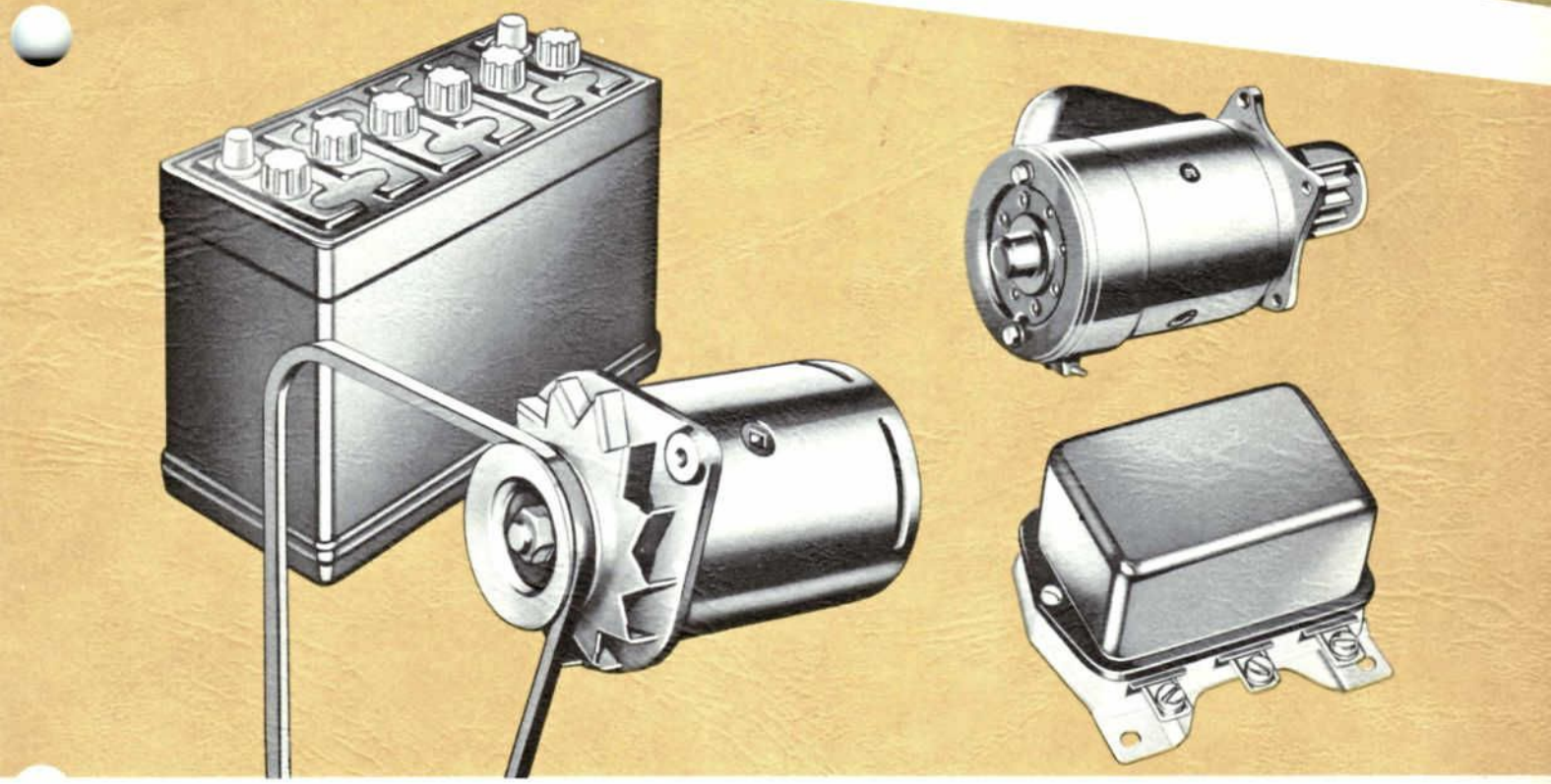
FORD *Service Handbook* 10001



ELECTRICAL SYSTEM
MAINTENANCE, DIAGNOSIS, and LIGHT REPAIR
AC DC

FOREWORD

The information in this Service Handbook covers Ford cars and trucks. It includes trouble diagnosis, tests, adjustments, and minor repairs for the following:

Battery; Starter, Generator, Generator Regulator, Alternator-Rectifier, Alternator-Rectifier Regulator, Drive Belts, and Headlights.

Also included in the handbook are replacement procedures for fuses, bulbs, and circuit breakers. All service specifications and special tools are listed in Part VI.

SERVICE DEPARTMENT
FORD DIVISION
FORD MOTOR COMPANY

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SERVICE DEPARTMENT
FORD DIVISION
Ford MOTOR COMPANY
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PART 1 BATTERY

1 LEAD ACID STORAGE BATTERY ACTION

The lead acid storage battery is an electro - chemical device for storing energy in chemical form so that it can be released as electricity.

The primary function of the storage battery is to store energy for starting the engine and to operate electrical units when the generator is not delivering sufficient output.

CHEMICAL ACTION OF DISCHARGE

When a cell is discharged by completing an external circuit, as in switching on the lights, the sulphuric acid acts on both positive and negative plate active materials to form a new chemical compound called lead sulphate. The sulphate is supplied by the acid solution (electrolyte) which becomes weaker in concentration as the discharge proceeds. The amount of acid consumed is in direct proportion to the amount of electricity used from the cell. When the acid in the electrolyte is partially used up by combining with the plates, the battery can no longer deliver electricity at a useful voltage and the battery is said to be discharged.

This gradual weakening of the electrolyte in proportion to the electricity delivered is a very useful action because a hydrometer may be used to measure how much unused acid remains with the water in the electrolyte and with this information it is possible to judge about how much electrical energy is left in the cell.

CHEMICAL ACTION OF CHARGE

By passing an electric current through the battery in a direction opposite to that of the discharge, the lead sulphate is decomposed. The sulphate is expelled from the plates and returns to the electrolyte, thereby gradually restoring it to its original strength. This action frees the plate active materials of sulphate and they are restored to their original chemical condition, ready to deliver electricity again. Hydrogen and oxygen gases are given off at the negative and positive plates respectively as the plates reach the fully charged condition. This is the result of the decomposition of water by an excess of charging current not utilized by the plates.

CHEMICAL REVERSIBILITY

The most valuable characteristic of the lead - acid storage battery is its chemical reversibility. This means that, unlike a dry - cell battery which must be thrown away when it becomes discharged, the storage battery may have an electrical current passed through it in the direction opposite to the direction of discharge and the battery's active chemicals may be restored to the "good - as - new" state.

2 BATTERY TESTS AND CONCLUSIONS

Tests are made on a battery to determine its capacity and state of charge.

Hydrogen and oxygen gases are produced in the course of normal battery operation. Flames or sparks can cause this gas mixture to explode if they are brought near the vent openings of the battery. The sulphuric acid in the battery electrolyte can cause a serious burn if spilled on the skin or splattered in the eyes. It should be flushed away immediately with large quantities of clear water.

BEFORE CHARGE TESTS

BATTERY CAPACITY TEST

A battery - starter tester should be used for this test. **If the battery solution is not within 60°F. to 100°F., let it stand until warm before making this test.** Add water if necessary to bring the battery solution up to the proper level. **Fill only to the narrow ring near the bottom of each vent well.**

1. Turn the load control knob to the extreme OFF position.

2. Turn the volts switch to the 20V position.

3. Connect the test leads as shown in Fig. 1.

4. Turn the load control knob toward the increase direction until the ammeter reads 3 times the ampere - hour rating of the battery.

5. At the end of 15 seconds, read the voltmeter. If the voltage reading is 9.6 volts or above, the output capacity of the battery may be considered good.

6. If the voltages as read are below the value stated above, the battery test charge below should be performed.

BATTERY TEST CHARGE

The condition of a discharged battery may be tested by passing current through it.

1. Connect a fast charger to the battery, and charge the battery for 3 minutes at a rate of 30 amperes.

2. After 3 minutes of fast charge, and with the fast charger still operating, test the individual cell voltages of the battery.

3. If the cell voltages vary more than 0.1 volt, replace the battery.

If the cell voltages are within 0.1 volt, test the total battery voltage with the charger still operating.

4. If the total battery voltage is now under 15.5 volts, the battery is satisfactory and may be safely fast charged. (See Specifications.) **Always follow the fast charge with a sufficient slow charge to bring the battery to a full charge.**

5. If the total battery voltage was more than 15.5 volts, the battery may be sulphated. (A sulphated battery is one which has been permitted to stand for a long period of time in a discharged condition. Such a battery is difficult, if not impossible, to bring up to full charge.) Place the battery on continued slow charge.

AFTER CHARGE TESTS

When the battery is fully charged, as determined with a hydrometer or battery charge tester, make a capacity test. If the terminal voltage is 9.6 volts or above, place the battery back in service. If the terminal voltage is below 9.6 volts, replace the battery.

BATTERY CHARGE TESTS

Battery charge may be tested by measuring the battery electrolyte solution specific gravity with a hydrometer, or by measuring the voltage of the battery cells on open circuit (no current flow) with a battery charge tester (open circuit voltage tester).

BATTERY CHARGING

A battery that is in a normal condition may be charged by either a fast charging or a slow charging method.

FAST CHARGING

Follow the instructions of the fast charger manufacturer.

Test the battery cells for specific gravity with a hydrometer. Then, fast charge the battery at 30 to 40 amperes maximum for the length of time shown in the Specifications, corresponding to the specific gravity condition of the battery.

SLOW CHARGING

Always follow a fast charge with a slow charge at 3 amperes for 12-volt batteries of less than 70-ampere-hour capacity. Batteries of 70-ampere-hour capacity or higher require a 4-ampere slow charge. Continue the slow charge until the battery is fully charged.

