- Tester (distributor sensor substitute) J-25331
- Insulated Pliers (grippers) for handling high tension cables

(1) Test battery using dc voltmeter. Voltage should be 12 to 13 volts for fully charged battery. If necessary charge or replace battery.

(2) Inspect ignition primary (low voltage) circuit for loose or damaged wiring. Inspect connectors for tight fit. Connect connectors.

(3) Inspect secondary (high voltage) cables for cracks and deterioration. Replace any defective wiring. Be sure ignition cables are routed correctly.

(4) Disconnect high tension cable from one spark plug. (Always grasp the spark plug boot and use a twisting motion when removing plug cables so as not to destroy the resistance wire termination.) Using insulated pliers, hold plug cable to create approximately 1/2 to a 3/4-inch gap between cable terminal and engine. Crank engine and observe spark. If a spark jumps the gap, ignition system is satisfactory. If no spark occurs, install spark plug cable and proceed to step (5).

CAUTION: *Do not attach jumper wire jaws directly to ignition wire. Insulation may be pierced, resulting in high voltage leaks.*

(5) Disconnect high tension cable from center tower terminal of distributor cap. Set up spark gap of approximately 1/2 to 3/4 inch by attaching paper clip to the high tension cable 1/2 to 3/4 inch away from metal tip at distributor end of cable (fig. 3-50). Connect one end of jumper wire to paper clip. Ground other end of jumper wire to engine. Crank engine and observe for spark between paper clip and ignition cable terminal. If spark occurs, distributor cap or rotor is faulty. Replace faulty part and check for spark at spark plug (step (4)). If no spark occurs between jumper wire clip and cable terminal, check coil secondary wire with the ohmmeter for 5,000 to 10,000 ohms resistance. If coil wire check is satisfactory, proceed to step (6). If coil wire is faulty, replace wire, then repeat step (4).

(6) Disconnect the sensor lead wires (black) from the sensor connector (blue and white). Refer to figure 3-50.

(7) Visually inspect the distributor primary wire connector for proper fit. Check female terminals with number 16 drill, which should have a slight drag when inserted in terminal. Male terminals must fit snugly in female terminals.

(8) Apply a light coat of General Electric Silicone Dielectric Compound G-623 (Jeep—8127445) or equivalent to all surfaces of male terminals. Fill female terminal cavities 1/4 full with Dielectric Compound.

(9) Connect distributor primary wires to control unit connector and crank engine. Observe for spark between paper clip and ignition cable terminal. If spark now jumps the gap, the ignition system is satisfactory. If no spark occurs between paper clip and cable terminal, proceed to step (10).

(10) Plug Tester J-25331 into wire harness as shown in figure 3-51. Turn ignition switch ON. Cycle test button and observe for spark between paper clip and ignition cable terminal. If spark occurs now but did not occur with distributor connected, distributor sensor unit is faulty and must be replaced. If no spark occurs, proceed to step (11).

(11) Connect voltmeter between coil positive (+) terminal and ground (fig. 3-52). With ignition switch ON, voltmeter should read battery voltage. If voltage at coil positive terminal is noticeably lower than battery voltage, a high resistance exists between the battery (through ignition switch) and the coil. Before proceeding, the resistance must be corrected. If voltage at coil positive terminal equals battery voltage, proceed to step (12).

(12) Connect voltmeter between coil negative (-) terminal and ground (fig. 3-53). With ignition switch ON, voltage should read 5 to 8 volts. A reading under 5 volts or over 8 volts indicates a faulty coil which must be replaced.

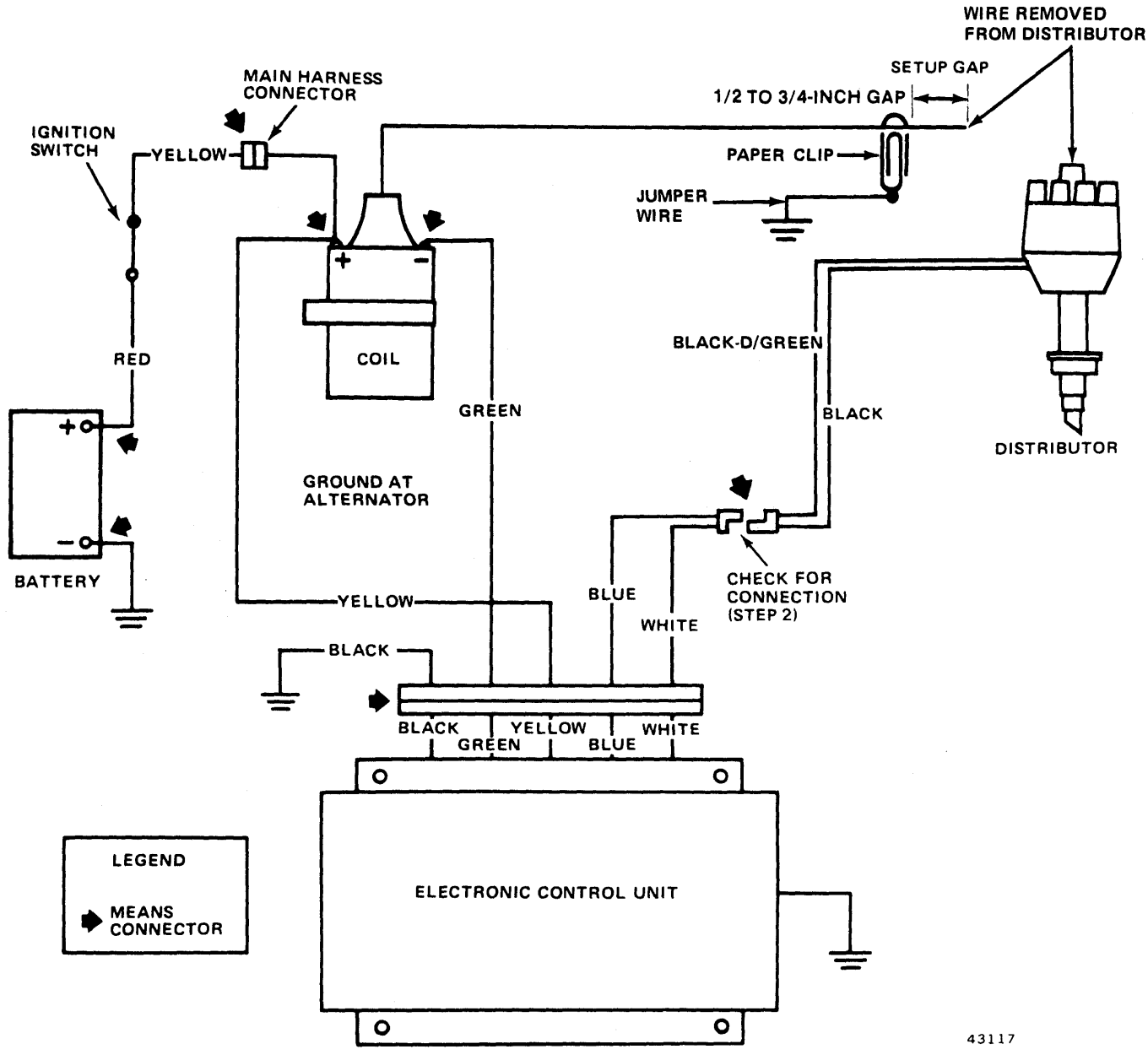


Fig. 3-50 Checking Spark Gap

NOTE: *If the trigger wheel teeth are positioned over the sensor, causing the control unit to shut off the coil primary, battery voltage will be indicated at the coil negative terminal. If this happens, crank the engine to position the trigger wheel teeth away from the sensor. Voltage should then drop to 5 to 8 volts.*

If voltage is satisfactory, press button on tester and observe voltmeter. Voltage reading should increase to battery voltage (12 to 13 volts). Release button on tester. Voltage should drop to 5 to 8 volts. If voltage does not switch up and down, the electronic control unit is faulty and must be replaced. If voltage switches up and down but there is no spark between paper clip and ignition cable terminal, proceed to step (13).

(13) Disconnect tester from control unit.

(14) Turn ignition switch OFF. Remove wire from the negative terminal of the ignition coil.

(15) Connect one clip lead from tester to negative terminal of ignition coil and the other clip lead to an engine ground (fig. 3-54).

(16) Turn ignition switch ON. Cycle test button.

(17) Spark should jump the gap. If not, replace the ignition coil.

Coil Tests

The coil can be tested on any conventional coil tester or with an ohmmeter. A coil tester is preferable as it will detect faults that an ohmmeter will not.

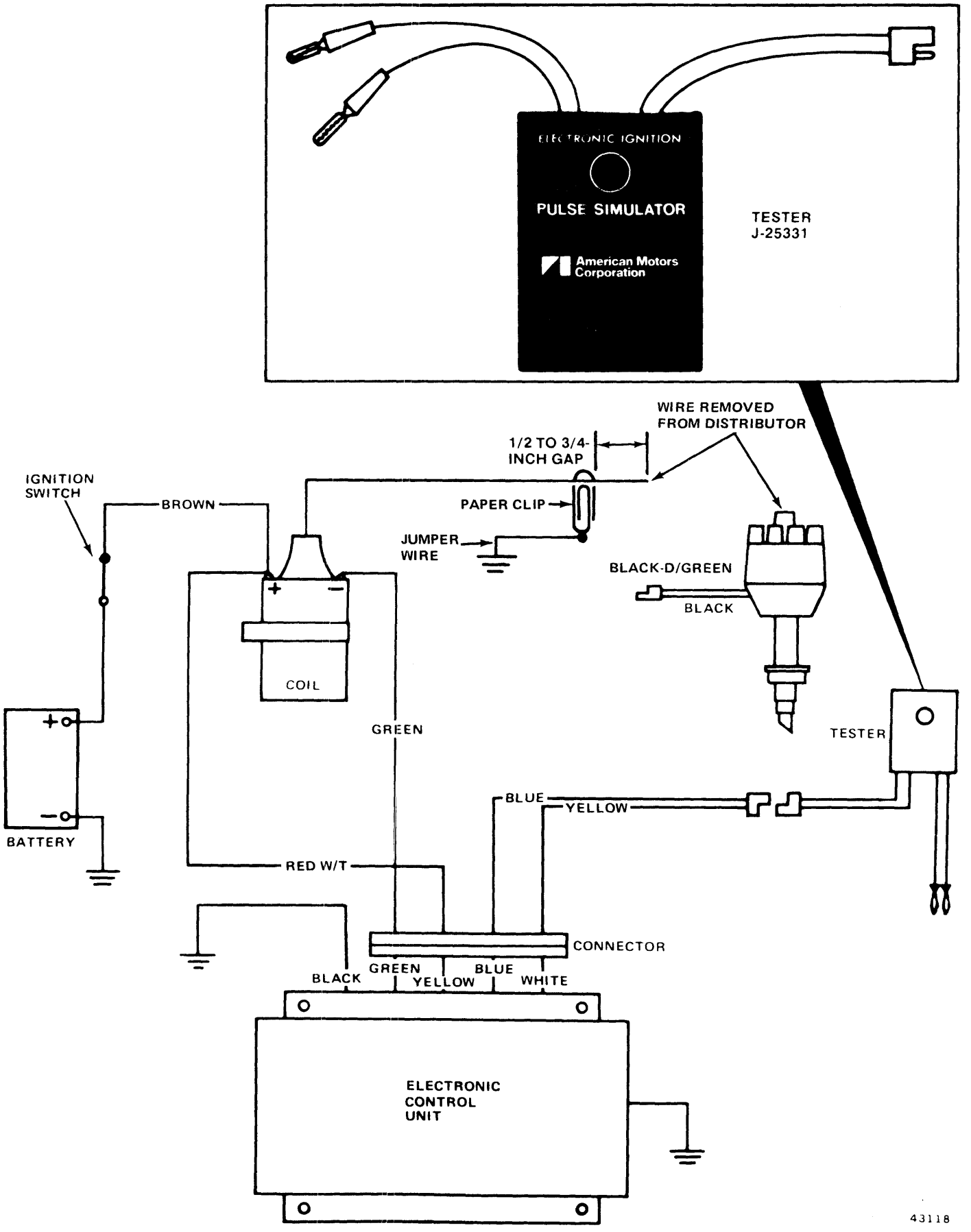


Fig. 3-51 Tester Connected in System

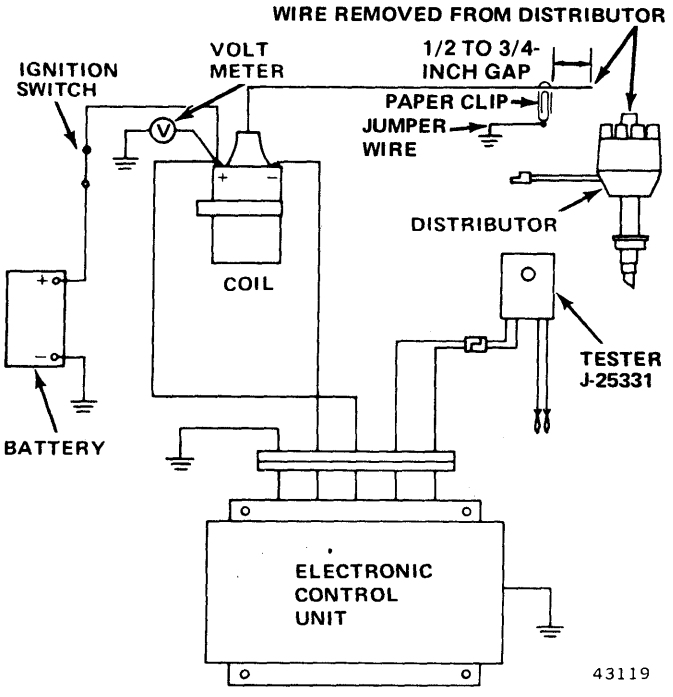


Fig. 3-52 Voltmeter Connected to Coil Positive Terminal

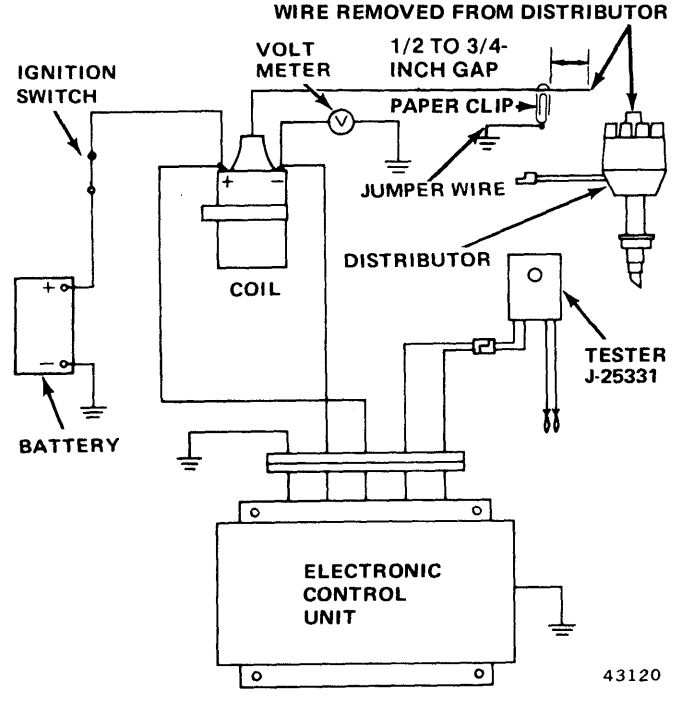


Fig. 3-53 Voltmeter Connected to Coil Negative Terminal

Primary Resistance Test

(1) Remove wires from negative and positive terminals of coil.

(2) Set ohmmeter to low scale and calibrate to zero.

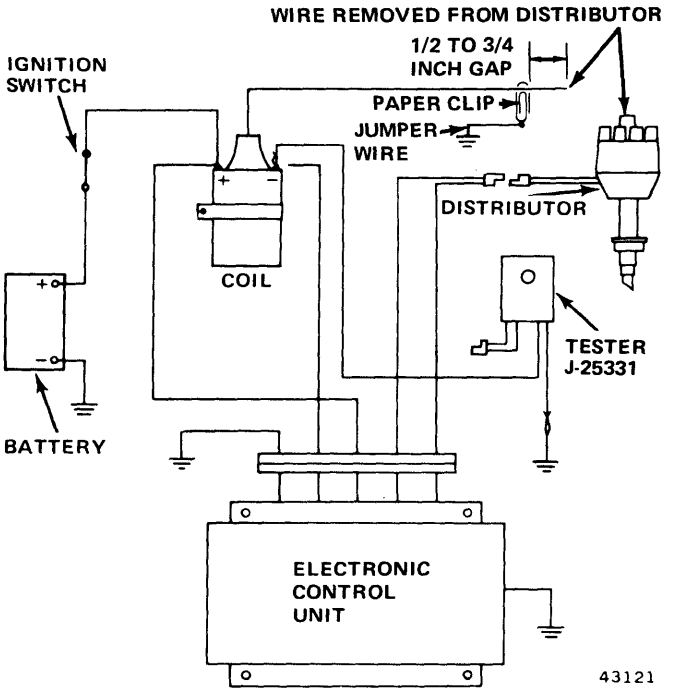


Fig. 3-54 Tester Connected to Coil Negative Terminal

(3) Connect ohmmeter to negative and positive terminals. Resistance should read 1.25 to 1.40 ohms at 75°F.

Secondary Resistance Test

(1) Remove cable from center terminal of coil.

CAUTION: *Ignition switch must be OFF.*

(2) Set ohmmeter to 1,000 scale and calibrate to zero.

(3) Connect ohmmeter to brass contact in center terminal and to either primary terminal. Resistance should read 9,000 to 12,000 ohms at 75°F. A maximum of 15000 ohms is acceptable if coil temperature is 200°F or more.

Current Flow Test

(1) Disconnect wire from coil positive terminal.

(2) Connect ammeter between positive terminal and disconnected wire.

(3) Disconnect wire from coil negative terminal.

(4) Connect jumper wire from negative terminal to known good ground.

(5) Turn ignition to ON position.

(6) Amperage should read approximately 7 amps, and should not exceed 10 amps. At temperatures above 75°F, current flow may be as low as 5 amps.

(7) Leave ammeter connected to coil positive terminal. Remove jumper wire from negative terminal. Connect green coil wire to negative terminal. Current flow should be approximately 4 amps.

(8) Start engine. Normal current flow with engine running is 2 amps.

Coil Output Test

(1) Connect oscilloscope to engine.

(2) Start engine and observe secondary spark voltage.

(3) Remove one spark plug wire from distributor cap. Observe voltage on oscilloscope corresponding to disconnected plug wire. This voltage, referred to as open circuit voltage, should be 20,000 volts minimum.

Sensor Test

Test sensor with an accurate ohmmeter. Resistance is 1.6 to 2.4 ohms at 77° F to 200° F. Replace sensor if it does not pass this test.

NOTE: *When testing a sensor, always start at the four-wire connector. This will also check resistance through the two-wire connector.*

DISTRIBUTOR REPLACEMENT

Removal

(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. Scribe a mark on distributor housing near clamp and scribe a matching mark on engine. 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.

Installation

(1) Clean distributor mounting area of engine block.

(2) Install a replacement distributor mounting gasket in counterbore of engine, if required.

(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.

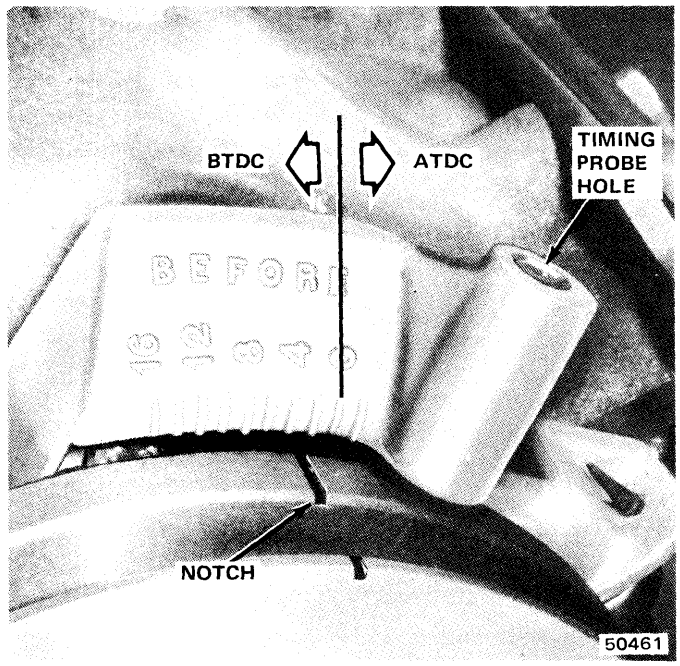
(b) Slide distributor down into engine. Align scribe mark on distributor with matching scribe mark on engine.

