ELECTRICAL

GENERAL

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

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

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

GROUND CONNECTIONS

First check for a poor or no ground condition when checking for electrical malfunctions such as erratic temperature and fuel gauge readings, directional lights glowing when headlights are operated, windshield wiper motor attempting to operate when some other electrical component is operated.

All models have the battery grounded directly to the engine and to the right front fender inner panel. To complete the ground return circuit from the load (bulb, gauge, etc.) back to the battery, the ground connections and their locations are as follows:

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

Frame-to-Engine Ground - All models utilize a ground strap. Six-cylinder engines have a strap attached to the left motor mount; V-8 engine strap is attached at the right motor mount.

CJ Models

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

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

The Hazard, Wiper Washer, and Lights panel lights are grounded by a ground wire attached to a screw at the lower lip of the instrument panel.

Cherokee-Wagoneer-Truck

The cluster is grounded from pin terminal on the cluster to a mounting screw on the lower lip of the instrument panel at the extreme left-hand side.

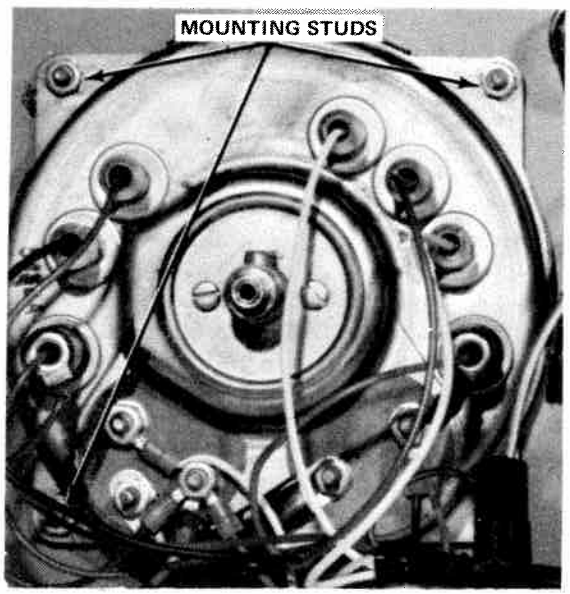


Fig. 3-1 Instrument Cluster Ground - CJ Models

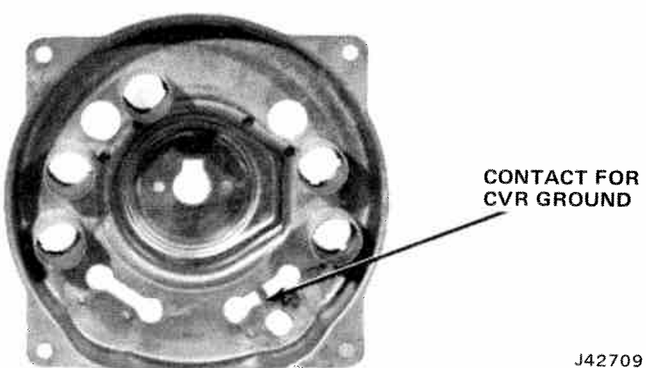


Fig. 3-2 Constant Voltage Regulator Ground - CJ Models

MAIN HARNESS CONNECTOR

The Cherokee, Wagoneer and Truck 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.*

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

CAUTION: *This circuit is live 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 the 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 negative post of a wet-charged battery is color coded to indicate ampere hour capacity as follows:

- Green - 50 Ampere Hour
- Yellow - 60 Ampere Hour
- Black - 70 Ampere Hour

Positive identification of the battery as to ampere hour rating can be made by referring to the catalog number on the battery cover decal (fig. 3-3).

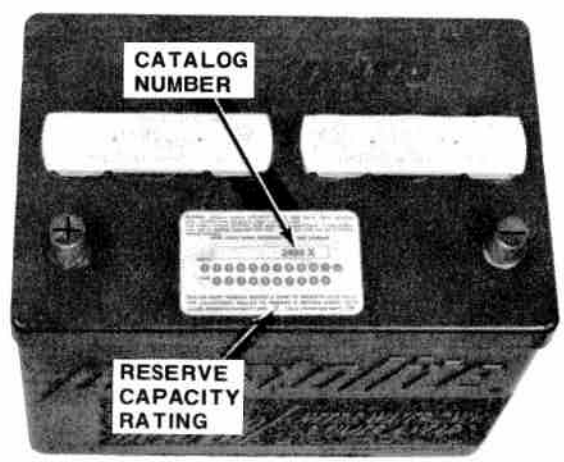


Fig. 3-3. Battery Code Information

Build Code Information

Reserve capacity is defined as the number of minutes a new, fully charged battery at 80 degrees F (26.7 degrees 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. Jeep batteries have a reserve capacity rating as follows:

Amp Hr Rating	Catalog Number	Reserve Cap. (Minutes)
50	2480X	73
60	2488X	93
70	2495X	106

Starting Procedure - Discharged Battery

The correct method for starting a car with a discharged battery is with either 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 cap and cover the cap openings with a cloth.

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

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

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

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

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

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

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

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

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

Install the vent caps.

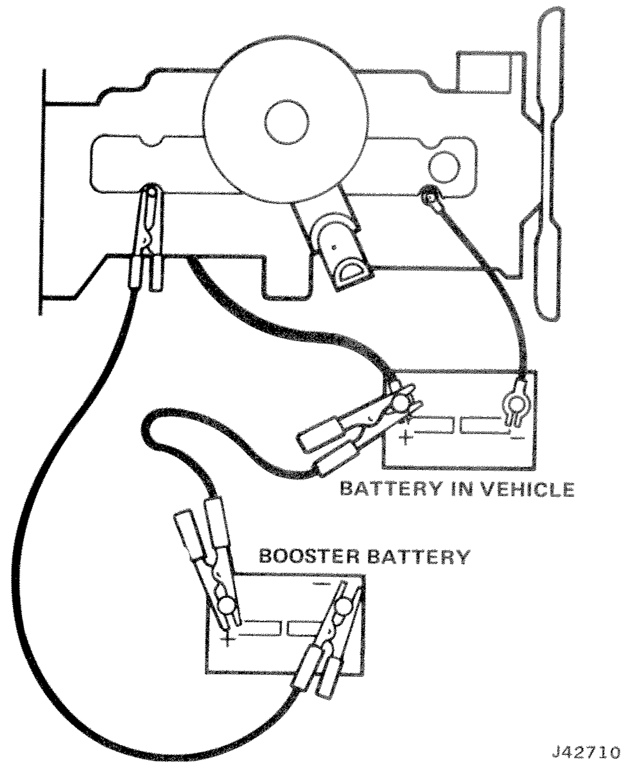


Fig. 3-4 Battery Jumper Cable Connections

BATTERY CHARGING

Slow Charge

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

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

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

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

The battery may be fully charged by this method unless it is not capable of accepting a full charge. **A battery is in a maximum charged condition when**

all cells are gassing freely and three corrected specific gravity readings, taken at hourly intervals, indicate no increase in specific gravity.

Fast Charge

Always disconnect one battery cable before using a fast charger.

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

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

Frozen Electrolyte

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

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

FREEZING TEMPERATURE CHART

Specific Gravity (Corrected to 80° F)	Freezing Temperature (°F)
1.270	-84° F
1.250	-62° F
1.200	-16° F
1.150	+ 5° F
1.100	+19° F

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 in 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 stength. Hydrogen and oxygen gasses are given off at the negative and positive plates as the plates approach the full charged condition. This is caused by an excess of charging current not totally accepted by the plates.

BATTERY MAINTENANCE

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

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

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

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

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

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

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

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

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

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

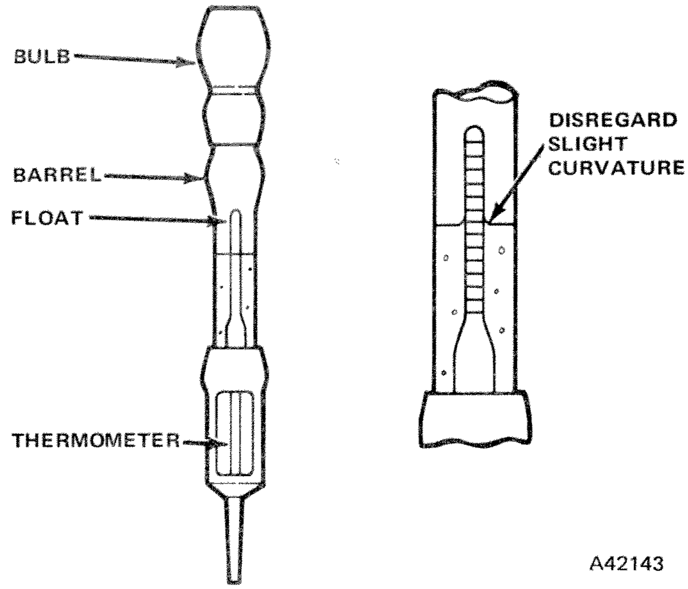


Fig. 3-5 Hydrometer and Proper Method of Reading

BATTERY TESTING

When testing a battery, perform the following steps in the sequence listed.

(1) Take hydrometer reading - if specific gravity indicates below 75 percent full charge, battery must be charged before any further testing can be done.

(2) Charge battery - a battery which does not accept a charge is defective and no further testing is required.

NOTE: *A sulfated battery may require an overnight slow charge to determine if the sulfation is light enough to be broken down by a charge.*

(3) Perform heavy load test as outlined in this section - a battery which is over 75 percent charged and does not pass the heavy load test is defective.

(4) 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 Data 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.

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

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

70 degrees divided by 10 degrees (Each 10 degree difference) equals 7.

7 x 0.004 (temperature correction factor) equals 0.028.

Temperature is below 80 degrees F, so temperature correction is subtracted.

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

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

SPECIFIC GRAVITY CHART

State of Charge	Specific Gravity as Used in Cold and Temperate Climates	Specific Gravity as Used in Tropical Climates
Fully Charged	1.265	1.225
75% Charged	1.225	1.185
50% Charged	1.190	1.150
25% Charged	1.155	1.115
Discharged	1.120	1.080

If the specific gravity of all cells is above 1.235 (1.196 tropical climate), but the variation between cells is more than 30 points (0.030), it is an indication of an unserviceable battery, and the unit should be removed from the car for further testing.

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

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

At the end of the charge period, if the cell variation is more than 30 points (0.030), replace the battery.

When the specific gravity of all cells is above 1.235 and variation between cells is less than 30 points, the battery may be tested under load.

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

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. 3-5). 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 hydrometer barrel with the bulb released. The hydrometer must be kept vertical while drawing in liquid and taking the reading. **Care should be taken when inserting the tip of the hydrometer into the cell, to avoid damage to separators.** Broken separators could result in premature battery failure.

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

Perform the hydrometer test as follows:

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

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

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

(a) If the variation in **temperature corrected** hydrometer readings found in step (3) is 30 points or more for the individual cells within a battery, replace battery.

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

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

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

(d) If all cells show a more than slight increase in **temperature corrected** gravities (with variation **within** 30 points) and have clear electrolyte, battery is probably only discharged and can be returned to service.

(4) Sulphated batteries may be brought back to serviceable 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 30 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 3-6.

(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 hr battery
180 amperes for 60 amp hr battery, etc.

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

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

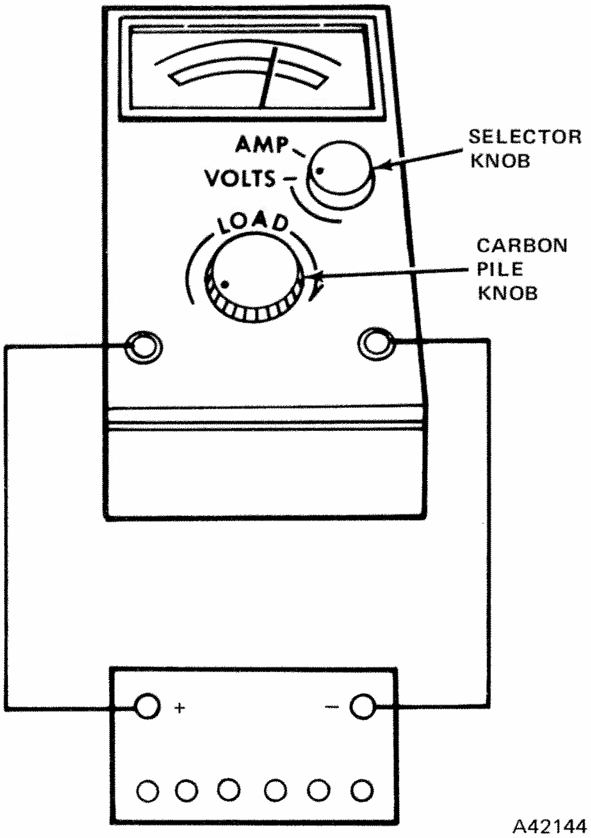


Fig. 3-6 Heavy Load Test

Battery Storage

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

ALTERNATOR

An alternator is an electro-mechanical device producing alternating current (ac), which is changed into direct current (dc) by rectifier diodes.

The alternator employs a three-phase stator winding. The rotor consists of a field coil encased between six poled interleaved sections, producing a 12-pole magnetic field with alternating north and south poles.

By rotating the rotor inside the stator, an alternating current is induced in the stator windings. This alternating current is changed to direct current by diodes and conducted to the output terminal and regulator terminals.

Only a small amount of current (approximately 2 amperes) passes through the brushes to excite the field windings in the rotor. For this reason, brush life is considerably longer than in a generator.

Alternators used in conjunction with 4V carburetors have an extra terminal on the rear housing which provides approximately seven volts of alternating current to a heating element located in the carburetor choke cover (fig. 3-7).

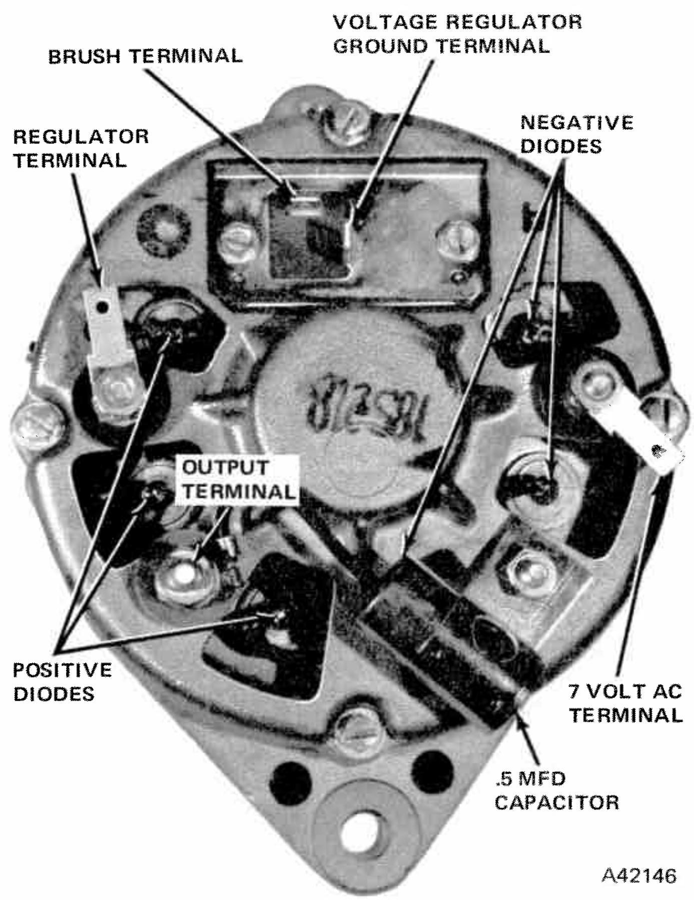


Fig. 3-7 Alternator - Rear View

Alternator Identification

The nameplate, riveted to the rear housing, contains voltage, type of ground, serial number, amperage rating, and model number information.

The alternator code is stamped on the end of the rear housing in large black numbers:
Example:

185	3	18
Vendor	Year	Week
(Motorola)	(3-1973, 4 -1974)	

Maintenance

When the engine is serviced, check the wiring for damage from accumulation of ice or mud. Check the drive belt for proper tension and other defects such a glazing, cracking, fraying, etc.

Check for misalignment of pulleys possibly caused by a broken mounting bracket or loose mounting bracket bolts.

Lubrication is not necessary since the bearings are sealed.

Alternator brush life depends primarily on the amount of dust and dirt encountered. Replace brushes when wear exceeds one-half the original length of the brush.

Check for clean and tight cable connections at the battery posts, engine block and starter relay.

Alternator Belt Adjustment

A belt which has been in service for some time should be checked first for general condition before attempting an adjustment. If it is severely cracked or oil soaked, it should be replaced.

Install Belt Strand Tension Gauge W-283 or J-23600 on the longest accessible span, midway between pulleys (fig. 3-8).

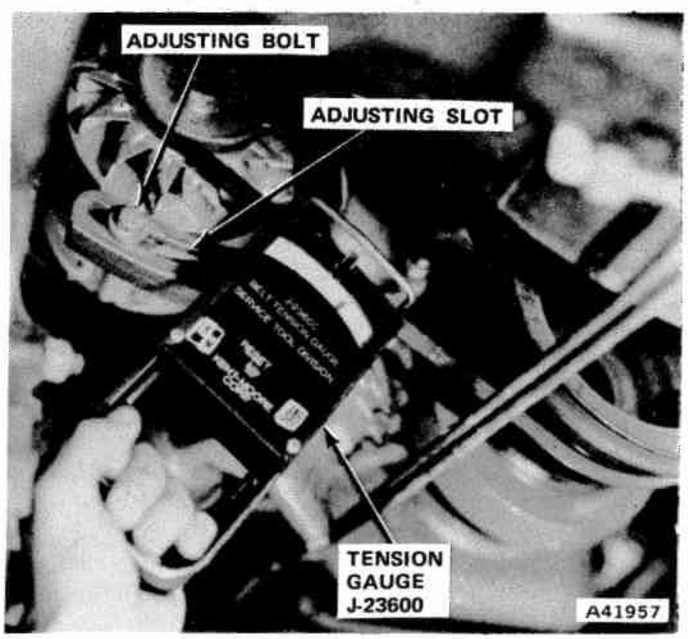


Fig. 3-8 Checking Belt Tension with Gauge J-23600

NOTE: *When using W-283 on a notched belt, the middle finger of the gauge should be in the notched cavity of the belt.*

Loosen the alternator mount bolt and the adjusting strap screw. Move the alternator away from the engine by applying pressure at the front housing with a suitable tool (fig. 3-9 and 3-10).

Tighten the adjusting strap screw and mount bolt while maintaining the specified tension.

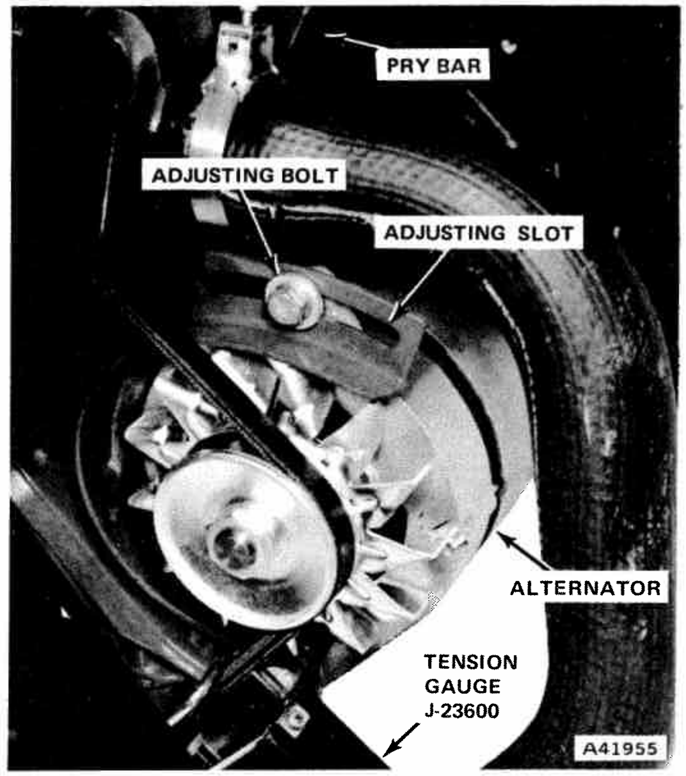


Fig. 3-9 Adjusting Belt Tension - Six-Cylinder Engine

Field Excitation and Indicator Bulb Circuit

Figure 3-11 illustrates the four connections required for regulated alternator operation: ground, field, regulator and output. The ground wire is required for voltage regulator operation only. The alternator is grounded through the mounting bracket on the engine and does not require an exterior ground. The ground and field terminals of the alternator connect to a two-terminal female connector of the wire harness.