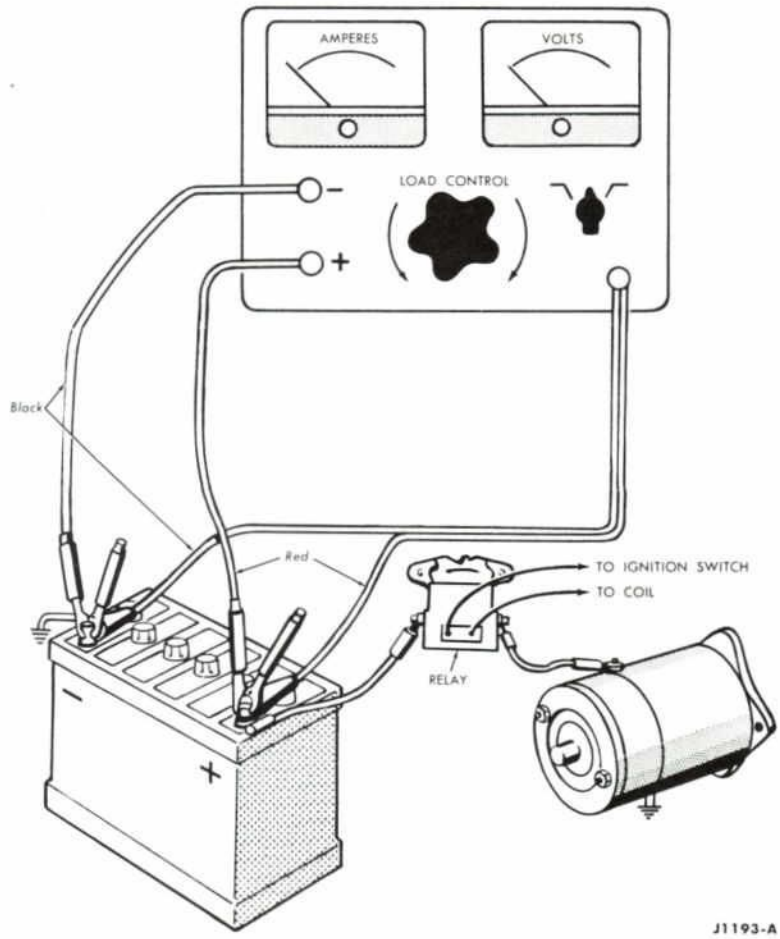
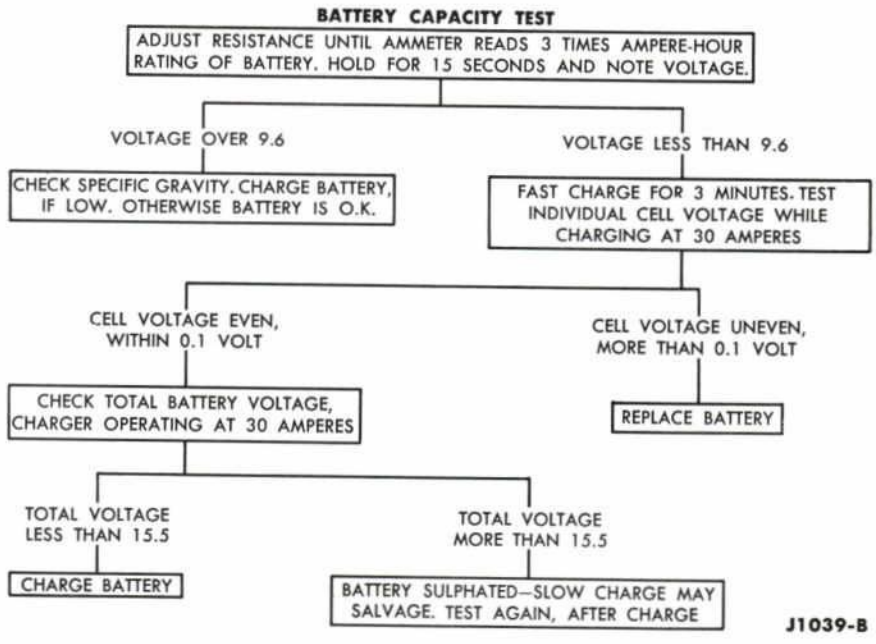


FIG. 1—Battery Capacity Test Connections

TABLE 1—Battery Capacity Test Outline



PART 2 STARTER

The function of the starting system is to crank the engine at a high enough speed to permit initial ignition and start the engine. The system includes the ignition switch (when held in the "START" position), battery, starter relay, starting motor and drive, and the necessary wiring to connect the components.

Schematic diagrams of the starting circuits used with manual-shift and automatic-shift transmissions are shown in Figs. 2 and 3. The Autolite and Delco-Remy starting circuits are shown in Figs. 4 and 5. These show the internal connections of the various starting system units currently in use. The neutral switch is in series with the "START" contacts of the ignition switch.

Vehicles equipped with an automatic transmission have a built-in safety factor to prevent starting the engine with the car in gear. A starter neutral switch in the starter control circuit prevents operation of the starter unless the selector lever is in the N (Neutral) or P (Park) position.

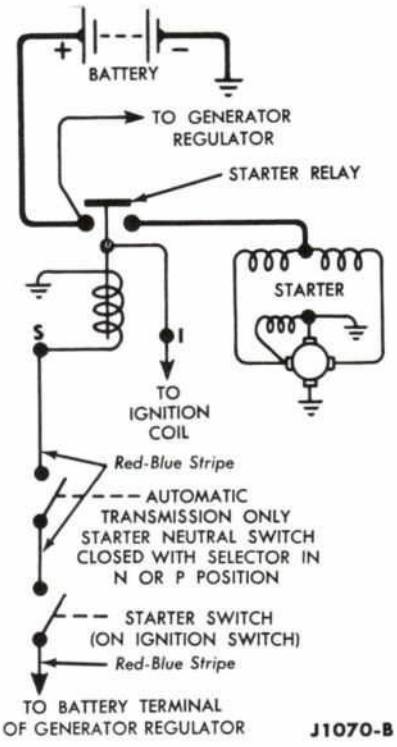


FIG. 2 — Starting Circuit with "Folo-Thru" Starter

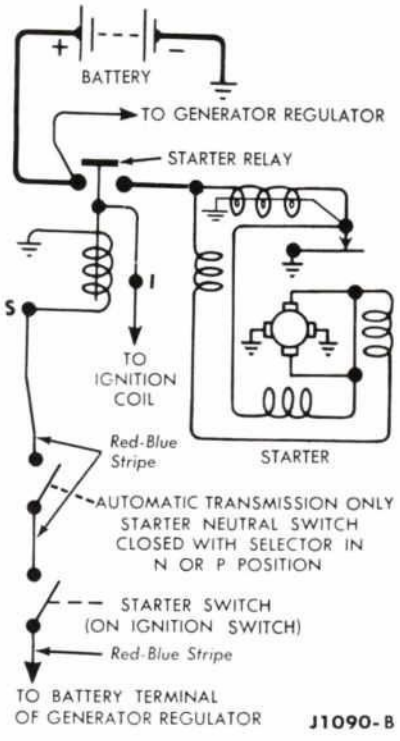


FIG. 3 — Starting Circuit With "Positive Engagement" Starter

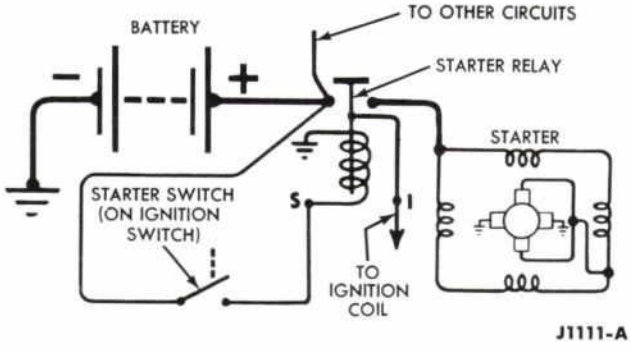


FIG. 4 — Autolite Starting Circuit

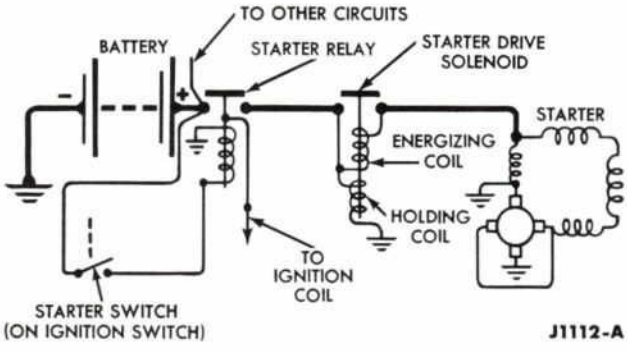


FIG. 5 — Delco-Remy Starting Circuit

1 STARTER AND STARTER CIRCUIT TESTS

DESCRIPTION

Heavy cables, connectors, and switches are used in the starting system because of the high current required by the starter while it is cranking the engine. The amount of resistance in the starting circuit must be kept to an absolute minimum to provide maximum current for starter operation. Loose connections, cor-

roded relay contacts, and partially broken or undersize cables will result in slower than normal cranking speed and may even prevent the starter from cranking the engine.

The standard (Folo-Thru) starter is a four-brush, series parallel wound unit. The circuit from the battery to the starter is completed by means of a relay controlled by a switch which is part of the ignition switch. The return circuit is through the starter housing, engine block, and battery ground cable to the battery.

Fig. 6 shows a typical starter mounting.

The Delco positive-action starter differs from the standard and Autolite starters in that it has a solenoid mounted on top of the starter housing (Fig. 7). The solenoid is energized when the starter relay contacts are closed. This action engages the starter drive with the flywheel ring gear. The starter current flows through the solenoid energizing coil until the solenoid plunger is at the end of its travel. The plunger then closes a set of contacts (Figs. 5 and 7) that bypass the energizing coil letting the holding coil keep the starter drive engaged. An overrunning clutch in the drive protects the starter from excessive speed when the engine starts.

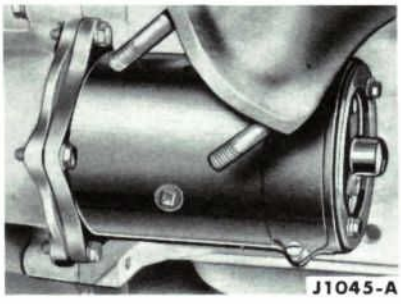


FIG. 6—Typical Starter Mounting

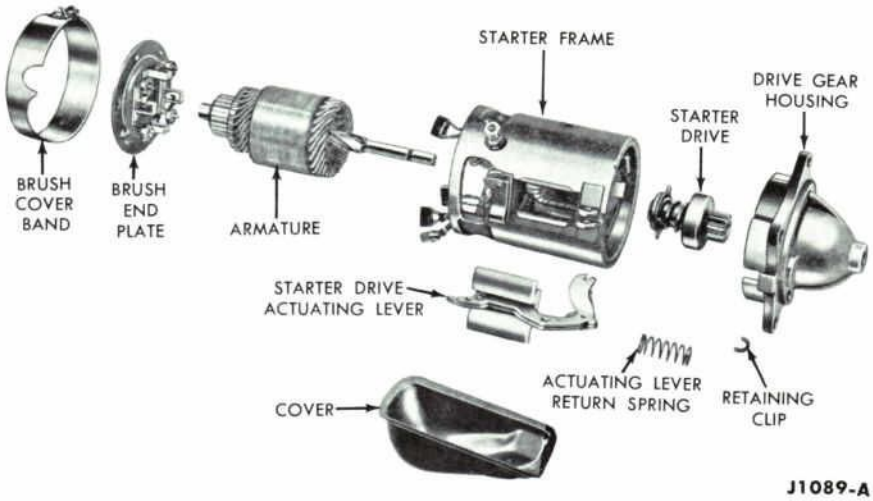


FIG. 8—"Positive Engagement" Starter—Disassembled

The starter used on the 144 and 170 6-cylinder engines and the 221 and 260 V-8 engines (Fig. 8) differs from the previously mentioned starters in that it uses 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). When the starter is first connected to the battery, 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 forced into engagement with the flywheel. When the movable pole shoe is fully seated, it opens the field coil grounding contacts, and the starter is then in normal operation. A holding coil is used to maintain the movable pole shoe in the fully seated position during the time that the starter is turning the engine.

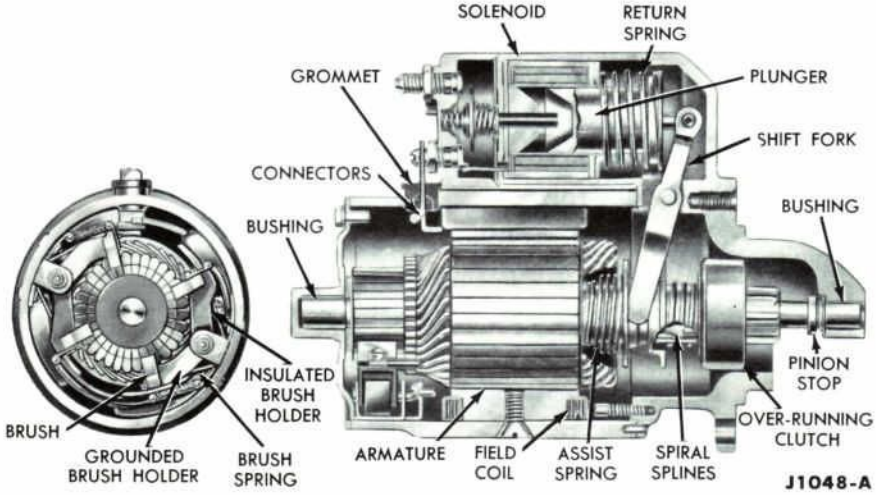


FIG. 7—Delco Positive-Action Starter—Cutaway

TESTS

Three different tests, pertaining to all starters and their circuits, are described. Arrangement of these tests is not intended to indicate an order of procedure. The selection of the test to be made is controlled by the circumstances encountered, usually as the result of analyzing troubles as covered in the trouble diagnosis (Section 2 of this part).