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.*

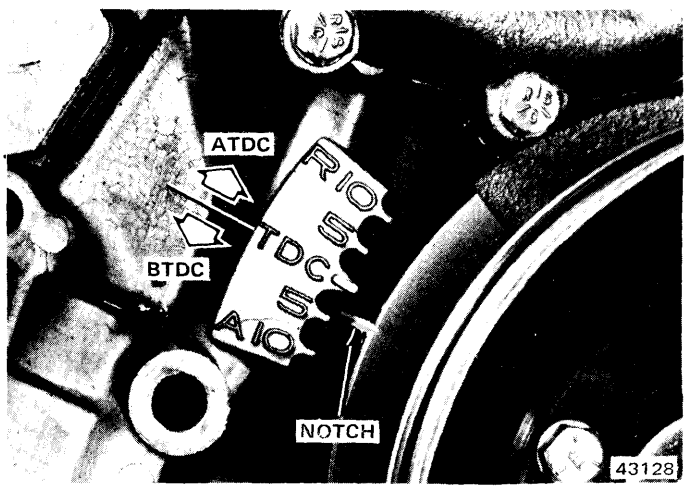
(c) Install distributor holddown clamp, bolt and lockwasher, but do not tighten bolt.

(4) If engine was cranked while distributor was removed, it will be necessary to 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. 3-55). Always rotate engine in direction of normal rotation. Do not turn engine backward to align timing marks.



VIEW A - SIX CYLINDER



VIEW B - V8

Fig. 3-55 Timing Mark Location

(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. Align scribe mark on distributor with matching scribe mark on engine.

NOTE: *It may be necessary to rotate the oil pump shaft with a long flat-blade screwdriver 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 ignition cables) on distributor housing, making sure tang on distributor housing aligns with slot in distributor cap and that cap fits on rim of 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: *The timing case cover has a hole provided for using a magnetic timing probe (fig. 3-55). Ignition timing may be checked by inserting the probe through the hole until it touches the vibration damper. The probe is calibrated to compensate for probe hole location which is 9.5°ATDC. Eccentricity of the damper properly spaces the magnetic probe and timing is indicated on a meter.*

(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 check timing to be sure it did not change.

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

DISTRIBUTOR COMPONENT REPLACEMENT

When replacing sensor or vacuum advance unit, it is not necessary to remove the distributor from the engine. If the distributor is not removed for component replacement, resetting ignition timing is not necessary.

A replacement drive gear has only one hole. The gear must be drilled using the distributor shaft hole as a guide for correct alignment.

The following equipment is required to perform proper distributor service:

- Small gear puller
- Sensor Locking Screw Removal Tool (Special Driver Bit) J-25097, or a pair of small needlenose pliers
- Sensor Positioning gauge
- Wire—0.050-inch OD

(1) If removed from engine, place distributor in suitable holding device.

(2) Remove rotor and dust shield (fig. 3-49).

(3) Remove trigger wheel using a small gear puller (fig. 3-56). Be sure the puller jaws grip 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.

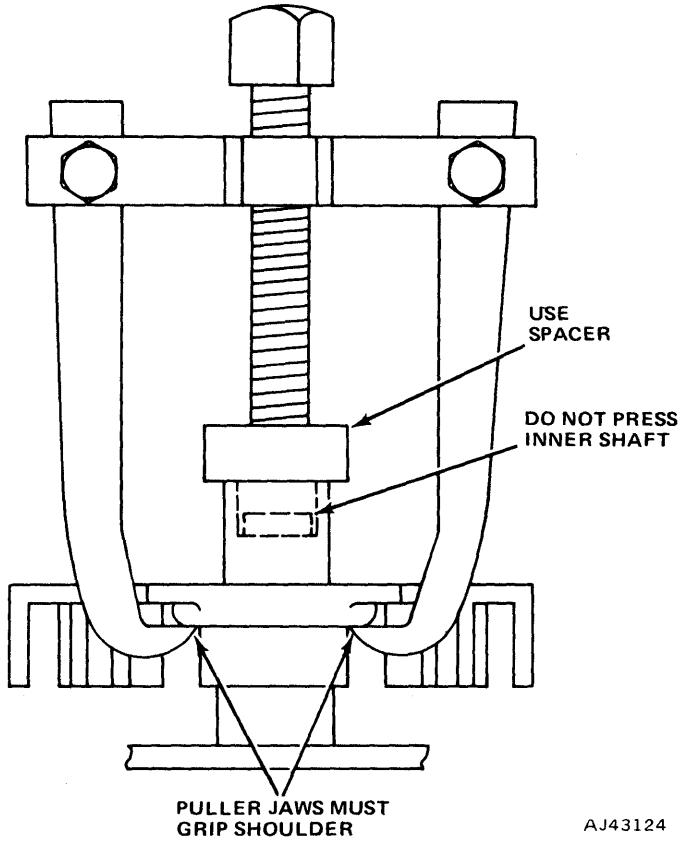


Fig. 3-56 Trigger Wheel Removal

(4) Loosen sensor locking screw about three turns. Lift sensor lead grommet out of distributor bowl. Pull sensor leads out of the slot around sensor spring pivot pin (fig. 3-57). Lift and release sensor spring, making sure it clears the leads, then slide the sensor off bracket.

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 replacement sensor has a standard slotted-head screw.*

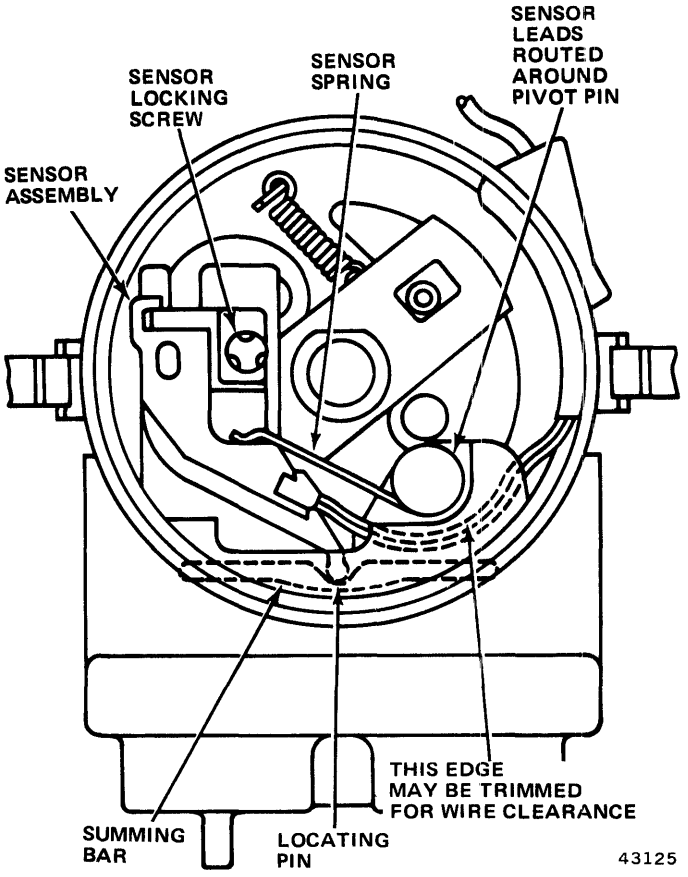


Fig. 3-57 Sensor Assembly Removal or Installation

(5) If vacuum advance unit is to be replaced, remove retaining screw, flat washer and sensor guide. Slide vacuum advance unit out of the distributor. Do not remove vacuum unit unless replacement is required.

(6) Clean sensor. The material used for sensor and vacuum unit requires no lubrication.

(7) Install vacuum unit. 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 bottom of sensor.

(8) If vacuum unit has been replaced and original sensor is being used, substitute replacement screw (contained in vacuum unit kit) for original special head screw to facilitate sensor positioning. Use existing flat washer.

(9) Install sensor assembly on vacuum unit bracket, making certain that locating pin of the sensor is located properly in summing bar (fig. 3-57). Place sensor spring in its proper position on sensor, then route sensor leads around spring pivot pin. Install sensor lead grommet in distributor bowl, making certain leads are positioned so they cannot be caught by trigger wheel.

(10) Place sensor positioning gauge over yoke (be sure gauge is against flat of shaft) and move sensor sideways until gauge can be positioned (fig. 3-58). With gauge in place, use small blade screwdriver to tighten 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 in.-oz., then check the sensor position as before.

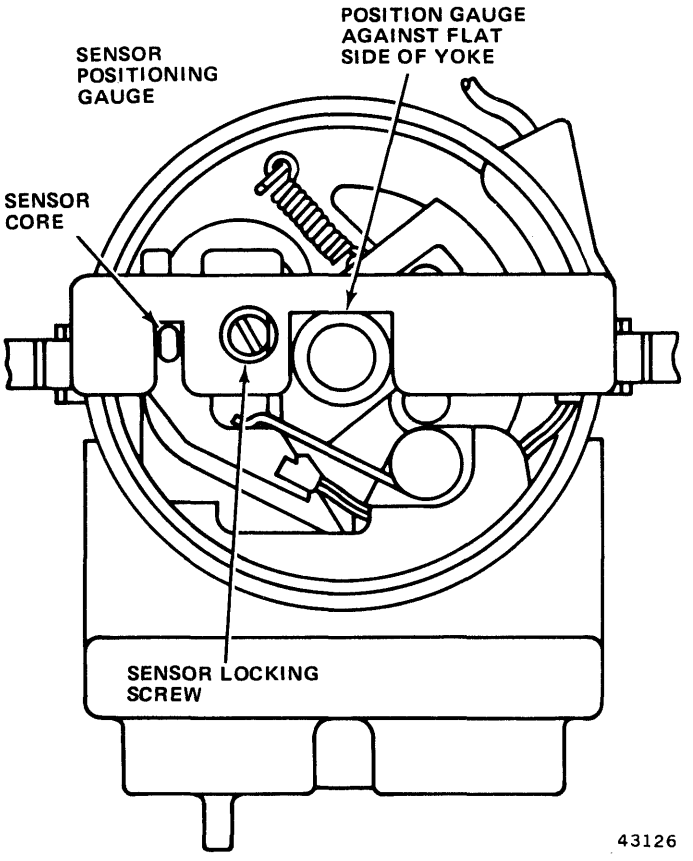


Fig. 3-58 Positioning Sensor

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

(12) Support distributor shaft (not necessary if distributor is on engine) and press trigger wheel onto yoke. Use deep socket (13/16-inch) and small hammer to drive trigger wheel to installed position. Using 0.050-inch wire (contained in kit), bend wire gauge to dimension shown in figure 3-59. Use gauge to measure distance between trigger wheel teeth and sensor base (fig. 3-59). Install trigger wheel until it just touches gauge.

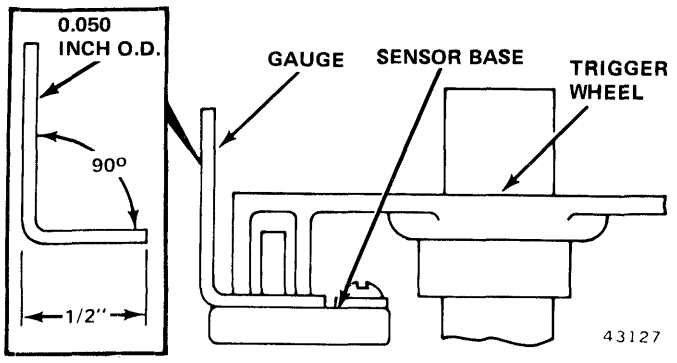


Fig. 3-59 Measuring Distance Between Trigger Wheel Teeth and Sensor Base

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

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

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. 3-60).

The voltmeter, oil pressure gauge, clock, and tachometer are separate from the instrument cluster. Refer to figure 3-60 for location on the instrument panel.

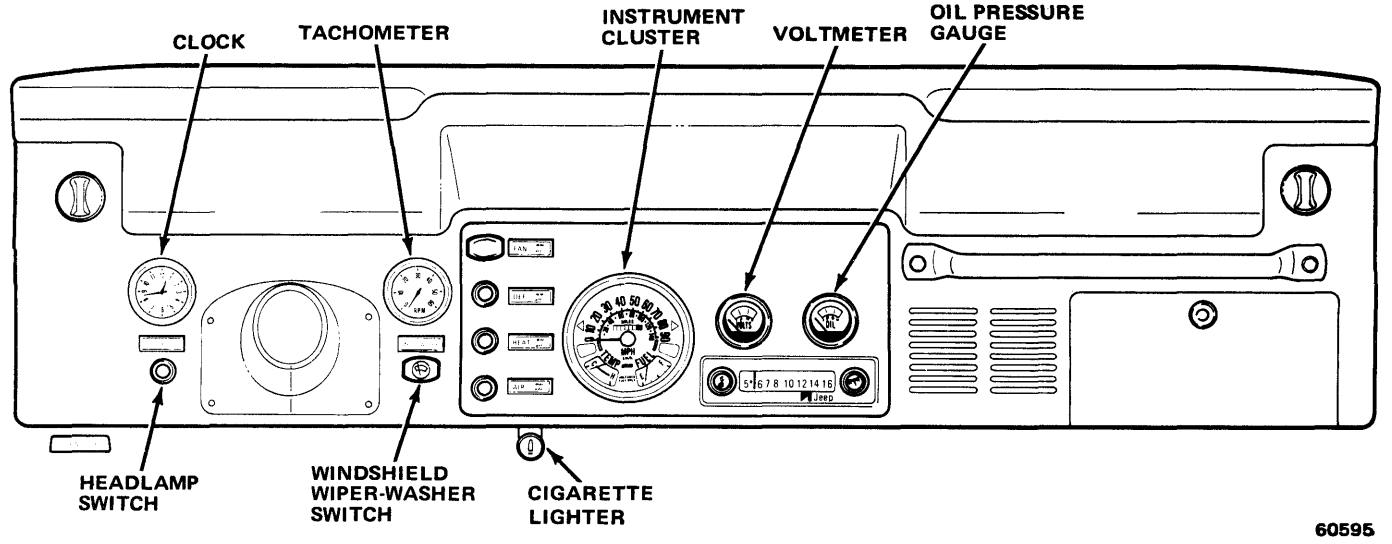


Fig. 3-60 Instrument Panel—CJ Models

Removal and Installation

(1) Disconnect battery negative cable.
(2) Separate speedometer cable from speedometer head.
(3) Remove four attaching nuts and pull cluster from mounting studs.
(4) Remove gauge wires and cluster lamps and remove cluster assembly.
(5) After installing cluster, connect battery cable and check all lights and gauges for proper operation.

NOTE: *The connector link (fig. 3-61) is not serviced. If connector link has to be replaced, manufacture a connector out of 16 gauge (or larger) insulated wire.*

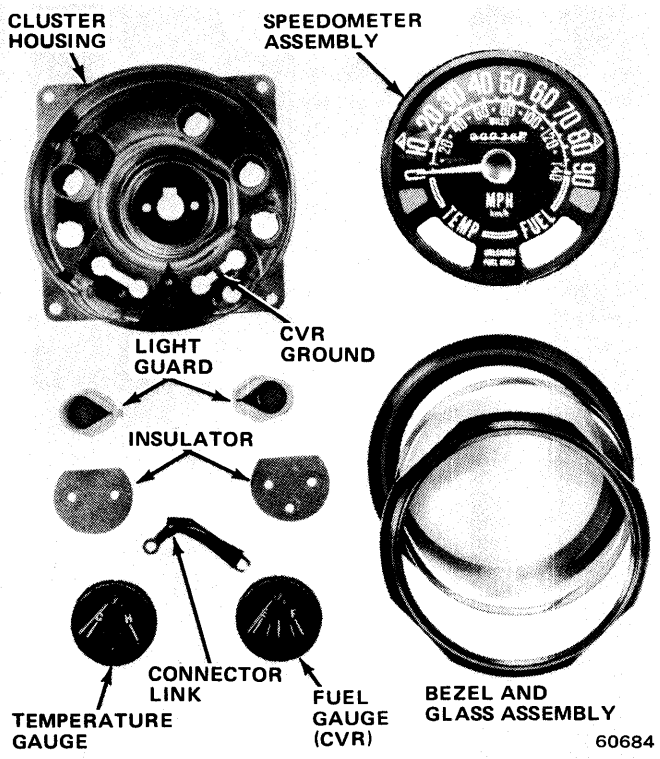


Fig. 3-61 Instrument Cluster Assembly—CJ Models

Cherokee-Wagoneer-Truck

The instrument cluster (fig. 3-62) 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.

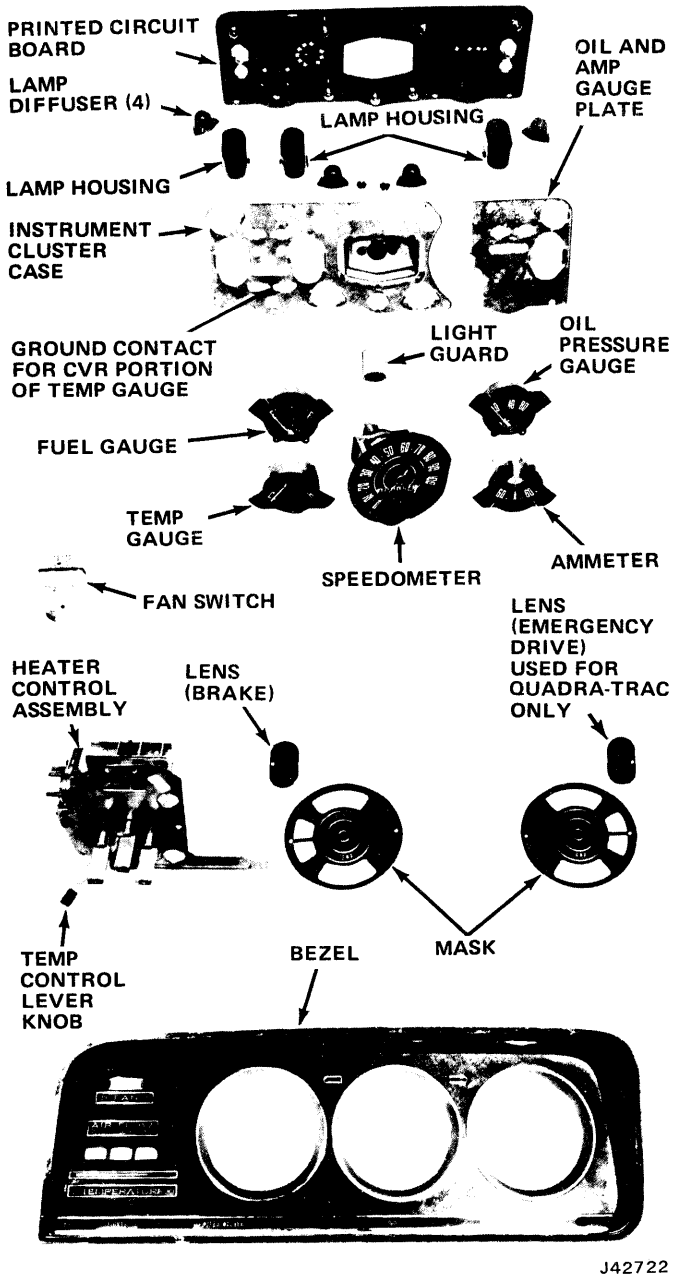


Fig. 3-62 Instrument Cluster—Cherokee-Wagoneer-Truck

(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.

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

Refer to figure 3-63 for component identification.

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

(2) Remove all indicator and illumination bulbs.

NOTE: *An ohmmeter or Test Lamp J-2l008 should be used. When using an ohmmeter, use low scale and adjust meter to 0 reading.*

(3) Connect test lamp or ohmmeter lead to correct pin plug terminal for circuit to be tested. If a circuit serves more than one bulb, there will be an uncoated position for each bulb. Test circuit between pin terminal and each uncoated position of the circuit. Test lamp should light or ohmmeter should indicate 0 resistance at each position.