Since there is little residual magnetism in the alternator, it is necessary to supply a small amount of excitation current to the alternator rotor (field) winding. The current is approximately 0.25 amperes and will cause the indicator light to operate when the ignition switch is turned on. See figures 3-11 and 3-12.

All models have basically the same method of lighting the alternator indicator bulb and providing the initial current to the alternator field brush. The follow-

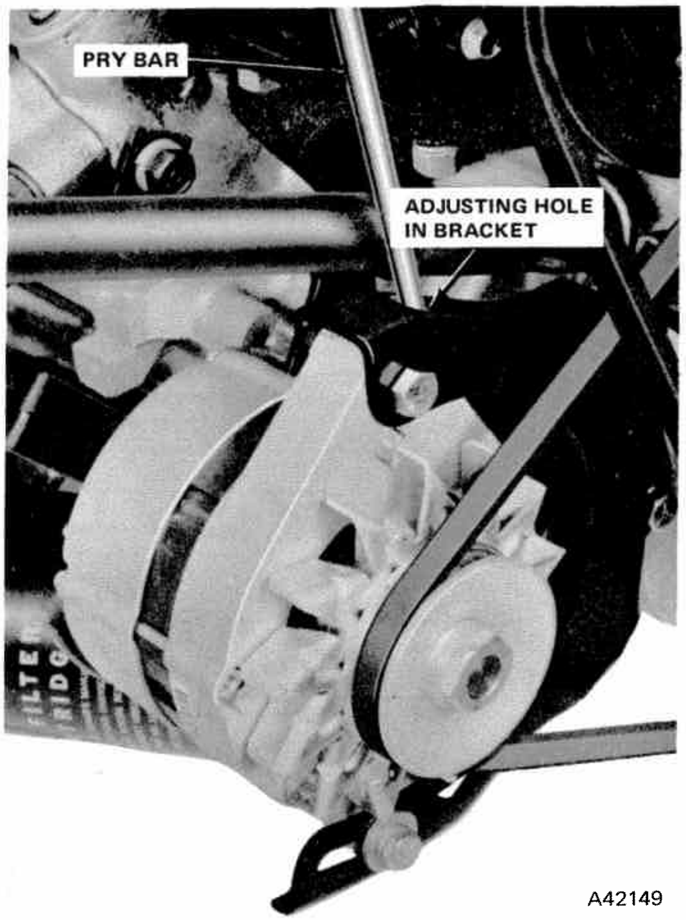


Fig. 3-10 Adjusting Belt Tension - V-8 Engine

ing description is of the circuit applicable to CJ models. The principles of operation are the same as for other series of Jeep vehicles, although there are some differences in color coding and instrument cluster.

When the ignition is turned on, current is supplied from the ignition switch IGN terminal (green with tracer) to the fuel gauge I-terminal of the instrument cluster (fig. 3-11).

From the fuel gauge I-terminal , the current is routed to the alternator bulb and then continues through the bulb to the alternator voltage regulator (grey wire). The circuit is completed through the voltage regulator to the field terminal (green with tracer wire) of the alternator, then through the field windings to the ground brush.

An 82-ohm resistor, located within the voltage regulator, is connected in parallel with the alternator indicator bulb. In the event of indicator bulb failure, defective bulb socket or wire, field current will be supplied through this resistor by the yellow wire from the I-terminal of the starter relay when the ignition is turned on. The resistor also prevents voltage feedback through the ignition switch to the battery when the alternator is charging.

When the alternator is operating, the voltage regulator senses voltage at the regulator terminal (grey wire) and automatically provides the correct current to the field terminal (green with tracer wire) of the alternator (fig. 3-12).

This same voltage, through a junction at the voltage regulator harness connector, is applied to one side of the alternator indicator bulb.

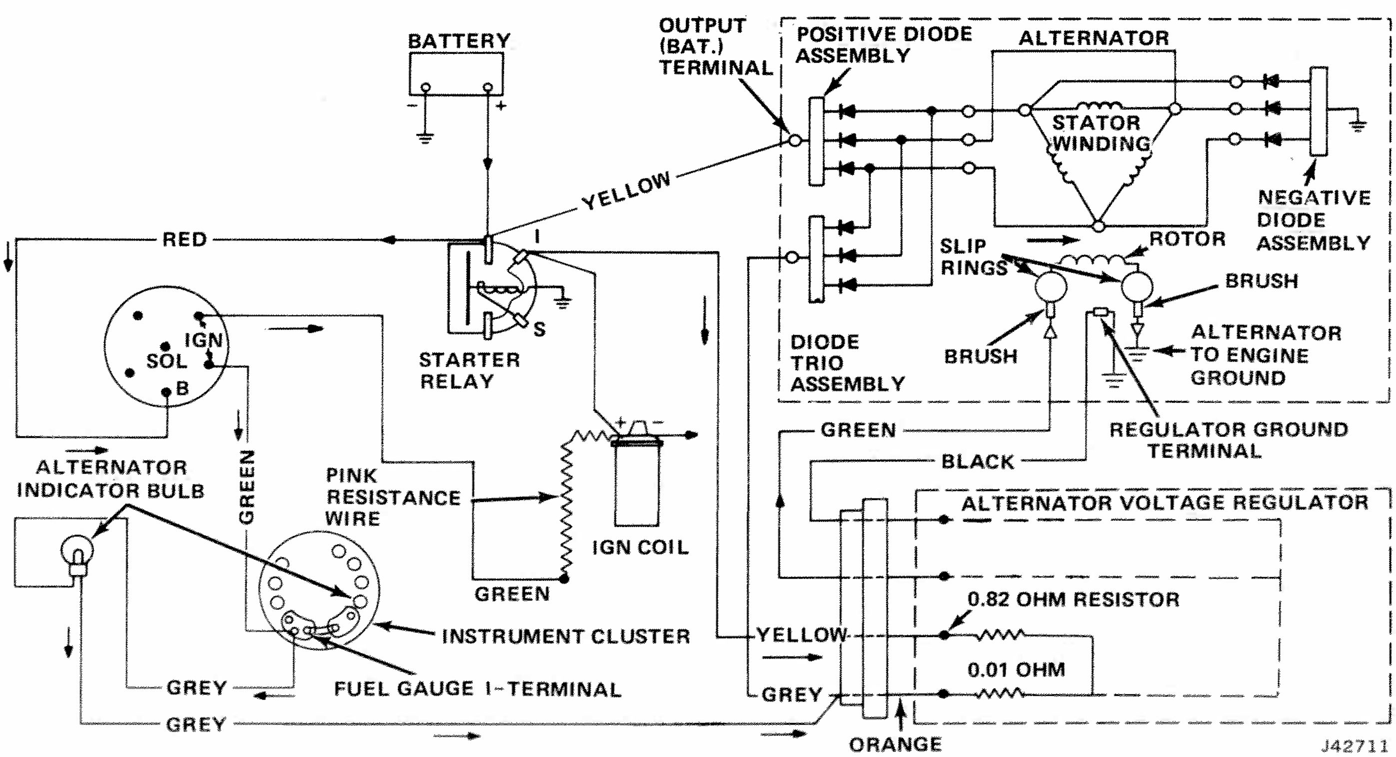
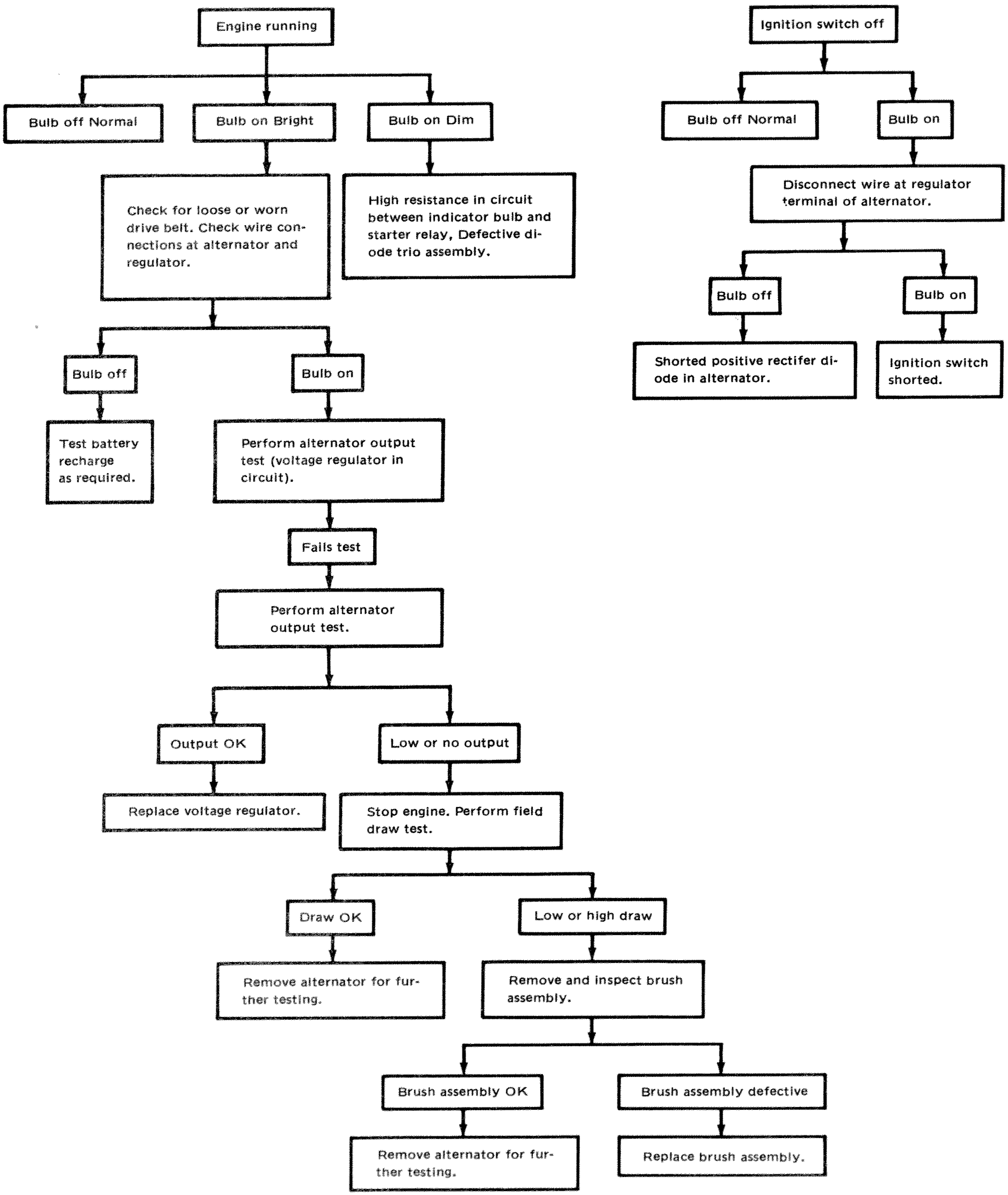
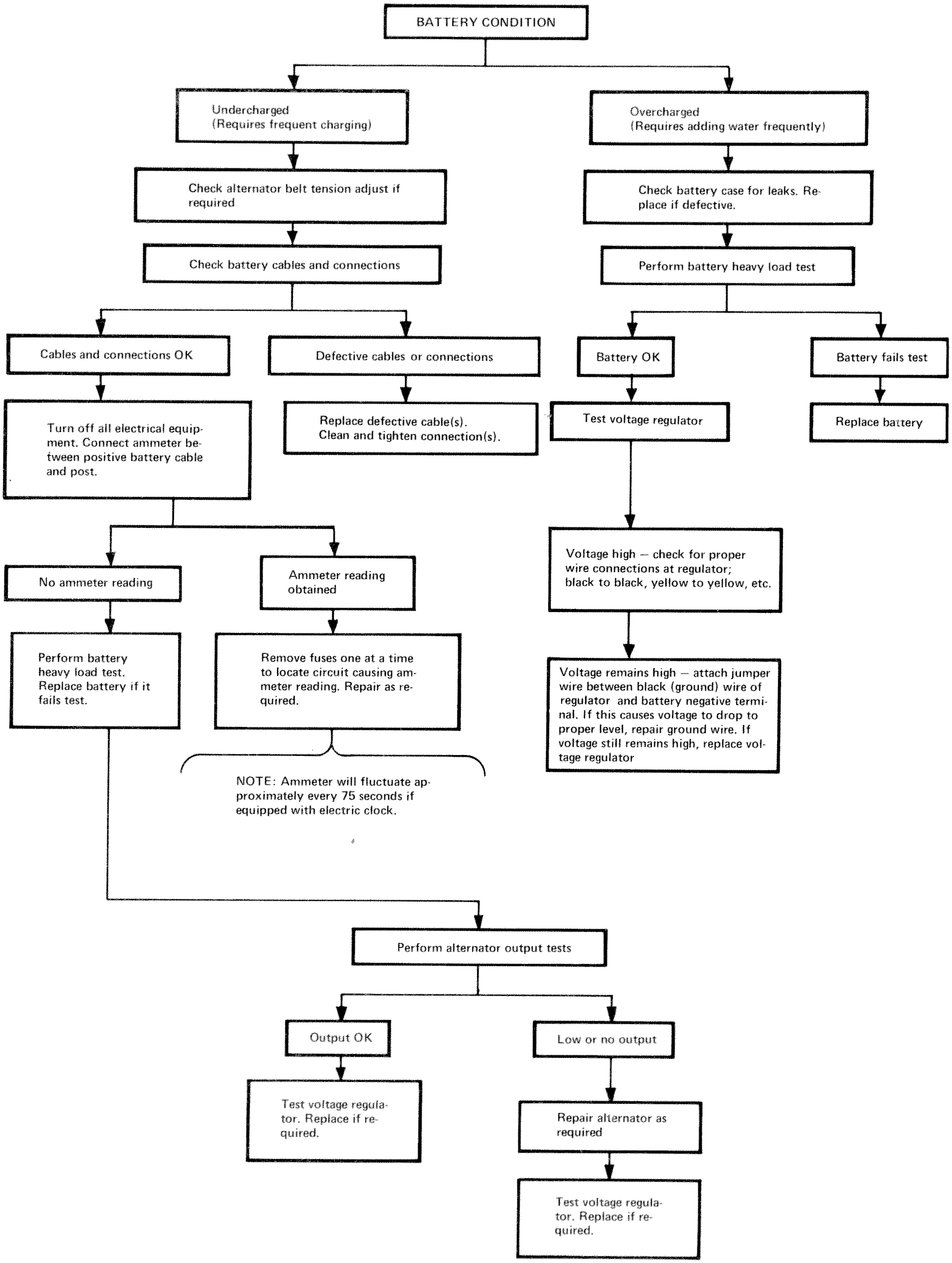


Fig. 3-11 Alternator Excitation and Indicator Bulb Circuit - Key On - Engine Not Running - CJ Models

CHARGING SYSTEM DIAGNOSIS GUIDE

ALTERNATOR INDICATOR BULB OPERATION




BATTERY CONDITION
Undercharged
(Requires frequent charging)
Overcharged
(Requires adding water frequently)
Check alternator belt tension adjust if required
Check battery case for leaks. Replace if defective.
Check battery cables and connections
Perform battery heavy load test
Cables and connections OK
Defective cables or connections
Battery OK
Battery fails test
Turn off all electrical equipment. Connect ammeter between positive battery cable and post.
Replace defective cable(s).
Clean and tighten connection(s).
Test voltage regulator
Replace battery
Voltage high — check for proper wire connections at regulator; black to black, yellow to yellow, etc.
No ammeter reading
Ammeter reading obtained
Perform battery heavy load test. Replace battery if it fails test.
Remove fuses one at a time to locate circuit causing ammeter reading. Repair as required.
Voltage remains high — attach jumper wire between black (ground) wire of regulator and battery negative terminal. If this causes voltage to drop to proper level, repair ground wire. If voltage still remains high, replace voltage regulator
NOTE: Ammeter will fluctuate approximately every 75 seconds if equipped with electric clock.
Perform alternator output tests
Output OK
Low or no output
Test voltage regulator. Replace if required.
Repair alternator as required
Test voltage regulator. Replace if required.

A42150

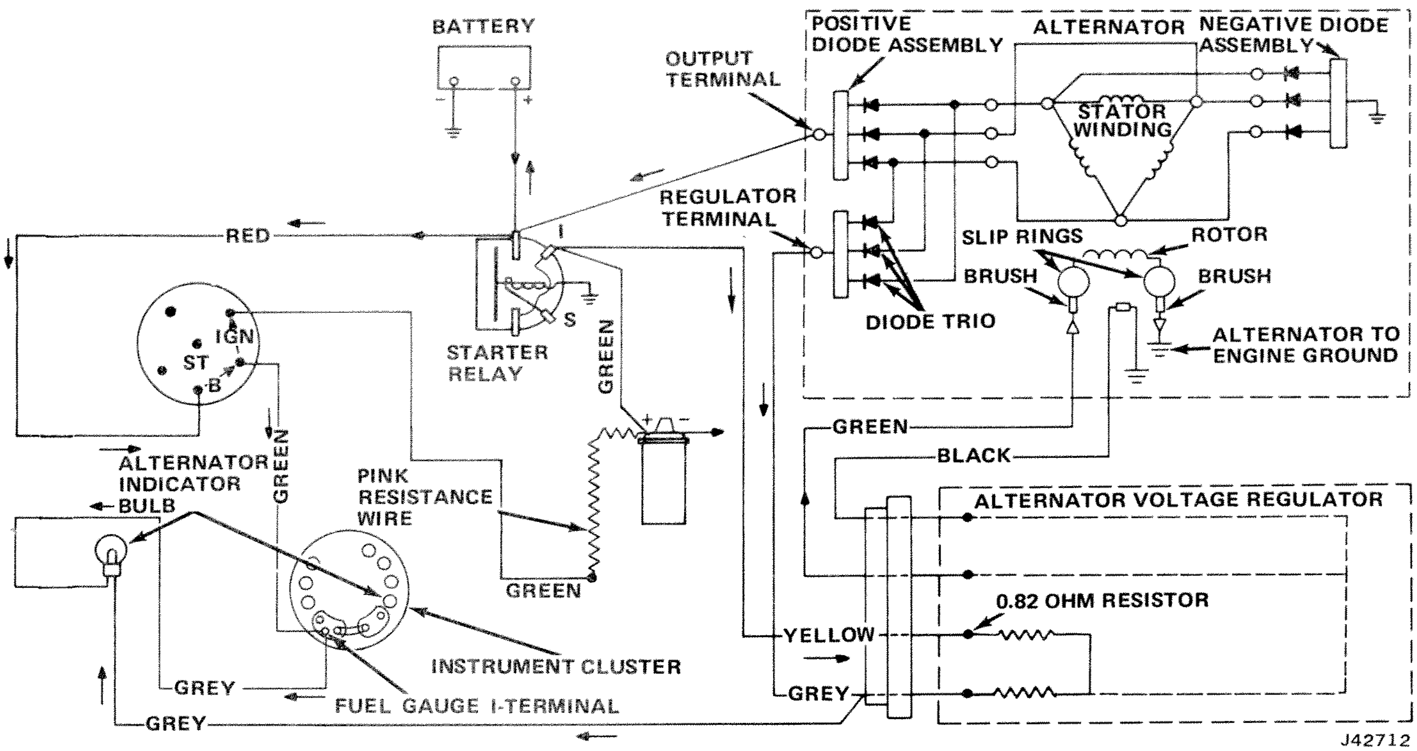


Fig. 3-12 Alternator Excitation and Indicator Bulb Circuit Engine Running - CJ Models