The following pieces of test equipment will be needed to perform the test procedures:

One battery-starter tester

One 0-300 ampere ammeter

Assorted connecting wires and jumper wires equipped with suitable connectors.

STARTER LOAD TEST

Use a battery-starter tester in this test. NOTE: This test does not apply to the 24 volt Leece Neville starter. To test the Leece Neville starter refer to the starter no-load test.

1. Turn the load control knob to the extreme off position.

2. Turn the volts switch to the 20 V. position.

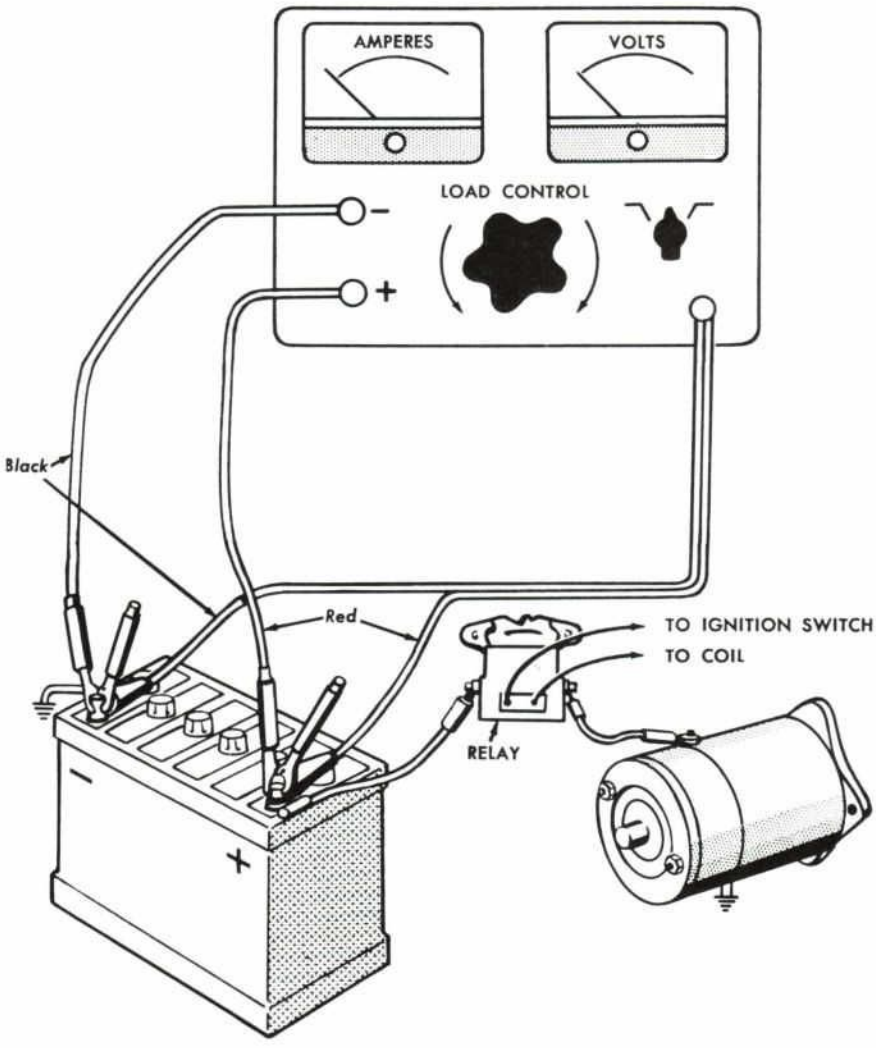


FIG. 9— Starter Load Test Connections

3. Connect the test leads as shown in Fig. 9. **Connect a jumper lead from the distributor primary terminal to a good ground.**

4. Operate the starter switch, and note the exact voltmeter reading while the starter is cranking the engine.

5. Release the starter switch. Then turn the load control knob toward the increase position until the voltmeter reads exactly the same as when the starter was cranking the engine.

6. Read the ammeter. The current reading as indicated on the ammeter is the current draw of the starter while cranking the engine. The maximum amperage should not exceed specifications.

7. Turn the load control knob to the extreme off position.

STARTER NO-LOAD TEST

The starter no-load test will uncover such faults as open or shorted windings, rubbing armature, and bent armature shaft.

This test can be performed on starters equipped with a "Folo-Thru" starter drive (Fig. 10) either on the engine or on the test bench. On models equipped with the standard starter drive (Fig. 11), the test can be performed on the test bench only. Perform the no-load test as follows:

On Engine ("Folo-Thru" Starter Drive— Galaxie, Station Wagons, Thunderbird, 100-800 Series, 850-1100 Series.) NOTE: The 24 volt Leece Neville starter cannot be tested on the engine.

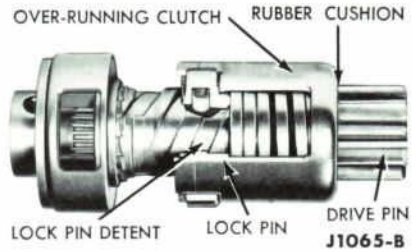


FIG. 10— "Folo-Thru" Starter Drive

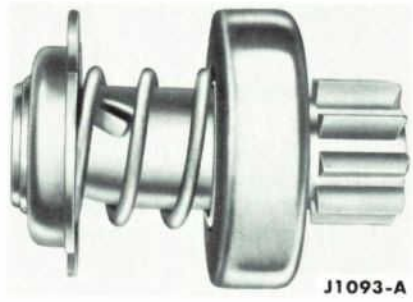


FIG. 11— Standard Starter Drive

To test the starter, the engine should be running at idle speed. With the engine idling, connect the ammeter as shown in Fig. 12. The reading should be to specifications.

To accomplish this test on the Delco positive-action starter, connect the ammeter negative lead to the starter terminal that protrudes

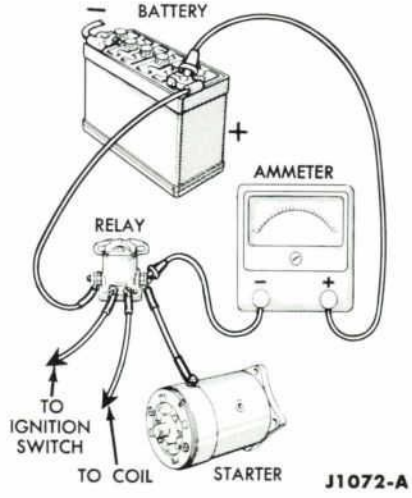


FIG. 12— Starter No-Load Test on Engine

through the rubber grommet in the starter housing. The no-load current draw on the ammeter should be to specifications.

On Test Bench (All Models)

To test 12 volt starters, connect the ammeter positive lead to the battery positive terminal and the ammeter negative lead to the starter terminal (Fig. 13). Connect a lead from the battery negative terminal to the starter ground. The starter will run at no-load, and the current draw indicated on the ammeter should be to specifications.

To test 24 volt starters, clamp the starter to the work bench. Connect the starter ground brush terminal (on brush end plate) to the negative terminal of a fully charged 12 volt battery. **To prevent damage to the unit do not apply 24 volts at no-load.** Connect the positive lead of the ammeter to the positive terminal of the battery. Connect the negative lead of the ammeter to the starter side terminal. The ammeter reading should not exceed specifications.

STARTING CIRCUIT TEST

Excessive resistance in the starter circuit will prevent the starter from operating properly. The results of this test will locate the high resistance.

1. Disconnect and ground the high tension lead from the ignition coil so that the engine cannot start.

2. With a fully charged battery, operate the starter switch to crank the engine. If the engine does not crank and the relay does not click, connect a jumper lead from the battery terminal of the relay to the starter switch terminal of the relay (Fig. 14, connection 1). If the engine does not crank, the starter relay is probably defective.

3. On vehicles with automatic transmissions, if the engine cranks in step 2, connect a jumper lead from the battery terminal of the relay to the relay side of the neutral switch (connection 2). If the engine does not crank, the wire or a connection between the neutral switch and the relay is loose or broken.

4. On vehicles with an automatic transmission, if the engine cranks in step 3, connect the jumper lead from the battery terminal of the relay to the ignition switch side of the neutral switch (connection 3). If the engine does not crank, the neutral switch is defective or out of adjustment.

5. If the engine cranks in the preceding steps, there are three possible defects:

The wire from the battery terminal of the starter relay to the ignition switch is loose or broken.

The ignition switch starter terminal is defective.

The wire from the starter switch to the automatic transmission neutral switch or to the starter relay is loose or broken.

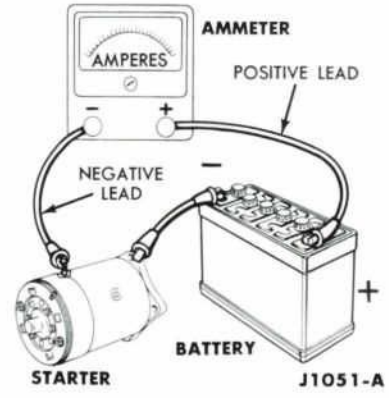


FIG. 13—Starter No-Load Test on Bench

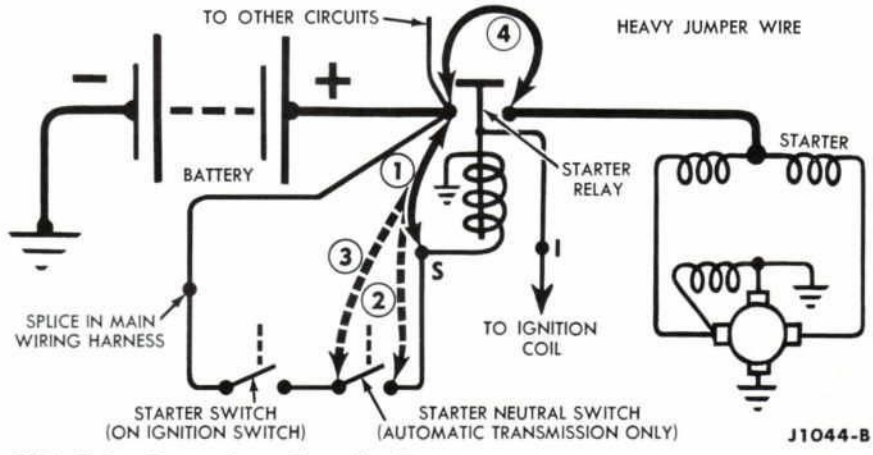


FIG. 14—Starting Circuit Test

2 STARTER TROUBLE DIAGNOSIS

Vehicles equipped with a Delco starter have a starter drive solenoid (Figs. 5 and 7) mounted on top of the starter. The solenoid must be taken into account when trouble shooting this starter because of the additional voltage drop through the solenoid contacts.

If the engine cranks but will not start, the trouble is in the engine (fuel or ignition system, engine parts), not in the starting system. If the engine will not crank even with a booster battery connected, engine parts may be seized, or the starter may be faulty. If the engine cranks but cannot be started with a booster battery connected, attempt to start it by pushing the vehicle. If it still will not start, push or tow the vehicle to the shop for a complete diagnosis.

Do not push or tow a car equipped with an automatic transmission for more than 12 miles without raising the rear wheels off the ground or disconnecting the driveshaft.

Do not push or tow a truck without disconnecting the driveshaft or removing the axle shafts.