(4) Following the above procedure, test circuit leading from each pin terminal. At each bulb location, test lamp should 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. 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

Instrument panel illumination is provided by three bulbs in the instrument cluster, six molded lamps in the instrument panel, and one bulb each in the voltmeter and oil gauge. 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 the headlamp

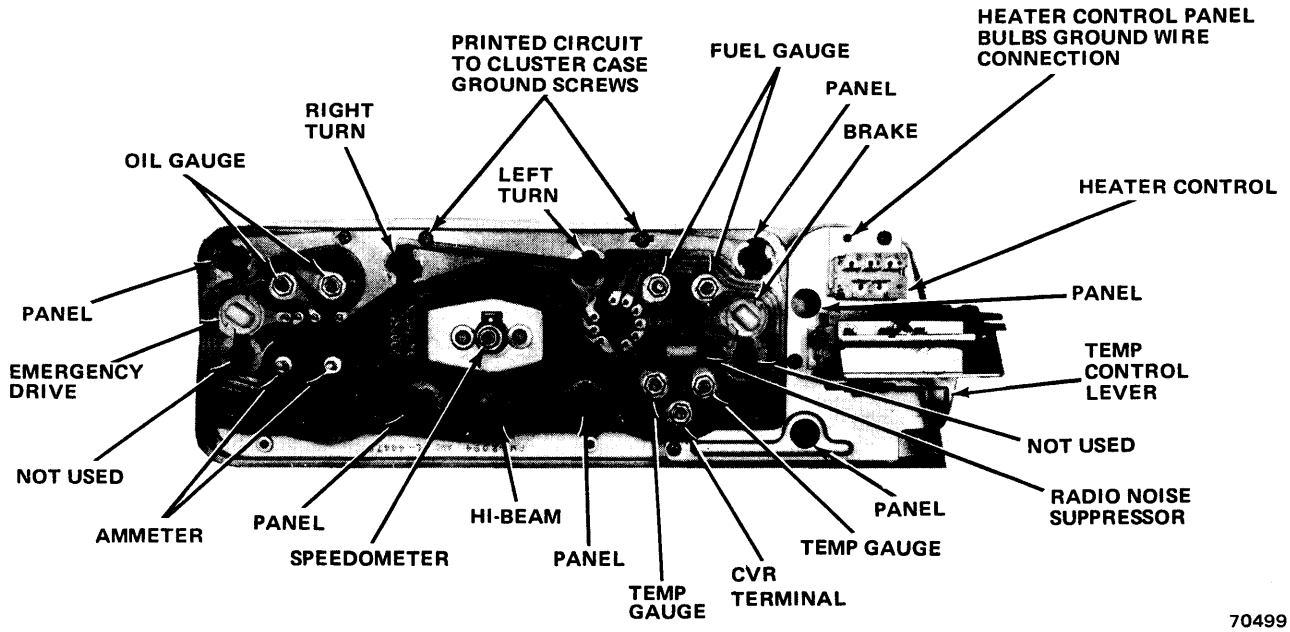


Fig. 3-63 Instrument Cluster—Rear View—Cherokee-Wagoneer-Truck

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 to free the spring clip which attaches the socket to the panel.

Ammeter

Ammeter Check

(1) Disconnect either cable from battery.
(2) Connect ammeter of known good quality between battery terminal and disconnected cable.
(3) With engine not running, apply electrical load to battery (headlamps ON, for instance).
(4) Compare reading of test ammeter with reading of vehicle ammeter.

If vehicle ammeter indicates a charge rather than a discharge, the gauge leads are reversed.

The vehicle gauge is a 5% instrument. If the test gauge is a 2% instrument, a difference of 7% between gauge readings would be acceptable. For instance, if a 25 amp load is applied in the test, the acceptable difference would be 1.75 amperes.

Voltmeter

The voltmeter registers regulated voltage which provides an indication of the charging system's 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. Continuous readings in the low green area can indicate faulty operation.

The voltmeter gauge needle may not return to zero when the ignition is turned OFF. This is characteristic of magnetic-type gauges.

NOTE: *When replacing the voltmeter lamp bulb, the radio has to be removed (if equipped) in order to seat the bulb socket.*

Voltmeter Check

(1) Connect voltmeter of known good quality across battery terminals.
(2) Turn ignition switch ON.
(3) Compare indication of test voltmeter with indication of vehicle voltmeter.

The vehicle gauge is a 5% instrument. If the test gauge is a 2% instrument, a difference of 7% between gauge indications would be acceptable. Additionally, a voltage drop of 0.2 volt is acceptable between battery and instrument panel gauge. For example, if the test gauge reads 14 volts, the acceptable range of the vehicle gauge is 12.82 to 14.78 volts.

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.

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

Oil Pressure Gauge Calibrations

Oil Pressure (PSI)	Resistance (Ohms)	
	CJ Models	Cke.–Wag.–Trk.
0	234–246	69–77
10	–	35–38
20	149–157	–
40	100.5–105.5	–
60	65–69	13–15
80	32.5–34.5	9.5–10.5

70500

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.*

Sending Unit Test

After verifying proper gauge operation, 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 and 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 consists 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, increasing or decreasing the temperature indication.

Fuel Gauge and Sending Unit

The fuel level gauge circuit consists 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, 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).

NOTE: *The fuel gauge sending unit in the fuel tank depends upon good contact between fuel tank and mounting bracket for ground.*

(6) Verify sending unit ground (fuel gauge only).

(a) Connect jumper wire between fuel tank and battery negative terminal. If fuel gauge reading increases, tank ground is poor.

(b) Repair tank ground and recheck gauge performance.

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

(8) 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. They must be accurate within 5 percent of a specific ohm value.*

Example: 5 percent of 60 ohms is 3 ohms. Accuracy is 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 3-64.

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

(2) Connect one tester lead to sender 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 gauge calibration chart.

(4) If gauge read incorrectly before but reads correctly now, sender unit or wire leading to sender unit is defective. If gauge reads correctly, disconnect sender unit wire at sender unit. Repeat test from sender unit wire to ground. If gauge is still inaccurate, replace sender unit wire. If gauge is accurate, sender unit is defective or fuel tank has poor ground. Poor ground gives low readings on gauge.

(5) If no reading is obtained, check input voltage to gauge (I-terminal) with test light or voltmeter (fig. 3-64).

(6) When checking input voltage, check fuel gauge first. The I-terminal of fuel gauge is fed battery voltage. This terminal voltage can be checked by placing positive lead of voltmeter on I-terminal and contacting known good ground with 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 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 once every second or less.

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

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

The fuel gauge CVR terminal feeds the temperature gauge. A defective CVR will cause **both** gauges to indicate 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 3-64.

If the gauge now indicates 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 a jumper 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. 3-65).

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 ignition feed jumper wire, protected by 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.

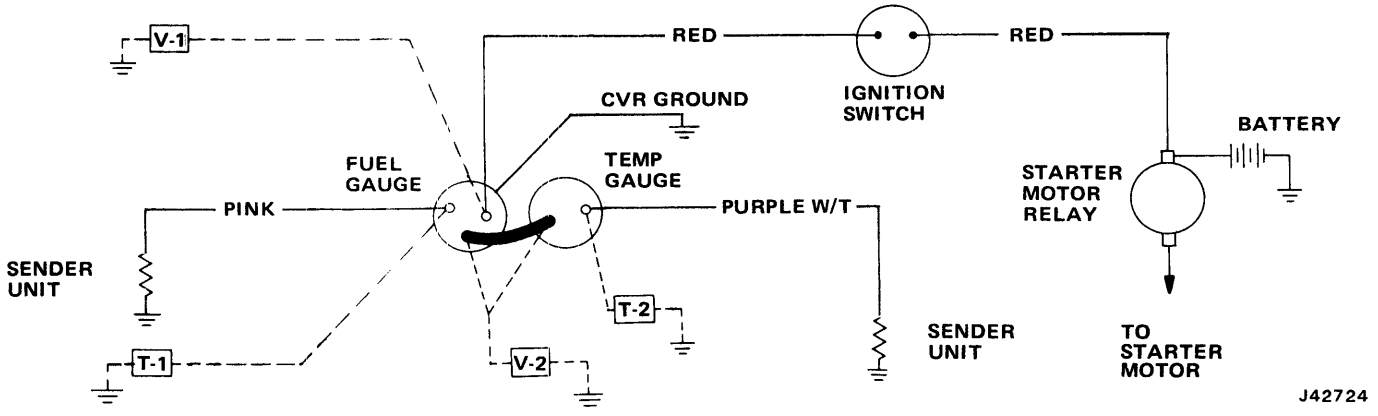
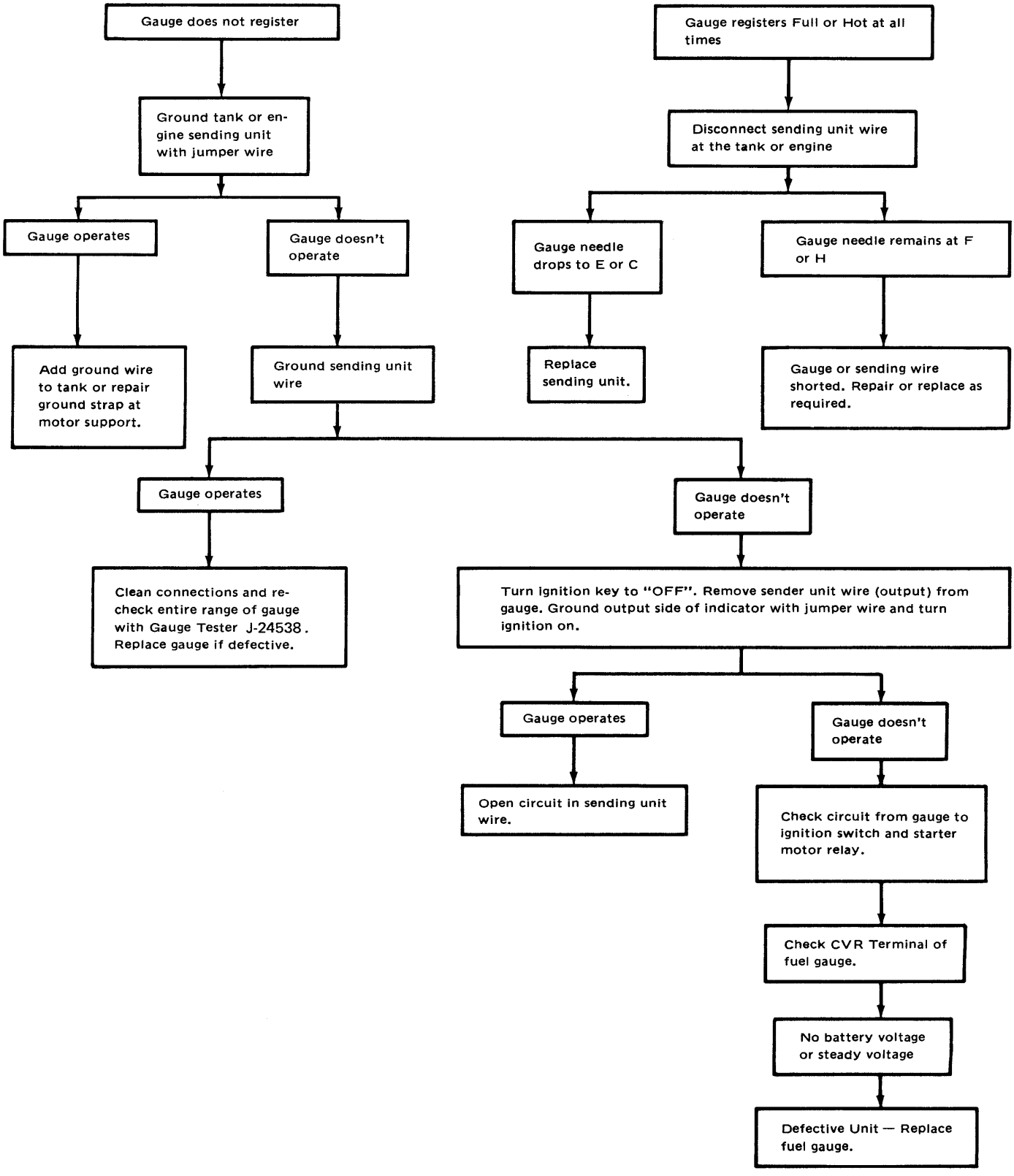


Fig. 3-64 Fuel and Temperature Gauge Circuitry—CJ Models

Fuel and Temperature Gauge Diagnosis Guide—CJ Models



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(9) Select resistance required as shown in 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 indicates too high through entire range, check for good contact between temperature gauge and cluster case.

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 temperature gauge.

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

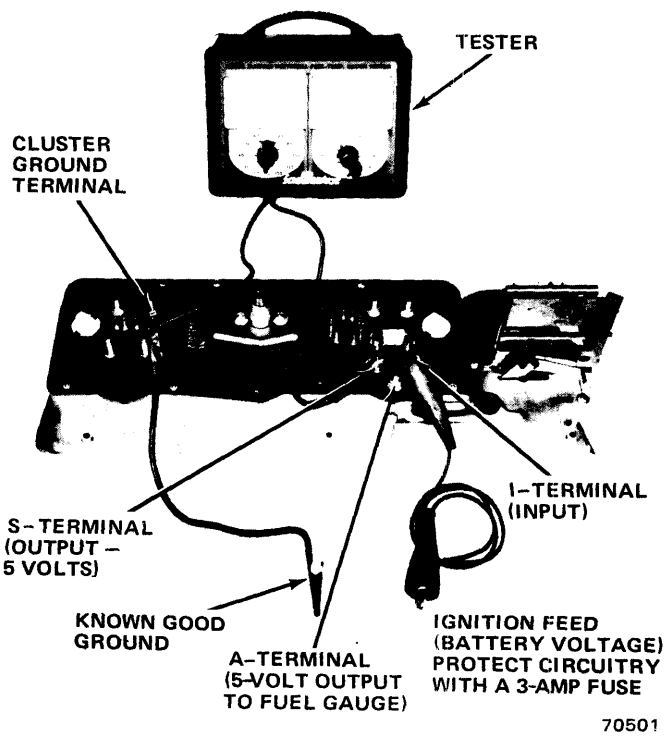


Fig. 3-65 Testing Temperature Gauge—Cherokee, Wagoneer and Truck

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.

Gauge Test Results—Cherokee, Wagoneer and Truck

TEST RESULTS With Tester Connected as Shown	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

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

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

Cherokee-Wagoneer-Truck

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

(1) Remove six printed circuit retaining screws and remove instrument cluster case (fig. 3-62).

(2) Remove gauge mask.

(3) Remove nuts 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. 3-62). Be sure printed circuit ground screws are tight.

Fuel Tank Sending 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.

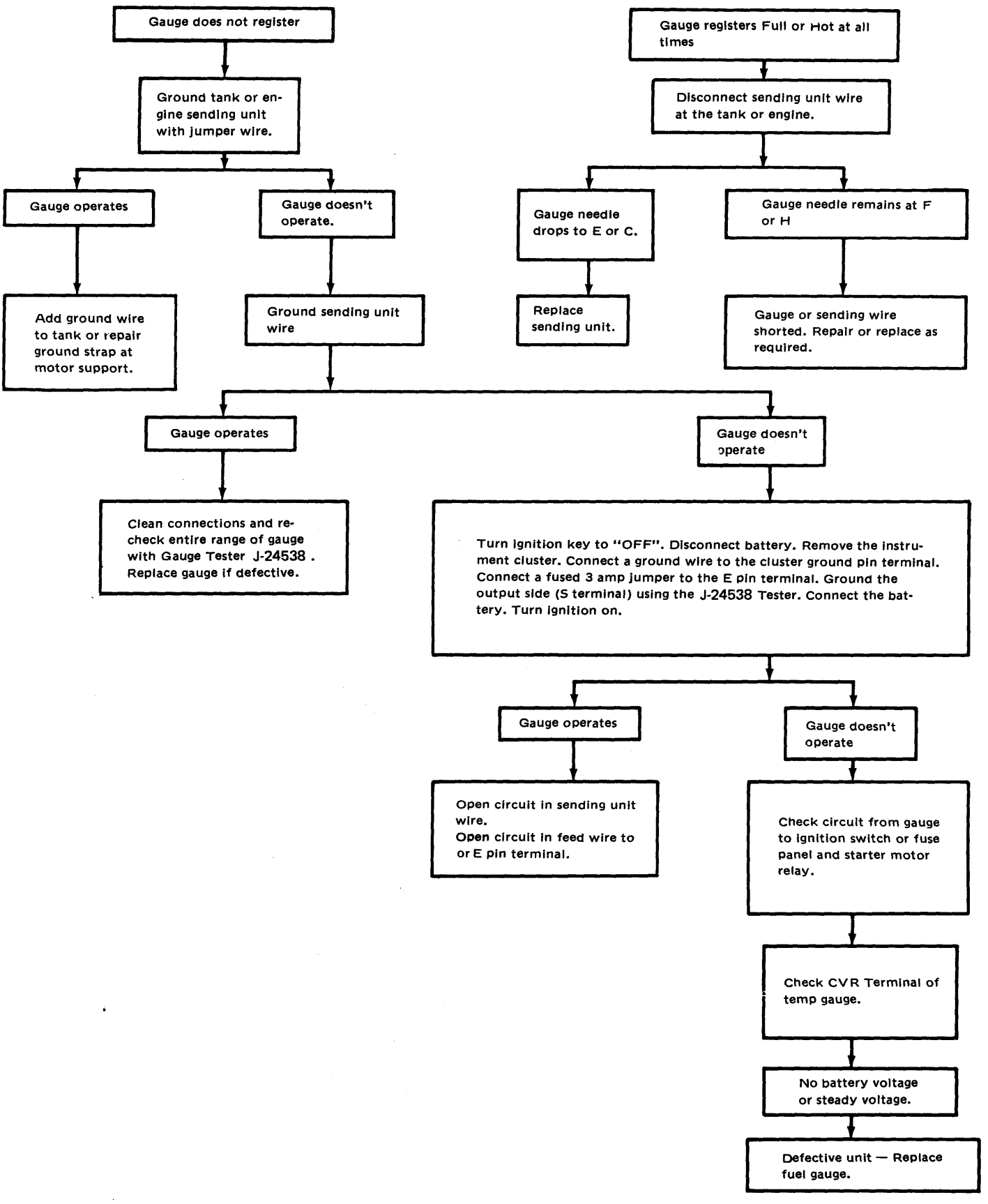
SPEEDOMETER

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.

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



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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 3-66.

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.

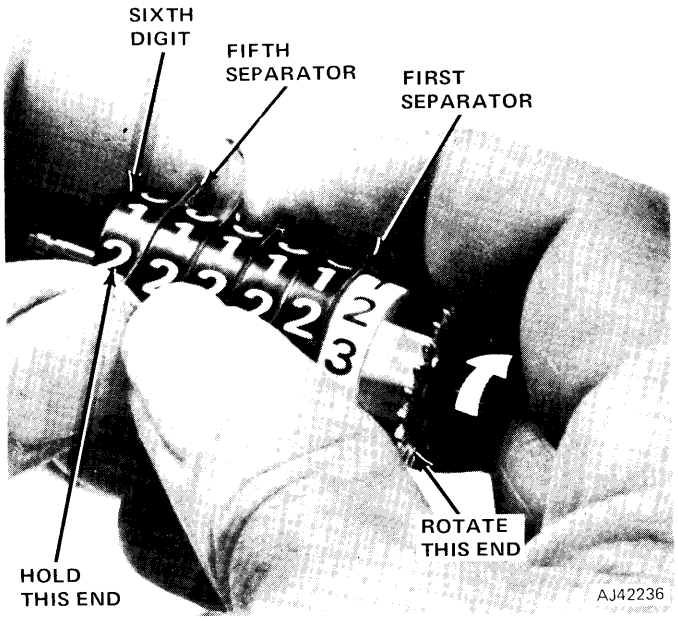


Fig. 3-66 Advancing Odometer Reading (for Replacement Only)

Speedometer Cable Inspection

To 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 graphite grease for lubrication.

CLOCK

CJ Models

The clock is attached to the instrument panel 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,* and *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, instrument panel ground, and the coil primary connector.

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.

On all models, the lighter circuit is protected 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.

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

Standard Column

(1) With actuator rod disconnected, position switch as shown in figure 3-67.

(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.

Tilt Column

(1) With actuator rod disconnected, position switch as shown in figure 3-67.