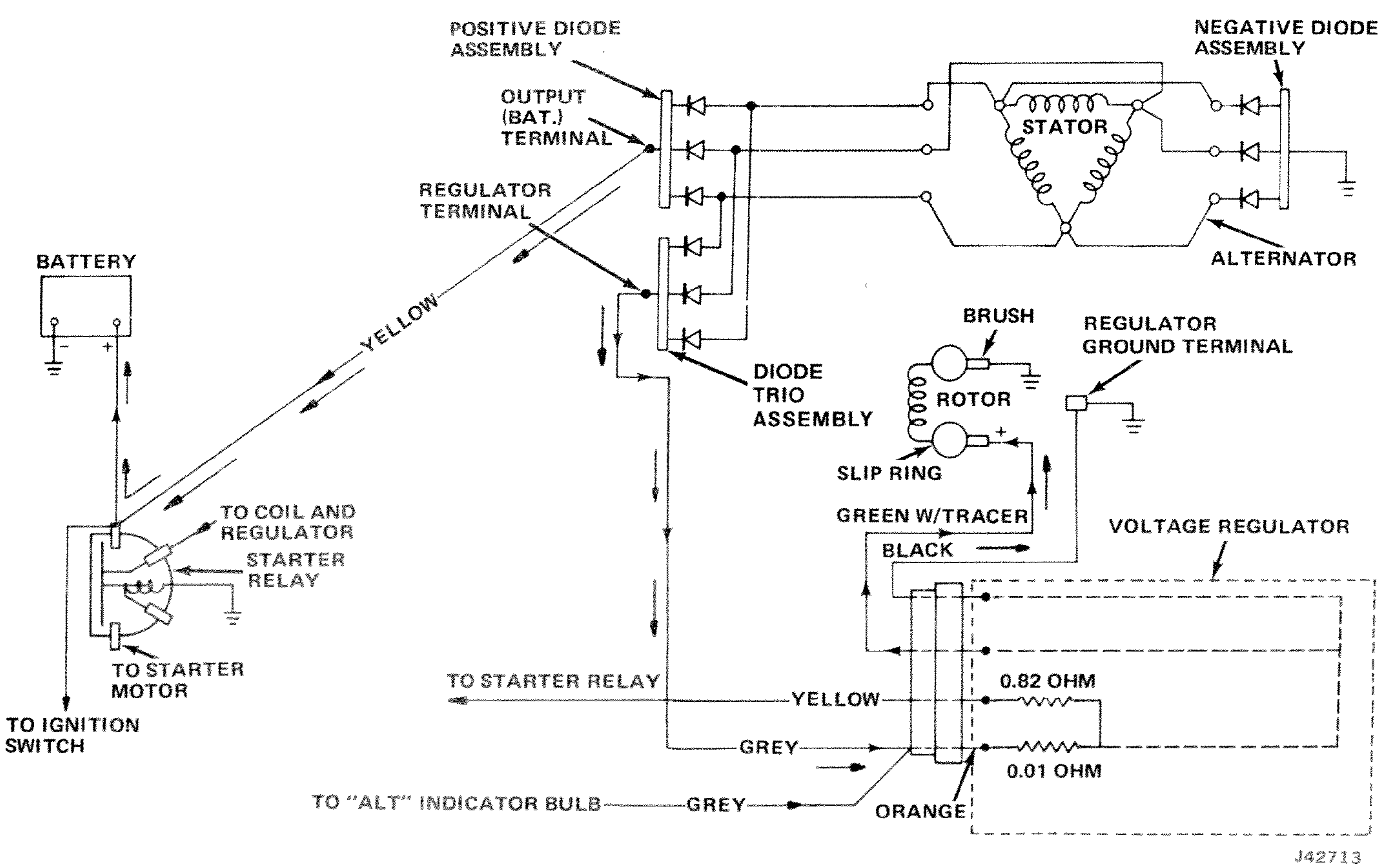


Fig. 3-13 Charging Circuit

Alternator output voltage is applied through the ignition switch to the opposite side of the indicator bulb. The output and sensing voltages are nearly equal; therefore, the bulb will go out since little or no current will flow through the bulb.

Charging Circuit

The charging circuit consists of three main components: alternator, battery and the voltage regulator (fig. 3-13).

Charging of the battery is accomplished by supplying current directly from the alternator output terminal (heavy yellow wire) to the battery, using the starter relay as a junction point. The positive (+) battery cable joins the heavy yellow wire at the relay. The alternator is grounded to the engine to complete the return circuit to the negative (-) side of the battery. The amount of charge the battery receives depends upon the state of charge and internal condition of the battery, proper operation of the voltage regulator and the amount of current consumed by other loads such as heater, lights, etc.

The remainder of the charging circuit, that is, voltage regulation and field current control is outlined under Voltage Regulator.

Alternator Noise Diagnosis

Alternator noise is usually caused by one of the following conditions: Loose or misaligned pulley, worn bearings or a shorted rectifier diode (indicated by high pitched whine).

Diode Trio Assembly

The diode trio assembly incorporates three small rectifier diodes (fig. 3-14). The input leads of the diodes are connected to the stator windings in parallel with the positive rectifier diodes. The output leads of the diodes are connected to the regulator terminal stud which is insulated from the positive diode heat sink and the alternator end housing.

When the alternator is operating, a portion of the ac current and voltage developed in the stator windings is rectified by the diode trio assembly and appears as dc current and voltage at the regulator terminal. This voltage is sensed by the voltage regulator to provide excitation current to the rotor (field) winding.

Alternator output will be affected if more than one of the diodes in diode trio assembly becomes opened or shorted.

If one of the diodes in the diode trio assembly becomes degraded, but not opened or shorted, the total resistance of the assembly will increase and cause the alternator indicator bulb to glow dimly. The diode trio assembly can be tested for this condition without removing the alternator from the engine. Refer to Diode Trio Test in this section.

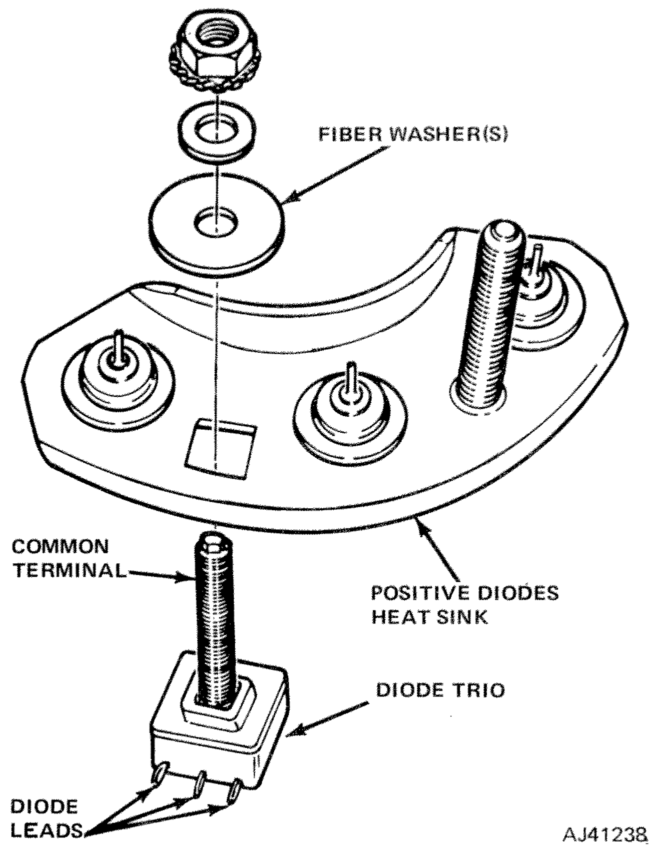


Fig. 3-14 Potted Diode Trio Assembly

CAUTION: *The regulator terminal is used solely for field excitation and should never be used as a source for running lights or other accessories, as operation of the voltage regulator would be adversely affected.*

Positive and Negative Diode Assemblies

The positive and negative diode assemblies incorporate three silicon rectifier diodes which change the three-phase alternating current (ac), produced in the stator windings, to direct current (dc).

This is accomplished by the characteristic of the diodes to allow current to flow in one direction only.

Since the diode(s) will pass current from the alternator to the battery or load, but will not pass current from the battery to the alternator, the alternator does not require the use of a cutout relay.

The electrical circuits of the 37- and 51-ampere alternators differ only in the type of stator winding used. The main circuit drawing of figure 3-15 illustrates the Delta Wound stator winding used in the 51-ampere alternators. The Wye Wound stator winding of the 37-ampere alternator is illustrated in the inset.

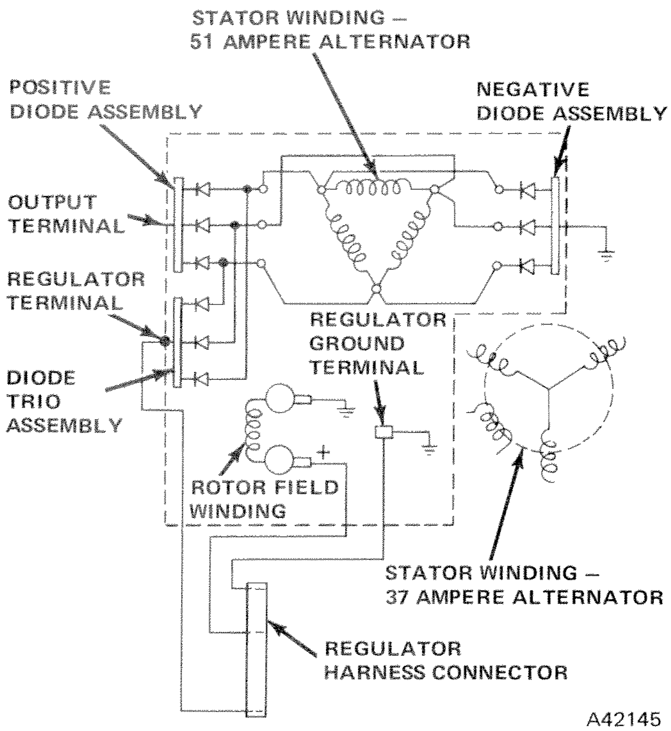


Fig. 3-15 Alternator Circuit

ALTERNATOR CHARGING TESTS

Various types of charging testers are available to perform the alternator and regulator tests outlined in the following paragraphs. Identical results may be obtained regardless of which type is used. For illustrative purposes, amserv test equipment is shown. If another type tester is used, follow the particular manufacturer's operating instructions.

The following tests are made with all wires connected including the voltage regulator.

CAUTION: *Do not disconnect alternator output lead while alternator is operating.*

CAUTION: *Do not disconnect voltage regulator while alternator is operating.*

CAUTION: *Do not ground field terminal.*

Alternator Output Test - In Vehicle

For most complaints, this test is all that is required for a pass-fail test.

(1) Connect voltmeter to battery, negative to negative, positive to positive.

(2) Start engine.

(3) Turn on headlamps (low beam).

(4) Operate engine at 1000 rpm and observe voltmeter reading for approximately two minutes. If voltage remains above 13 volts, alternator and regulator are performing satisfactorily.

(5) If alternator fails this test, perform Field Draw Amperage Test and Regulator Bypassed Test.

Field Draw (Amperage) Test

This test will determine if there is an open or short circuit in the brush circuit.

(1) Disconnect voltage regulator.

(2) Connect an ammeter between the battery positive post and the green wire leading to the insulated brush terminal (+) of the alternator. The black wire is connected to the grounded (-) terminal.

(3) The ammeter should indicate no less than 1-1/2 ampere and no more than 3 amperes.

(4) Turn the alternator rotor slowly by hand. If the reading varies, the slip rings require cleaning. Remove brush assembly and clean with a fine crocus cloth. If amperage is too high, remove brush assembly and perform continuity and isolation test as outlined under Alternator Disassembly in this section.

NOTE: *If the field draw remains too high or too low after determining that the brush assembly and slip rings are in good condition, remove the alternator for further testing of the rotor field windings.*

Regulator Bypassed Test

To determine which component, the alternator or the voltage regulator, is at fault for a low or no charge condition.

(1) Disconnect voltage regulator.

(2) Perform Field Draw (Amperage) Test. Disconnect ammeter after test.

(3) Connect voltmeter to battery: negative to negative, positive to positive.

(4) Start engine and operate at idle speed.

(5) Connect ammeter between battery positive (+) post and alternator insulated brush.

(6) Observe voltage reading while slowly increasing engine rpm.

(7) If 16 volts can be obtained, the alternator is not defective.

CAUTION: *Do not exceed 16 volts or damage to electrical components may occur.*

NOTE: *A dead battery may require charging for two to three minutes to obtain 16 volts.*

Voltage Regulator In Circuit

(1) Prior to testing, check the alternator belt for proper tension.

(2) Turn off all electrical equipment prior to performing test.

(3) Connect amserv Tester Model 21-317 as outlined in tester instruction booklet.

(4) Turn selector knob to ALT TEST.

(5) Start engine and hold speed between 1000 to 2000 rpm.

(6) Observe the GOOD-DEFECTIVE ALT scale. If defective, repair or replace alternator.

(7) Turn the selector knob to VOLTS and observe the regulator limit zone. The needle should slowly move into the shaded area. If defective, repair or replace voltage regulator.

Diode Trio Test (On Car)

A diode trio assembly with one or more of its diodes completely opened or shorted will cause reduced alternator output and necessitate alternator disassembly to unsolder the diode leads for testing.

This test is designed to check the diode trio assembly for marginal defects which are not affecting alternator output but may be the cause of alternator indicator bulb glowing dimly.

Before testing the field diode assembly, perform an alternator output test to determine if the alternator is operating at its rated output.

Select a tester incorporating a multirange voltmeter (amserv Battery-Starter Tester, Model 16-30 or equivalent) and adjust the meter to the low range. Refer to figure 3-16 for proper connection sequence.

(1) Start engine and operate at idle speed.

(2) Connect voltmeter to alternator. If no reading is indicated, switch test leads.

(3) Turn on headlights and place blower motor on high speed. This electrical load will heat up diode trio after approximately two minutes of operation. Turn off headlamps and blower motor.

(4) Note reading on voltmeter. A good diode trio will read from zero volts to 0.2 volt. A reading above 0.2 volt means the diode trio is becoming degraded. It is not necessary to replace a diode trio unless it indicates a 0.6 voltage drop.

If meter begins to pulsate, either the diode trio, a positive diode or one of the soldered connections connnecting the positive diode to the diode trio is beginning to break down under heat. In either case, the alternator will have to be disassembled, the diode trio unsoldered and a heavy load test performed on the positive diodes and the diode trio.

If the voltmeter reading is over 0.6 volt and alternator output was determined satisfactory in an earlier test, remove the diode trio assembly for bench test. The bench test is necessary to determine whether the diode assembly or the solder joints are the cause of the problem. Refer to Diode Test for bench test procedures.

If the voltmeter reading is less than 0.6 volt, the diode trio assembly is functioning properly. If the alternator indicator bulb continues to glow, inspect for loose or corroded connections in the bulb circuit at the following locations:

- Alternator output (battery) terminal
- Starter relay battery terminal
- Main wiring harness connector
- Ignition switch
- Fuse panel
- Instrument harness connector
- Instrument cluster printed circuit
- Alternator indicator bulb socket

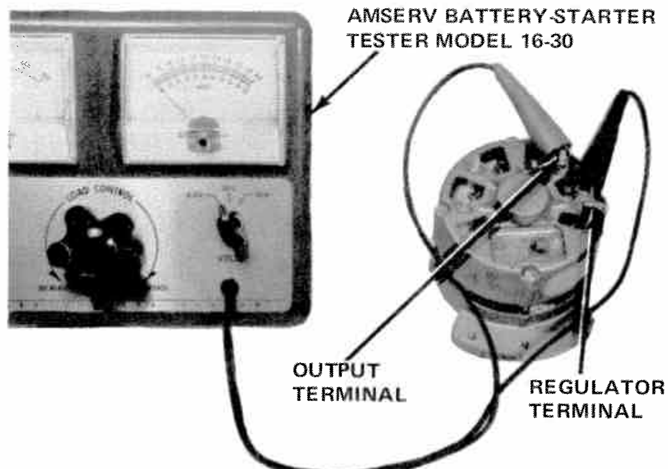


Fig. 3-16 Diode Trio Test - On Car (Alternator Removed for Clarity)

AC Terminal Test

To check the voltage at the ac terminal, connect a dc voltmeter from the terminal to a known good ground. Start the engine. The voltmeter reading should be approximately seven volts.

NOTE: *The maximum amount of current that the 7-volt terminal will be expected to deliver is 5 amps.*

ALTERNATOR - COMPONENT TEST AND REPLACEMENT

Brush Assembly - Replacement

The brush assembly can be removed with the alternator on the vehicle.

(1) Remove the two self-tapping screws and cover.

(2) Pull the brush assembly back just enough to clear the locating pins and then tip brush assembly away from housing.

NOTE: *Do not attempt to pull the brush assembly straight away from the alternator as one of the brushes may break and drop down between the slip rings.*

The complete brush assembly is available for replacement (fig. 3-17).

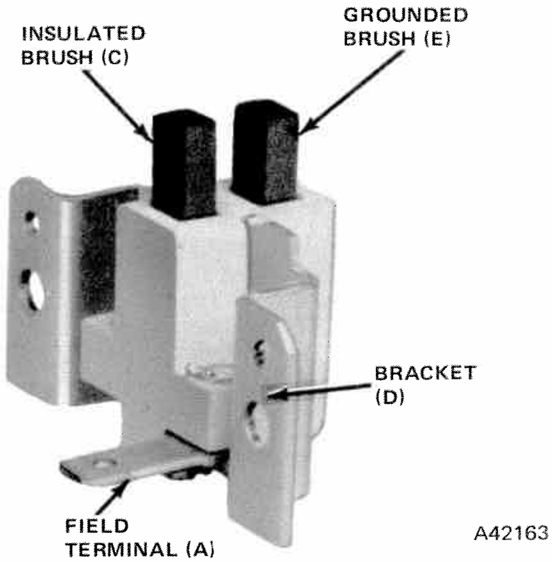


Fig. 3-17 Brush Assembly

Brush Assembly Insulation Test

(1) Connect an ohmmeter or a test light to field terminal and bracket.

(2) Resistance should be high (infinite) or test bulb should not light. If resistance is low or test bulb lights, brush assembly is shorted and must be replaced.

Continuity Test

(1) Connect an ohmmeter to field terminal and insulated brush. Use an alligator clip to assure good contact to brush at test points A and C (fig. 3-17). Resistance reading should be zero.

CAUTION: *Do not chip brush.*

(2) Move brush and brush lead wire to make certain that the brush lead wire connections are not intermittent. Resistance reading should not vary when brush and lead wire are being moved.

(3) Connect ohmmeter to bracket and grounded brush, test points E and D (fig. 3-17). Resistance reading should be zero.

Rear Housing Removal

Refer to figure 3-18.

To ensure correct housing alignment during assembly, scribe a line across the front housing, stator, and rear housing.

(1) Remove brush assembly.

(2) Remove four through-bolts and nuts.

(3) Very carefully separate rear housing by using two screwdrivers to pry stator from front housing at two opposing through-bolts slots.