TABLE 2— Starter Trouble Diagnosis Guide

SYMPTOM	PROBABLE CAUSE	TESTS TO PERFORM	ALTERNATE TESTS
ENGINE WILL NOT CRANK, AND STARTER RELAY DOES NOT CLICK	Discharged battery.	Perform a battery capacity test (Part 1). Replace the battery if the tests indicate that it is worn out or under capacity.	If the battery does not test as having good capacity, perform a battery test charge (Part 1).
ENGINE WILL NOT CRANK, BUT STARTER RELAY DOES CLICK	Defective starting circuit.	Perform a starter circuit test.	
	High resistance caused by dirty or loose cable connections, frayed or broken cables.	Check area of high resistance (See Starter Circuit test).	Repair, clean or replace defective cable(s) and/or connections.
	Hydrostatic (water) locked engine.	Remove spark plugs. If engine now cranks freely, locate and correct cause of water leaking into engine cylinders.	
	Locked starter drive.	Place vehicle in gear and rock back and forth to "break loose" the starter pinion from the flywheel. Loosen starter mounting bolts and rock the vehicle back and forth if the preceding step does not work. If the vehicle cannot be rocked or if it has an automatic transmission and the starter pinion is locked, remove the starter from the engine, and examine the starter drive pinion for burred or worn teeth. Examine the teeth on the flywheel ring gear for burrs and wear.	If the starter pinion is not locked and the engine does not crank, remove the starter and perform a no-load current test.
	Engine seized	Determine the cause of the seizure (bearings, etc.), and recommend necessary mechanical repairs.	
STARTER SPINS BUT WILL NOT CRANK ENGINE	Worn or dirty starter drive.	Clean or replace the starter drive.	
	Broken starter drive.	Replace the starter drive.	
ENGINE CRANKS SLOWLY	Battery low in charge	Locate area offering high resistance. (See starter circuit test) Replace defective relay, or clean, tighten or replace the defective cables or connections.	
	Low cranking current.	Check the current draw (current no-load test and starter load test).	Repair or replace the starter.
	High cranking current.	Check the current draw (see starter no-load test).	Repair or replace the starter.
	Excessive engine friction.	Check the current draw (current no-load test). Normal draw and slow cranking speed indicate that the engine is offering excessive friction. Locate the cause and recommend the necessary repairs.	

PART 3

GENERATOR AND GENERATOR REGULATOR

The schematic wiring diagram (Fig. 15) shows the internal connections and windings of the various units. Color codes are shown to aid in tracing the circuit. Wire sizes are given as a guide for replacing any of the wires in the circuit.

Since the generator and regulator are precision-built units, they must be checked with accurately calibrated instruments. Correct regulator setting requires that voltmeters be accurate to 0.05 (1/2 of one tenth) volt within the ranges of 12 to 16 volts. Ammeters must be accurate between the following ranges:

AMMETER ACCURACY

Falcon	25 & 45 amps
Fairlane	25 & 45 amps
Galaxie and Station Wagons	30 & 60 amps
Thunderbird	30 & 50 amps
Econoline	30 & 60 amps
100-800 Series	30 & 60 amps
850-1100 Series	55 & 60 amps

All meters should be calibrated once a year and the date of the calibration stamped on the meter face.

1 GENERATOR TESTS

The DC generating system is a negative (–) ground system. Output is controlled by a regulator which is connected between the armature and field. The field is grounded internally (Fig. 15) except for the Autolite generator which is grounded externally.

The armature shaft is supported by permanently lubricated ball bearings which fit into the end plates. The shaft is keyed to an integral pulley and cooling-fan assembly which is belt-driven from the engine. Typical generator mountings are shown in Fig. 16.

A volt-amp tester, a battery adapter switch, and a 0-5 ampere ammeter are used in the three generator tests outlined below.

To obtain the most accurate generator readings, the ammeters and voltmeter should register the expected readings in the middle range of the meter scale.

GENERATOR OUTPUT TEST

When a generator output test is conducted off the vehicle, a generator-regulator test bench must be used. In this case, the generator is placed on a test bench and driven by a motor. Follow the procedure given by the manufacturer.

To test the generator output on the vehicle, use a volt-amp tester as follows:

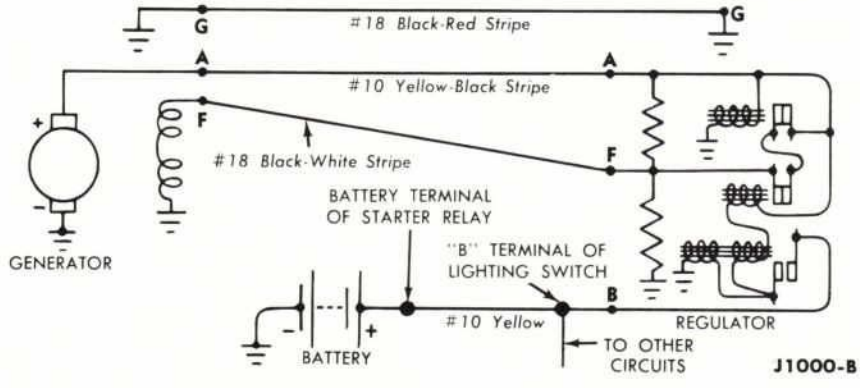


FIG. 15—Generating System Schematic

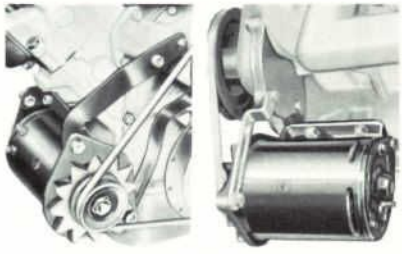


FIG. 16—Typical Generator Mountings

1. Turn the generator type switch to the "B" circuit position ("A" circuit for Autolite generators). **Do not change this switch position during the entire test procedure.**

2. Turn the volts switch to-20 for vehicles with a negative ground.

3. Make the connections as shown in Fig. 17. (While making the connections have the battery adapter switch (Fig. 18) in the open position. Connect the red ammeter lead last).

4. Close the adapter switch. Start the engine. Open the adapter switch and operate the engine at a sufficient speed to produce the rated generator output.

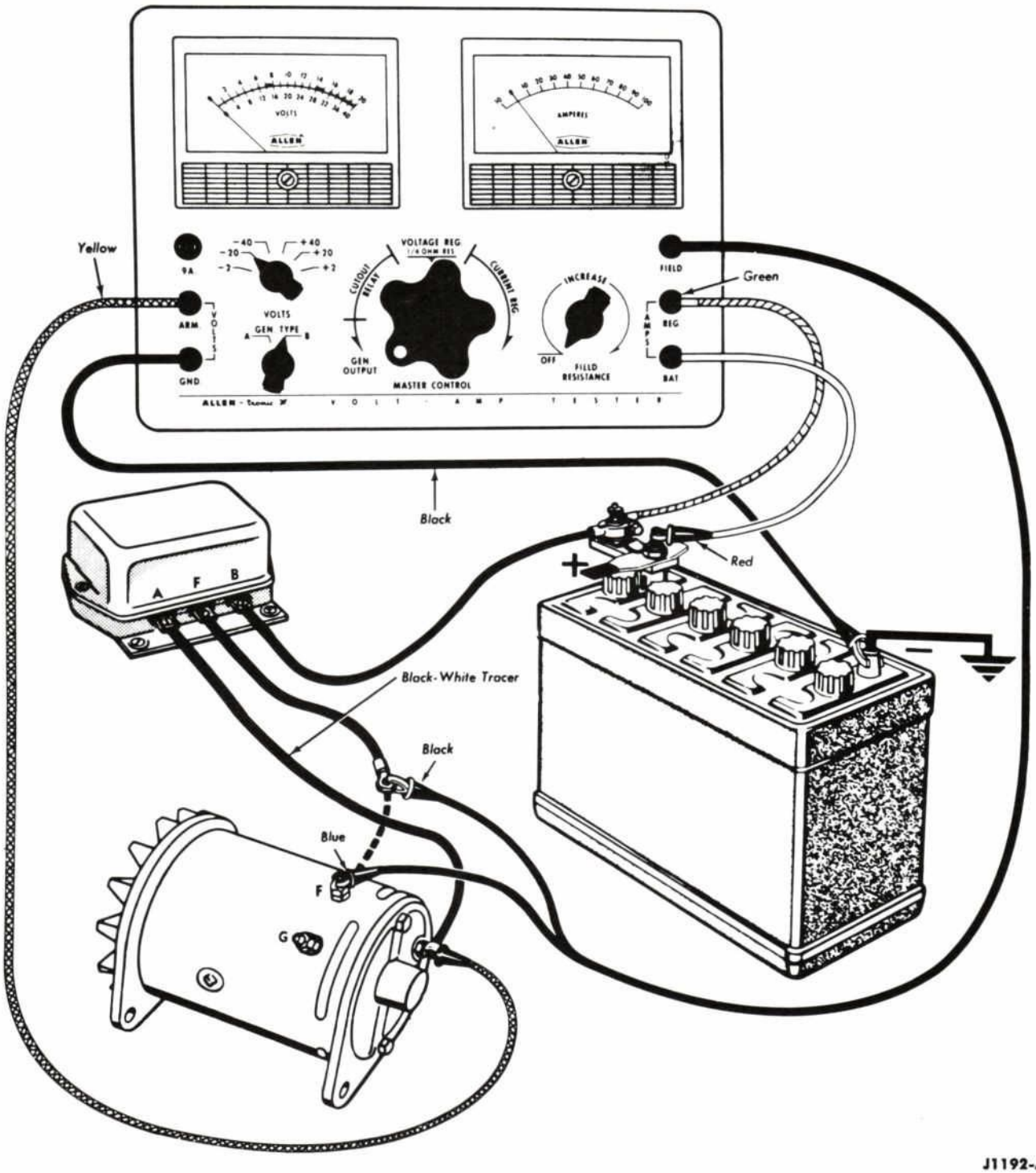


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FIG. 17—Generator Output and Regulator Cutout Relay Test Connections

5. Turn the master control knob to the generator output position. Read the output current.

If the generator output current is according to or above specifications, proceed with the generator regulator cutout test. Do not stop the engine or disconnect the leads because the cutout test uses the same connections and speed.

If the output is below specifications, connect a heavy jumper wire from the battery negative terminal to the generator ground terminal and repeat the output test. If the output now reaches or exceeds specifications, either the generator or the battery is not properly grounded to the engine. Check the cables and connections. If the output is still low with the jumper wire in place check for an open or short circuit in the field, armature, brushes, or brush holders, or the brushes can be worn too short or may be sticking in the brush holder and not making good contact on the commutator.

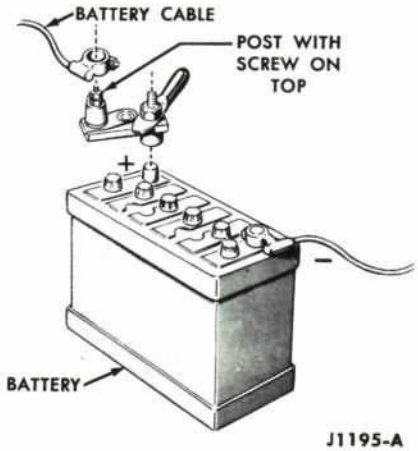

FIG. 18—Sun Battery Adapter Switch

ARMATURE TESTS

Checking the armature for open, shorted, or grounded circuits must be done off the vehicle.

OPEN CIRCUIT TEST

An open circuit in the armature can sometimes be detected by examining the commutator for evidence of bad burning. A badly burned spot on the commutator is caused by an arc formed every time the commutator segment connected to the open circuit passes under a brush.

SHORT CIRCUIT TEST

To test the armature for a short circuit in the winding, a "growler" must be used as shown in Fig. 19. Rotate the armature slowly. When the shorted winding is under the steel strip, it will cause the strip to vibrate.

FIG. 19—Armature Short Circuit Test

GROUNDED CIRCUIT TEST

To determine if the armature windings are grounded, make the connections as shown in Fig. 20. If the voltmeter indicates any voltage, the armature windings are grounded to the frame.