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

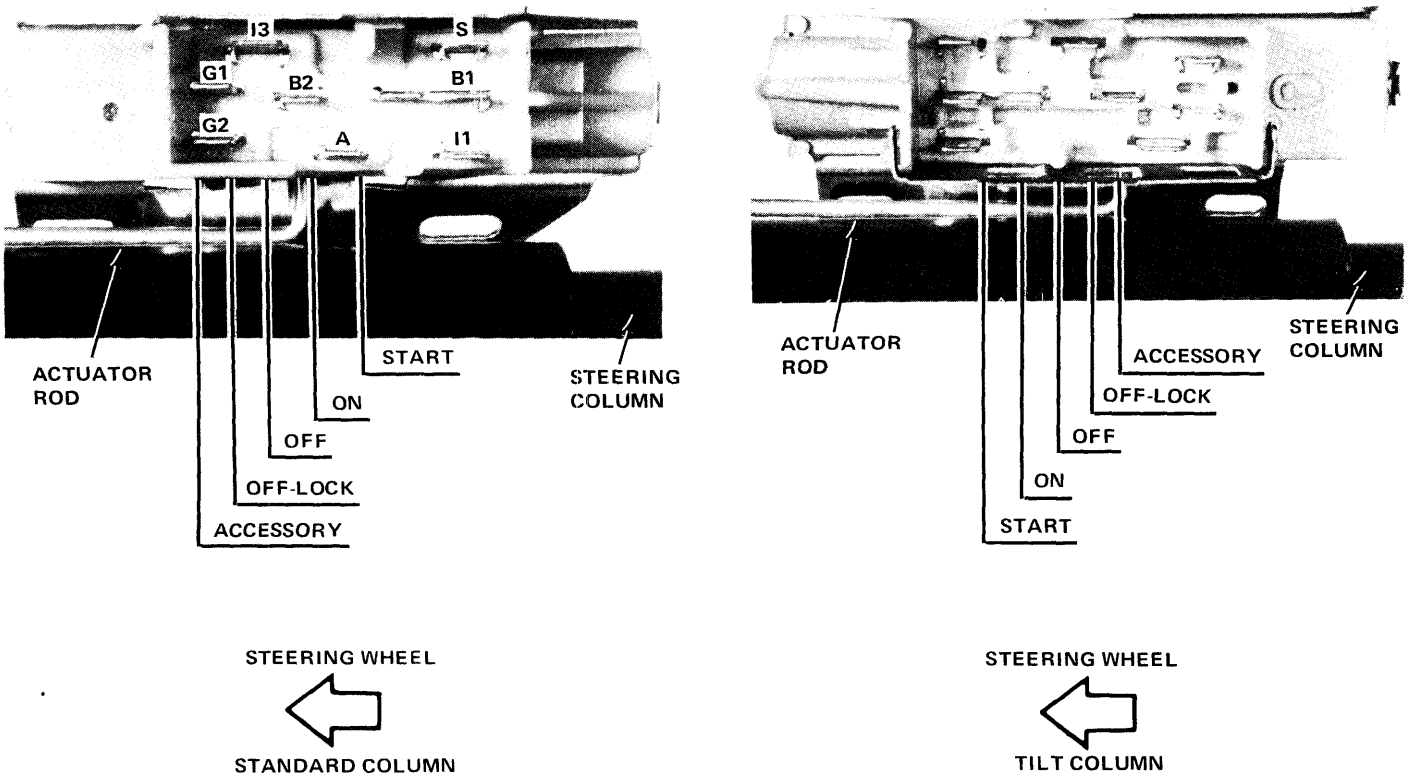
NOTE: *The right side of the ignition switch is downward from the steering wheel.*

(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.



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. 3-67 Ignition Switch Positions

Cylinder Service

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

Ignition Switch Test

The ignition switch terminals are shown in figure 3-67.

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 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 (0.125 volt) to appear on the scale. An indication 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 darkened area with level floor and with screen (wall) having nonreflecting white surface.

(2) Mark reference line on floor 25 feet away from and parallel to screen (fig. 3-68).

(3) Position vehicle perpendicular to screen and with 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.

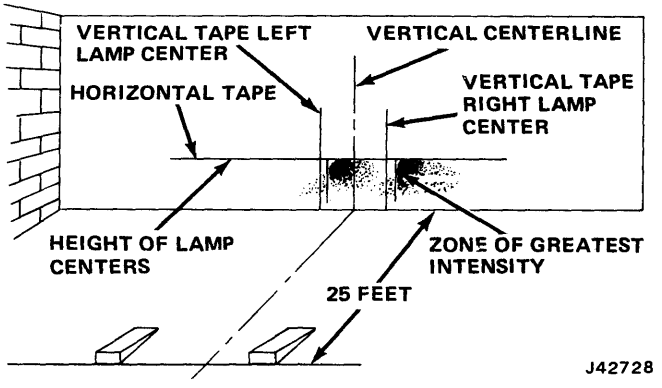


Fig. 3-68 Headlamp Aiming Chart

(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.*

(14) Turn vertical aiming screw counterclockwise until lamp beam is considerably lower than horizontal reference line on screen (fig. 3-69).

(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. 3-68).

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

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.*

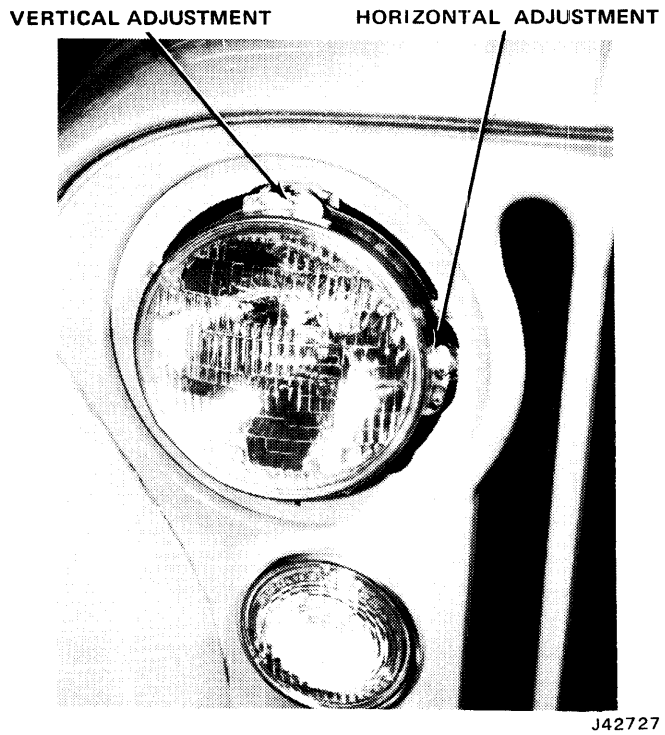


Fig. 3-69 Headlamp Adjustment

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 screw(s) and remove door.
(2) Remove screws in retaining ring.
(3) Pull headlamp out and disconnect wire harness.
(4) Install replacement headlamp with number 2 at **top** of 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. 3-70). Rotating the knob clockwise dims the panel lights. Rotating the knob fully counterclockwise turns on the dome and courtesy lamps.

Headlamp Switch Replacement

(1) 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 3-70, inset) and pull knob out of switch.

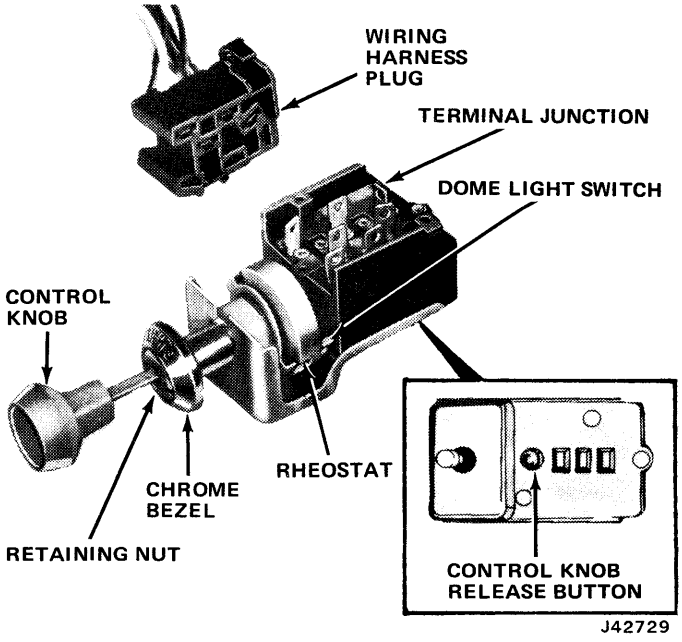


Fig. 3-70 Headlamp Switch

(4) Remove retaining nut and bezel.
(5) Remove switch through rear of instrument panel.
(6) When installing switch, make sure wire terminal plug on switch is tight on connectors.

Dimmer Switch Replacement

Refer to figure 3-71.

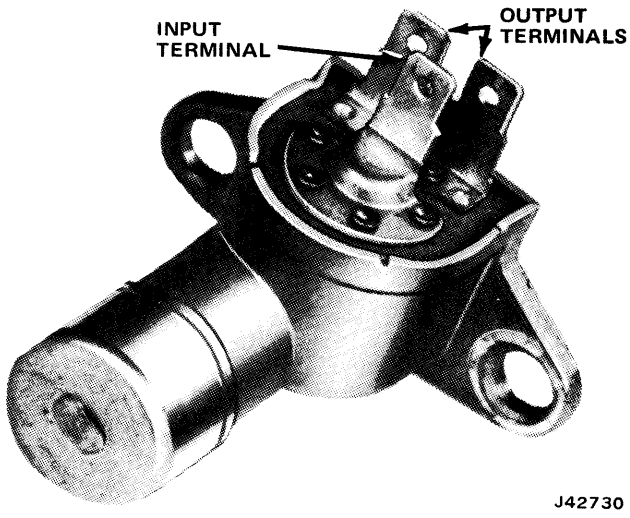


Fig. 3-71 Headlamp Dimmer Switch

(1) Remove wire plug from switch.
(2) Remove capscrews that hold dimmer switch to floorboard.
(3) Remove switch.

(4) Check operation of dimmer switch with test lamp. Connect one test lamp lead to switch input terminal (fig. 3-70). Probe each output terminal with other test lamp lead. Continuity should alternate from one output terminal to the other as the 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. 3-72). The lamps are on when headlamp switch knob is pulled out.

Parking and Directional Bulb

(1) Remove screws.
(2) Remove lens.
(3) Replace bulb.

Parking Lamp Assembly

(1) Remove screws.
(2) Remove lens and gasket.
(3) Remove housing from front panel.
(4) Disconnect wire connector from harness.

Side Marker Bulbs

(1) Reach under fender and pull back rubber portion of socket assembly.
(2) Twist socket to remove from housing.
(3) Replace bulb.

Cherokee-Wagoneer-Truck

Cherokee and Truck parking lamps are mounted in the panel just above the bumper (fig. 3-73).

Wagoneer parking lamps are mounted in the radiator grille panel (fig. 3-74).

The front side marker lamp flashes 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.

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 gasket.

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

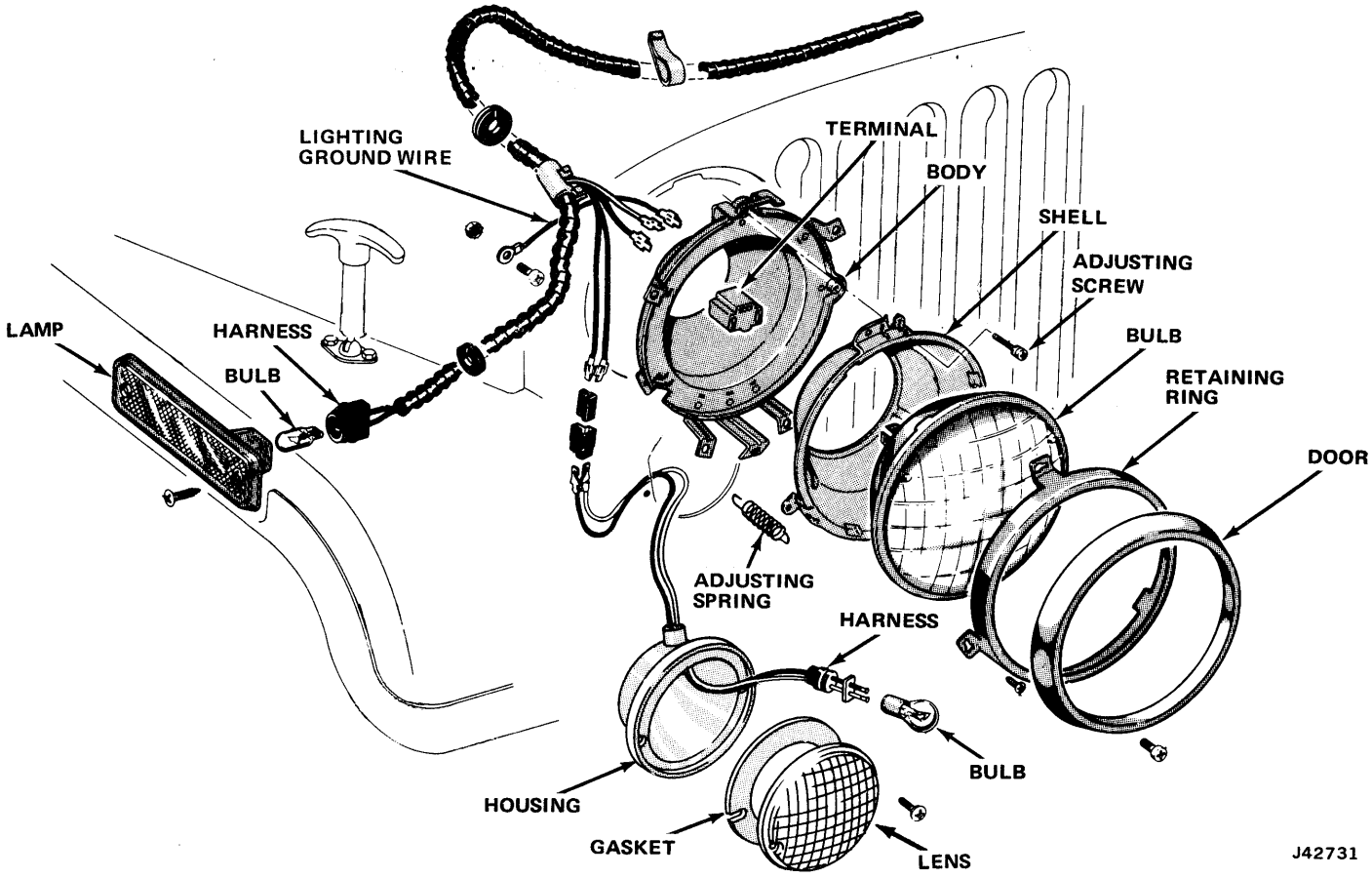


Fig. 3-72 Headlamp, Parking, Directional and Side Marker Lamps—CJ Models

the 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 3-75 for parts identification.

Taillamp Bulb Replacement

Remove lens screws, lens, and gasket. Clean lens and reflector before installing.

Cherokee

Refer to figure 3-76 for parts identification.

Taillamp Bulb Replacement

Remove the taillamp lens and remove the bulb. Clean the lens and housing before installing lens.

Taillamp Housing Replacement

(1) Remove interior rear quarter trim panel. On right side, pull panel out at top to remove. On left side, trim panel is attached with 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.