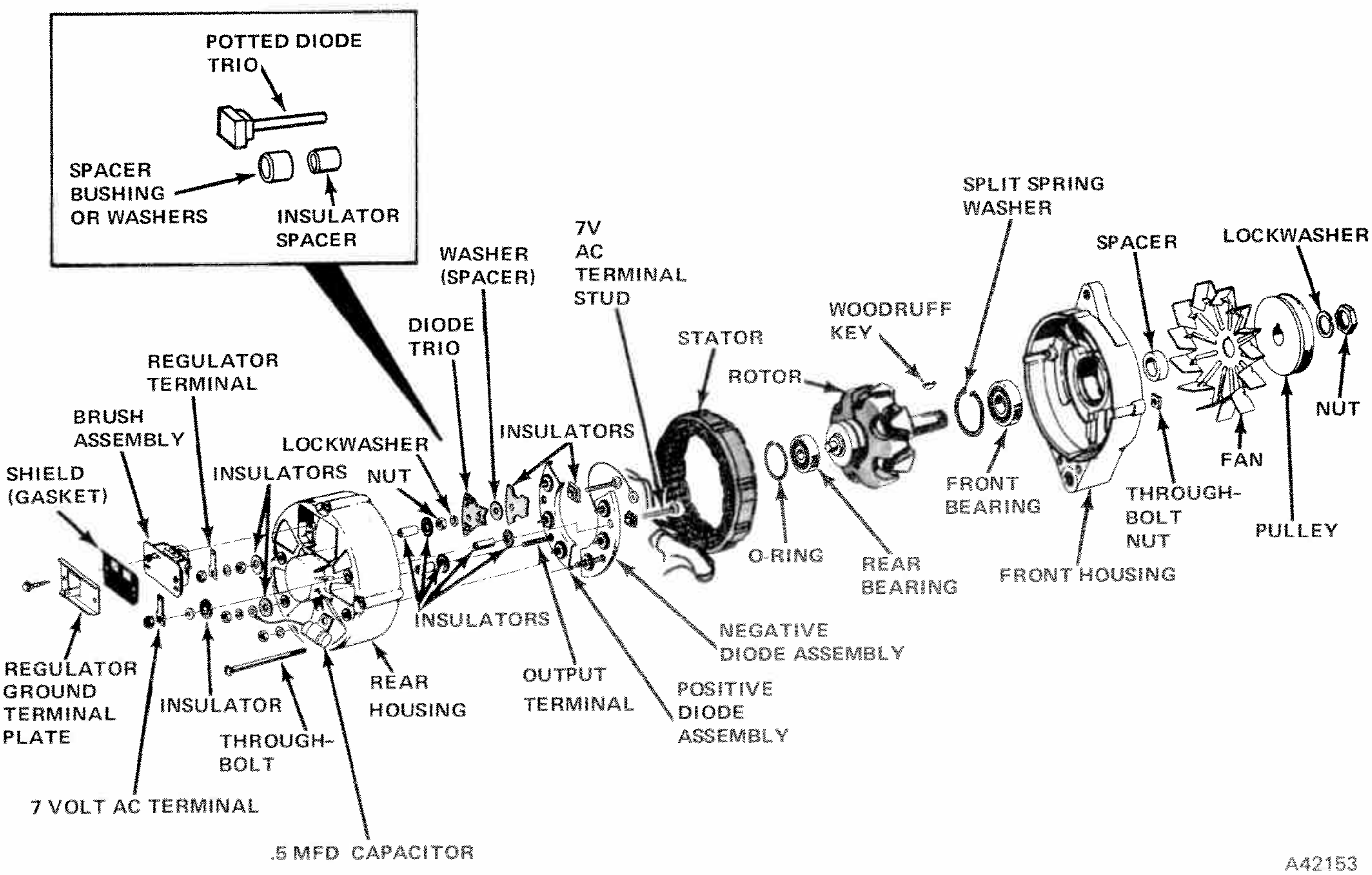


Fig. 3-18 Alternator - Disassembled View

NOTE: *Do not burr the stator core to avoid difficulty during assembly.*

CAUTION: *Do not insert screwdriver blades deeper than 1/16 inch (to avoid damaging stator windings).*

Rear Housing Installation

(1) Align scribe marks previously marked on front housing and stator assembly.

(2) Check that insulating washers are installed on regulator and battery post terminals. Attaching posts on negative diode assembly are not insulated.

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

(4) Install nylon bushings, insulating washers and holddown nuts on the battery and regulator terminal studs.

NOTE: *The regulator stud also receives a spade connector and another holddown nut.*

(5) Turn rotor and check for free movement.

NOTE: *Before installing the brush assembly, check the slip rings for grease or grime and clean if necessary.*

Stator and Diode Assembly Removal

(1) Remove brush assembly and rear housing.

(2) Remove four locknuts and insulating washers.

NOTE: *The insulating washers and nylon sleeves are used to insulate the positive plate studs from the housing. With these four nuts removed, the stator can be separated from the rear housing.*

NOTE: *Do not unsolder any stator-to-diode wire junction.*

(3) Remove stator and diodes as an assembly.

NOTE: *Avoid bending stator wires at each junction when removing positive and negative diode assembly from housing.*

Stator In-Circuit Test

When making the in-circuit stator leakage test, some consideration must be given to the rectifier diodes that are connected to the stator winding. The rectifier diode assemblies will conduct in one direction when properly polarized. A shorted diode in the rectifier diode assembly would make the stator appear to be shorted. For this reason, the rectifier diode plate assembly and stator must be checked individually after alternator has been disassembled, if the test shows a defect.

CAUTION: *Use Diode Continuity Light Tool J-21008 or a dc test lamp. Do not use a 120-volt test lamp as diodes will be damaged.*

(1) Connect the test lead to diode terminal and ground other test lead (fig. 3-19).

(2) Reverse test probes. The test bulb should light in one direction but not in the other direction.

(a) If test bulb does not light in either direction, this indicates that all three rectifiers in the negative diode assembly are open.

(b) If the test bulb lights in both directions, the stator winding is shorted to stator, or one of the negative rectifier diodes is shorted. Check stator again when stator is unsoldered from diode assemblies.

(3) Remove stator and diode assemblies from rear housing after removing rear housing. Note the diode assembly-to-stator wire connections, being certain replacement diodes are connected to the same wires. The positive diode assembly has red markings and negative has black markings. Do not interchange.

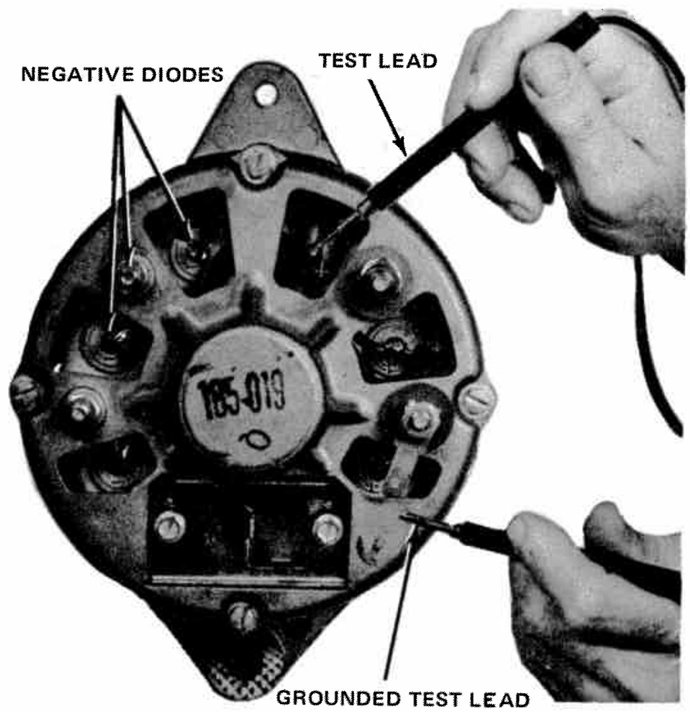


Fig. 3-19 Stator In-Circuit Test

Stator Short Test

This test checks for shorts to ground for the stator coil windings. To make the test, the winding junctions must be separated as shown in figure 3-20. An ohmmeter or test lamp may be used.

Stator Load Test

This test is used to detect shorts or resistance between the stator coil windings.

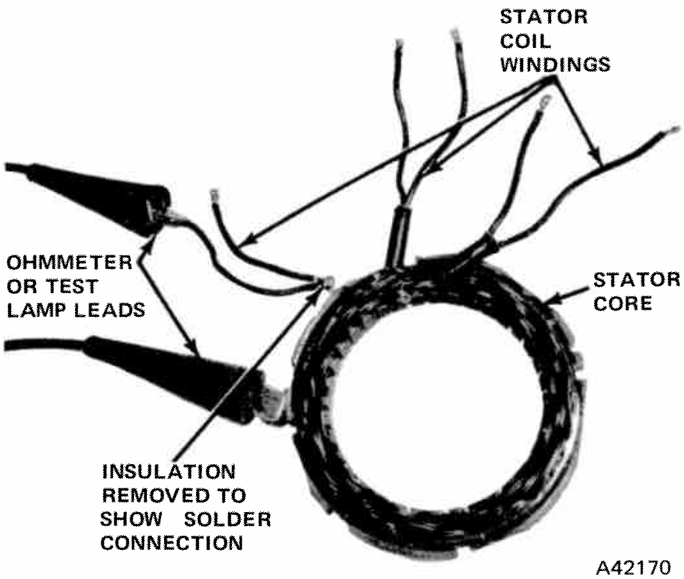
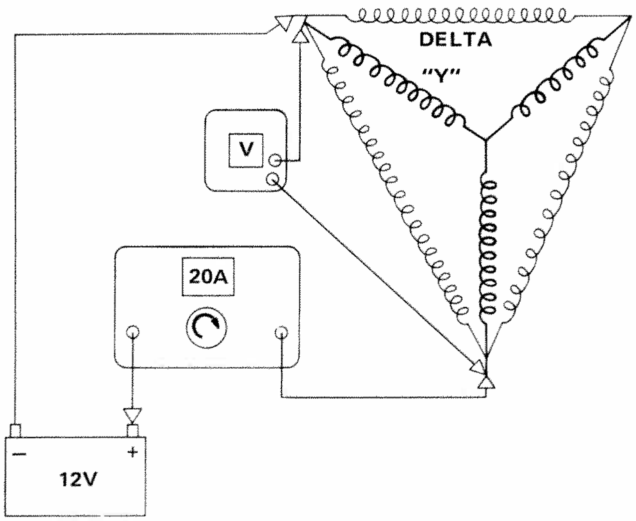


Fig. 3-20 Stator Coil Short Test - Coil to Core

This test is performed with the diodes unsoldered from the stator leads.

Tools required are a voltmeter, ammeter, a variable load control and a fully charged 12-volt battery. Refer to figure 3-21 for the test.



ALTERNATOR	LOAD	MAXIMUM VOLTAGE DROP	MAXIMUM VARIANCE BETWEEN WINDINGS
37	20A	7.2 – 8.2	.7
51	20A	5.5 – 6.5	.6

A42169

Fig. 3-21 Stator Load Test

(1) Connect negative battery lead to any one of three stator winding leads.

(2) Connect positive battery lead to variable load control.

(3) Connect remaining load control lead to either of the other two stator leads.

(4) Connect voltmeter to same two stator leads and adjust load control to draw 20 amps. Allow windings to heat up for approximately 15 seconds, then note voltmeter reading. It should not exceed 8.2 volts or a 37-ampere alternator, or 6.5 volts for a 51-ampere alternator.

(5) Reduce amperage draw to zero, disconnect voltmeter and load control test leads from stator lead and connect to other remaining stator lead.

(6) Apply 20-amp draw, and note voltmeter reading. Variance between each winding must not exceed 0.7 volt for the 37-ampere alternator, or 0.6 volt for the 51-ampere alternator.

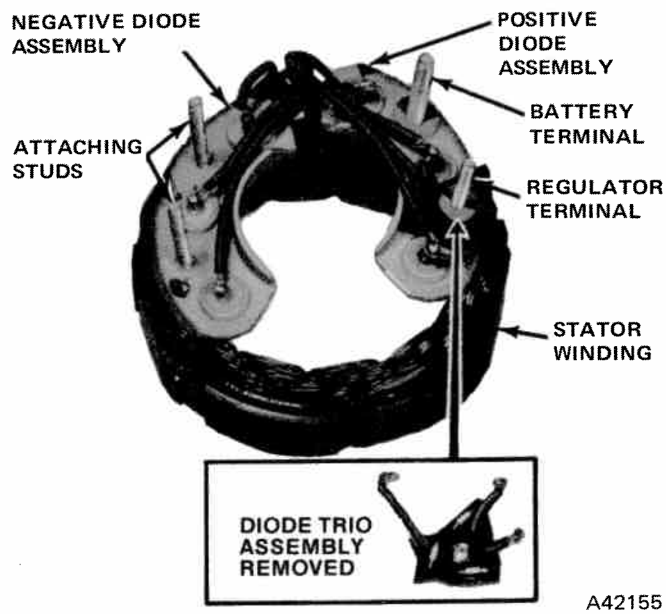


Fig. 3-22 Stator and Diode Assembly

AC Terminal Removal and Installation

The ac terminal stud is located in the negative diode assembly heat sink (fig. 3-18). Removal of the stud is accomplished by removing the rear housing and the ac terminal attaching nut. The stud then can be dropped through the heat sink and removed. When installing the stud, be certain that all insulators are properly installed.

Diode Trio

There are two types of diode trios used. One is a board type (fig. 3-22) and the other is a potted type which is encased in epoxy. The potted type will eventually supersede the board type.

Board Type

Removal

(1) Remove diode assembly attaching nuts.

(2) Separate stator from end housing.

(3) Unsolder leads at each positive diode.

(4) Remove diode trio attaching nut and remove diode trio.

Installation

(1) Install diode trio on stud. Refer to disassembled view for parts assembly sequence. Be sure ceramic insulator is not cocked in the diode heat sink when tightening down the diode trio attaching nut.

(2) Install pliers or wet cotton between solder point and positive diode to act as a heat sink (fig. 3-23).

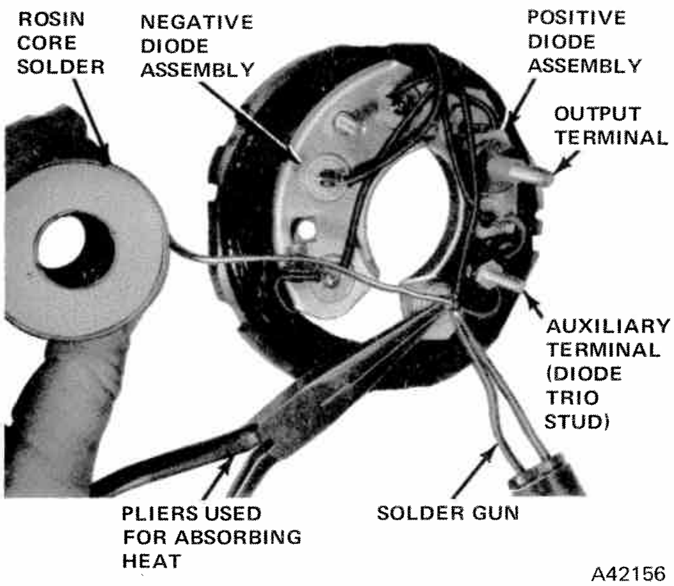


Fig. 3-23 Soldering Diodes

(3) Solder three diode trio leads to positive diodes. Use only rosin core solder and use no more heat than necessary to obtain a good bond.

(4) Install stator to rear housing. Each positive diode terminal stud should have a fiber washer on each side of the end housing and a plastic sleeve over the stud.

Potted Type

Removal

(1) Separate stator and diode assemblies from rear housing.

(2) Unsolder leads at diode trio and remove assembly (fig. 3-24).

NOTE: *Use no more heat than necessary to unsolder connections.*

Installation

(1) Position diode trio with solder connections toward outside of alternator.

(2) Solder wires to diode assembly. Use only rosin core colder and use no more heat than necessary to make a good solder connection.

(3) Install stator and diode assemblies to rear housing.

NOTE: *For diode test procedures, refer to Diode Trio and Rectifier Diode - Bench Tests.*

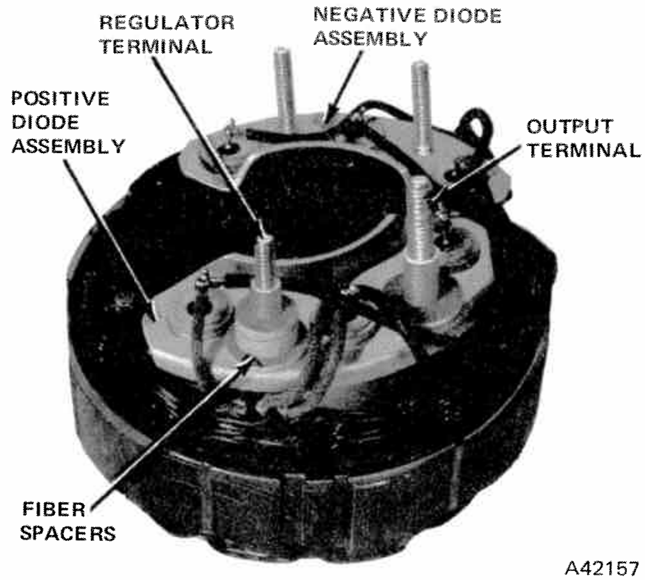


Fig. 3-24 Potted Diode Trio - Installed

Diode Trio and Rectifier Diode - Bench Tests

A continuity test lamp (self-powered) is not recommended for testing alternator diodes as there is not enough of a load to check for diode breakdown caused by heat.

The difference in checking a diode trio and a rectifier diode is the load. A one-amp load is used on the diode trio and a 15-amp load is used on a rectifier diode.

When a test load is connected to a diode, it must be connected so that the test bulb is lighted. If a test lamp lights for one diode, it must light for all three when current is flowing in the same direction for each diode. Leave the load on the diode for at least one minute to detect a heat failure.

If the test lamp does not light for one diode, it must not light for the remaining diodes. Reverse the test leads and test again. The diode is good if the test lamp lights in one direction only.

NOTE: *A shorted stator coil or a poorly soldered connection will appear to be a shorted negative rectifier diode assembly. Check stator for shorts and the connections for poor solder joints after disassembly.*

Diode Trio Test (Rear Housing Removed)

A testing device that draws a one-amp load (maximum) at 12 volts should be used. An ohmmeter will show whether a diode is open or shorted but the heat of the one-amp load is necessary for testing diodes that show intermittent failures (such as alternator indicator bulbs that glow intermittently).

(1) Unsolder wires at diode trio. Use test apparatus as shown in figure 3-25.

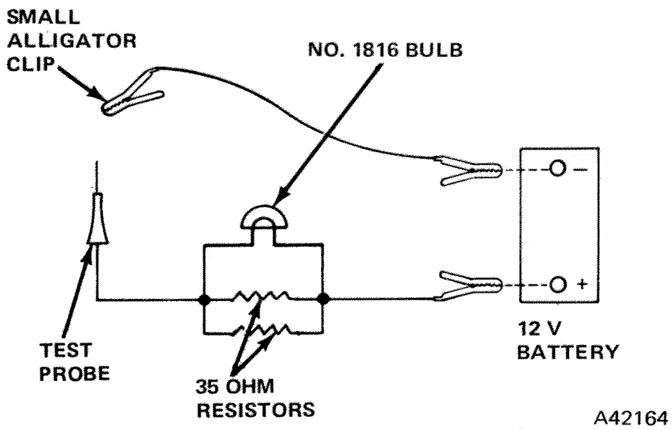


Fig. 3-25 Diode Heavy Load Tester

(2) Attach tester to a 12-volt battery.

(3) Attach negative clip of tester to common terminal (threaded stud) of diode trio.

(4) Attach positive clip to one of diode trio terminals (fig. 3-26).

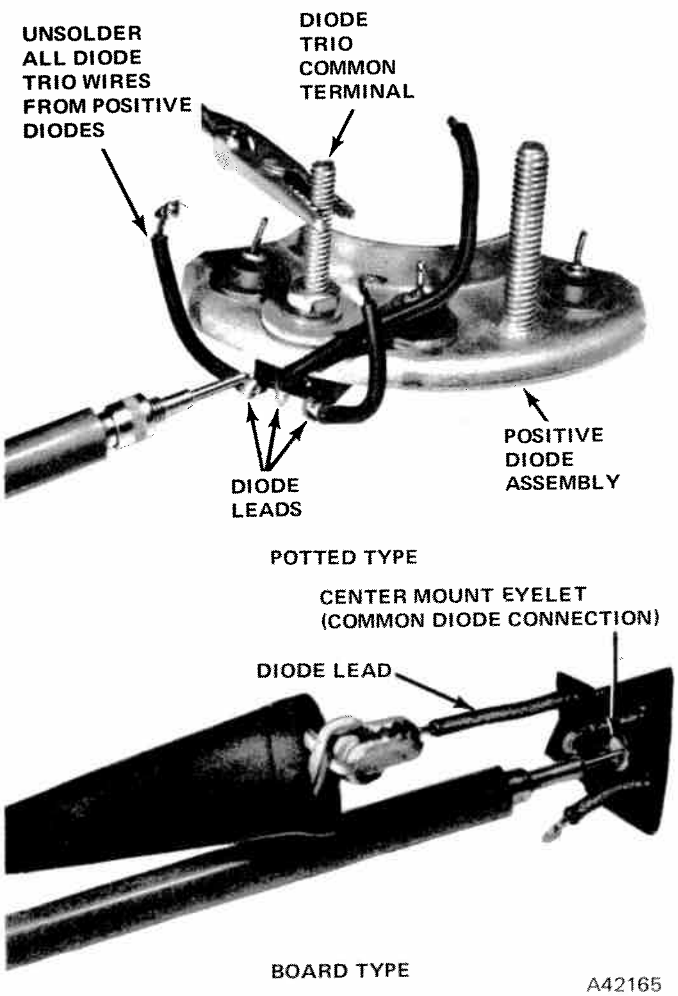


Fig. 3-26 Diode Trio Bench Test

(5) Test lamp should light. Keep load on diode for one to three minutes. If light flickers or goes out, diode is defective.