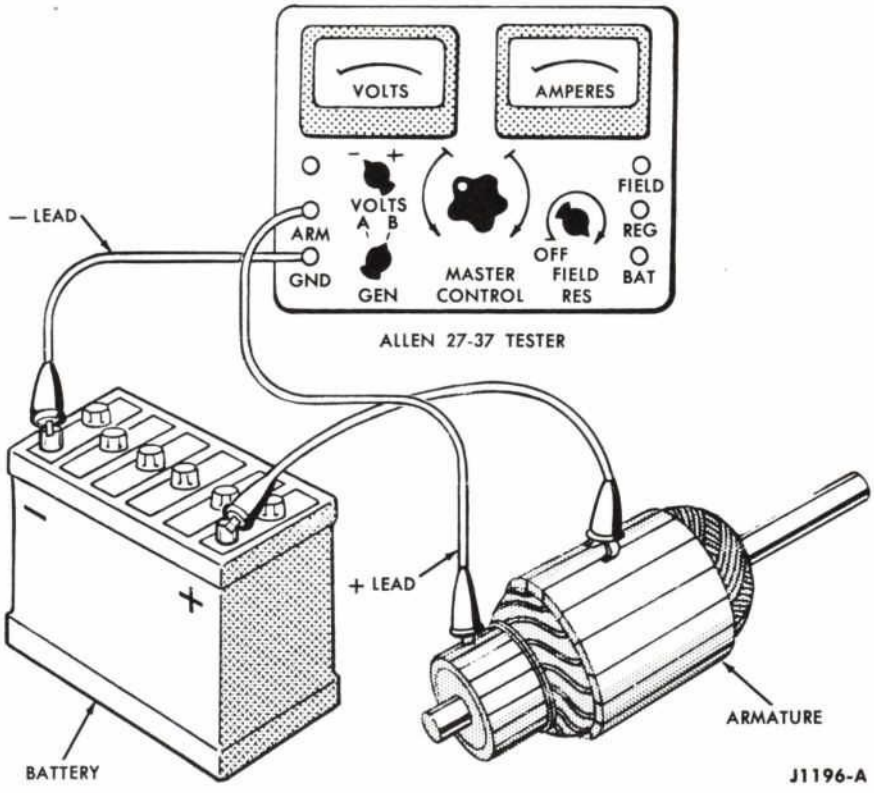

FIG. 20—Armature Grounded Circuit Test

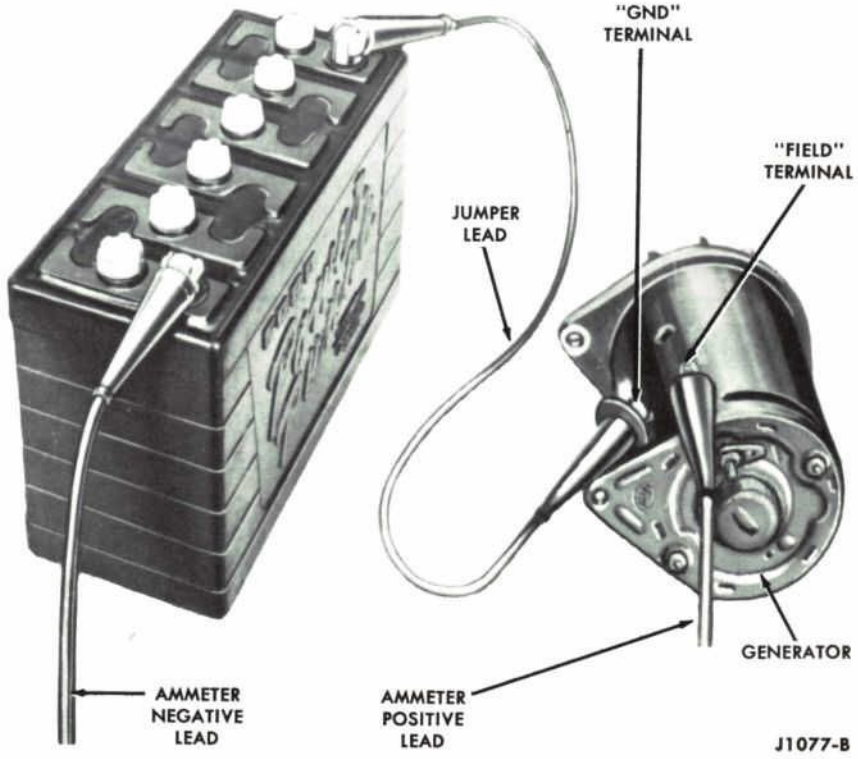

FIG. 21—Field Open or Short Circuit Test

FIELD TESTS

Only two tests are necessary for checking the field. Both open and short circuits can be tested in one operation. The second test is for a grounded circuit.

OPEN OR SHORT CIRCUIT TEST

Disconnect the field lead from the generator terminal. Connect a 0-5 amp ammeter from the battery to the field terminal as shown in Fig. 21. The normal current draw, as indicated by the ammeter, should be 1.5 to 1.6 amperes. If there is too little or no current flow, the field has a high resistance or is open. A current flow considerably higher than that specified above indicates shorted or grounded turns.

GROUNDED CIRCUIT TEST

Remove the ground terminal stud from the generator frame. Make the meter and battery connections as shown in Fig. 22. If the voltmeter indicates any voltage, the field coils are grounded. **Be sure that the ground terminal stud is not touching the housing.**

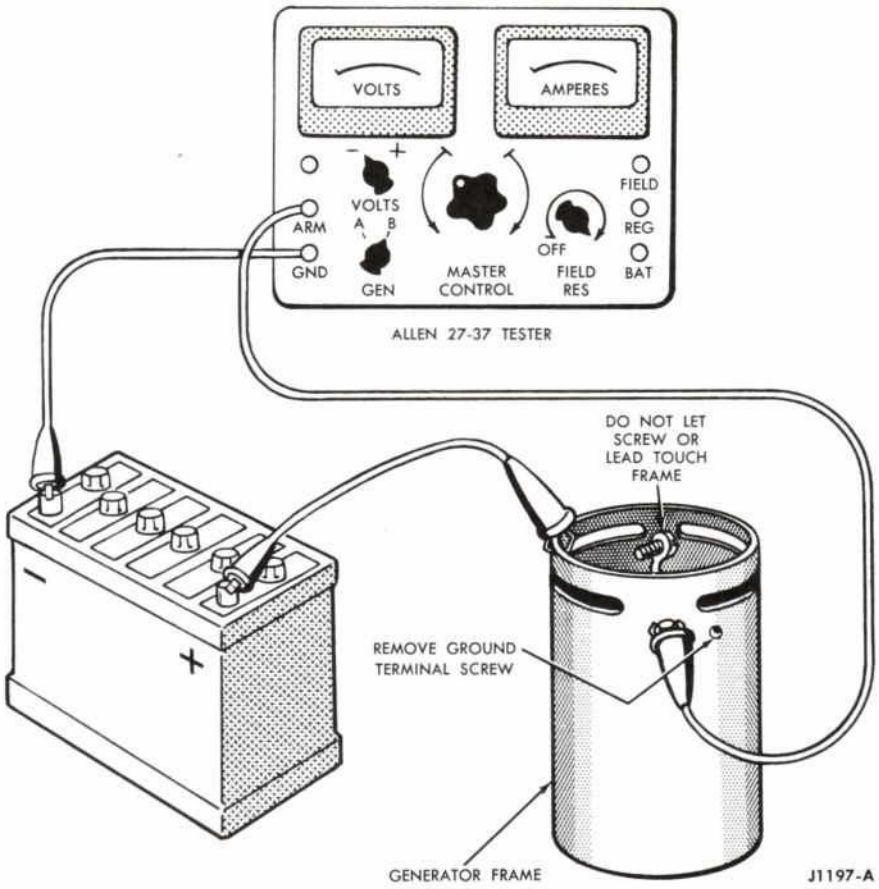

FIG. 22— Field Grounded Circuit Test

2 GENERATOR REPLACEMENT

1. Disconnect the armature, field, and ground wires at the generator terminals.

2. Remove the adjustment arm to generator bolt, the generator belt, and the two pivot bolts from the mounting bracket. Then remove the generator.

3. To install the generator, clean the mating surfaces of the generator frame and mounting bracket.

4. Install the generator in the bracket with the two pivot bolts and lockwashers.

5. Install the generator belt and the adjustment arm to generator bolt. Adjust the belt tension and tighten all bolts securely.

6. Connect the armature, field, and ground leads on the generator terminals. Start the engine, and check the generator operation.

3 DRIVE BELT(S)

The fan belt(s) should be properly adjusted at all times. A loose belt causes improper generator or alternator operation. A belt that is too tight places a severe strain on the generator or alternator bearings.

ADJUSTMENT

1. Install the belt tension tool (Fig. 23) on the drive belt, and check the tension, following the instructions of the tool manufacturer.

2. If adjustment is necessary, loosen the generator or alternator mounting bolts and the generator or alternator adjusting arm bolt. Move the generator or alternator toward or away from the engine until the correct tension is obtained. Tighten the adjusting arm bolt and the mounting bolts before checking the tension.

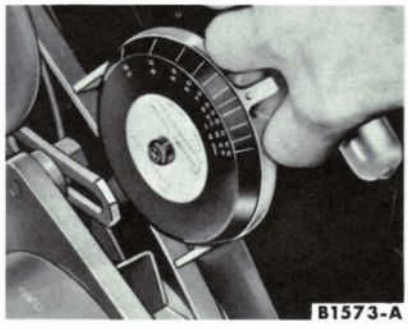

FIG. 23— Drive Belt Tension Adjustment

4 GENERATOR REGULATOR

OPERATION

The generator regulator is composed of three control units mounted as an assembly (Figs. 24, 25). Each unit has a set of contact points and an energizing coil for operating the points, and each of the units performs a separate function to maintain control of the generator.

CUTOUT RELAY

When the engine is not operating, the contact points on the cutout relay (Figs. 24 and 25) are held open by spring tension.

At approximately 12 volts, the coil is energized sufficiently to overcome the spring tension and close the cutout points connecting the generator to the external load.

VOLTAGE LIMITER RELAY

The voltage limiter holds the generator voltage below a predetermined setting by limiting the amount of voltage applied to the field coils. The voltage limiter thus protects the battery, lights, ignition system, etc., from high voltage when the system load demand is low.

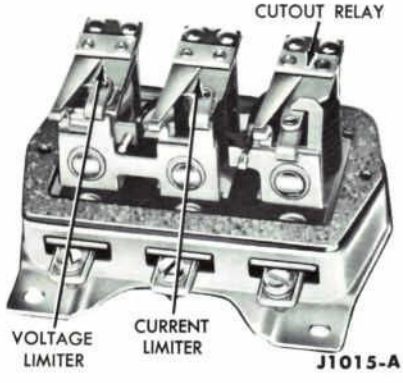

FIG. 24— Generator Regulator

FIG. 25— Heavy-Duty Generator Regulator

CURRENT LIMITER RELAY

The current limiter relay protects the generator armature windings by limiting the maximum amount of current supplied by the generator. Like the voltage limiter, the current limiter performs its function by limiting the voltage that is applied to the generator field coils. The current limiter thus protects the generator when the system load demand is high.

TEMPERATURE COMPENSATION

The generator regulator has been designed to exercise automatic control over the generating system and also to compensate for seasonal temperature changes. In cold weather a higher voltage output is required to handle the load. In warm weather the voltage must be reduced to avoid overcharging the battery. The temperature compensation is built into the regulator unit by making the armature hinge of bimetal. The temperature sensitivity of the bimetal causes the regulator voltage setting to change according to temperature. Therefore, it is necessary to establish a "normal" or stabilized regulator operating temperature to coincide with the specified voltage setting of 14.6 to 15.4 volts. The standard ambient air temperature established for this setting is 70° to 80° F. The regulator temperature for this or any setting is defined as the temperature of the regulator after 1/2 hour of operation in the vehicle or after the regulator has been heated until it becomes stabilized.