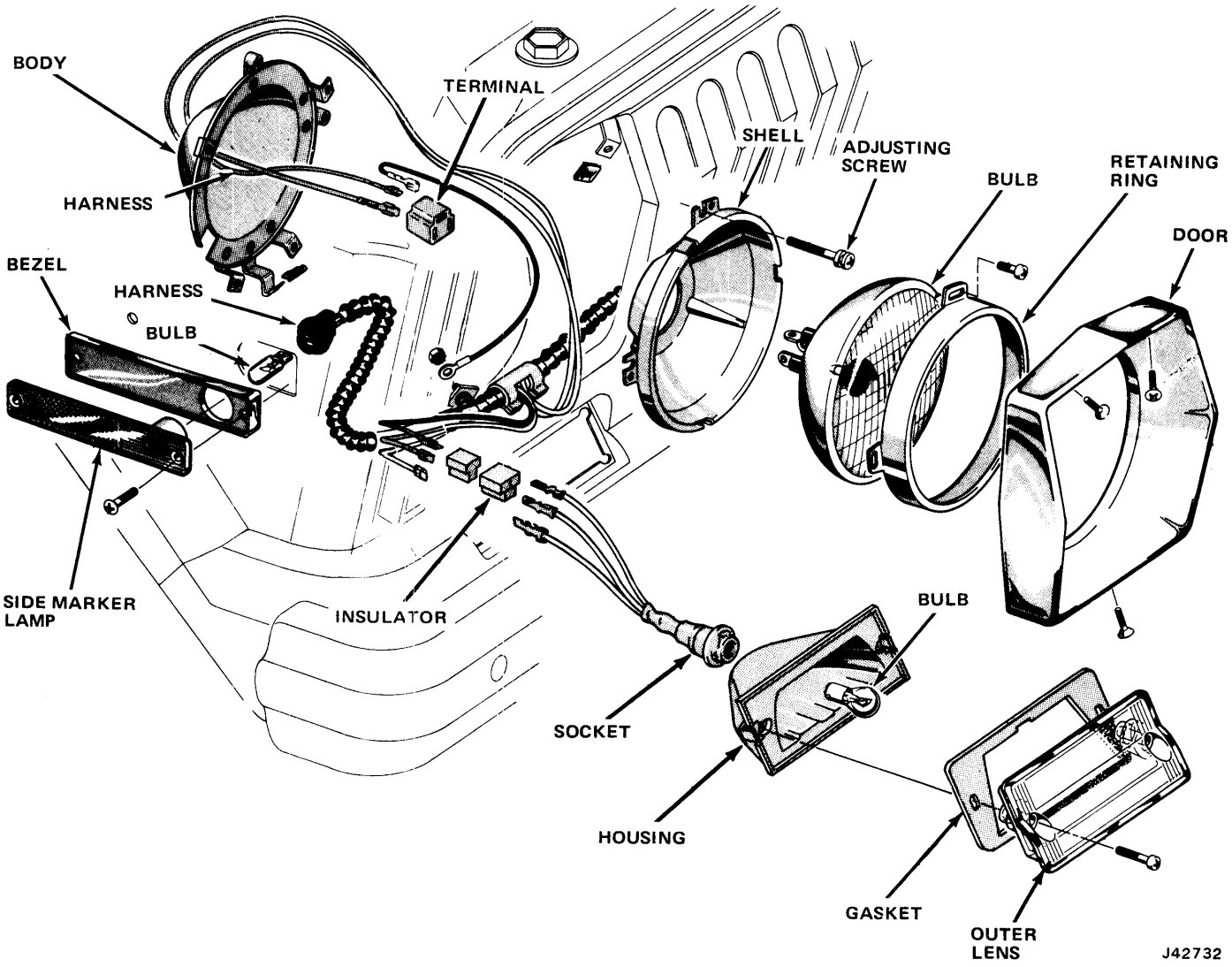


Fig. 3-73 Headlamp, Parking, Directional, and Side Marker Lamps—Cherokee-Truck

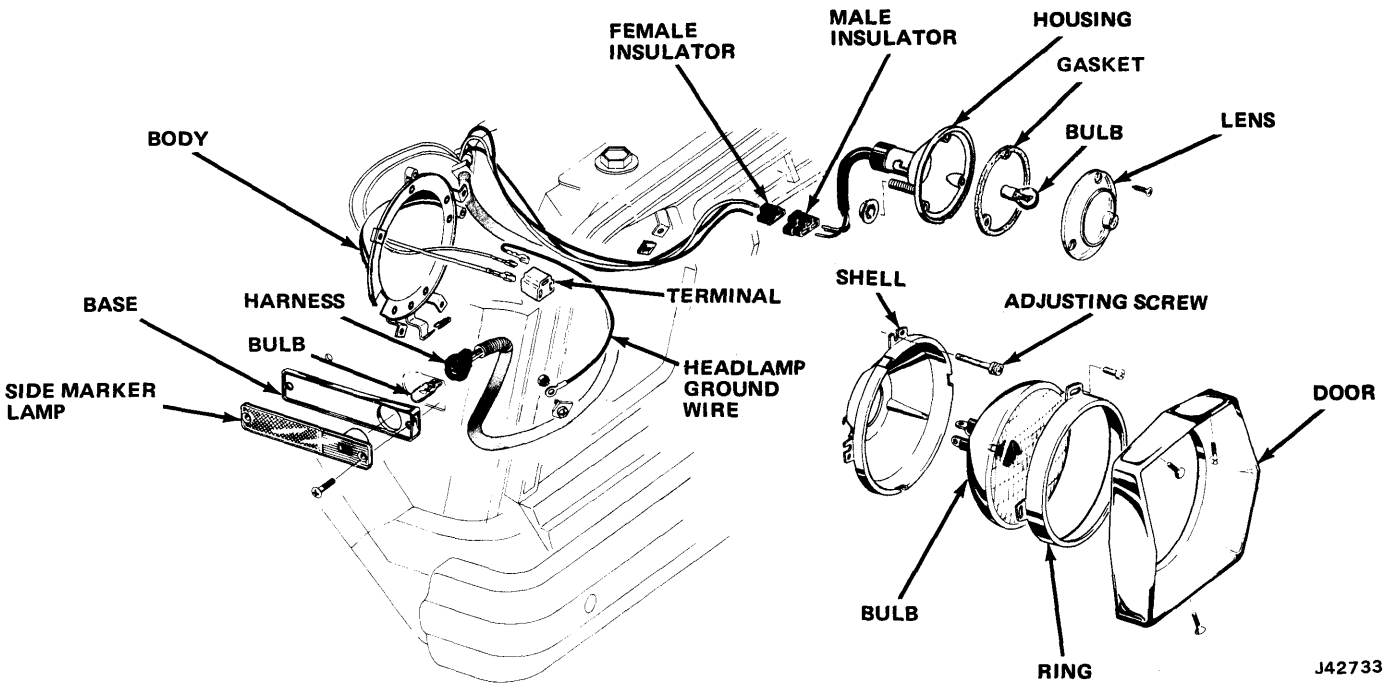


Fig. 3-74 Headlamp, Parking, Directional and Side Marker Lamps—Wagoneer

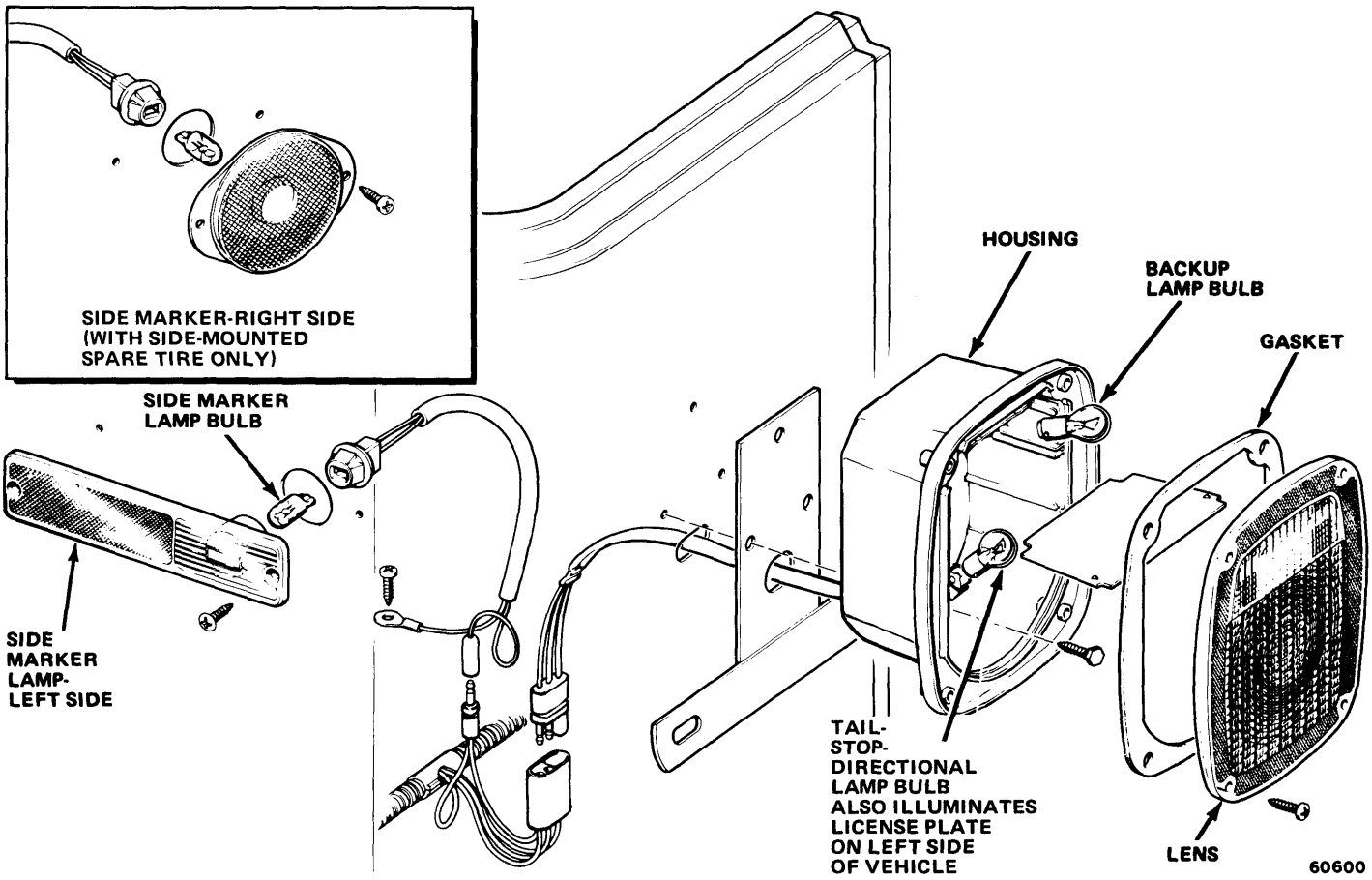


Fig. 3-75 Rear Directional, Stop, Backup, Taillamps and Side Marker Lamps—CJ Models

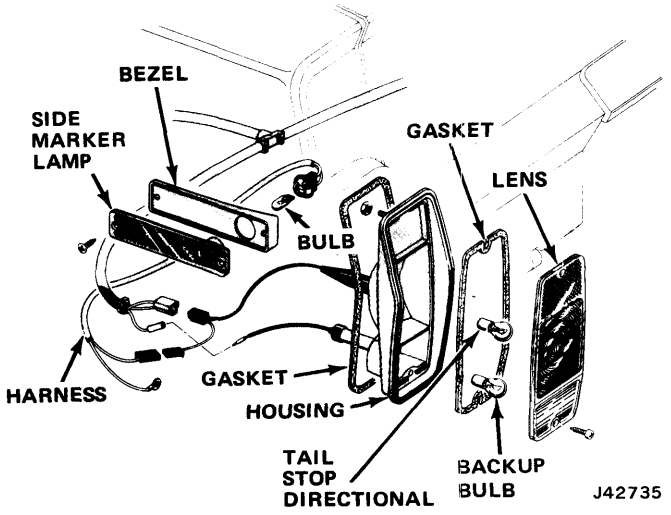


Fig. 3-76 Rear Directional, Stop, Backup and Taillamps—Cherokee

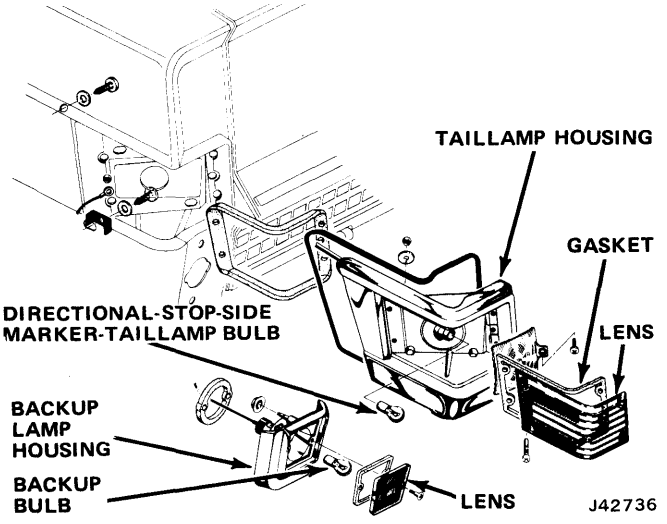


Fig. 3-77 Rear Directional, Stop, Backup and Taillamps—Wagoneer

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.

Wagoneer

Refer to figure 3-77 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 3-77 and follow the housing replacement procedure as outlined for Cherokee models.

Truck

The lamp assemblies are mounted in the pickup box end caps (fig. 3-78).

Taillamp Bulb Replacement

Remove lens and remove bulb. Clean lens and reflector before installing.

Taillamp Housing

(1) Remove lens.
(2) Remove screws.
(3) Remove housing and disconnect lamp harness.

License Plate Lamp

CJ Models

The left taillamp illuminates the license plate. Refer to figure 3-75.

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 circuit for the license plate bulb is completed through metal-to-metal contact between the bulb bracket, license plate bracket, and the frame (fig. 3-78).

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.

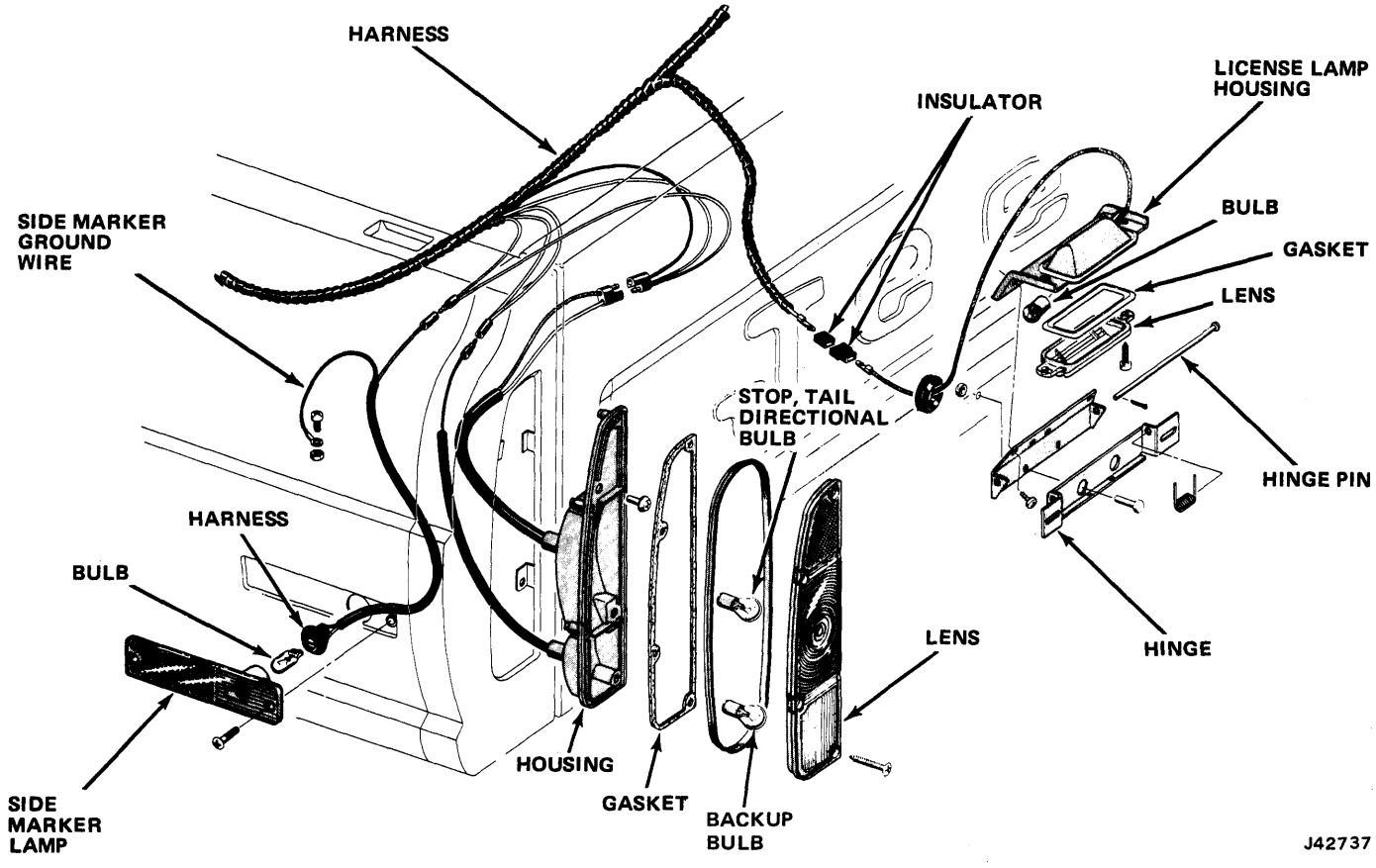


Fig. 3-78 Rear Directional, Stop, Backup, Taillamps and Side Marker—Truck

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 are 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.

Cherokee-Wagoneer-Truck

The courtesy and dome lamps operate when the front doors are opened. The door pillar switch provides a ground for the circuit.

Battery feed is from the headlamp switch. 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. 3-79).

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.

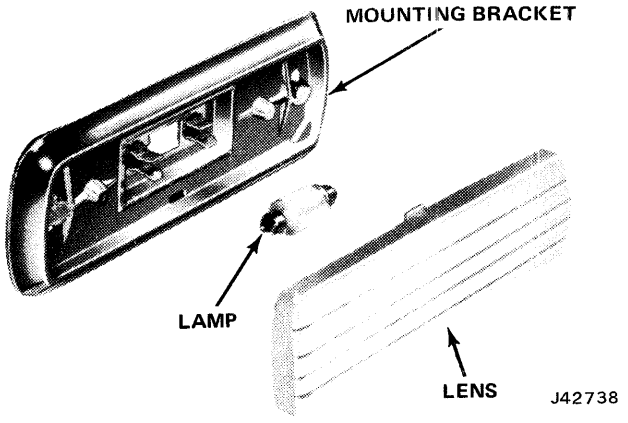


Fig. 3-79 Dome Lamp

A cargo lamp is offered on some Truck models (fig. 3-80). The cargo lamp bulb is replaced by removing the outer lens.

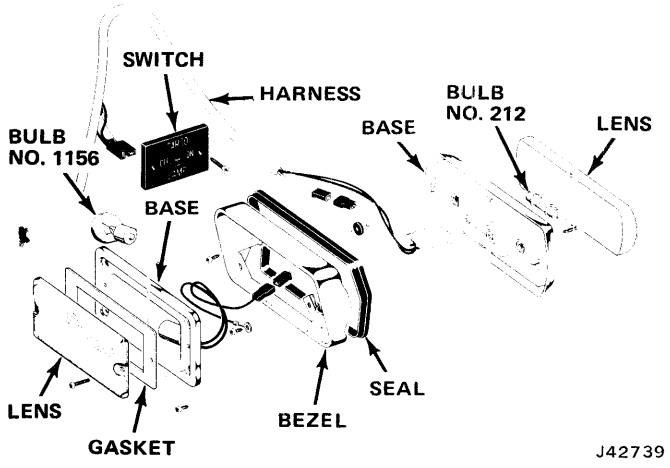


Fig. 3-80 Cargo Lamp—Truck

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. 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, substitute 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 center button by pulling straight out.

(3) Remove screws, bushing, receiver and spring.

(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. 3-81).

(8) 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.

Fig. 3-81 Lock Plate Snap Ring Removal

(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.

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. 3-82).

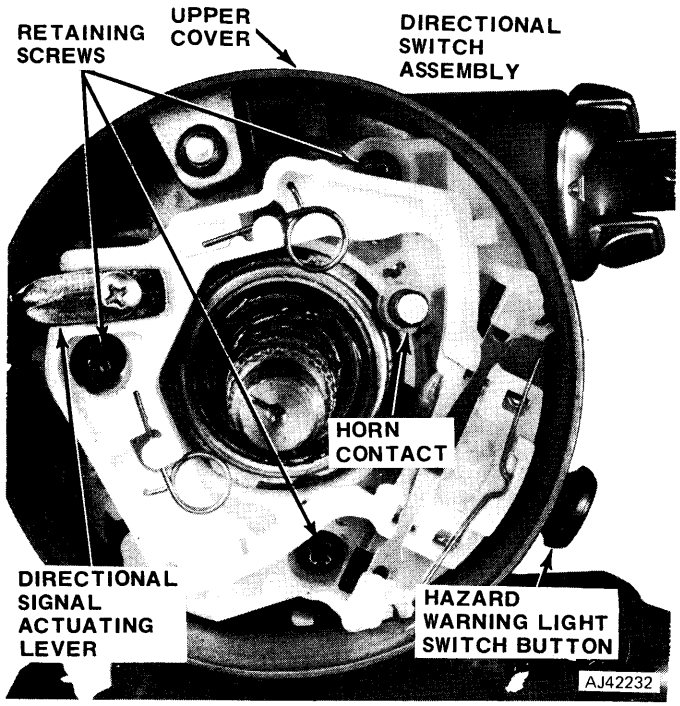


Fig. 3-82 Directional Switch

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 correct operation.

(3) Place thrust washer, spring, and directional signal canceling cam on upper end of steering shaft.

(4) Align lock plate splines with steering shaftsplines 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.

(7) Install steering wheel. Align mark on steering wheel with previously noted mark on housing.

(8) Install washer and nut. Tighten nut to specified torque.

(9) Install spring. **Raised side** of spring must be **up**.

(10) Install receiver and bushing. Receiver must be free to move after bushing screws are tightened.

(11) Line up notch on receiver with nib on horn button. Push button until in snaps into place.

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 with both turn signal indicator lights on the instrument clusters.

This system makes use of the conventional turn signal wiring and bulbs, but has a separate battery feed wire, flasher unit and switch. It is possible to leave a vehicle with the 4-way flasher operating, with the ignition switch and vehicle doors locked. When the 4-way flasher is turned on, the normal directional signal supply is disconnected at the directional signal switch and a separate battery feed circuit is connected into the switch from the fuse panel. The 4-way flasher circuit uses 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. 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 on the switch button.

The 4-way flasher can only be canceled by pulling out on the flasher switch knob.

Refer to Directional Signal Switch for 4-way flasher switch 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.

STOPLAMP SWITCH

The stoplamp switch is self-adjusting and is the same for all models. The switch is retained in its mounting bracket by a spring clip which engages the threaded portion of the switch housing (fig. 3-83). The switch may be removed by pulling straight out of the mounting bracket and retainer.

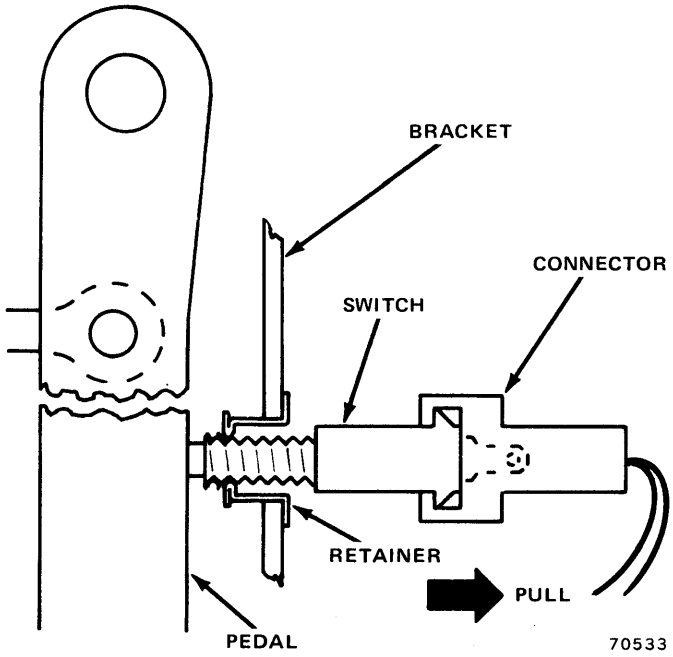


Fig. 3-83 Stoplamp Switch

Adjustment

(1) Depress brake pedal and hold in depressed position.

(2) Push stoplamp switch completely into mounting bracket until switch bottoms.

(3) Release brake pedal and allow it to return to undepressed position. Brake pedal will push switch to properly adjusted position.

(4) Check switch operation. Stoplamps should operate after 3/8 inch to 5/8 inch of pedal travel.

Stoplamp Switch Electrical Test

This test requires a voltmeter.

(1) Ground one lead of voltmeter.

(2) Probe each connection of stoplamp switch with other lead of voltmeter.

(a) With switch plunger depressed (brake not applied), one switch connector should indicate voltage and the other should not.

(b) With switch plunger released (brake applied), both switch leads should show voltage.

RADIOS

GENERAL

Jeep radios are transistorized. They operate with the ignition in the ON or ACCESSORY position. All models use nonadjustable, whip-style antennas.

AM radios are available on all Jeep models. Station selection is controlled manually on CJ models (fig. 3-84) while Cherokee, Wagoneer, and Truck models have pushbutton or manual tuning (fig. 3-85). 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. 3-85). 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 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.

Truck models use a 2-speaker system with the stereo radio. A speaker is mounted in each front door.