(6) After one to three minutes with test lamp on, immediately reverse leads. If test lamp lights, diode is defective.

(7) Test second and third diodes in the same manner.

Rectifier Diode Test (Rear Housing Removed)

(1) Attach a needlenose pliers or some other type of heat absorber between diode and diode wire solder joint.

(2) Unsolder wire(s) from each diode. Use a test apparatus as shown in figure 3-27. This apparatus places about a 15-ampere load on diode.

(3) Attach tester to a fully charged 12-volt battery.

(4) Connect one test lead to diode heat sink.

(5) Connect remaining test lead to diode lead (fig. 3-28). Connect test leads so that test lamp lights.

(6) Maintain test load on diode for one to three minutes. If light flickers or goes out, diode is defective.

(7) After one to three minutes with test lamp on, immediately reverse leads. If test lamp lights, diode is defective.

(8) Test each remaining diode in the same manner.

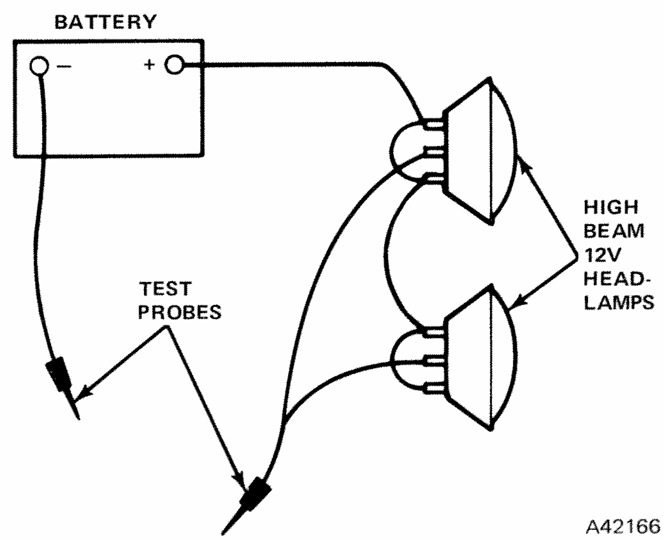


Fig. 3-27 Rectifier Heavy Load Tester

Rotor Removal

The rotor requires removal from the front housing only if there is a defect in the field coil itself or in the front bearing.

Front and rear bearings are permanently lubricated and sealed. If the rotor must be removed, use a double-jaw puller to remove the pulley. Remove the woodruff key and spacer. The split ring washer must be unseated by inserting Tool J-21157 through the opening in the front housing and compressing the washer while exerting pressure toward the rotor (fig. 3-28). Remove the washer only after the rotor and front bearing have been removed. The rotor and front bearing can be removed from the front housing by tapping the rotor shaft lightly.

NOTE: *The split ring washer must be removed from its retaining groove before attempting to remove the front bearing from the front housing.*

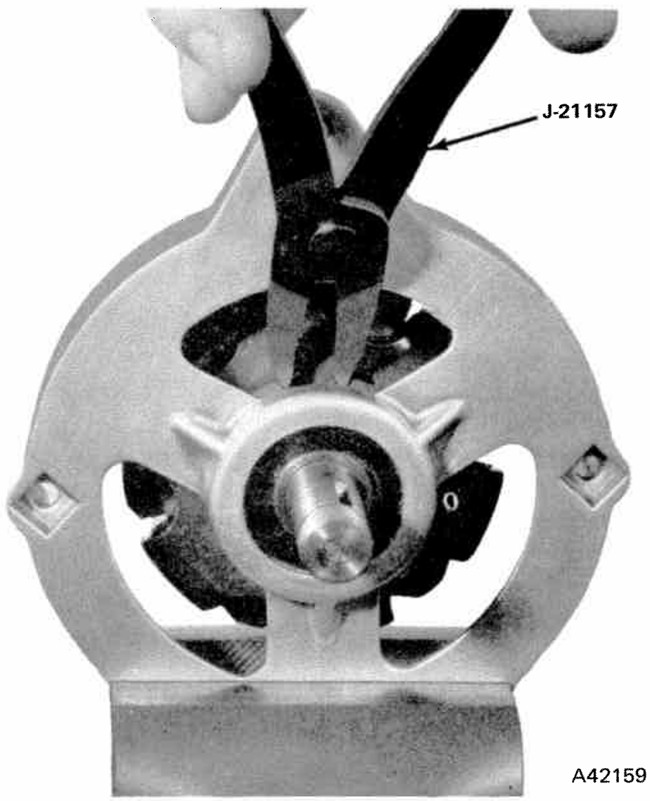


Fig. 3-28 Removing Spit Ring Washer

Rotor - Bench Test (Field Coil Test)

Test the rotor for grounds and shorted turns in the winding. The ground test is made with the test probes connected in series with a 110-volt test lamp. Place one test probe on a slip ring and the other on the rotor core. If the bulb lights, the rotor winding is grounded.

To test for shorted turns, check rotor field current draw (fig. 3-29). Slowly reduce resistance of rheostat to zero. With full battery voltage (12.6 plus, minus 0.2 volts) applied to field coil (rotor), the field current should be 1.8 amperes minimum to 2.5 amperes maximum. Excessive current draw indicates shorted turns in the field windings. Less than minimum indicates open windings.

Front and Rear Bearing Removal

The bearings are removed from the rotor as shown in figures 3-30 and 3-31 using Tool J-21155.

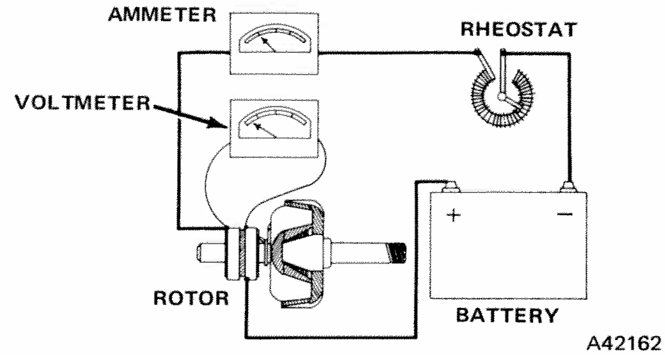


Fig. 3-29 Rotor Test

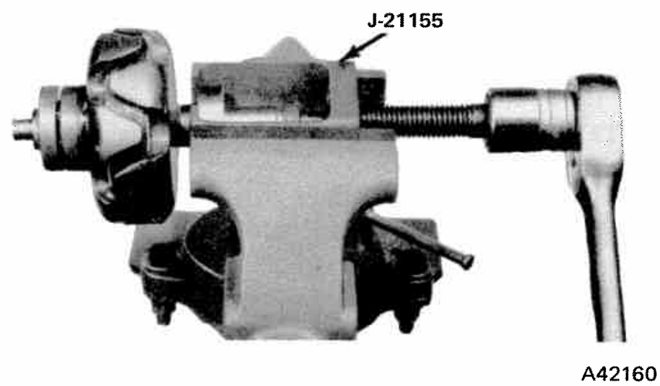


Fig. 3-30 Front Bearing Removal

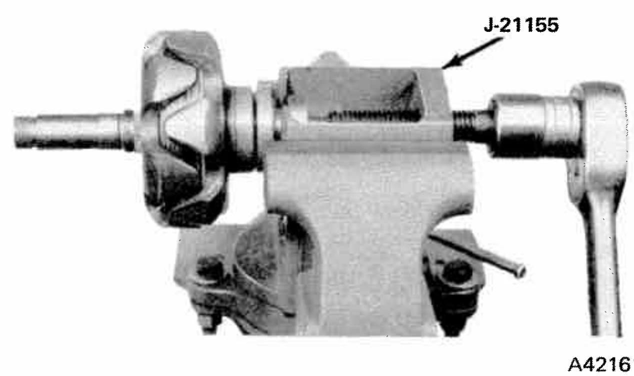


Fig. 3-31 Rear Bearing Removal

ALTERNATOR ASSEMBLY

(1) Clean bearing and inside of bearing hub of front housing.

(2) Support front housing and using Drive Tool J-21154, J-8092, or J-8592 Driver Handle, apply sufficient pressure to outside race of bearing to seat bearing as shown in figure 3-32. A 1-1/8-inch socket also can be used to seat bearing in front housing.

(3) Insert split ring washer into hub of front housing and use Tool J-21154 to seat washer into groove of hub.

CAUTION: *Do not use a screwdriver or any small object to compress washer that can slip off and damage bearing seal.*

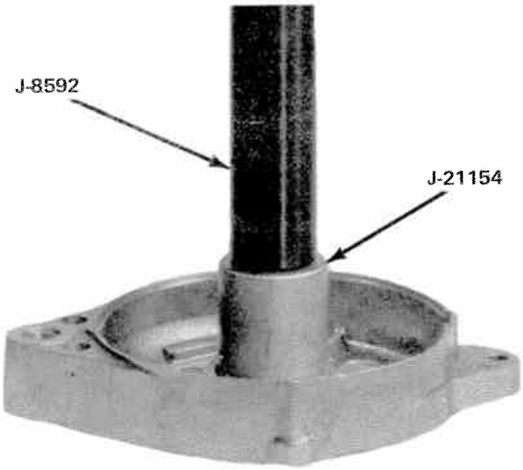


Fig. 3-32 Installing Front Bearing

NOTE: *Make certain that split ring washer has been installed prior to assembling front housing and rotor.*

(4) Before installing rotor into front housing, clean any rust or corrosion from shaft. Lightly lubricate rotor shaft.

(5) Use Tool J-21156 and apply sufficient pressure to seat front bearing against shoulder on rotor shaft. Bearing drive tool must fit inner race of bearing (fig. 3-33).

NOTE: *A small press also can be used to install rotor or rotor can be installed by tapping on end of rotor shaft with soft-faced hammer.*

(6) Install fan and pulley spacer, woodruff key, fan, and pulley.

(7) Use a 7/16-inch socket, or equivalent tool, to fit inside race of rear bearing and apply sufficient pressure to drive bearing against shoulder of rotor shaft.

Stator Installation

(1) Install flat fiber washers on positive diode attaching studs. If alternator has a 7-volt ac terminal, install a fiber washer on ac stud.

(2) Install stator assembly into rear housing.

(3) Install plastic sleeves on all insulated terminals.

(4) Install flat fiber washers, metal flat washers, and locknuts.

NOTE: *The ac terminal (if so equipped) has a polarizing blade. This blade is identified by a short protruding tab that prevents the regulator terminal harness connector from being accidentally installed on the ac (electric heated choke) terminal blade. Before tightening the ac terminal, check that the diode wire end does not contact the heat sink.*

(5) Install two terminal blades, tighten securely.

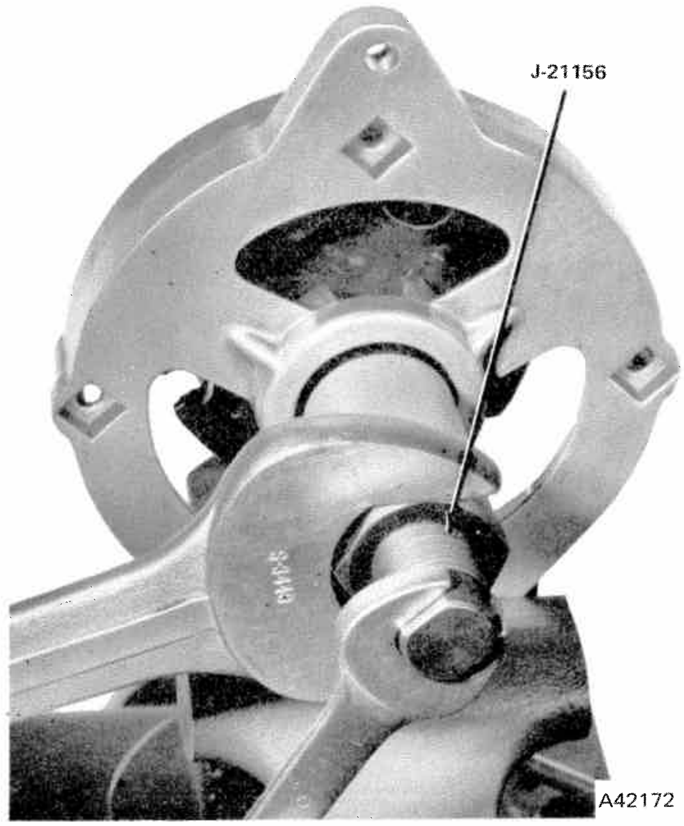


Fig. 3-33 Assembling Front Housing and Rotor

Rear Housing Installation

Before installing the rear housing assembly, check the slip rings for grease or grime and clean if necessary.

(1) Align scribe marks previously marked on front housing and stator assembly.

(2) Check that insulating washers are installed on regulator and battery post terminals.

NOTE: *When equipped with a 7-volt ac terminal, the ac terminal also serves as one of the negative diode assembly attaching studs. This is the only negative diode assembly stud that must be insulated from the rear housing assembly.*

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

(4) Turn rotor and check for free movement.

VOLTAGE REGULATOR

The voltage regulator is an electronic switching device which senses voltage at the alternator regulator terminal. The regulator automatically provides the amount of field current required by the alternator to maintain the specified system voltage at the alternator output (Bat.) terminal under all electrical load conditions. If high voltage occurs with a known good battery and the regulator grounded to the battery, the voltage regulator is defective. Refer to the specifications at the rear of this section for the acceptable voltage range for various regulator temperatures.

Voltage Regulator Test

(1) Connect voltmeter to battery, negative to negative, positive to positive.

(2) Turn headlamps on (low beam).

(3) Start engine and operate for several minutes to bring regulator up to operating temperature.

(4) Set engine at 1000 rpm and note voltage.

(5) Voltage reading should be within specification for temperature of regulator. If an overcharge or undercharge is experienced, refer to Overcharging or Alternator Output tests in this section.

IMPORTANT: The voltage setting of the regulator will vary due to high or low underhood temperatures. It is the temperature of the regulator, not the outside air temperature, that determines the voltage setting. Refer to Specifications at the rear of this section.

Out-of-Circuit Test

A commerical tester is available for testing transistor voltage regulators on or off the vehicle. The tester shown in figure 3-34 will register internal defects and show maximum voltage regulator setting.

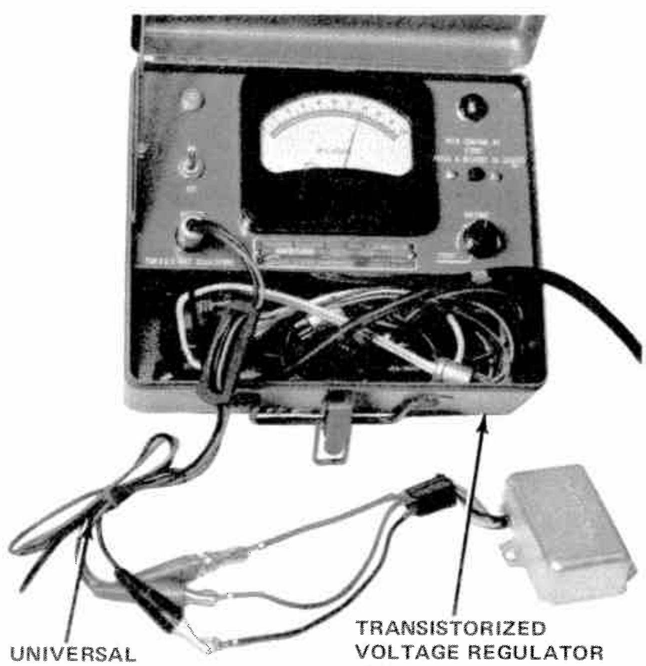


Fig. 3-34 Voltage Regulator Test - Out-of-Circuit

Overcharging

Overcharging results in excessive battery water usage and a shortened life for all electrical components. Any time an overcharge is experienced, it is due to excessive voltage applied to the alternator insulated brush terminal. Three conditions will cause an overcharge:

- Voltage regulator loss of ground
- Defective battery
- Defective voltage regulator

To check for a regulator ground problem, connect a jumper wire from the regulator case to the battery negative post. If the voltage drops, the regulator ground requires repair. Be sure the black wire of the regulator is connected to the black wire of the engine compartment harness. A battery can be checked by applying a heavy load test or a light load test. Refer to Battery in this section.

GENERATOR

A 35-ampere capacity generator is available as an option with the 258 CID engine on Truck Models.

The generator is an air-cooled, two-brush unit; output cannot be adjusted. For replacement, voltage regulator and generator must be matched for voltage and capacity, polarity, and common source of manufacture. Otherwise, either a loss of ampere capacity or a burned-out generator will result. Generators for these vehicles are 12 volt.

The circuit breaker, voltage regulator, and current-limiting regulator are built into one combination unit. Because the regulator and battery are part of the generator circuit, the output of the generator depends upon the state of charge and temperature of the battery. With a discharged battery, the output will be high, decreasing proportionally as the battery becomes charged.

Generator Maintenance

A periodic inspection should be made of the charging circuit. The interval between these checks will vary depending upon type of service. Dust, dirt, and high-speed operation are factors which contribute to increased wear of bearings and brushes.

Under normal conditions, a check should be made each 5,000 miles.

A visual inspection should be made of all wiring to be sure there are no broken or damaged wires. Check all connections to be sure they are tight and clean.

If the commutator is rough or worn, the armature should be removed and the commutator turned and undercut.

The brushes should slide freely in their holders. If they are oil soaked one-half their original length, they should be replaced. When new brushes are installed, they should be sanded to provide full contact with the commutator. Generators should not be checked for output until the brushes are seated.

Brush spring tension is important. High tension causes rapid brush and commutator wear; low tension causes arcing and reduced output. Test the tension with a spring scale. Refer to Specifications at the end of this section for correct spring tension.

Preliminary Inspection

Wiring - Check the wiring to see that it is properly connected to the generator.

Generator Performance - Make sure the generator operates without the regulator in the circuit. Remove the armature and battery leads from the regulator and connect an ammeter between them. Remove the field lead from the regulator and, while operating at idle speed, touch the field lead to the regulator base. Increase the speed slowly, noting the charging rate.

CAUTION: *Do not increase the output above the rated output of the generator.*

If the generator output will not build up, inspect the wiring harness for shorts and opens and remove the generator for an overhaul. To check the generator circuit when a suitable ammeter is unavailable, disconnect the armature cable at the regulator. Connect one lead of a 12-volt test lamp to the regulator terminal marked Armature and, with the engine running, ground the other lead. Should test lamp fail to light, there is a fault either in the generator or regulator. To localize the fault, disconnect both the field and armature cables at the generator. Connect a wire from the field terminal and use a 60-watt, 110-volt test lamp to ground the armature terminal. If the generator is charging satisfactorily, the test lamp will glow at approximately 1500 rpm engine speed and the fault will be localized in the regulator.

Incorrect Regulator - Make sure the regulator is the correct type for use with the generator.

Battery - Check the specific gravity and terminal voltage of the battery. If the battery is not up to specifications, substitute, temporarily for test purposes, a fully charged battery of the same type and capacity.

High Resistance Connections - Inspect the wiring between the generator, regulator and battery for broken wires and high resistance connections. Pay special attention to the ground connections at all three units. Connect an ammeter with one ampere graduations in series with the regulator B-terminal and the lead removed from this terminal. Run the generator at a medium speed and turn on the lights or accessories until the ammeter shows a 10-ampere charging rate. At this charging rate, measure the voltage drop between the following points using an voltmeter graduated in 0.1-volt divisions. The voltmeter should not show a reading above the maximum noted.

- Generator A-terminal to regulator A-terminal - 0.1-volt maximum.
- Generator F-terminal to regulator F-terminal - 0.05-volt maximum.
- Battery terminal to regulator B-terminal - 0.1-volt maximum.
- Regulator ground screw to generator frame - 0.03-volt maximum.
- Regulator ground screw to generator post - 0.03-volt maximum.
- Generator frame to battery ground post - 0.03-volt maximum.

Disassembly

Refer to figure 3-35.

(1) Remove two frame screws in the commutator end plate and remove end plate assembly.

(2) Pull the armature and drive head completely from the generator housing.

(3) Remove generator pulley from armature by removing nut and washer.