For correct voltage regulation adjustment, first be sure that the regulator has reached "normal" operating temperature as defined above; then make the voltage adjustment setting to coincide with the prevailing ambient air temperature. The specifications section shows the proper voltage limits for various ambient air temperatures.

ON THE VEHICLE

On the vehicle, ambient air temperature will be the temperature of the engine compartment air. To measure the air temperature, first clip the voltage regulation setting thermometer onto the regulator cover (Fig. 26).

Run the engine to stabilize the regulator. The engine fan will cause the air in the engine compartment to circulate past the regulator until the regulator has stabilized at the ambient air temperature. After the regulator and thermometer have stabilized, the thermometer will show the voltage setting at which the regulator should be operating.

When checking or adjusting the heavy-duty regulators, observe the temperature indicated by the thermometer, and refer to the specifications section for the correct voltage setting.

ON THE TEST BENCH

When the regulator is mounted on a regulator test bench, the ambient air temperature will be the room temperature. Clip the voltage regulator setting thermometer onto the regulator cover (Fig. 26). Mount a small fan on the regulator test bench about 12 to 15 inches away from the regulator. Operate the fan and the regulator to stabilize the regulator. The fan will provide sufficient air flow to ensure stabilization of the regulator at the temperature in-

FIG. 26— Voltage Regulation Setting Thermometer

dicated by the thermometer. After stabilization, the thermometer will show the voltage setting at which the regulator should be operating.

REGULATOR AND CIRCUIT TESTS

The four tests presented here are outlined for on-the-car operation and should be conducted in the sequence indicated. Be sure that the regulator is at "normal" operating temperature (equivalent to the temperature after thirty minutes of operation on the vehicle with a 10 ampere load).

Always be careful when making any test connections to the regulator so as not to short the battery lead or terminal to the regulator field terminal. To do so will burn the regulator contacts. Open the battery adapter switch and disconnect the red ammeter lead while making these connections.

CUTOUT TEST

Use the volt-amp tester as follows:

1. Set the generator type knob at the B position (A position on Autolite generators), set the voltage knob at the -20 position.
2. Make the connections as shown in Fig. 17.
3. Adjust the engine speed to approximately 1500 rpm and open the battery adapter switch.
4. Turn the field resistance knob counterclockwise, and observe that the ammeter pointer will move to the left of zero. The greatest meter reading to the left of the zero scale marking is the opening ampere setting of the cutout relay and should be read just before the meter pointer returns to zero.
5. Slowly turn the field resistance knob clockwise, and watch both the voltmeter and the ammeter.
6. The cutout closing voltage setting will be the highest value indicated by the voltmeter just before the ammeter pointer starts to show a charging current. This value will usually be indicated by an abrupt decrease of climb in the voltmeter reading. Refer to specifications for the correct closing voltage, and adjust if necessary. If any adjustment of the cutout relay is necessary, the battery adapter switch should be opened, and the ammeter "BAT" wire disconnected.

If the cutout relay tests are according to the specifications, proceed with the next test.

VOLTAGE LIMITER TEST

1. Make the connections as shown in Fig. 27.
2. With the engine operating at approximately 1500 rpm, as for the cutout relay check, turn the master control knob to the voltage regulator 1/4-ohm resistance position.
3. Turn the field resistance knob to the off position and then to its maximum clockwise rotation, which will cycle the generator.
4. Observe the voltmeter reading, which will indicate the setting of the voltage limiter. Refer to the specifications for the correct setting.

CURRENT LIMITER TEST

The connections for checking the current limiter remain the same as for the voltage limiter check (Fig. 27). An increase in engine rpm may be required, depending upon the specific generator used in the charging system.

1. Turn the field resistance knob to its maximum clockwise rotation.
2. Turn the master control knob to the current regulator position.

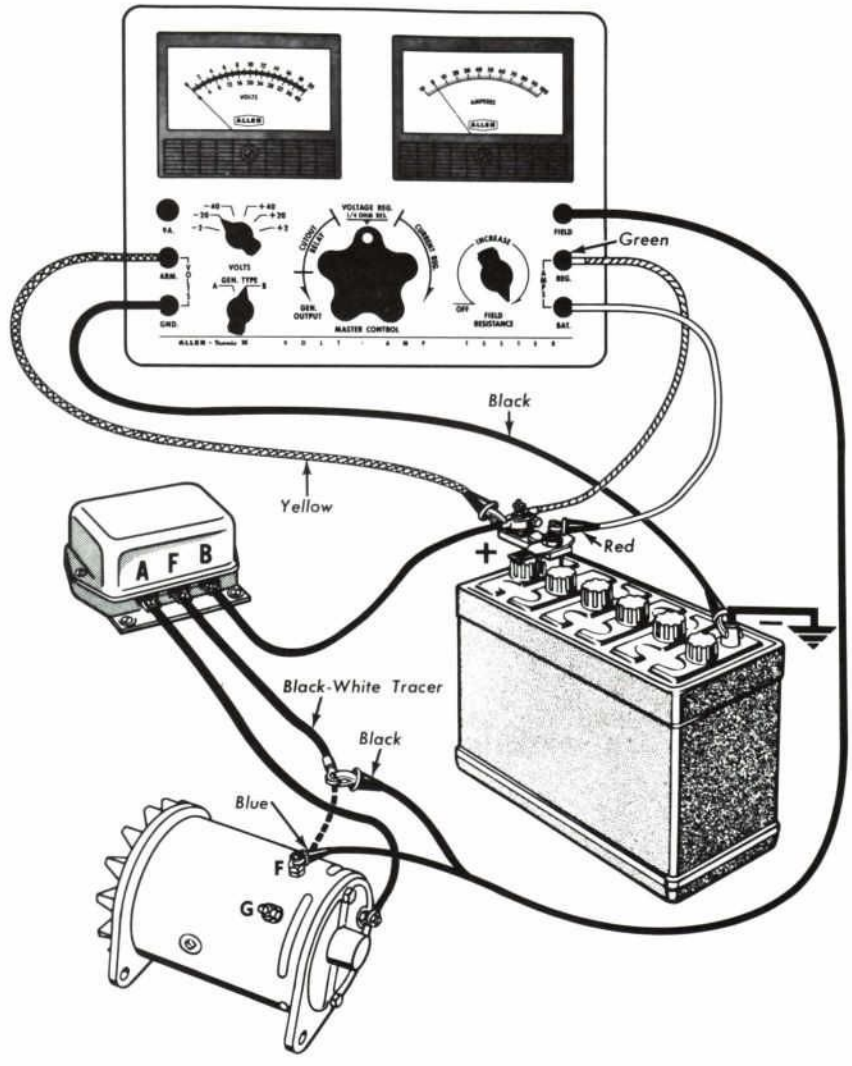

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FIG. 27 — Voltage Limiter and Current Limiter Test Connections

3. Continue to adjust the master control knob in a clockwise rotation until the highest ammeter indication is reached.

4. The ammeter reading will indicate the setting of the current limiter.

5. Observe the ammeter reading, and release the master control knob. Refer to the specifications for the correct setting, and make the adjustments if necessary.

Upon completion of this test, turn the master control knob to the cutout relay position, and proceed with the next test.

External Circuit Resistance Test

For the purpose of this test, the resistance values of the circuit have been converted to voltage drop readings.

There are two parts to this test. The first covers the voltage drop from the generator to the regulator ground, and the second covers the voltage drop from the generator armature terminal to the battery positive terminal.

VOLTAGE DROP (GENERATOR TO BATTERY GROUND)

An excessive voltage drop in the generator to battery ground circuit may be caused by a defective ground circuit between the generator and battery ground.

1. Make the connections as shown in Fig. 28.

2. Adjust the field resistance knob to produce a charging current of 20 amperes.

3. Observe the voltmeter. No reading, or at best a very low reading, should be indicated. If the reading is less than 2 volts, turn the volts switch to the 2-volt position.

4. Voltage drop between the generator frame and the battery negative terminal should not exceed 0.1 volt.

5. After the test is completed, turn the volts switch back to the -20 position.

VOLTAGE DROP (GENERATOR ARMATURE TO BATTERY)

An excessive voltage drop in the generator armature to battery circuit may be caused by loose or corroded connections or defective wiring in the charging circuit between the generator output terminal through the regulator to the hot battery terminal.

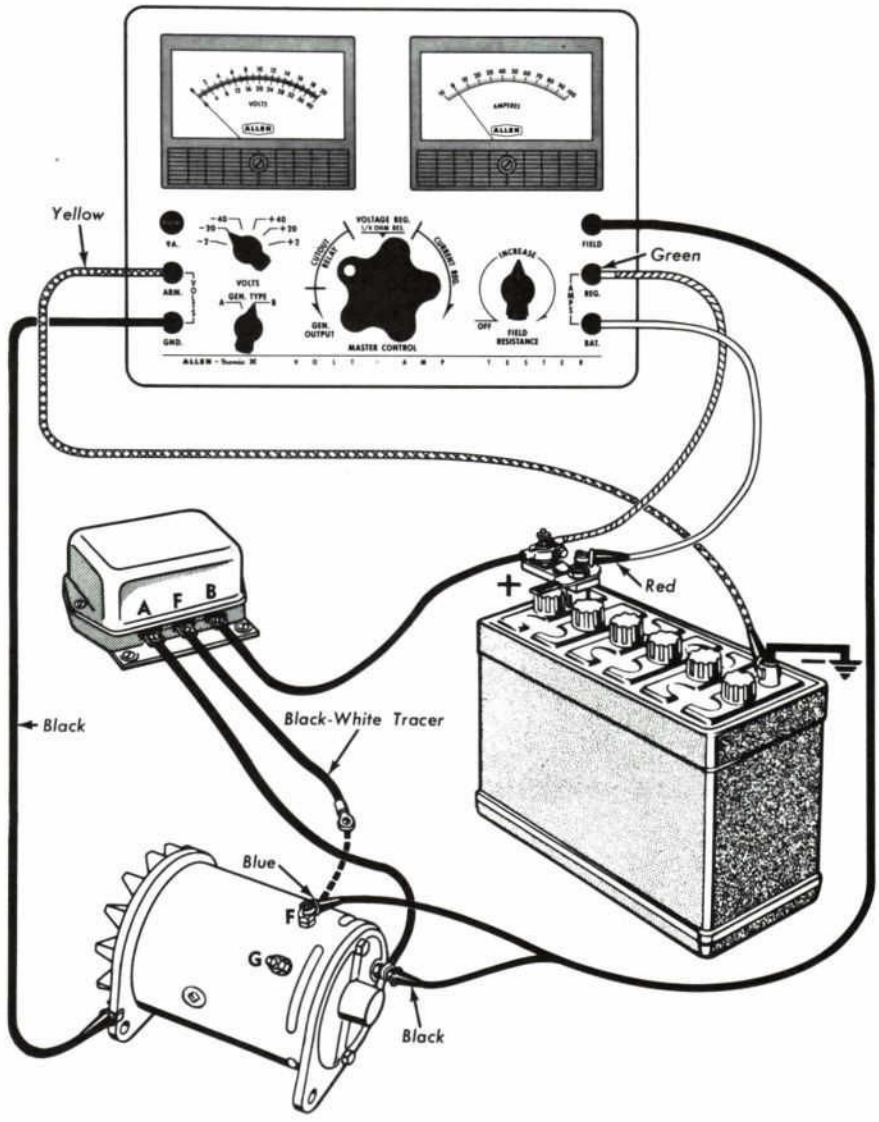

FIG. 28 — Voltage Drop (Generator to Battery Ground)

1. Except for the black voltmeter lead which is not connected at this time, make the connections as shown in Fig. 29.

2. Turn the master control knob to the cutout relay position.

3. Adjust the field resistance knob to produce an ammeter reading of 20 amperes. Now connect the black voltmeter lead to the adapter switch terminal (Fig. 29).