Fig. 3-84 AM Radio—CJ Models

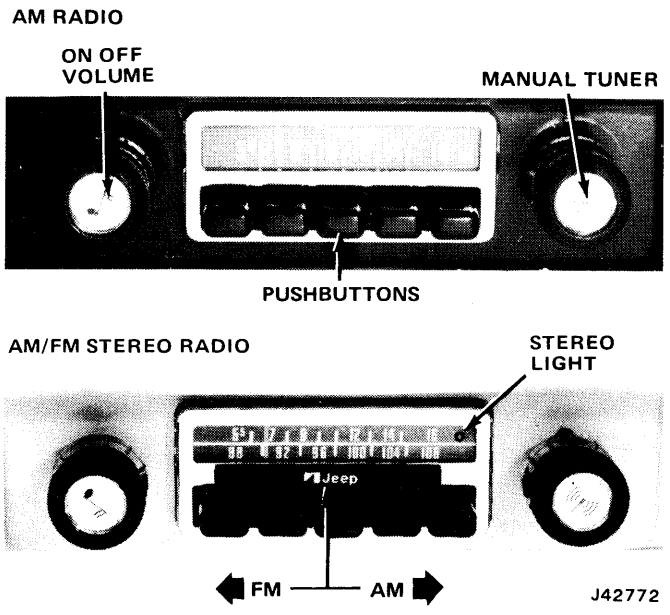


Fig. 3-85 AM and AM-FM Stereo Radio—Cherokee-Wagoneer-Truck

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 maximum sound possible with the volume control at medium volume setting. Adjust the trimmer as follows:

(1) Remove inner and outer tuning control knobs (except CJ).

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 static). Turn volume control to medium level.

(4) Insert a flat blade screwdriver into trimmer adjustment screw. This screw is located inside the small hole above tuning control on Cherokee, Wagoneer and Truck models. On CJ models, the trimmer adjustment screw is on the back of the radio case.

(5) Turn screw left or right until maximum volume is obtained without touching volume control.

(6) Install inner and outer tuning control knob, if removed.

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): 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: Cycles per second.
Ignition Noise: Undesirable radio signals or noise that interfere with the reception of desired radio signal. Examples include 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.

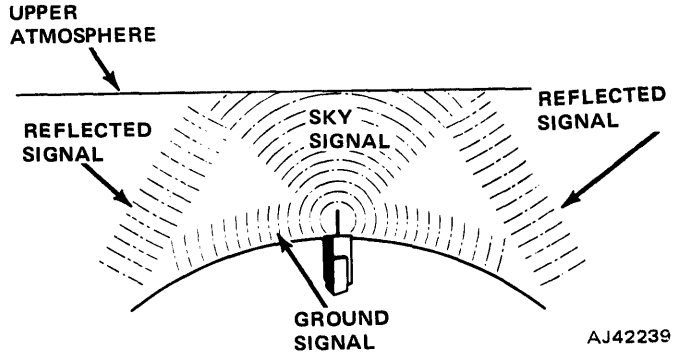


Fig. 3-86 AM Reception

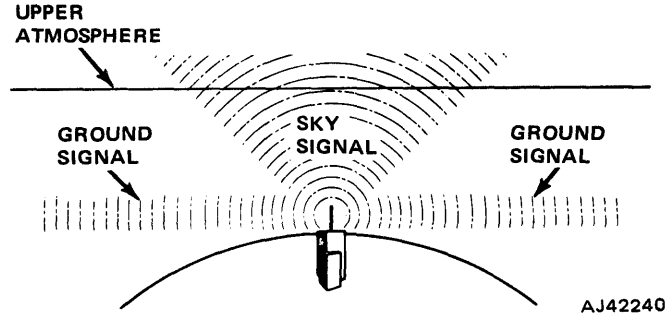


Fig. 3-87 FM Reception

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 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. 3-86). FM is limited to line-of-sight reception (25 to 40 miles) under average conditions of terrain and transmitted power (fig. 3-87). The area of good FM stereo reception may be even slightly less than that of regular FM because of stronger signal requirements. Figure 3-88 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."

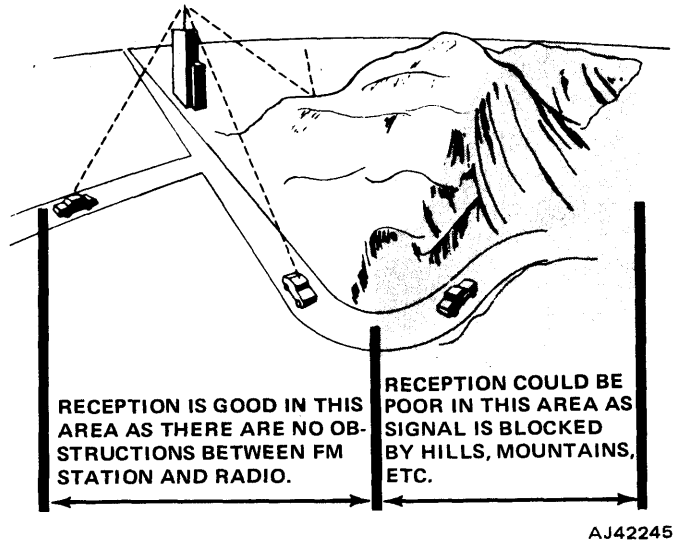


Fig. 3-88 FM Fading

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. 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 causes a detrimental side effect, multipath reception (fig. 3-89). It is caused by a direct signal and a reflected signal arriving at the vehicle antenna at the same time. This causes distortion, partial or complete loss of the station, or poor FM stereo reception. This type of interference is usually of short duration because the area of interference is usually only a few inches or feet across. It is mostly encountered in downtown areas.

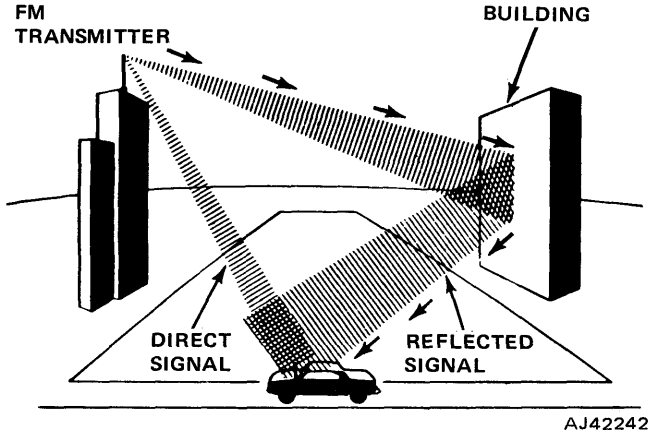


Fig. 3-89 Multipath Reception

Some FM stations use a technique known as circular or vertical polarization. This technique can improve radio performance in areas of multipath reception.

AM Interference

Interference and Ignition Noise

AM reception is susceptible to certain types of electrical interference. These include power lines, thunderstorms and other situations where electrical charges in the air cause disturbances resulting in buzzing and static. AM does not usually suffer from ignition interference of nearby vehicles, because suppression equipment installed on the vehicle (resistance ignition wire, noise suppression capacitors, etc.) prevents ignition noise in the radio.

FM Interference

Ignition Noise Interference

FM usually is not affected by 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.

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. The 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 operator.

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 systmeatic apptoach to troubleshoot noise problems.

- Determining if 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 the radio:

- Antenna
- A-line (battery feed wire to the radio)
- Speaker leads (by themselves or from noise radiated from the other car wires)
- Defective radio
- 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. 3-90).

Lay the screen across the top of the dash and attach the clips to good body ground.

To determine the exact source of the noise, improvise a tool from an antenna lead-in cable.

To make the tool, cut or remove the lead-in at the antenna. Remove approximately 2 inches of the outer plastic covering and the woven shield (fig. 3-91).

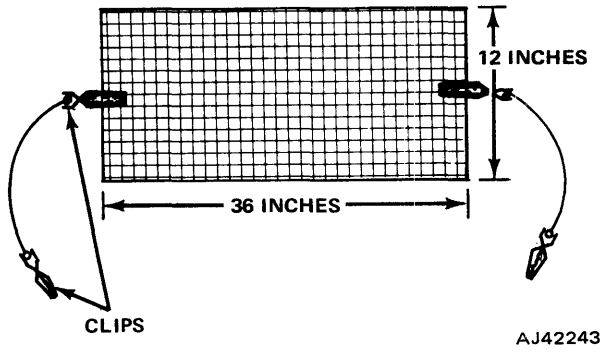


Fig. 3-90 Noise Suppression Tool

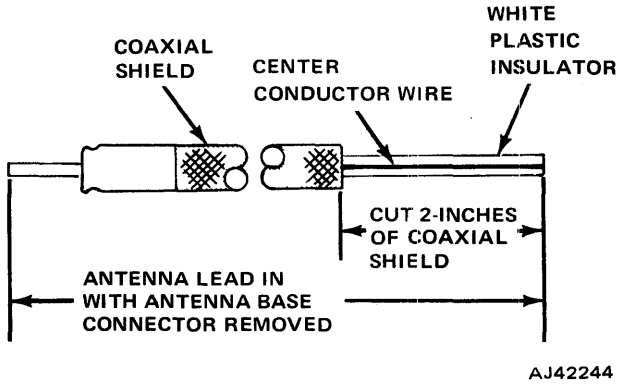


Fig. 3-91 Noise Probe

(1) Disconnect original antenna lead-in and plug in test probe.

(2) Turn radio on and use probe to locate source of noise. Do not touch end of probe with hand as this will give false indication. As probe comes closer to noise source, loudness of noise will increase.

(3) If source is a switch, connect 0.5 mfd capacitor from battery feed side of switch to good chassis ground.

(4) Gauges and sender units generally can be silenced by installing 0.5 mfd capacitor at each terminal.

(5) If source is found to be a wire, reroute wire. If this is not successful, connect 0.5 mfd capacitor from wire to ground or wrap piece of screen around wire or harness and attach one or more ground leads to screen. It also may be possible to isolate area radiating noise with grounded screen.

(6) If noise is caused by motor, install a 0.25 mfd coaxial (feed-through) capacitor.

Noise radiated from the engine compartment can be one of three types:

- Primary ignition noise
- Secondary ignition noise
- Alternator whine

Primary ignition noise generally affects AM reception. The frequency and loudness of this noise vary with engine rpm. The noise stops instantly when the ignition switch is turned OFF. Primary ignition noise is not generated with the ignition switch turned to ACCESSORY position.

Ignition noise may be caused by a poor ground at the ignition control unit or by improper routing of control unit wiring. The noise may be eliminated by cleaning the ignition control unit ground.

Prepare an extra-long antenna lead-in as shown in figure 3-91 and use to probe noise. Remove the ignition coil and mounting bracket. Clean coil and bracket thoroughly and install tightly. In many cases this will reduce noise radiated from the ignition system. Be sure to check coil polarity. The distributor must be connected to the negative side of the coil.

Secondary ignition noise affects FM. If it is severe, it may also affect AM. Secondary ignition noise may be heard across the entire FM band, or it may be heard only between stations, depending on severity and station signal strength.

If secondary ignition noise is evident, look for the following problems:

- Distributor carbon button eroded
- Distributor cap loose or cracked
- Burned contact on rotor
- Poorly seated secondary wire
- Defective coil
- Oily film on a lead terminal
- Copper core wiring substituted for original wires
- Defective or improper spark plugs

If a an improperly seated wire is found, remove wire to inspect end for carbon. If defective, do not repair. Replace the wire.

If the noise sounds like it is caused by one or two ignition secondary leads, but definitely not all of them, the coil may be eliminated as the source. Use an assistant to listen to radio while probe is moved from spark plug to spark plug.

If the engine was not originally equipped with resistor plugs, substitute plugs may be installed. The resistor equivalent of the original N-12Y is RN-12Y or XN-12Y.

Alternator whine is an annoying, high-pitched whistle or squeal that increases and decreases with engine rpm. This noise may be eliminated by several methods:

- Provide good fender ground strap
- Provide grounded shield for offending wire
- Check alternator slip rings and brushes for cleanliness and good contact
- Align hood to keep hood-to-fender gap at a minimum

- Install 0.5 mfd coaxial capacitor at alternator output terminal. Be sure it is rated to handle maximum output current.

A-Line (Battery Feed Wire to Radio)

If disconnecting the antenna does not eliminate the noise, the A-line is the probable source. Motor noise on the A-line is usually the result of voltage spikes that are too large for the radio input filter to handle. This type of noise is corrected by locating the source of the spikes and installing external filters to reduce the spikes to a size that the radio can handle.

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 lockwashers must be used to cut into the surface layers of metal. Grounding straps must be as short and heavy as possible.

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 is a high-pitched whine which increases with rpm. It does not stop instantly when the ignition key is turned quickly to ACCESSORY at fast idle. Correct alternator whine as follows:

(1) Install coaxial capacitor rated at 0.5 to 2 mfd from alternator output terminal to ground (fig. 3-93).

(2) Install coaxial capacitor in alternator output wire (fig. 3-93).

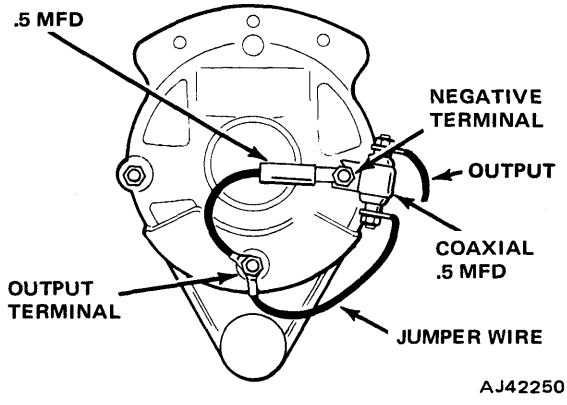


Fig. 3-93 Alternator Noise Suppression

(3) Install noise suppressor kit.

(4) Replace alternator diodes.

(5) Install 0.5 mfd coaxial capacitor in alternator brush feed wire.

Wiring harness noise can normally be corrected as follows:

(1) Relocate wiring away from ignition wires.

(2) Install 0.5 mfd capacitor on each fuse panel lead. Be sure capacitor is grounded (fig. 3-94).

(3) Relocate wiring away from tachometer and ammeter wiring.

(4) Remove loops from harness wires.

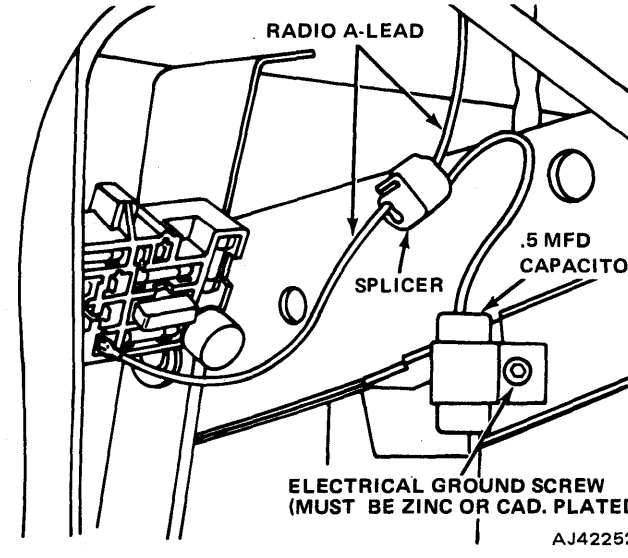


Fig. 3-94 Wiring Harness Noise Suppression

Radio noise suppressor must be installed on the instrument cluster of Cherokee, Wagoneer and Truck equipped with a radio. This suppressor is plugged into the back of the instrument cluster printed circuit. Be sure that the suppressor has not been installed over the copper jumper that is installed on vehicles not equipped with factory-installed radio.

Tap on the instrument panel with the ignition switch ON and in ACCESSORY position. If the noise occurs only in the ON position, check for a loose choke connection or defective choke.

Poor radio ground may be checked by attaching a jumper wire between the radio case and 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 speaker coil wires by installing loom over each wire.

(2) Install 0.002 mfd thumbnail-type capacitor across speaker leads.

Speaker-induced noise normally will not occur on front mounted one- or two-speaker systems. It is most common on four-speaker systems when the fader is in mid-position.

Defective Radio

Exchange with known-good radio to determine if the radio is defective.

Noise Entering Directly into 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.

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. 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. 3-95).

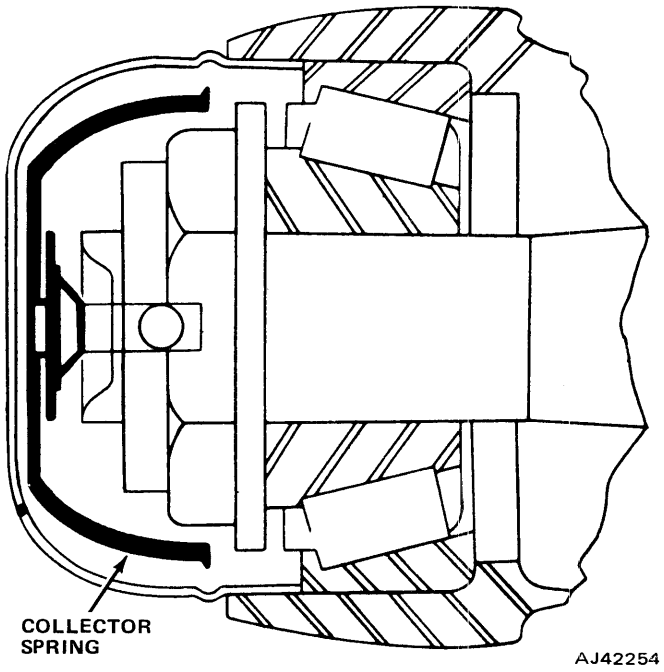


Fig. 3-95 Collector Springs

Static discharges between the tire and the road surface 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. Tire static can be checked by washing the tire with water. Water provides a good conduction path to ground. Tire static is most common during hot, dry weather.

Turn and Stop Signals

The flasher in the turn siganls and the switch in the stop signal may cause popping noises in the radio. In most cases, the noises are interference caused by arcing at the contacts. The cure is a 0.5 mfd 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 interruption 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 capacitor is installed at the point where the battery lead feeds the horn relay.

Accessories

Noise from a brush-type motor, such as electric windshield wipers, blowers or fans, generally can be suppressed by installing 0.25 mfd capacitor at motor terminals.

RADIO REPLACEMENT

CJ Models

(1) Disconnect battery negative cable.
(2) Remove radio control knobs, attaching nuts, and bezel.
(3) Disconnect radio support bracket from instrument panel.
(4) Remove radio by tilting it downward and toward steering wheel.
(5) Disconnect antenna lead, speaker wires, and feed wire.
(6) Remove bracket from radio and install on replacement radio.
(7) Connect antenna lead, speaker wires, and feed wire to replacement radio.
(8) Install radio in instrument panel.
(9) Connect radio support bracket to instrument panel.
(10) Install radio bezel, attaching nuts, and control knobs.
(11) 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 reflector 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 3-96.

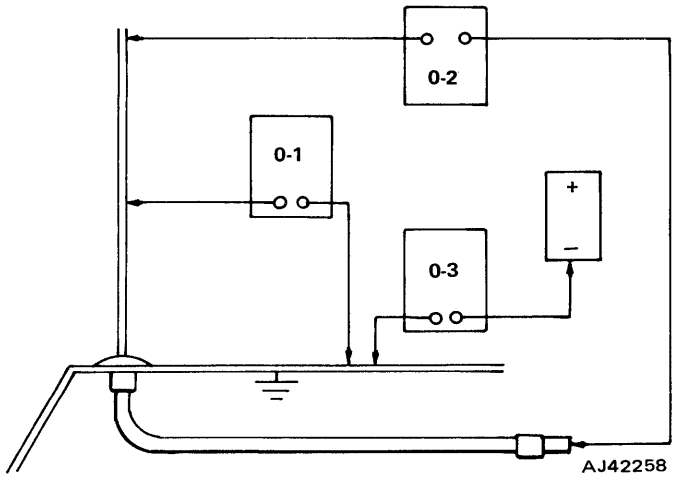


Fig. 3-96 Antenna Ohmmeter Test

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.

Tip of Mast-to-Tip of Conduct 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 negative 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 a speaker having the proper part number. 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. 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 lead to a good ground. An infinity reading should be indicated. Check each individual speaker wire in this manner.
(3) 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. Connect ohmmeter between the two speaker leads. 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 control switch, 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. 3-97).
A separate control circuit, connected to the heater control switch, operates the relay and timer in the relay.

With the control switch on the instrument panel activated and ignition switch on, the relay contacts close. The timer in the relay operates the defogger for 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.

NOTE: *The defogger switch and the electric tailgate window switch are serviced as an assembly.*

TESTING

Switch Test

(1) Turn ignition switch on and press defogger switch.