NOTE: *Do not lose the woodruff key when pulley is removed.*

(4) Remove drive end head assembly which includes oil seal and bearing.

(5) Remove three screws and lockwashers in grease retainer and remove retainer and felt washer.

(6) Remove bearing, oil guard and felt washer.

Armature

If the commutator is rough and worn, turn it down in a lathe. After turning, the mica insulation between the segments should be undercut to a depth of 1/32-inch (0,8 mm).

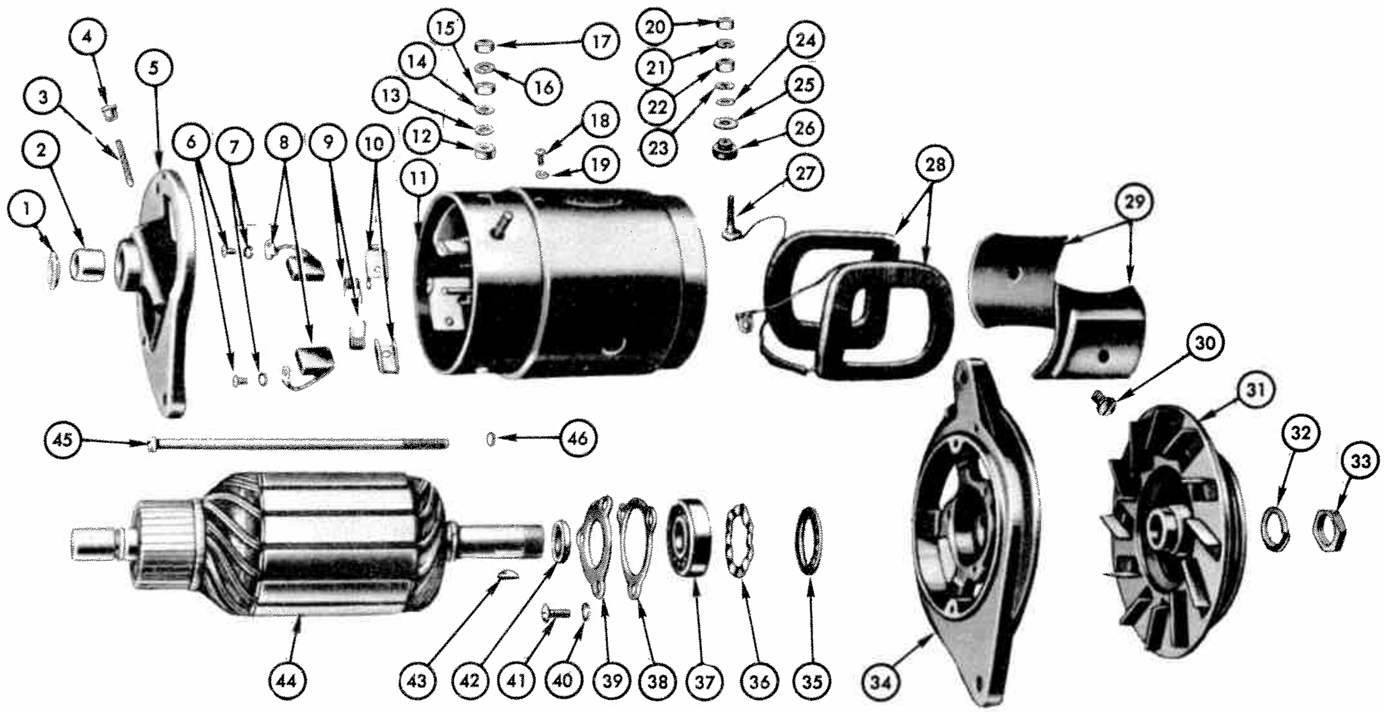
To test the armature for a ground, connect one prod of a test lamp to the core or shaft (not on bearing surface) and touch each commutator segment with the other prod. If the lamp lights, the armature segment is grounded and the armature must be replaced.

To test for short in armature coils, a growler (fig. 3-36) is necessary. Place the armature on the growler and lay a thin steel strip on the armature core. The armature is then rotated slowly by hand and if a coil is shorted, the steel strip will vibrate. If a coil is shorted, the armature must be replaced.

NOTE: *If precision test equipment is available, accurate tests can be made in accordance with instructions furnished with the testing equipment.*

Field Coils

Inspect the field coils for chafed wires, and using



1. OIL RETAINER
2. BEARING
3. FELT WICK
4. OILER
5. COMMUTATOR END HEAD
6. BRUSH LEAD SCREW
7. LOCKWASHER
8. BRUSH SET
9. BRUSH SPRING
10. BRUSH ARM
11. FRAME
12. INSULATING BUSHING
13. WASHER
14. LOCKWASHER
15. HEX NUT
16. LOCKWASHER
17. HEX NUT
18. GROUND SCREW
19. LOCKWASHER
20. HEX NUT
21. LOCKWASHER
22. HEX NUT
23. LOCKWASHER
24. WASHER
25. INSULATING WASHER
26. INSULATING BUSHING
27. STUD
28. LEFT AND RIGHT FIELD COIL
29. POLE SHOES
30. POLE SHOE SCREW
31. DRIVE PULLEY AND FAN ASSEMBLY
32. LOCKWASHER
33. SHAFT NUT
34. DRIVE END HEAD
35. FELT WASHER
36. FELT WASHER RETAINER
37. BALL BEARING
38. GASKET
39. BEARING RETAINER
40. LOCKWASHER
41. RETAINER SCREW
42. FELT WASHER
43. WOODRUFF KEY
44. ARMATURE
45. THROUGH-BOLT
46. LOCKWASHER

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Fig. 3-35 Generator - Prestolite 35-Ampere

test lamp prods, check for both open and grounded circuits. To test for open coil, connect the prods to the two leads from each coil. If the lamp fails to light, the coil is open and must be repaired or replaced.

To test for ground, place one prod on ground and the other on the field coil terminal. If a ground is present, the lamp will light and the coil must be repaired or replaced.

NOTE: *If accurate test equipment is available, check the field coils for current draw which should be within the limits of 1.2 to 1.3 amperes at 10 volts for both coils.*

A shorted coil will show a much higher draw, while an open coil will show no draw. In either case, the generator output will be below normal.

To replace a field coil, disconnect the field terminals, use a heavy screwdriver to remove the field pole piece screws, then the coils together with the pole pieces may be removed. When replacing the coils, set the pole piece screws by staking with a center punch.

Brush Holders

With test prods, check the insulated brush holder to be sure it is not grounded. Touch the brush holder with one prod and the frame with the other prod. If the lamp lights, a grounded brush holder is indicated.

Inspect the brush holders for cracks, distortion, and improper alignment. The brushes should slide freely and should be in perfect alignment with the commutator segments.

Assembly

(1) Install felt grease retainer and washer in drive end head (fig. 3-35).

(2) Check bearing to be sure it is clean and fill it one-half full with a high melting point grease.

(3) Install bearing and inside felt washer and attach the bearing retainer with lockwashers and screws.

(4) Place drive end head over front end of armature shaft.

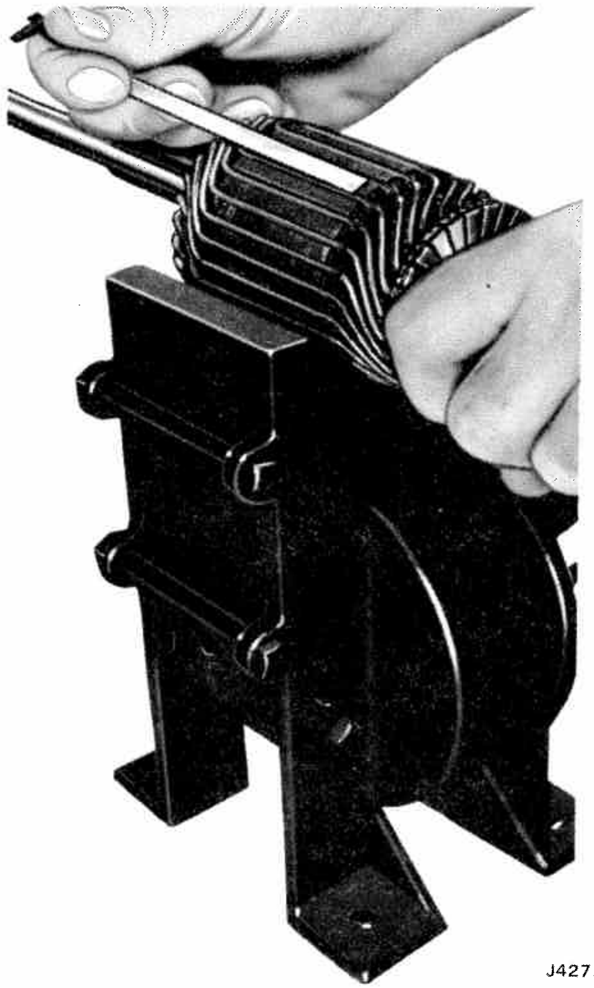


Fig. 3-36 Testing Armature for Shorted Winding

(5) Install the woodruff key in armature shaft and install drive pulley, being sure key is in position.

(6) Secure in position with washer and nut.

(7) Place assembly on end so it rests on pulley with commutator end up.

(8) While holding brushes clear of commutator, place generator housing and field coils assembly in position.

(9) Turn front end bracket so dowel pin in housing enters hole in end head.

(10) Place commutator end plate on shaft and install long frame screws.

NOTE: *When installing the generator on the engine, tighten the bracket bolt to 25 to 35 foot-pounds torque.*

CURRENT-VOLTAGE REGULATOR (GENERATOR)

For replacement, a voltage regulator must be matched for voltage and capacity, polarity, and common source of manufacture. Otherwise, either a loss of ampere capacity or a burned out generator will result.

These regulators are used with shunt-type generators and have three units each with a separate function to perform. These units are the circuit breaker unit, the voltage regulator unit, and the current limiting regulator unit (fig. 3-37).

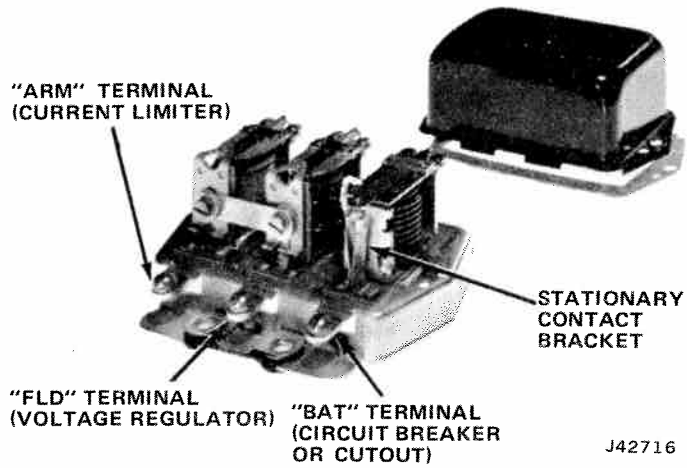


Fig. 3-37 Voltage Regulator - Prestolite

Circuit Breaker - Cutout

Consists of an electromagnet and a set of contacts. The contacts are mounted with one on a stationary bracket, and the other on a movable armature, which is controlled by the electromagnet. The movable contact is mounted on a spring arm so that as the contacts open and close a slight wiping action is produced.

The electromagnet of the circuit breaker has two windings: one, the shunt coil which is connected across the generator output (like a voltmeter), and the other a series coil connected in series with the generator output (like an ammeter). These coils are wound in the same direction so that when the generator is charging the battery, the magnetism of the series coil increases the total magnetism. When the battery discharges back through the generator, the magnetism of the series coil is reversed and the magnetism of the two coils is opposed. This results in a decreased pull on the armature and spring action opens the contacts.

The sequence of operation of the circuit breaker is as follows:

When the generator is not running, the contacts are open. When the generator is started, the voltage builds up at the armature terminal and in the shunt coil. As soon as it reaches the value for which the circuit breaker is calibrated, there is sufficient magnetism created by the shunt coil to pull down the armature, closing the contacts which automatically connects the generator to the battery. With the contacts closed, the current in the series coil flows from the generator to the battery or in the same direction as the current in the shunt coil, so that the pull on the armature is increased by the magnetism of the series coil.

When the engine is stopped and the generator loses speed, the voltage falls. As the generator voltage drops below the battery terminal voltage, the current flows from the battery to the generator, reversing the direction of current in the series coil so that the magnetism created by the series coil opposes and reduces the magnetism of the shunt coil. This reduces the pull on the armature to a point where spring action opens the contacts.

Voltage Regulator

The function of the voltage regulator is to hold the generated voltage at a predetermined value as long as the circuit values allow the voltage to build up to the operating voltage.

The electromagnet of the voltage regulator unit has a winding of many turns of fine wire. It is connected across the charging circuit so that the system voltage controls the amount of magnetism. The contacts of the voltage regulator unit are connected in the generator field circuit. The field circuit is completed through the contacts when they are closed and through a resistor when the contacts are opened.

When the voltage rises to a predetermined value, there is sufficient magnetism created by the regulator winding to pull the armature down. This opens the contacts and inserts resistance in the field circuit of the generator reducing the field current. The generated voltage immediately drops, reducing the pull on the armature to the point where the spring closes the contacts. The output again rises and the cycle is repeated.

These cycles occur at high enough frequencies to hold the generated voltage at a constant value. They will continue as long as the voltage of the circuit is high enough to keep the voltage regulator unit in operation. With the addition of a current load great enough to lower the battery voltage below the operating voltage, the contacts will remain closed and the generator will maintain a charging rate as limited by its speed of the current limiting regulator.

Due to the effect of heat on the operating characteristics of regulator windings, it is necessary to compensate for the changes in coil resistance. This is accomplished through the use of a nickel iron magnetic bypass on the voltage regulator unit. This shunt bypasses some of the magnetic flux when the unit is cold, allowing most of the flux to act on the armature when the unit is hot. When the coil is hot and not as efficient, the magnetic shunt reduces the amount of flux needed to vibrate the armature.

The compensation is usually more than enough to offset the changes in regulator coil resistance due to heat. The excess allows the regulator to operate at higher voltage under cold operating conditions than under hot conditions. This is necessary as it requires a higher voltage to charge a battery with its internal resistance increased by low temperatures.

Current-Limiting Regulator

The function of the current-limiting regulator is to limit the output of the generator to its maximum safe output.

The electromagnet consists of a winding of heavy wire connected in series with the generator output. When the output reaches a predetermined value, the current in the winding produces enough magnetism to overcome the spring tension, pulling the armature down. This opens the contacts and inserts resistance in the field circuit of the generator. With the field current reduced by the resistance, the generator output falls and there is no longer enough magnetism to hold the contacts open. As soon as the spring closes the contacts, the output rises and the cycle is repeated. These cycles occur at high enough frequencies to limit the output to a minimum fluctuation.

VOLTAGE REGULATOR TEST AND ADJUSTMENT

Circuit Breaker

(1) Connect an ammeter in series between regulator B-terminal and lead wire removed from that terminal.

(2) Connect a voltmeter between regulator A-terminal and regulator mounting base.

(3) Disconnect field lead from regulator F-terminal and insert a variable resistance (3-amp, 50-ohm capacity) between lead and regulator terminal.

(4) Run generator at approximately 1000 generator rpm.

(5) Insert all resistance in field circuit, then slowly reduce resistance, noting the voltage reading just before change caused by closing of circuit breaker.

(6) Increase charging rate to figure specified for regulator being tested, then reduce charging rate by inserting resistance in field circuit. Note voltmeter and ammeter readings just before the circuit breaker opens and ammeter reading drops to zero.

NOTE: *The closing voltage and the opening voltage or current should be within the limits specified.*

(7) Adjust closing voltage by changing armature spring tension. Bend the hanger at the lower end of spring to increase spring tension and raise closing voltage. To decrease tension, lower closing voltage.

(8) Adjust opening voltage by raising or lowering stationary contact. Increasing contact gap lowers opening voltage. Change contact gap by expanding or contracting stationary contact bracket.

NOTE: *Do not adjust the gap between the contacts to less than the specified minimum.*

Voltage Regulator

(1) Connect ammeter.

(2) Connect voltmeter between regulator B-terminal and regulator base.

(3) Remove variable resistance from field circuit.

(4) Run generator at half output for 15 minutes to bring regulator to normal operating temperature.

NOTE: *Keep the cover on the regulator during the warmup period and also when taking readings.*

(5) Stop engine, then bring it up to approximately 2500 generator rpm.

(6) Adjust amperage to half maximum output by turning on lights or accessories and then note voltmeter reading. This reading should be within limits specified for the voltage regulator operation.

(7) To adjust operating voltage, change armature spring tension by bending hanger at lower left end of armature spring.

NOTE: *After each adjustment, stop the engine then restart. Bring engine up to speed and adjust the current before taking a reading.*

NOTE: *Contacts should be flat and not burned and should be aligned to make full face contact.*

Current Regulator

(1) Connect regulator and test equipment.

NOTE: *With the generator running at approximately 3000 generator rmp, turn on lights and accessories so that the generator must charge at maximum rate.*

(2) To adjust opening amperage, change armature spring tension by bending hanger at lower end of armature spring.

NOTE: *After each adjustment, stop the engine, then restart. Bring the engine up to speed and take an ammeter reading. Keep the cover on the regulator when taking these readings.*

NOTE: *Contacts should be flat and not burned excessively and should be aligned to make full face contact.*

Contacts

(1) Inspect contacts on all three units. In normal use, contacts will become greyed.

(2) If contacts are burned, dirty, or rough, file with a No. 6 American Swiss cut equalling file.

(3) File parallel and lengthwise to the armature. File just enough so that contacts present a smooth surface toward each other.

(4) After filing, dampen a piece of linen or lintless band tape in refined carbon tetrachloride and draw tape between contacts.

(5) Repeat with a dry piece of tape. Use clean tape for each set of contacts.

Low Charging Rate Check

A fully charged battery and a low charging rate indicates normal regulator operation.

A further check of the regulator operation can be made by using the starting motor for 5 to 10 seconds with the coil wire disconnected. Then connect the coil wire and start the engine and operate at a generator speed of 2500 to 3000 rpm. The charging rate should rise to its maximum value then taper off to a minimum charge as the battery becomes charged.

High Charging Rate Check

This is usually an indication that the voltage regulator is not operating correctly. The high voltage will cause the battery to gas excessively and will shorten the life of the ignition contacts and, in general, will have a detrimental effect on all connected loads.

Connect an ammeter in series with the regulator B-terminal and the lead removed from the terminal. Run the generator at a medium speed and perform the following operation. After each test is completed, reconnect whatever leads have been opened.

(1) Disconnect field lead at generator.

(a) Output drops to zero - shorted field circuit in regulator or in wiring harness. See step (2).

(b) Output does not drop - shorted field circuit in generator. Inspect generator.

(2) Disconnect field lead at regulator.

(a) Output drops to zero - shorted field in regulator. (See step (3)).

(b) Output does not stop - shorted wiring harness. Repair or replace wiring harness.

(3) Remove regulator cover and hole voltage regulator contacts open.

(a) Output drops to zero - regulator contacts sticking, regulator out of adjustment or regulator inoperative. Check for high resistance (step (4)) and clean contacts.

(b) Output does not drop - shorted field circuit in regulator. Clean regulator contacts and inspect regulator visually for incorrect wiring between units and shorted leads.

(4) Operate units at 10 amperes output and measure voltage drop from regulator base to generator frame.

(a) Voltage reading below 0.03 volts - ground circuit is satisfactory. See step (5).

(b) Voltage reading above 0.03 volts - inspect ground circuit for poor connections and eliminate high resistance.

No Charging Rate - Low Battery

(1) Check all wiring for loose connections, frayed insulation and high resistance connections and correct any fault.

(2) Make sure generator operates correctly without regulator in the circuit.

(3) Remove A and B leads from regulator and connect an ammeter between them.

(4) Remove field lead from regulator and, while operating at idle speed, touch field lead to regulator base. Increase speed slowly, noting charging rate.

NOTE: *Do not increase the output above the rated output of the generator.*

(5) If generator output will not build, inspect wiring harness for shorts and opens and remove generator for an overhaul.

(6) Connect an ammeter between battery lead and regulator B-terminal.

(7) Connect field lead to regulator F-terminal and connect armature lead to regulator A-terminal.

(8) Connect a voltmeter from regulator A-terminal to regulator base. Operate generator at a medium speed.