4. Observe the voltmeter; and, if the reading is less than 2 volts, turn the voltage switch to the -2 volt position.

5. If the voltage drop as indicated by the voltmeter is not within specifications, the connections and cables should be inspected for corrosion or looseness causing excessive charging circuit resistance. Make repairs if required.

6. Turn the voltage switch to the -20 volt position. Disconnect the black voltmeter lead. Stop the engine, and disconnect the rest of the test leads.

GENERATOR REGULATOR ELECTRICAL ADJUSTMENT

The adjustment of the regulator must be checked with the regulator at normal operating temperature.

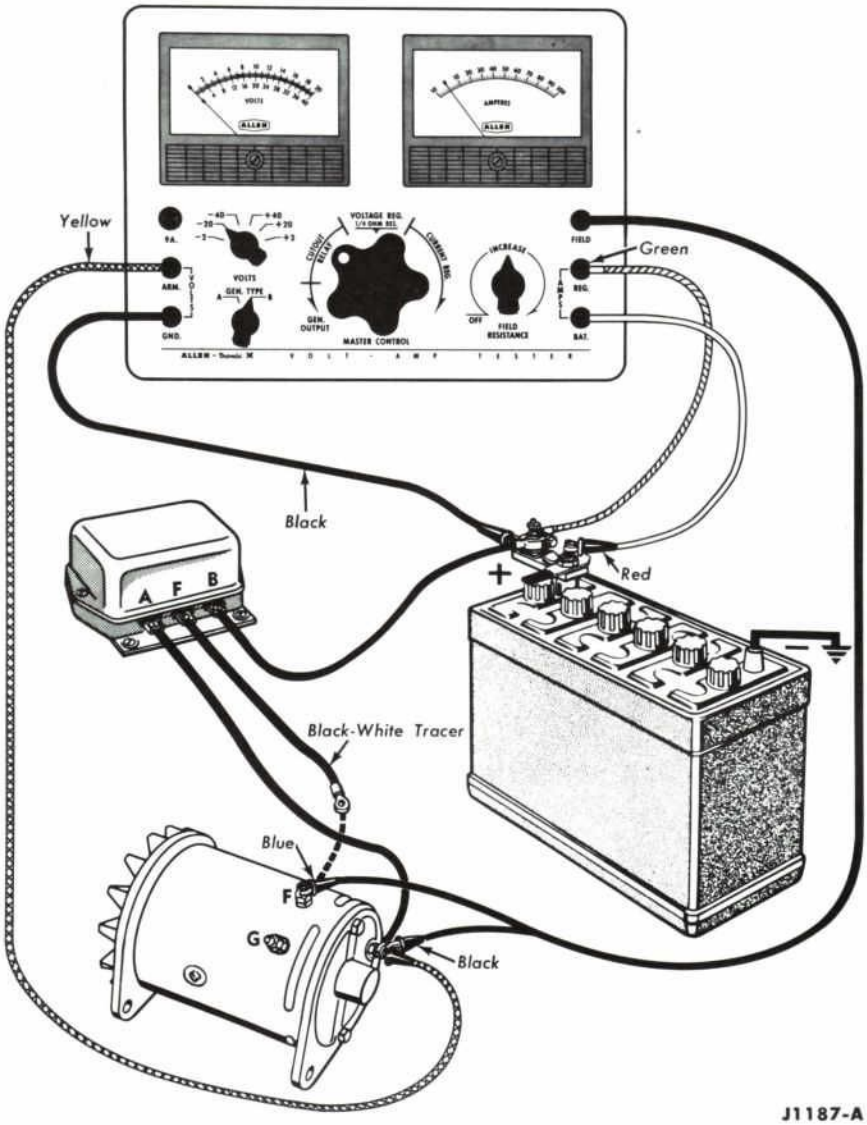

FIG. 29— Voltage Drop (Generator Armature to Battery)

ADJUST CUT-IN VOLTAGE

The cut-in voltage is increased by bending the adjusting arm upward or decreased by bending it downward (Fig. 30).

To adjust the cut-in voltage on the heavy-duty Autolite regulator, bend the cut-out spring adjusting arm upward to decrease the cut-in voltage and downward to increase the cut-in voltage (Fig. 31).

ADJUST VOLTAGE LIMITER

Make a regulator voltage setting test with the cover on. If the regulator is not within the limits as shown in the Specifications Section for the ambient temperatures involved, compute the difference as a positive or negative correction. Remove the regulator cover and make a new regulator voltage limit test. Adjust the new setting either up or down by the amount of the correction just computed. If the voltage is less than that specified, increase the spring tension by bending the adjusting arm upward (Fig. 32). To decrease the voltage, bend the adjusting arm downward. Check the voltage setting with the cover replaced. Readjust it if necessary.

To adjust the voltage limit on the Autolite heavy-duty regulator, bend the voltage limiter

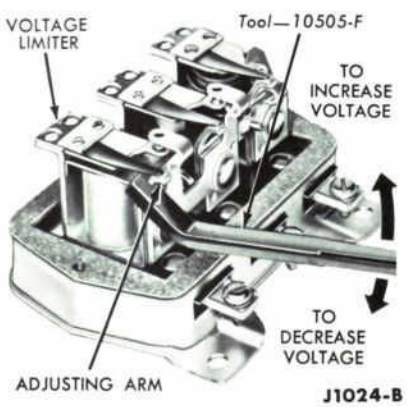

FIG. 30— Cut-In Voltage Adjustment

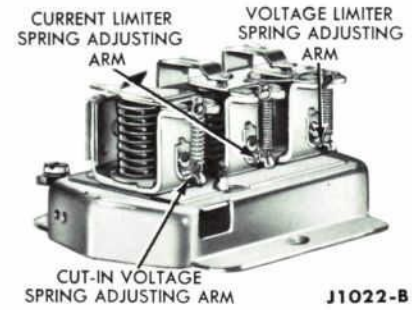

FIG. 31— Autolite Heavy-Duty Regulator Adjustment

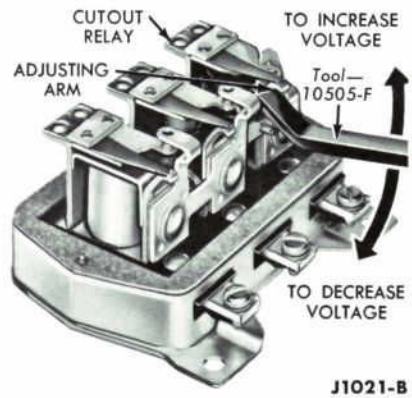

FIG. 32— Voltage Limit Adjustment

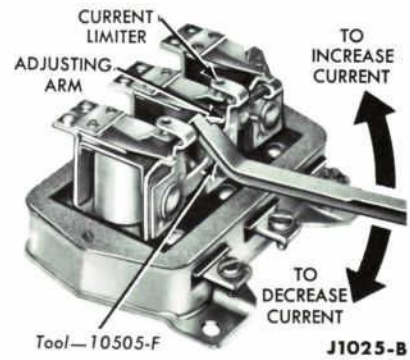

FIG. 33— Current Limit Adjustment

spring adjusting arm upward to decrease the voltage and downward to increase the voltage (Fig. 31). Recheck the voltage with the cover temporarily in place.

ADJUST CURRENT LIMITER

If the current on the regulator is less than that specified, increase the spring tension by bending the adjusting arm upward (Fig. 33).

To decrease the current limit, bend the adjusting arm downward. Install the cover and check the setting.

For the current limit adjustment on the Autolite heavy-duty regulators, bend the current limiter spring adjusting arm upward to decrease the current and downward to increase the current (Fig. 31). Install the cover gasket, cover and screws.

5 GENERATOR AND GENERATOR REGULATOR TROUBLE DIAGNOSIS

If a battery has failed, is low in charge, or requires water frequently, the reason for the condition must be found.

Possible causes for these conditions are given in the trouble diagnosis guide. Follow through the complete procedure to make sure that all possible causes have been checked and corrected.

TABLE 3—Generator and Regulator and Alternator-Rectifier and Regulator Trouble Diagnosis Guides

SYMPTOM	PROBABLE CAUSE	TESTS TO PERFORM
SLOW CRANKING, HARD STARTING, HEADLIGHTS DIM AT IDLE SPEED	Driver belt worn, improperly adjusted, or broken	Adjust the drive belt to specifications, or replace the drive belt.
	Excessive resistance in the generator to battery, alternator to battery, or battery to ground circuit	Locate the cause of the high resistance. (See the External Circuit Test.) Clean, tighten, repair or replace the unit causing the high resistance.
	Open or short Field Circuit	Locate the defective circuit. (See Generator Open or Short Circuit Test, Part 3, or Alternator Open or Short Circuit Test, Part 4.) If a defective circuit is indicated, repair or replace the generator or alternator.
	High regulator cut-in voltage	Check cut-in voltage. (See Generator Regulator Cut-out Test, Part 3, or Alternator Regulator Load Relay Test, Part 4.) If necessary, adjust to specifications, or replace regulator.
	Low amperage in generator or alternator to battery circuit	Test the generator or alternator output. (See Generator Output Test, Part 3, or Alternator Output Test Part 4.) If necessary adjust current limiter. (See Adjust Generator Regulator Current Limiter, Part 3, or Adjust Alternator Regulator Current Limiter, Part 4.)
SLOW CRANKING, HARD STARTING, HEADLIGHTS DIM AT IDLE SPEED (Cont.)	Low voltage setting of regulators	Check voltage. (See Generator Regulator Voltage Limiter Test, Part 3, or Alternator Regulator Voltage Limiter Test, Part 4.) If necessary, adjust voltage to specifications. (See Adjust Generator Regulator Voltage Limiter, Part 3, or Adjust Alternator Regulator Voltage Limiter, Part 4.)
	Defective Regulator	Replace the regulator.
GENERATOR, LIGHTS, FUSES, AND RADIO TUBES BURN OUT FREQUENTLY, BATTERY REQUIRES TOO-FREQUENT FILLING, IGNITION POINTS BURNED	Improperly adjusted voltage limiter	Check voltage. (See Generator Regulator Voltage Limiter Test, Part 3, or Alternator Regulator Voltage Limiter Test, Part 4.) If necessary, adjust voltage to specifications. (See Adjust Generator Regulator Voltage Limiter, Part 3, or Adjust Alternator Regulator Voltage Limiter, Part 4.)
	Defective regulator	Replace the regulator.

PART 4

ALTERNATOR-RECTIFIER AND REGULATOR

The alternator-rectifier system produces power in the form of alternating current. The alternating current is then rectified to direct current for use in charging the battery and supplying power to the electrical system. A three-element voltage regulator controls the alternator by controlling the current from the system to the alternator field.

The mechanical construction of the alternator differs from the DC generator in that the field rotates and the generating windings are stationary. Energy is supplied from the system to the rotating field through two brushes to two slip rings. The slip rings are mounted on the rotor shaft (Fig. 34).

Two completely sealed bearings support the rotor in the end housings. Schematic diagrams of the alternator system are shown in Figs. 35, 36, and 37.

The alternator regulator contains a load relay, voltage limiter, and current limiter mounted as an assembly. The control units are similar to those in the generator regulator.

All alternator tests are shown in Section 1. All alternator regulator tests are shown in Section 2. In order to quickly locate the cause of a malfunction, all tests should be performed in the order shown.