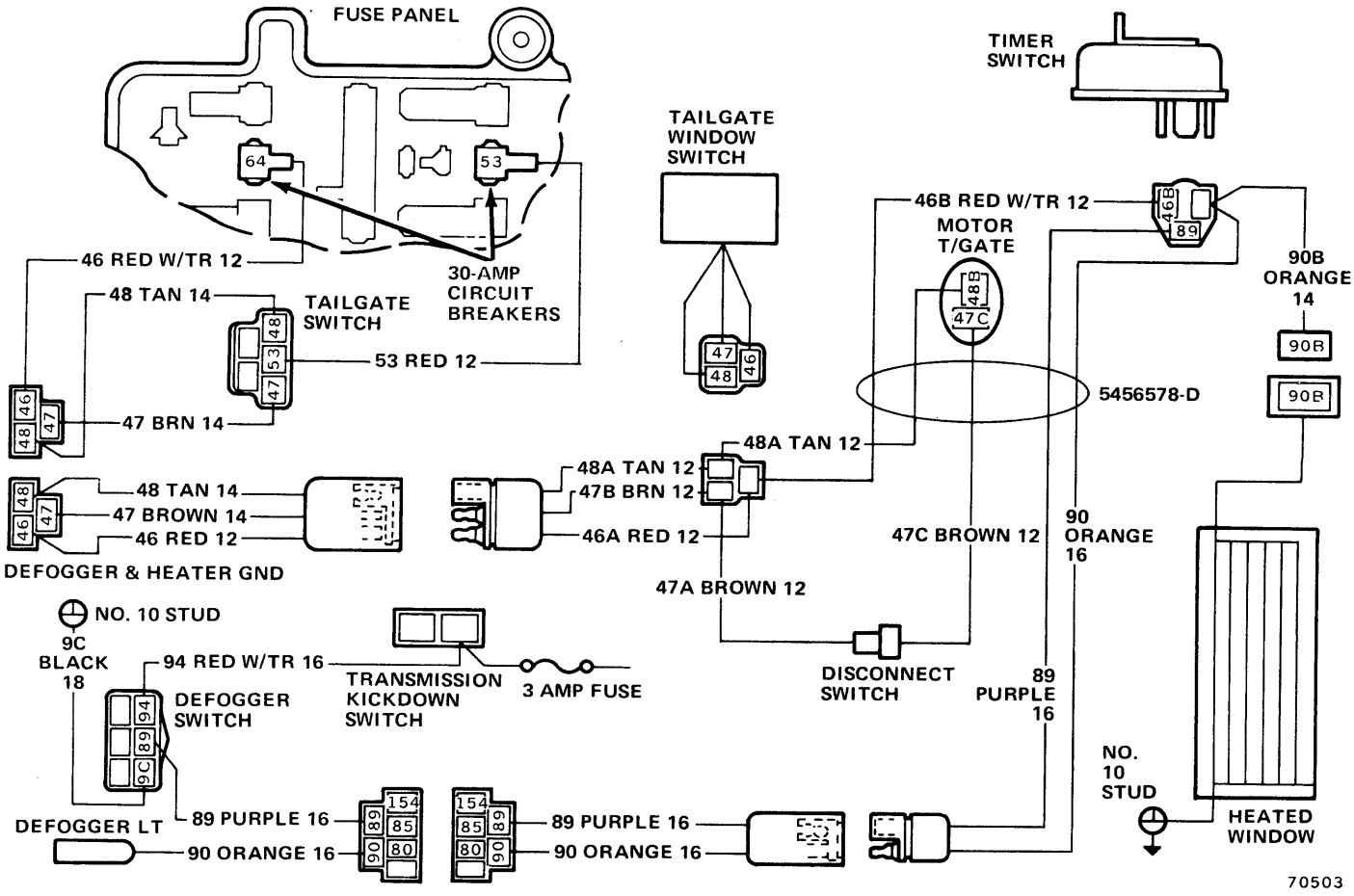


Fig. 3-97 Heated Rear Window Wiring Diagram

(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. 3-97). 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

NOTE: *Terminals on the relay are labeled X, L and P.*

(1) Attach negative lead of voltmeter to ground. Probe red w/t wire (X-terminal) with voltmeter positive lead. Voltmeter should indicate battery voltage regardless of ignition switch position.

If no voltage is indicated, operate the tailgate window. (The tailgate window and rear window defogger are fed by the same wire.) If the window operated, the wire between the window switch and relay is open.

(2) Probe orange wire (L-terminal) with voltmeter positive lead. No voltage should be indicated.

(3) Turn ignition switch to ON or ACCESSORY position. Voltmeter should indicate voltage. If no voltage is indicated, relay is defective, or is not receiving voltage from purple wire (P-terminal).

If relay activates properly, it should remain energized 8 to 12 minutes before opening (ignition switch must remain ON). If the time period is too short or excessively long, relay is defective.

(4) If relay did not energize, connect jumper wire to known good 12-volt source in tailgate and probe relay P-terminal. If relay clicks when probed, trace purple wire for open or short.

If relay does not click when probed by jumper, check relay ground and repair if necessary. If relay still fails to operate, it is defective.

Grid Test

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.

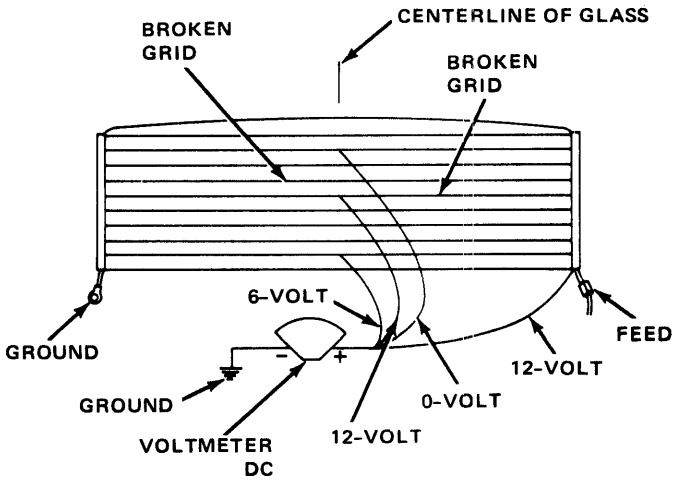


Fig. 3-98 Voltmeter Connections and Voltage Drop for Grid Continuity

(1) With engine running at idle, press tailgate window defogger switch. Defogger lamp should light, 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.*

(2) Use 12-vdc voltmeter and contact positive lead of voltmeter to right side (feed) vertical bus element on inside surface of glass. Contact negative lead to left side (ground) bus element (fig. 3-98). Voltage drop indicated on meter should be 11 to 13 volts. Connect negative lead of voltmeter to good ground—meter reading should not change.

(3) Keep negative lead connected to ground. Use positive lead and carefully contact each grid at approximate centerline of window.

(4) Voltage drop of one-half full amount, approximately six volts, indicates good grid or closed circuit.

(5) Full voltage drop of 12 volts at centerline indicates break in grid between positive lead and ground.

(6) No voltage drop (0 volts) at centerline indicates break in grid between centerline and 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.

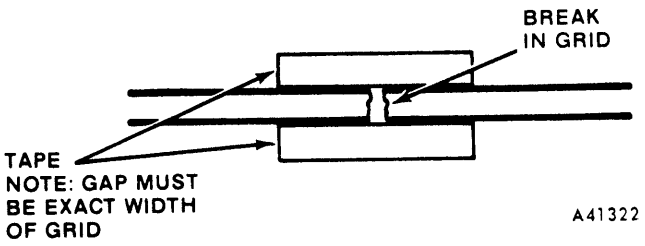


Fig. 3-99 Tailgate Window Defogger Grid Repair

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 3-99.

(4) Mix repair coating until uniform in consistency, with silver particles mixed throughout fluid. Apply coating to break in grid with small brush furnished in kit. Apply 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 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.

NOTE: *If a more finished appearance is desired, repaired area may be stained with tincture of iodine.*

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 battery to ignition switch to fuse panel, through a 30-amp circuit breaker, and to instrument panel tailgate window switch (fig. 3-100).

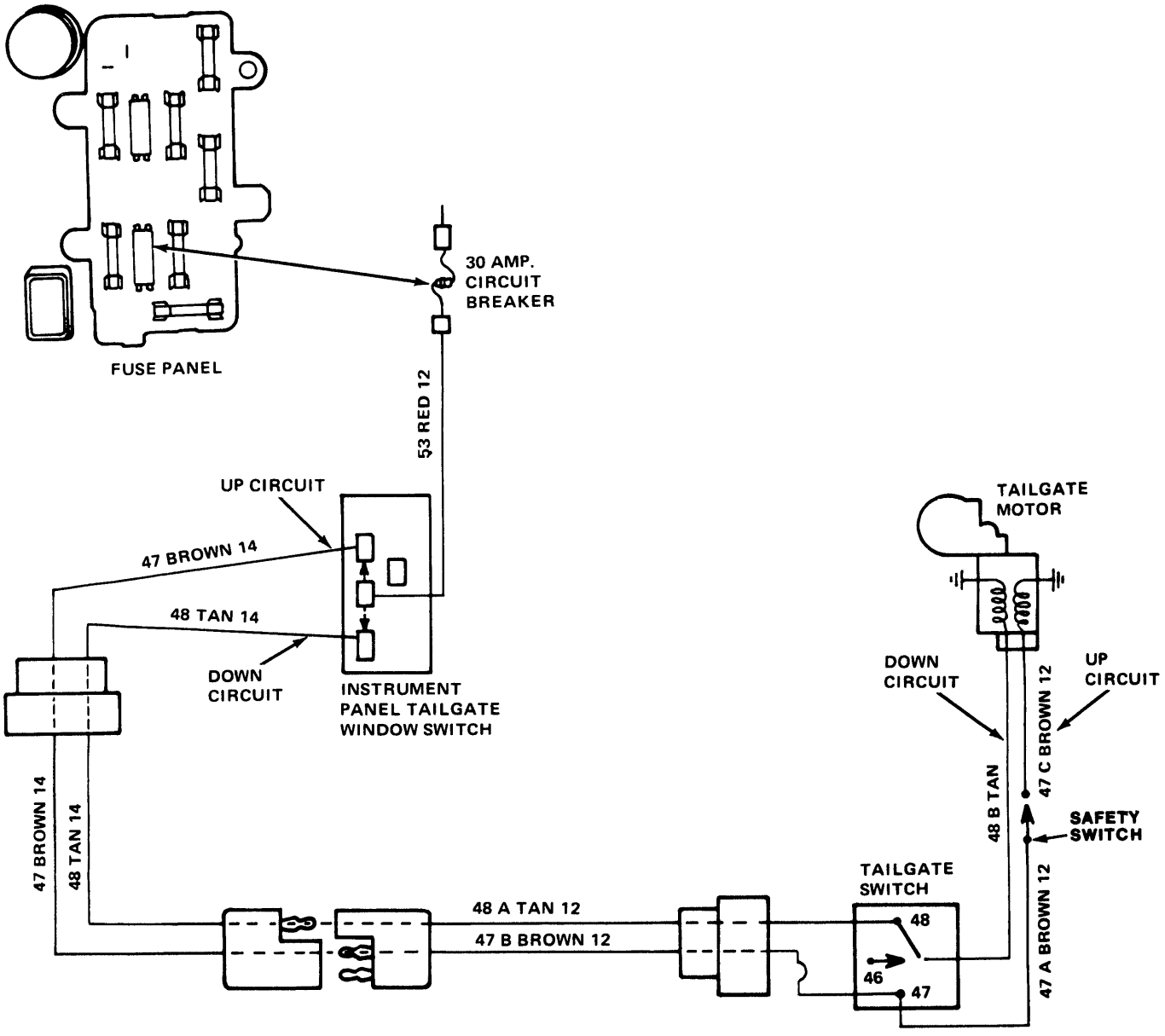


Fig. 3-100 Instrument Panel Tailgate Window Switch Circuitry—Cherokee-Wagoneer

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 to fuse panel, through a 30-amp circuit breaker, and to red (No. 46) wire of tailgate window switch (fig. 3-101).

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. 3-100). 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.

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

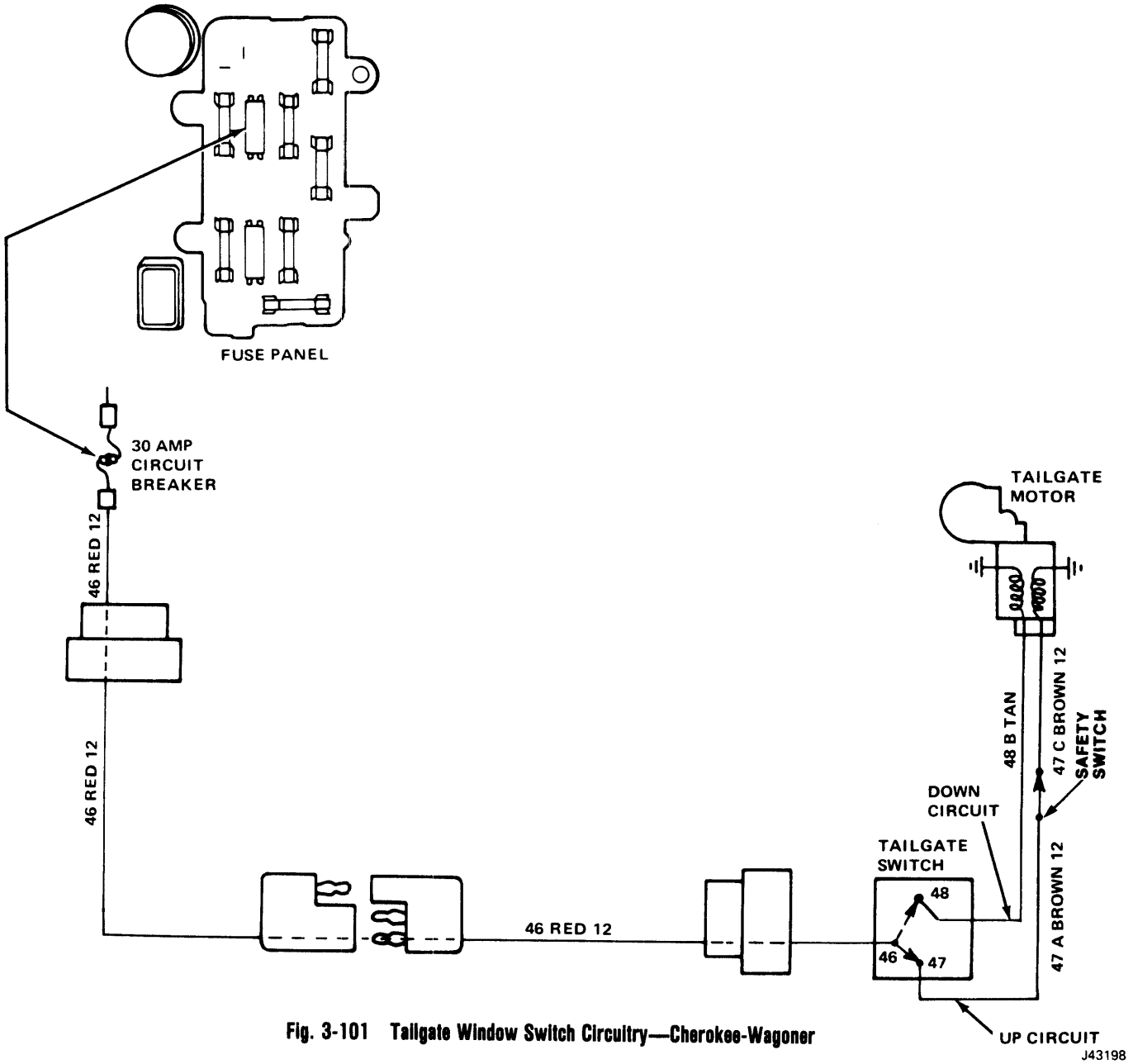


Fig. 3-101 Tailgate Window Switch Circuitry—Cherokee-Wagoner

tailgate window switch (fig. 3-101). 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. 3-101). 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 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. 3-101). 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 tailgate electric motor removal, refer to Section 16 of this manual.

CRUISE COMMAND

GENERAL

Cruise Command automatic speed control senses vehicle 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 the legal speed limit.

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 signal lever. The second switch is a pushbutton switch located at the end of the directional signal 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 signal 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. 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 consists of five basic components: the regulator, the relay, the vacuum servo, the control switch, and the release circuit.

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 vehicle 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.

OPERATION

Once the car has been started and the ignition key 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 the car speed reaches about 30 mph (fig. 3-102). At this speed,

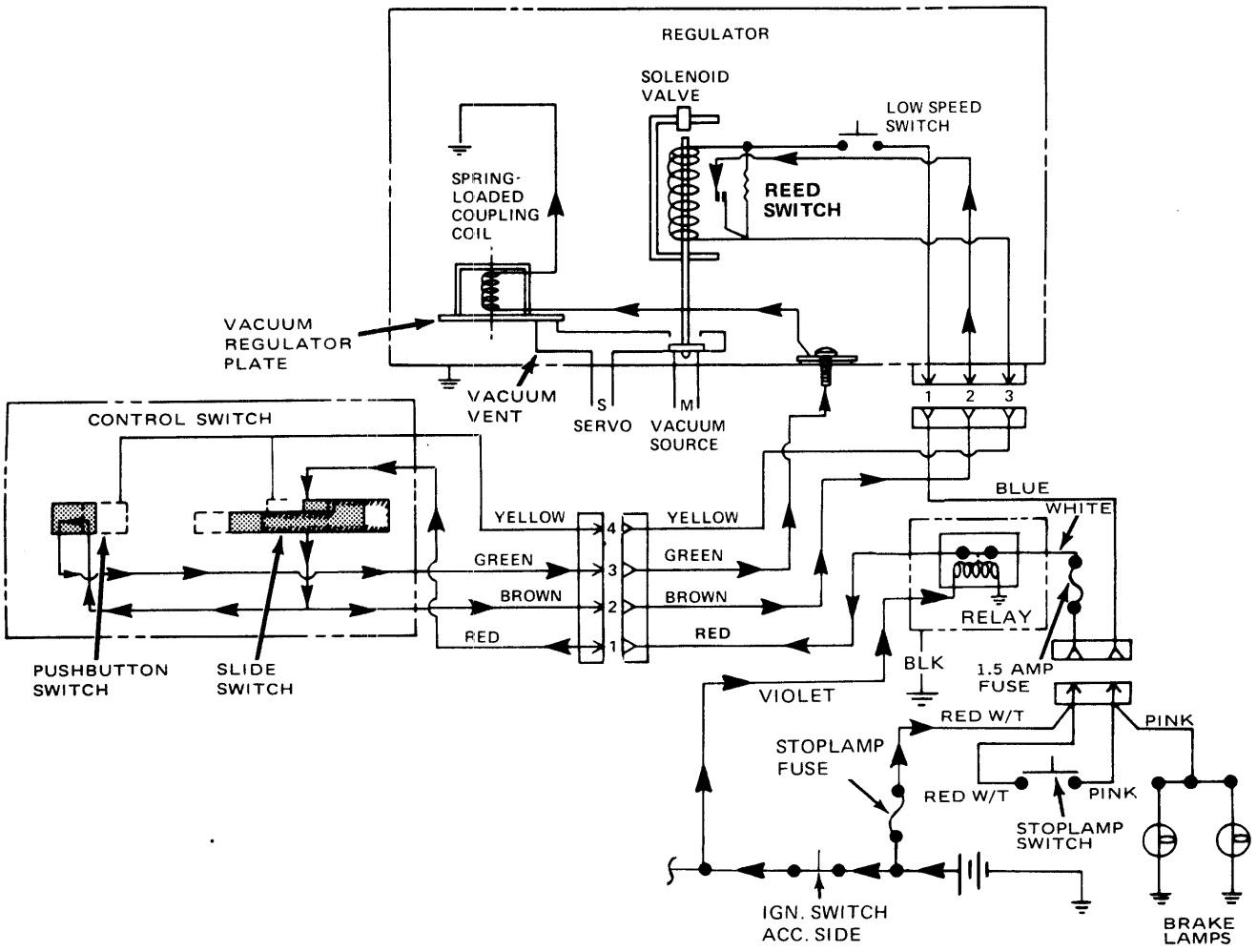


Fig. 3-102 Current Flow with Slide Switch in the ON Position—Below 30 MPH

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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 cannot 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 car 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.

A glass-encapsulated reed switch is mounted on the outside of the solenoid coil. The magnetic field surrounding the energized coil activates the reed switch and permits current to pass. As long as current is supplied to the reed switch, the coil remains energized, and the plunger is held off the manifold vacuum port.

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 car 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. 3-103).

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.