(9) Read voltmeter.

(a) Voltage builds up - open series circuit. See step (10).

(b) Voltage does not build up - regulator out of adjustment, field circuit open, grounded series circuit. See step (11).

(10) Remove regulator cover and, with generator operating at a medium speed, hold circuit breaker contacts closed.

(a) Ammeter shows no charge - open circuit breaker shunt winding, incorrect setting of circuit breaker, or dirty contacts. Clean contacts and reset circuit breaker. If circuit breaker cannot be set, shunt coil is open and regulator should be replaced.

(b) No generator output - clean circuit breaker contacts and try test again. If there is still no charge, series windings are open and regulator should be replaced.

(11) Run generator at idle speed and momentarily connect a jumper from F-terminal to the regulator base.

(a) Voltage builds up - open field circuit or regulator out of adjustment. See step (12).

(b) Voltage does not build up - grounded series circuit. Replace regulator.

(12) Operate at a medium speed with jumper removed. Remove regulator cover and hold voltage regulator contacts closed.

(a) Voltage builds up - voltage regulator contacts burned, dirty, or incorrect regulator setting. Clean contacts and adjust regulator.

(b) Voltage does not build up - clean contacts and repeat test. If voltage still does not build up, see step (13).

(13) Remove regulator cover and hold current contacts closed.

(a) Voltage builds up - current regulator contacts burned, dirty, or incorrect regulator setting. Clean contacts and adjust regulator.

(b) Voltage does not build up - clean contacts and repeat test. If voltage still does not build up, replace regulator.

STARTER SYSTEM

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

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

A low and high current circuit make up the starting system and is shown in figure 3-38. The low current is the control circuit and includes the connections and wires from the ignition switch to the S-connection at the starter relay. This circuit activates the pull-in winding in the starter solenoid and closes the switch to complete the high current circuit. The high current circuit is from the battery through the starter relay switch to the starter motor to ground.

The Starter Motor Diagnosis Guide may be used to trace the source of the problem when the starter will not crank the engine or cranks slowly.

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

STARTER MOTOR

The starter has an integral positive engagement drive. When the starter is not in use, one of the field coils is connected directly to ground through a set of contacts (fig. 3-39). When the starter is first engaged, a heavy current flows through the grounded field coil actuating a movable pole shoe. The pole shoe is attached to the starter drive actuating lever, thus the drive is engaged with the flywheel.

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

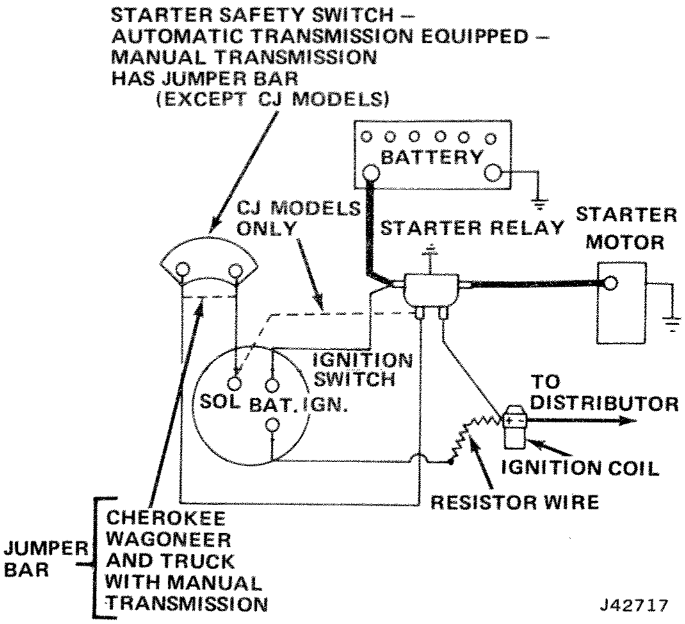


Fig. 3-38 Starter Circuit Wiring Diagram

Identification

The starter motor identification code is stamped on the frame, below the American Motors part number, at the time of manufacture.

Example:

4	F	C	A
Year	Month	Week	Work
(1974)	(June)	(3rd Week)	Shift

The letter I is never used in starter coding.

Current Draw Test - On Vehicle

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

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

(2) Disconnect and ground ignition coil secondary wire.

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

(4) Connect battery-starter tester leads as shown in figure 3-40. Operate remote control starter switch and read voltage indicated on voltmeter while starter is cranking engine.

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

(5) Turn remote control starter switch off.

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

Read the current draw on the ammeter scale. This is the current being used by the starter under full load

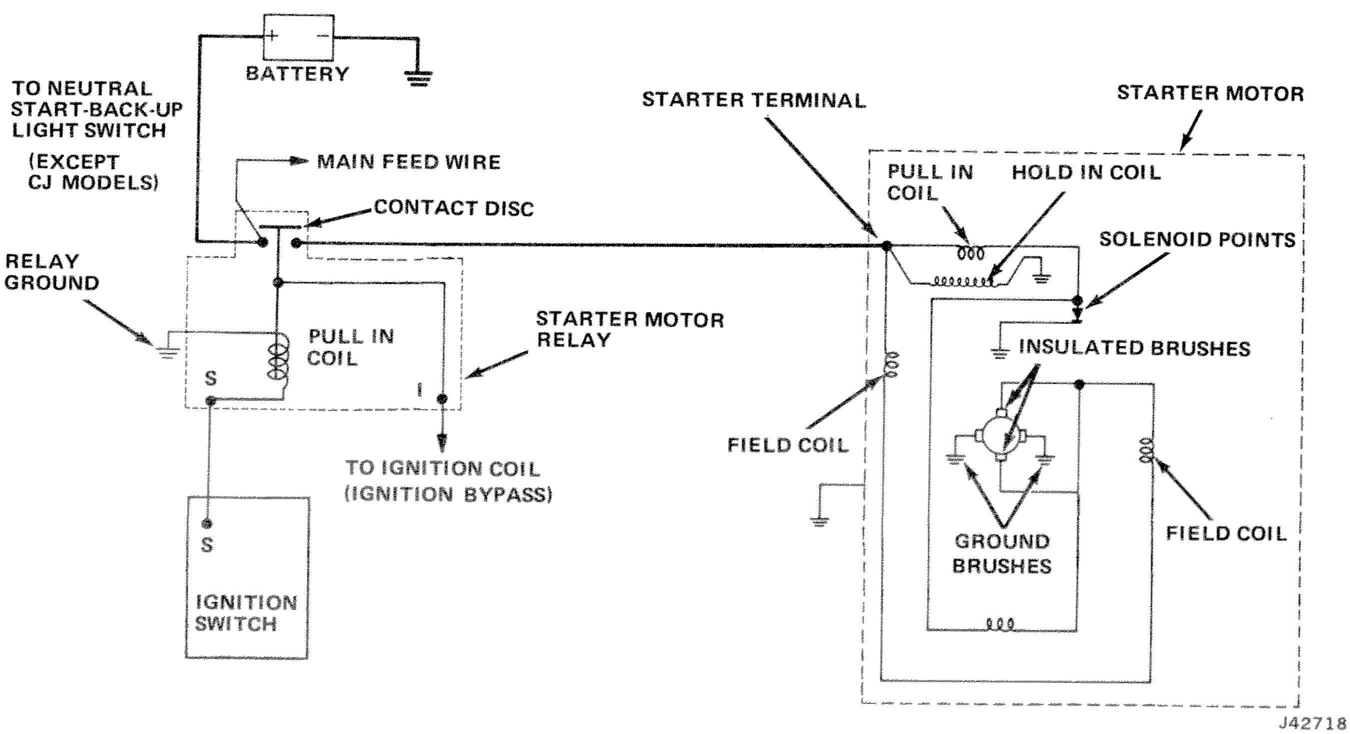


Fig. 3-39 Starter Motor - Wiring Diagram

conditions. If the current draw is not 180 to 220 amperes at room temperature, remove the starter motor from the engine for bench testing.

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

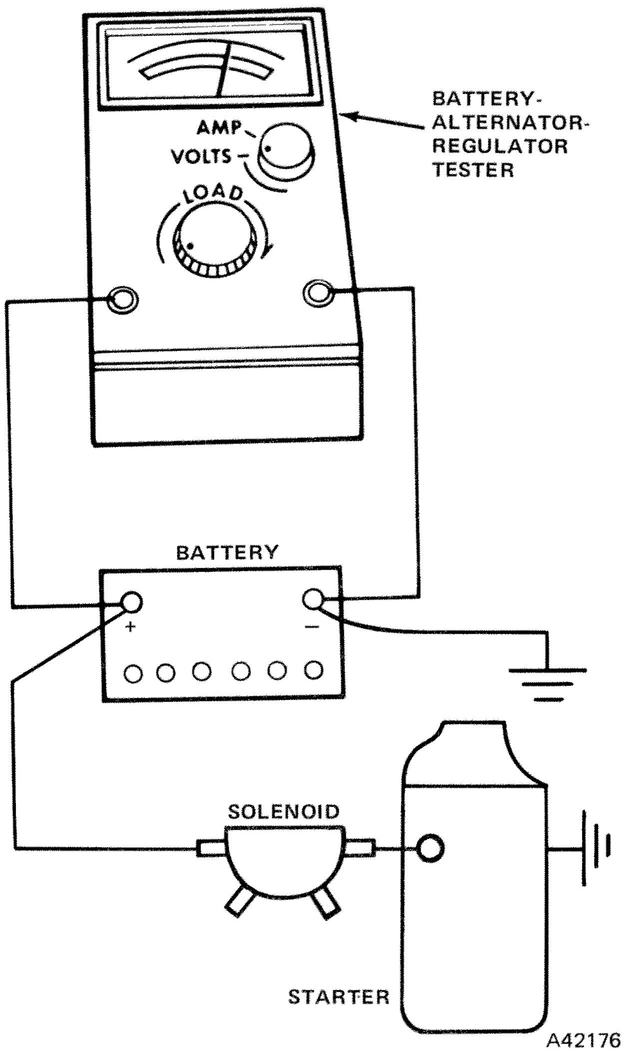


Fig. 3-40 Starter Motor Current Draw Test

No-Load Test - Out of Vehicle

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

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

(1) Operate starter with test equipment connected as shown in figure 3-41. Note voltage reading.

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

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

(3) Disconnect starter from battery.

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

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

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

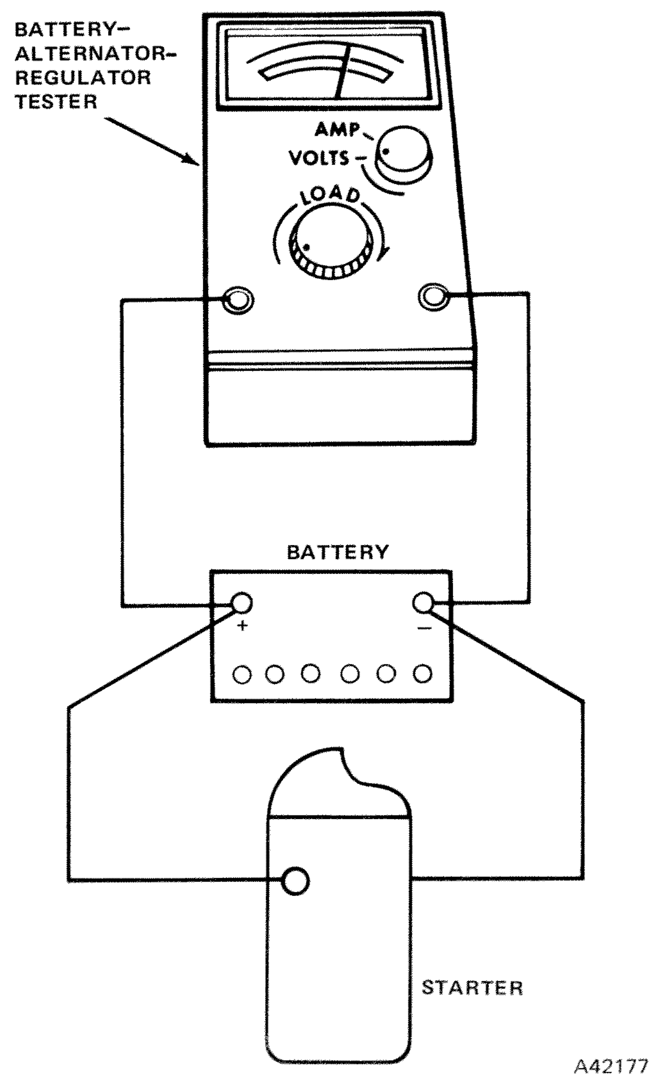


Fig. 3-41 Starter Motor No-Load Test

Disassembly

Refer to figure 3-42 for parts identification.

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

(2) Remove brushes from brush holders.

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

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

(5) Remove pivot pin and starter drive yoke.

(6) Remove armature and drive assembly.

(7) Remove brush end plate.

Cleaning and Inspection

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

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

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

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

(5) If the commutator is dirty, it may be cleaned with No. 00 or 000 sandpaper.

NOTE: *Never use emery cloth to clean the 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.

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

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

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

(10) Check brush holders for broken springs and insulated brush holders for shorts to ground. Tighten

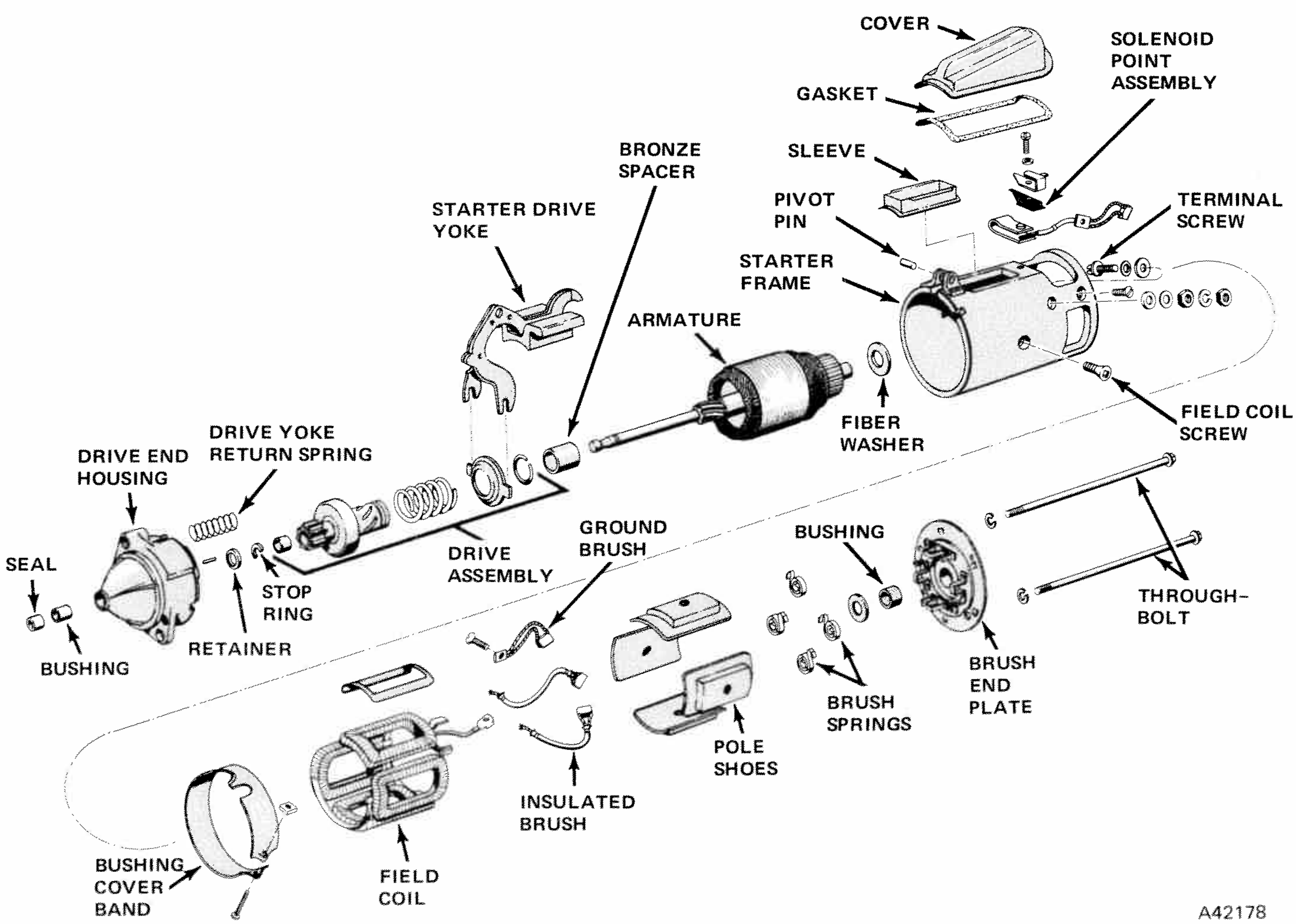
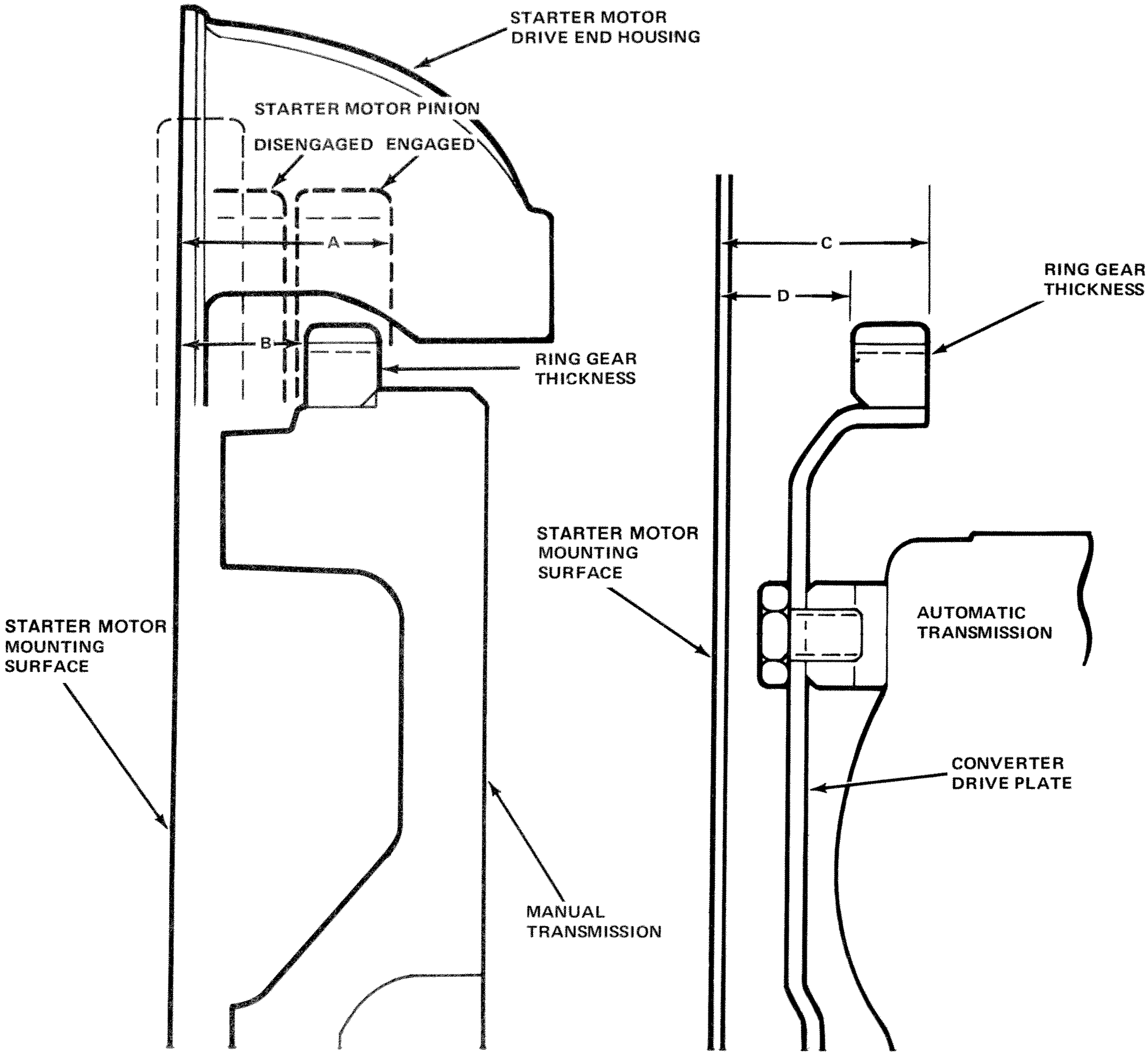


Fig. 3-42 Stater Motor - Disassembled View

any rivets that may be loose. Replace brushes if worn to 1/4 inch in length.