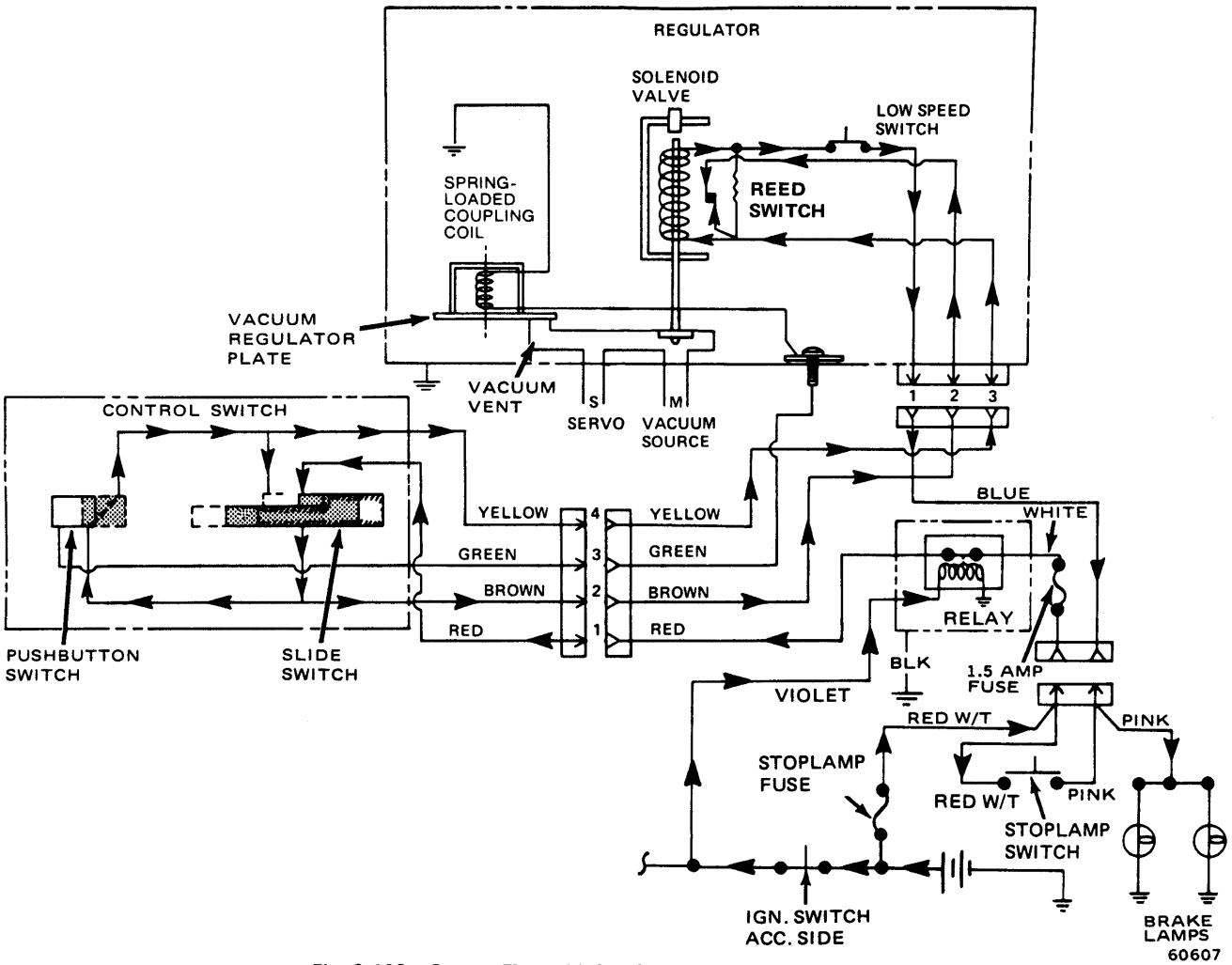

Fig. 3-103 Current Flow with Pushbutton Pressed—Above 30 MPH

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 vehicle speed decreases as in ascending a hill, the coupling coil rotates counterclockwise. This moves the vacuum regulator plate counterclockwise which competely covers the vacuum vent. With the vent sealed, more manifold vacuum is applied to the servo which opens the throttle further causing the vehicle to gain speed. The speed increases until the set speed is attained.

When the vehicle 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 and has a centering spring. When 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 a 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 vehicle speed is above 30 mph), the pushbutton switch stops current flow to the coupling coil circuit and applies current to solenoid valve (fig. 3-103). 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 vehicle speed increases, the plate decreases vacuum to the servo. If vehicle 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. 3-104). 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 car accelerates back to the 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 lifts the solenoid plunger which completes the hold-in circuit and opens the manifold vacuum port (fig. 3-105).

Since the coupling coil is not deenergized during braking, the vehicle begins to accelerate once the solenoid valve is energized during the 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 applies more vacuum to the servo and produces acceleration until set speed is attained. Then the vacuum regulator plate agains maintains the constant set speed.

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 in this section.

Centering Spring Adjustment

NOTE: *The centering spring adjustment is extremely sensitive and must never be turned more than one-eighth turn in either direction.*

Adjustment is made by turning the centering spring adjustment screw. If speed control engages at two or more mph higher than selected speed, turn centering spring adjusting screw "C" toward "S" 1/32 inch or less. If engagement speed is any amount below selected speed, turn centering spring adjusting screw toward "F" 1/32 inch or less (fig. 3-106).

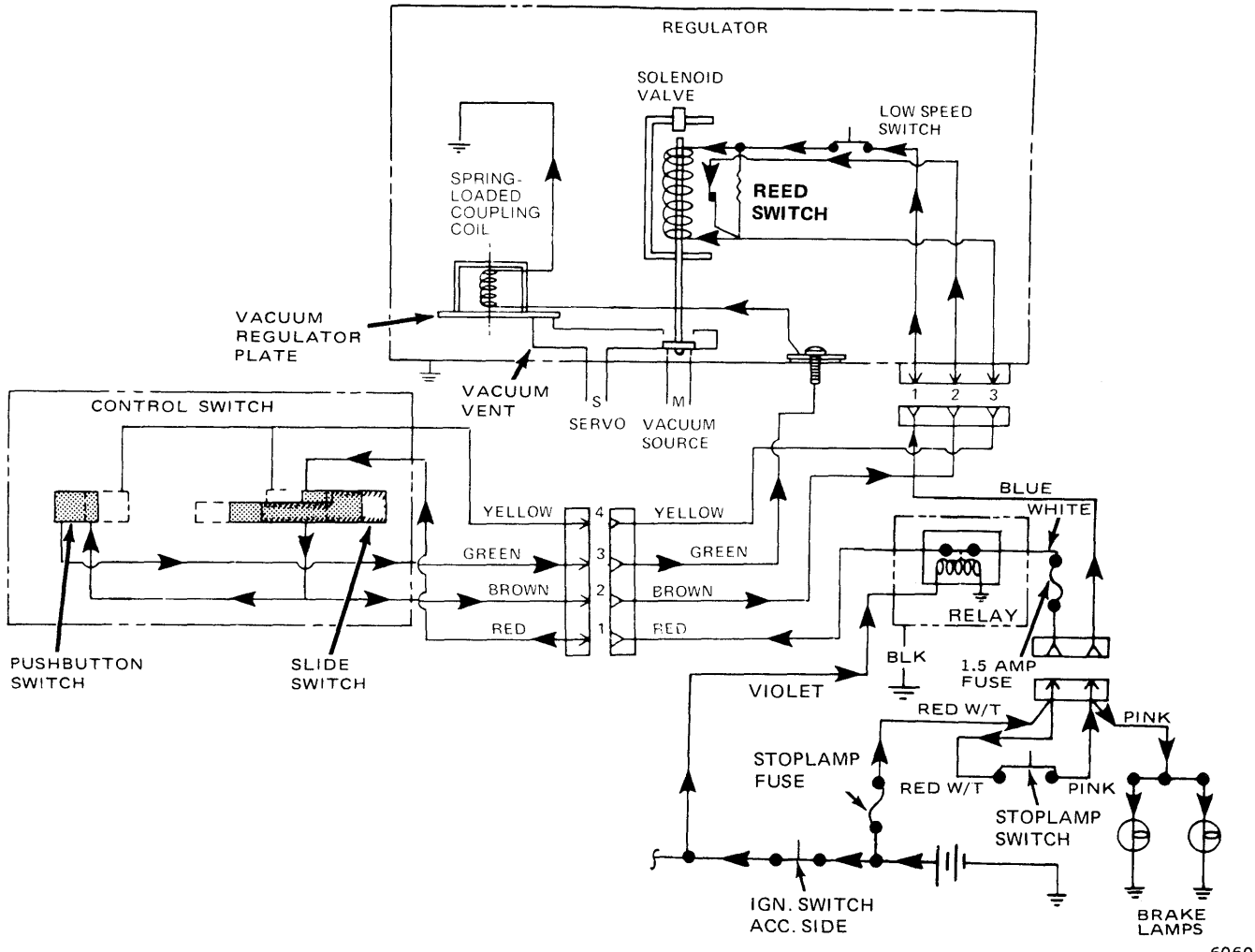

Fig. 3-104 Current Flow—Brake Release Circuit

NOTE: *The centering spring is adjusted ideally when speed remains steady or increases very slightly when Cruise Command is engaged. The centering spring adjustment has no effect on maintaining speed unless the centering spring is completely out of adjustment.*

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 connectors at the steering column. Refer to the Control Switch Continuity Chart for wire connections and switch positions.

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 3-107.

(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.

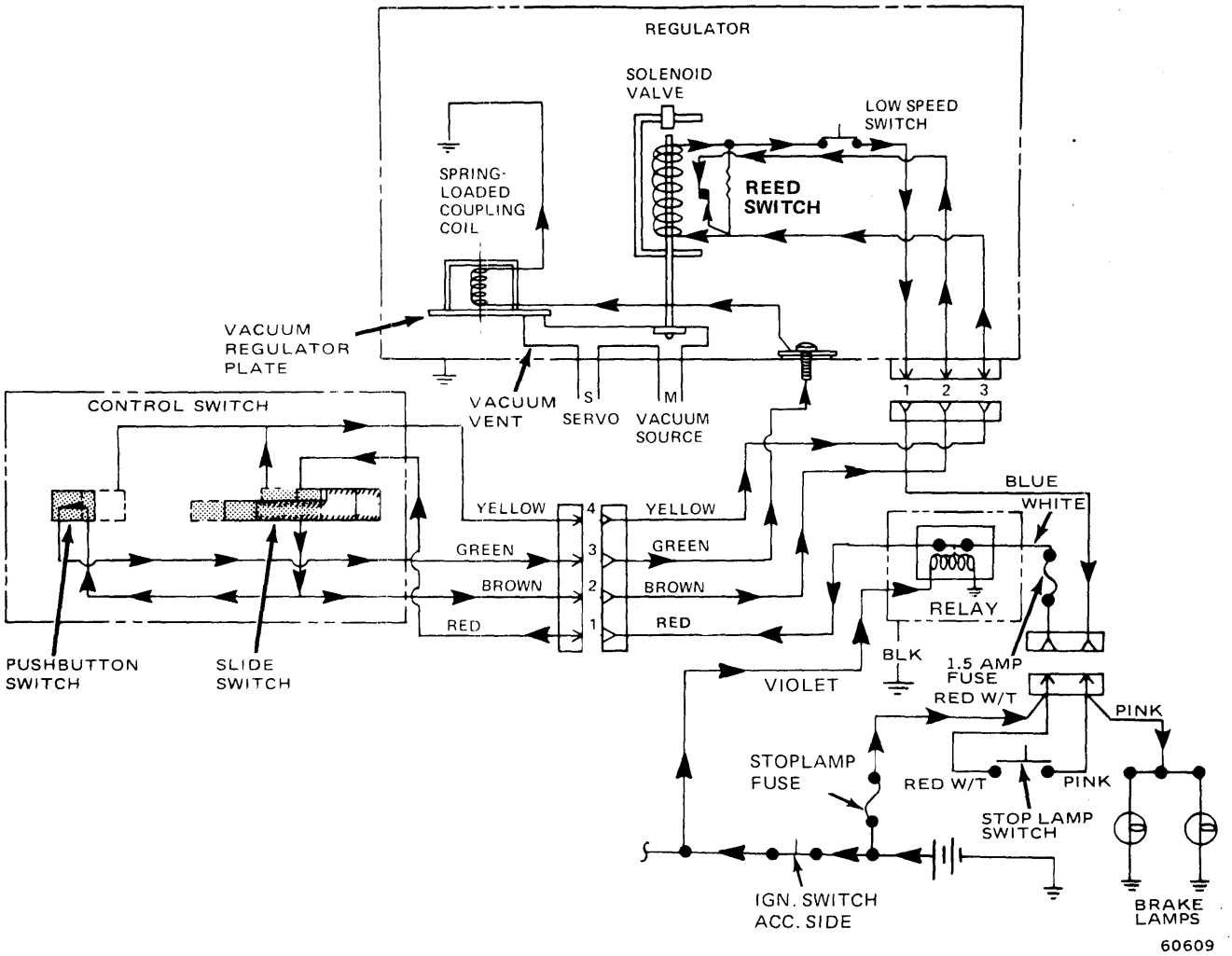

Fig. 3-105 Current Flow with Slide Switch in RESUME Position

(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 vehicle, 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.

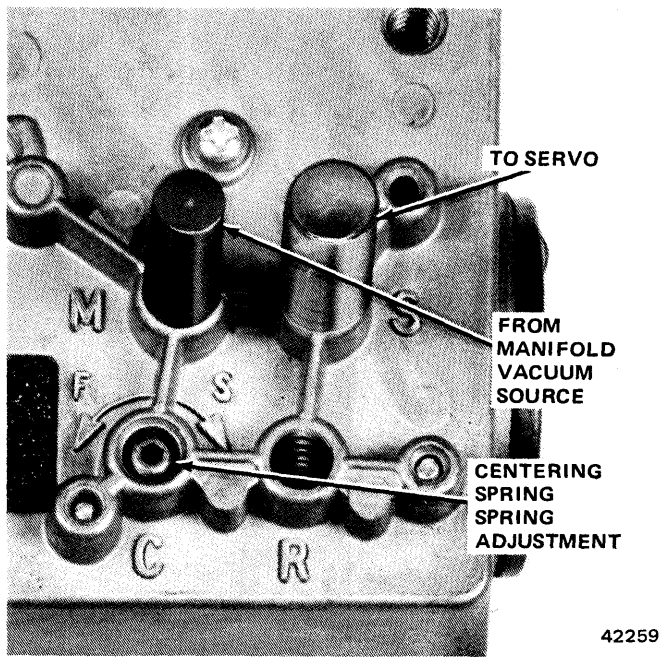

Fig. 3-106 Centering Spring Adjustment

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 ground wire attaching screw).
	(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.
SYSTEM DISENGAGES ON ROUGH ROAD WITHOUT APPLYING BRAKE	(1) Stop lamp switch out of adjustment.	(1) Adjust switch.
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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(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 button 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.

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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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.*

Release Circuit Test

The release circuit is part of the stoplamp circuit. To test the brake release circuit, 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 brakes are applied, the stoplamp circuit must not be shorted. 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) Disconnect three-wire connector at regulator.

(2) Connect one side of test lamp to ground and other to blue wire. Test lamp should not light.

(3) Press brake pedal 3/8 inch. Test lamp should light. If test lamp does not light, check power source from 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 the dash panel.

NOTE: *Check all connections prior to testing.*

(1) Turn ignition switch and slide switch to ON position.

(2) Connect one lead of 12 volt test lamp to ground. Touch other lead to each connection at relay. Lamp should light at each connection except ground (black) wire.

If test lamp lights at ground (black) wire, ground wire is not grounded. If lamp lights on white and violet wires but not on red wire, replace relay. Check power sources if test lamp does not light on white and violet wire.

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.

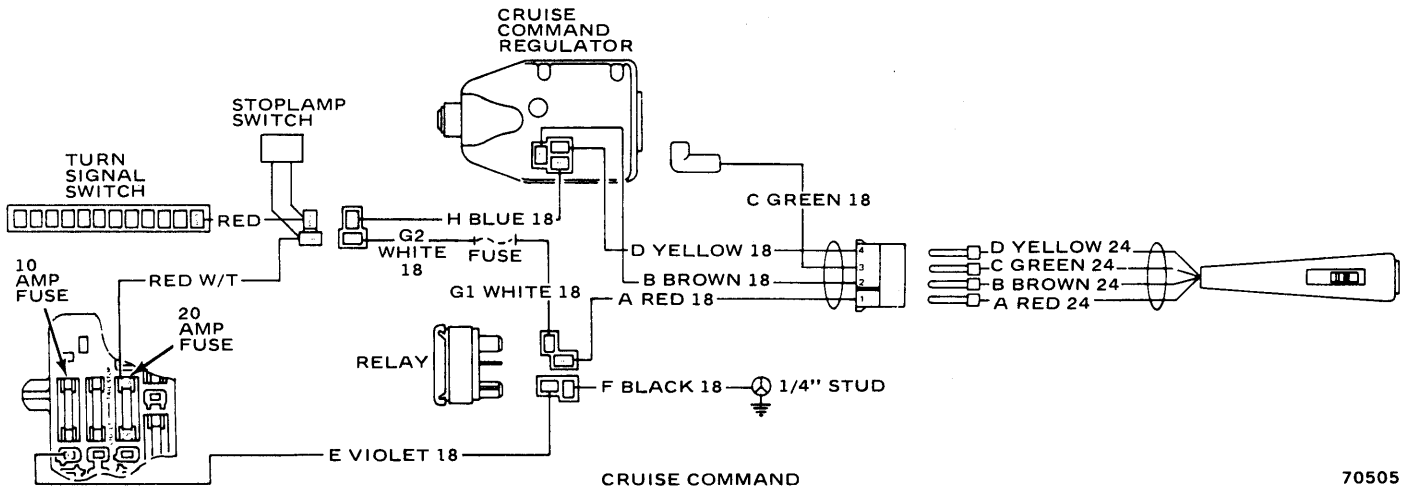

Fig. 3-107 Cruise Command Schematic

(8) *Standard Column*—Tie or tape a string to the plastic connector.

(9) Remove lever and harness assembly from column.

Installation

(1) Check replacement 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

60603A

IGNITION SYSTEM

Sensor

Resistance: 1.6 to 2.4 ohms at 77° 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
Cargo Lamp	–	25 amp (Circuit Breaker on headlamp switch)
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 and 3 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)
Tail and Stop Lamps/Cruise Control	20 amp	20 amp

BULB CHART	CJ Models	Cherokee-Wagoneer-Truck
Front Lamps		
Headlamp	6014	6014
Side Marker	194	194
Parking and Directional	1157 NA	1157 (1157 NA-Wag.)
Rear Lamps		
Backup Lamp	1156	1156
Cargo Lamp	–	(1156-Truck Only)
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

60603B

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 Screw	20-30 in-lb	15-30 in-lb
Hazard Warning Knob Mounting Screws	2-5 in-lb	2-5 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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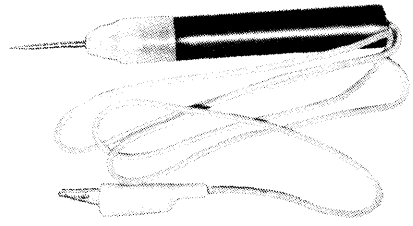
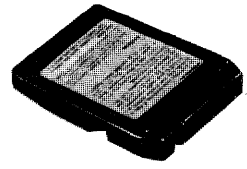
Special Tools

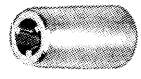
J-25331
BID PULSE SIMULATOR



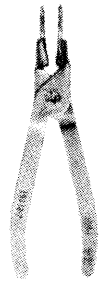
J-21008
CONTINUITY LIGHT



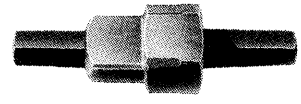
J-22683-01
STEREO TEST TAPE



J-25097
BID SENSOR
SCREW REMOVAL BIT

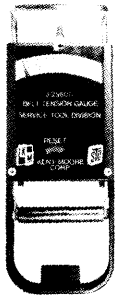


J-21157
SNAP RING PLIERS

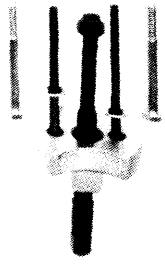


J-21501
MOTORCRAFT PULLEY
REMOVER/INSTALLATION
TOOL

J-22516
STARTER POLE
SCREW WRENCH

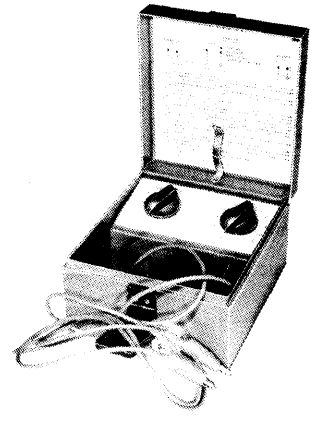


J-23600 BELT STRAND
TENSION GAUGE



C-3428 STEERING
WHEEL PULLER

J-23653 LOCK
PLATE COMPRESSOR



J-24538 FUEL AND TEMPERATURE
GAUGE TESTER

J42774

TECHNICAL BULLETIN REFERENCE

Date	TB No.	Subject	Changes Information on Page No.

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