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

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



ENGINE	FLYWHEEL (INCHES)				DRIVE PLATE (INCHES)			
	A		B		C		D	
6 CYLINDER 232 & 258	1.2465 1.2060	1-1/4 1-13/64	0.8365 0.7660	27/32 49/64	1.2875 1.1870	1-9/32 1-3/16	0.8305 0.7700	53/64 49/64
V-8 304 360 401	1.2465 1.2035	1-1/4 1-13/64	0.8365 0.7635	27/32 49/64	1.2875 1.1875	1-9/32 1-3/16	0.8305 0.7675	53/64 49/64

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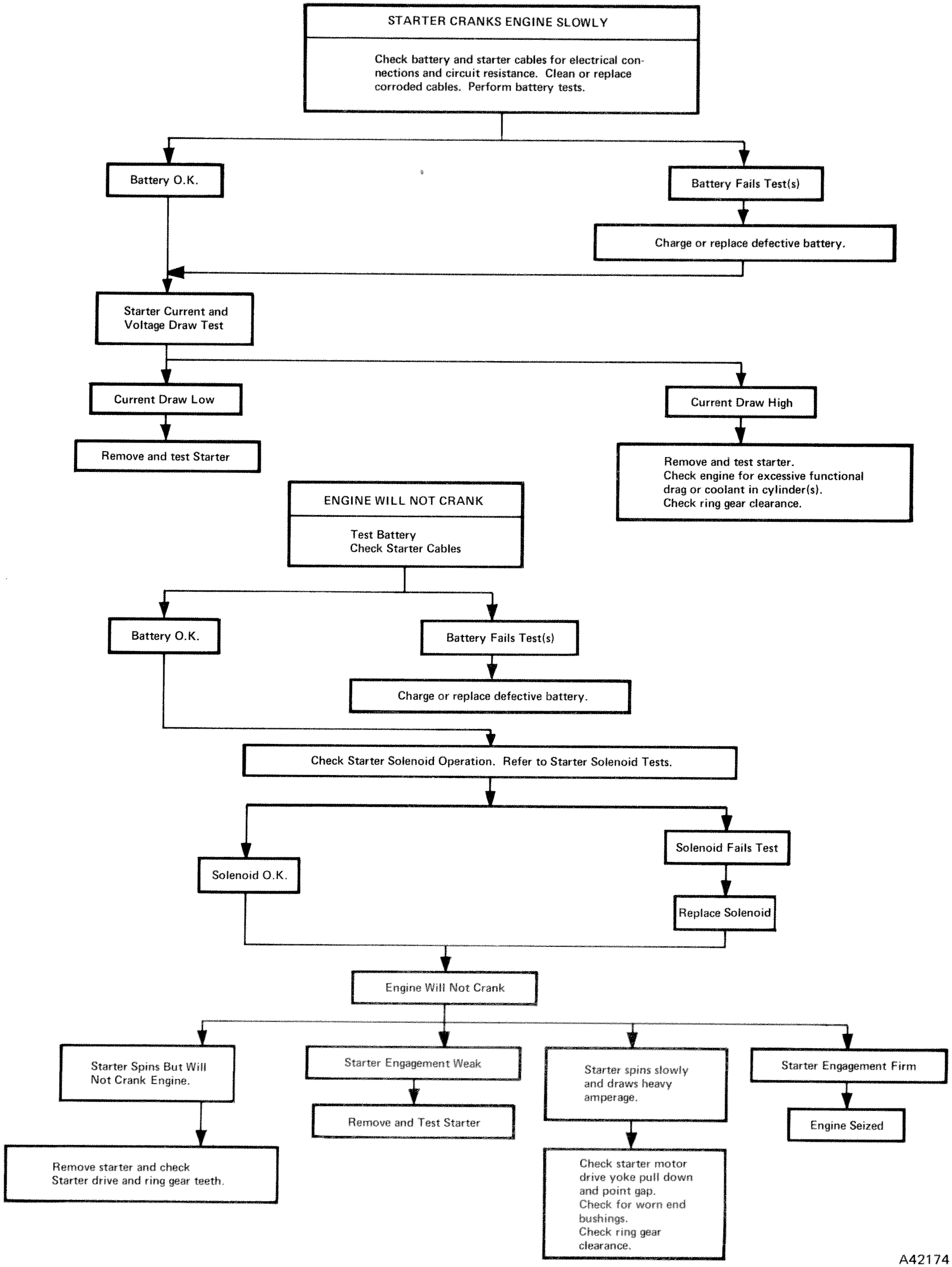
Fig. 3-43 Ring Gear Location

STARTER MOTOR DIAGNOSIS GUIDE



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Field Ground Circuit Test (On Test Bench)

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

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

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

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

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

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

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

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

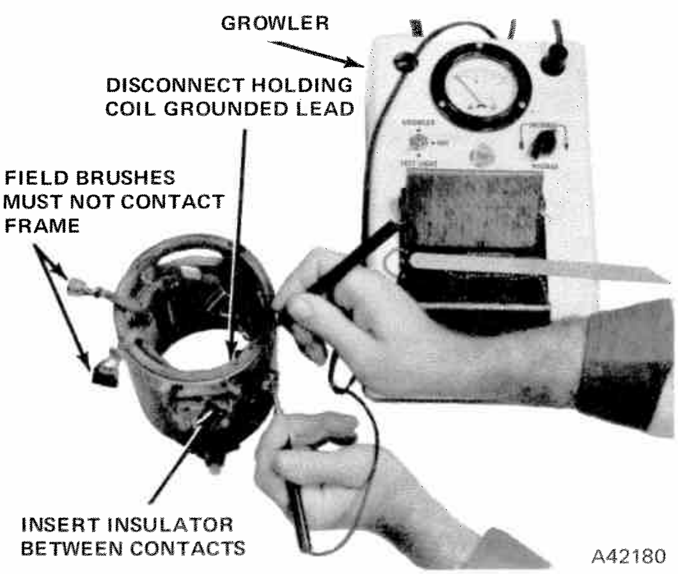

Fig. 3-44 Field Grounded Circuit Test

Field Coil Replacement

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

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

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

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

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

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

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

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

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

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

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

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

(11) Cut upper ground brush lead as close to threaded terminal block as possible.

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

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

Solenoid Contact Assembly Replacement

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

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

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

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

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

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

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

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

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

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

(9) Solder connection using rosin core solder.

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

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

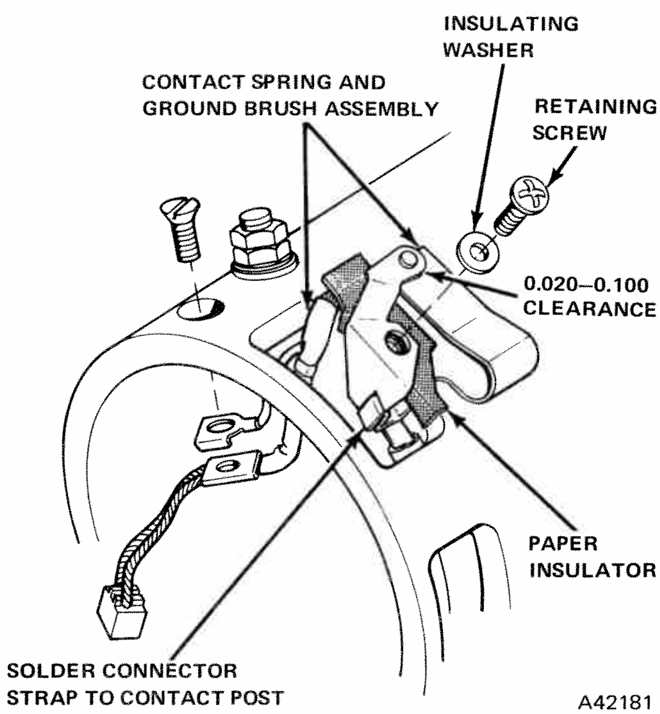

Fig. 3-45 Starter Motor Contact Kit

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

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

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

(15) Install end plate.

(16) Install through-bolts and tighten.

(17) Insert brushes into their holders.

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

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

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

(21) Tighten brush cover band retaining screw.

Armature Test Procedure

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

Ground Test

(1) Place armature in growler jaws.

(2) Turn power switch to test position.

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

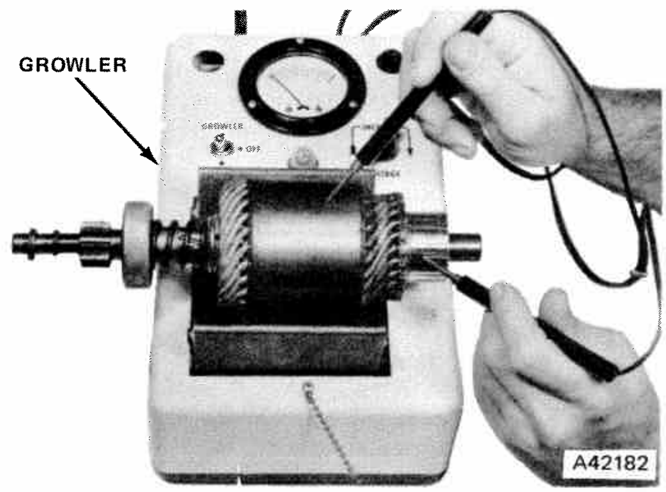

Fig. 3-46 Armature Ground Test

Short Test

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

(1) Place armature in growler jaws.

(2) Turn power switch to growler position.

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

Balance Test

(1) Place armature in growler jaws.

(2) Turn power switch to growler position.

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

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

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

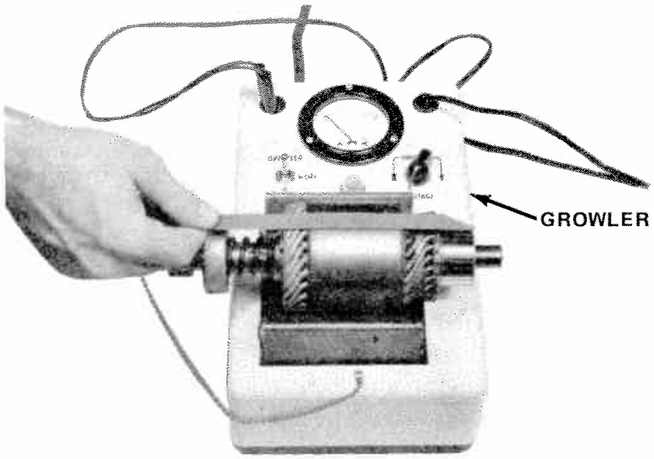

Fig. 3-47 Armature Short Test

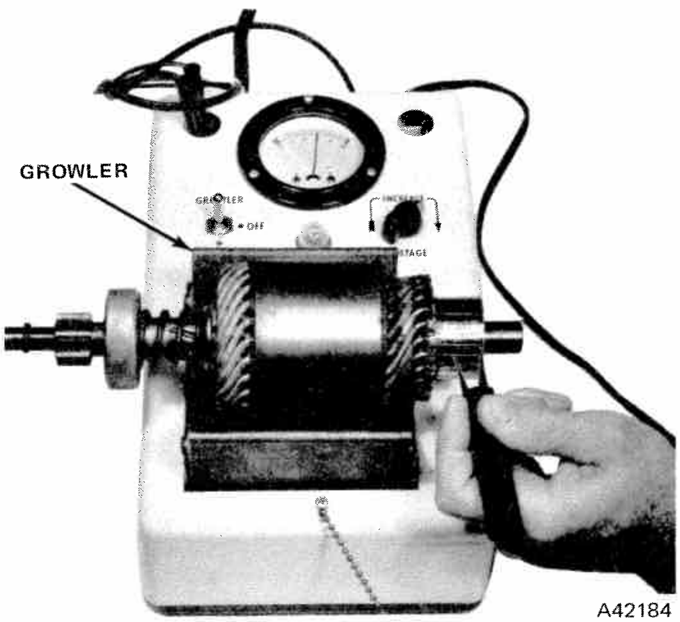

Fig. 3-48 Armature Balance Test

Assembly

Refer to figure 3-42 for parts identification.

Bushing Replacement

Drive End

(1) Support drive end housing.

(2) Remove original bushing and seal.

(3) Install new bushing using a suitable tool.

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

Commutator End

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

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

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

Drive Assembly Replacement

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

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

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

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

Drive End, Armature, End Plate Installation

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

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

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

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

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

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

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

(6) Install through-bolts and tighten.

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

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

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

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

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

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

STARTER SOLENOID TEST (ON CAR)

Engine Will Not Crank

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

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

(3) Disconnect wires at solenoid S and I terminals.

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

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

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

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

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

STARTER CABLE TEST (VOLTAGE DROP)

General

The starter cable tests will determine if there is excessive resistance in the circuit (fig. 3-39). When performing these tests, it is important that the voltmeter be connected to the terminals that the cables are connected to instead of to just the cables. For example, when checking from the battery to the solenoid, the voltmeter probes must be touching the battery post and the solenoid threaded stud.

Before performing tests

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

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

(3) Be sure battery is fully charged.

Battery to Starter Motor Voltage Drop Tests

(V-1, Fig. 3-49)

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

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

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

Battery to Solenoid Voltage Drop Tests

(V-2, Fig. 3-49)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Starter Motor Solenoid Pull-In Winding Test

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

(1) Remove S-terminal wire from solenoid.

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

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

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

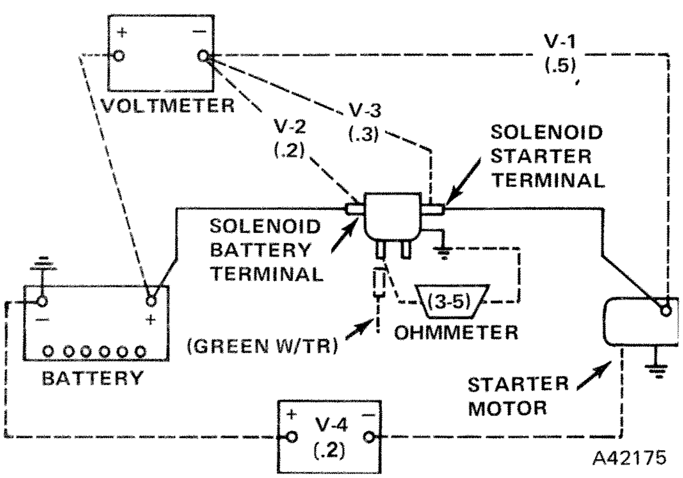

Fig. 3-49 Starter Cranking Circuit Test

IGNITION SYSTEM

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

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

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

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

Engine Spark Knock (Ping)

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

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

Other causes of spark knock to be considered are:

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

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

- *Combustion Chamber Deposits* - An excessive buildup of deposits in the combustion chamber may be caused by not using recommended fuels and lubricants, prolonged engine idling, or continuous low speed operation. The occasional use of Carburetor and Combustion Area Cleaner, Part Number 8992352 (Group 15.410) or operating the car at turnpike speeds will reduce deposits.

- *Distributor Advance Mechanism* - The centrifugal and vacuum advance units should be checked to be sure the mechanism is operating freely.

Ignition System Diagnosis and Testing

Refer to Ignition System Diagnosis Guide.

Ignition system diagnosis can be accomplished by means of an ignition system scope analyzer or by individual test equipment designed to perform a specific function check, such as Tach-Dwellmeter, VAT (Volts-Ampere-Tester), Ohmmeter, Timing Light, etc.

Ignition system problems are caused by a failure in the primary or second circuit, incorrect ignition timing, or incorrect distributor advance. Circuit failures may be caused by shorts, loose primary connections, loose or corroded secondary terminals, faulty wire insulation, cracked rotor or distributor cap, defective contact points or incorrect dwell angle, fouled or worn spark plugs.

Ignition Primary Circuit Tests

Excessive voltage drop in the primary circuit will reduce the secondary output of the ignition coil resulting in hard starting and poor performance. The input (primary) voltage to output (secondary) voltage ratio is approximately 2000:1. That is, a one-volt drop in primary voltage to the coil will result in approximately a 2000-volt drop (secondary) to the spark plugs. Inspect all primary wiring for loose or corroded terminals, worn insulation, and broken strands.

(1) Connect an ammeter in series between the positive ignition coil terminal and the ignition lead (fig. 3-50).

(2) Remove high tension lead from coil and ground to engine.

(3) Turn vehicle ignition on.

(4) Using a remote control starter switch, crank engine until distributor points are closed. Ammeter reading should be 3 to 3.5 amps.

(5) If reading is less than 3 amps, connect jumper wire from negative ignition coil terminal to ground. If ammeter reading increases to at least 3 amps, check distributor point or ground condition.

(6) If ammeter reading does not increase to at least 3 amps, resistance is excessive in primary circuit. If ammeter reading is over 3.5 amps, circuit resistance is too low.

An ohmmeter is used to check the resistance of the primary resistance wire. Connect one end of the ohmmeter to the positive side of the ignition coil (fig. 3-50). To make a connection at the other end of the resistance wire, perform the following:

CJ Models - Disconnect the six-way connector (in the engine compartment) and connect to the coil feed wire (refer to Wiring Diagram at the rear of the Manual).

Cherokee, Wagoneer, and Truck - Unfasten the bulkhead connecting screw from the engine compartment side and separate the connector. Touch the ohmmeter probe to the BY terminal (see Wiring Diagram at the rear of this manual) and note the ohmmeter reading.

The meter should indicate 1.8 ohms for a six-cylinder and 1.35 (plus or minus 0.05 ohms) for a V-8 engine.

If the ohmmeter test results indicate that the resistance of the resistor wire is within specifications, connect a voltmeter (V-1) between the battery positive post and the ignition switch side of the resistor wire. The voltmeter reading should not exceed 0.4 volt.

If the voltmeter reading exceeds 0.4 volt, resistance is excessive between the resistor wire and the battery. The maximum allowable resistance between any two connected terminals of the ignition switch is 12.5 mil-

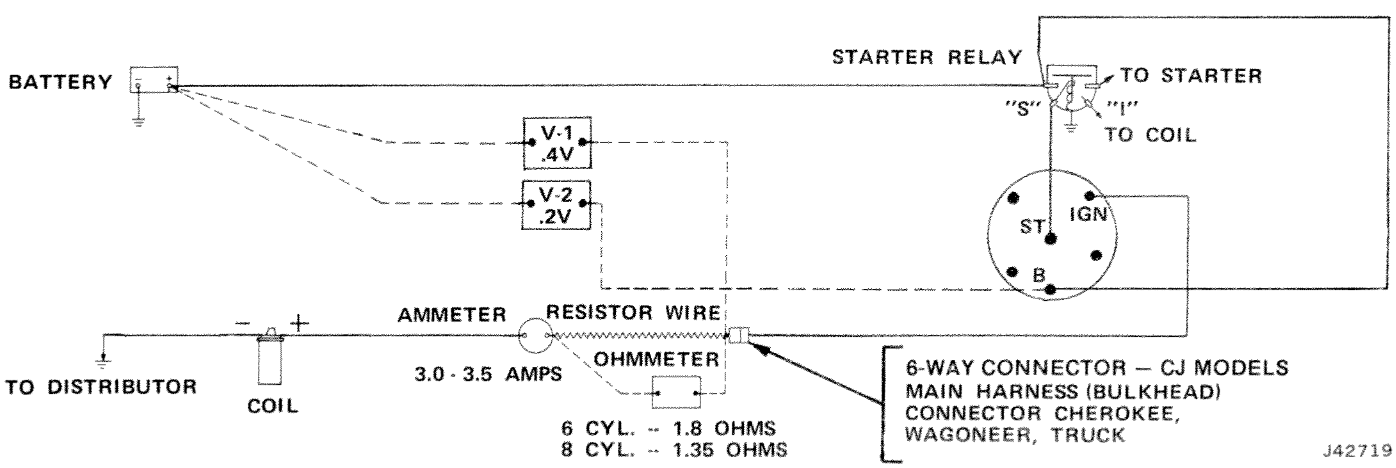

Fig. 3-50 Ignition Circuit Tests