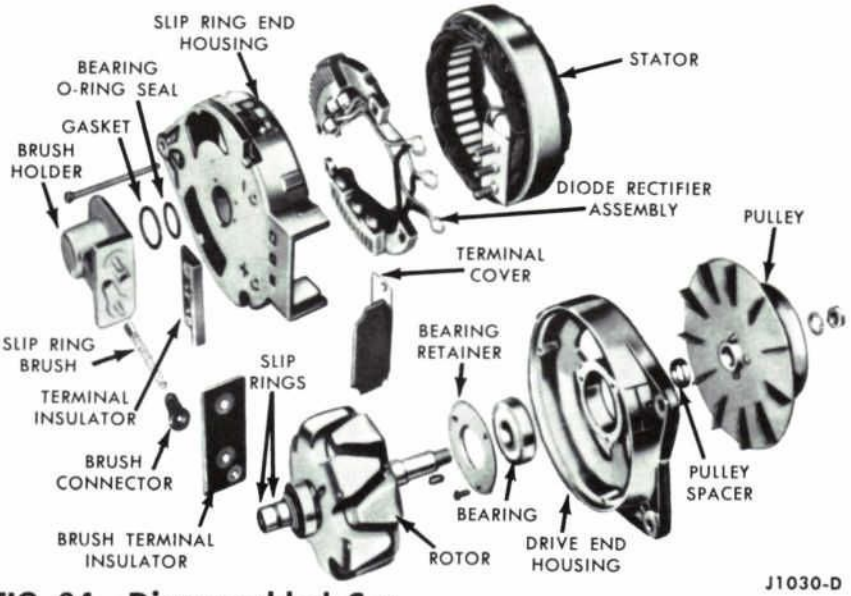

FIG. 34— Disassembled Car Alternator

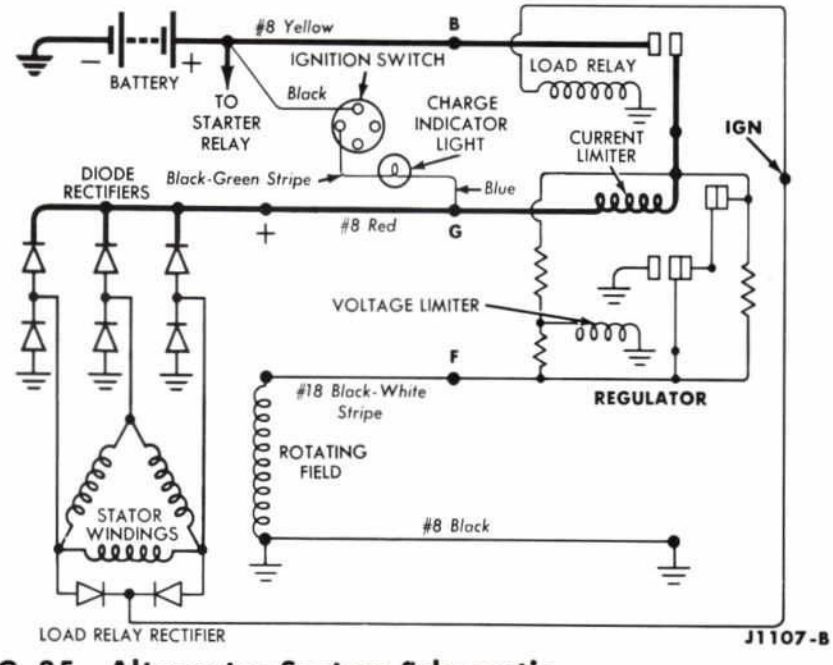

FIG. 35— Alternator System Schematic (All but Heavy-Duty Truck)

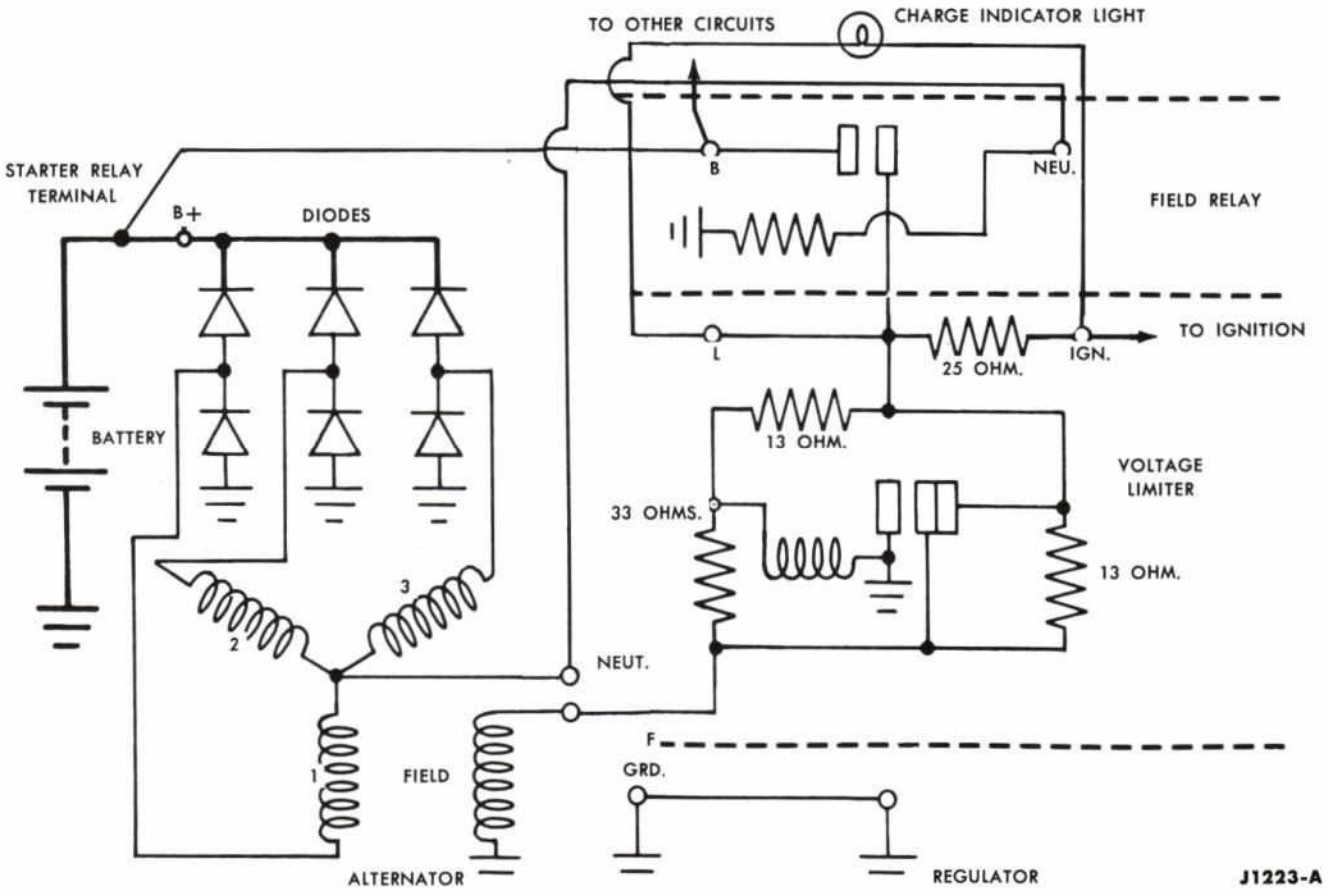

FIG. 36— Alternator System Schematic (40amp)

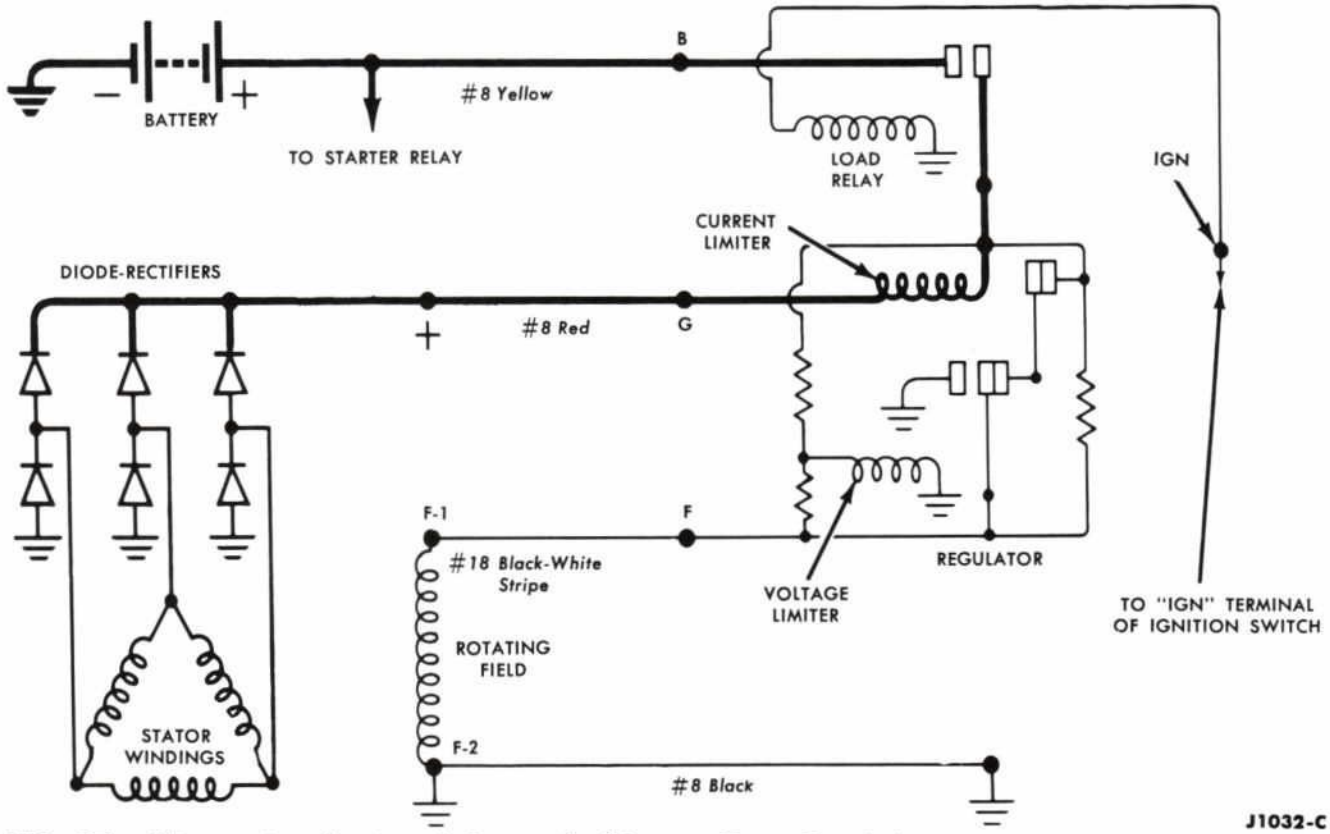

FIG. 37— Alternator System Schematic (Heavy-Duty Trucks)

1 ALTERNATOR-RECTIFIER TESTS

The equipment necessary for the alternator-rectifier tests is outlined below:

Volt-amp tester
Diode rectifier tester
Battery adapter switch
Storage battery

If a special test bench is used to test the alternator, be sure to follow the manufacturer's instructions.

ALTERNATOR-RECTIFIER OUTPUT TEST

When an alternator-rectifier output test is conducted off the vehicle, a test bench must be used. In this case, the alternator is placed on the test bench and driven by a motor. Follow the procedure given by the manufacturer.

To test the alternator on the vehicle, proceed as follows:

1. Place the volts switch at the -20 position.

2. Turn the generator type switch to the "B" position.

3. Make the connections as shown in Fig. 38.

4. Close the battery adapter switch. Start the engine and operate it at 1600 rpm.

5. Open the battery adapter switch. Turn the master control knob to generator output. Read the output current. Do not exceed the maximum rated output as indicated in the specifications. **If the output is according to specifications, stop the engine and disconnect the leads in a minimum amount of time to prevent overheating the rectifier.**

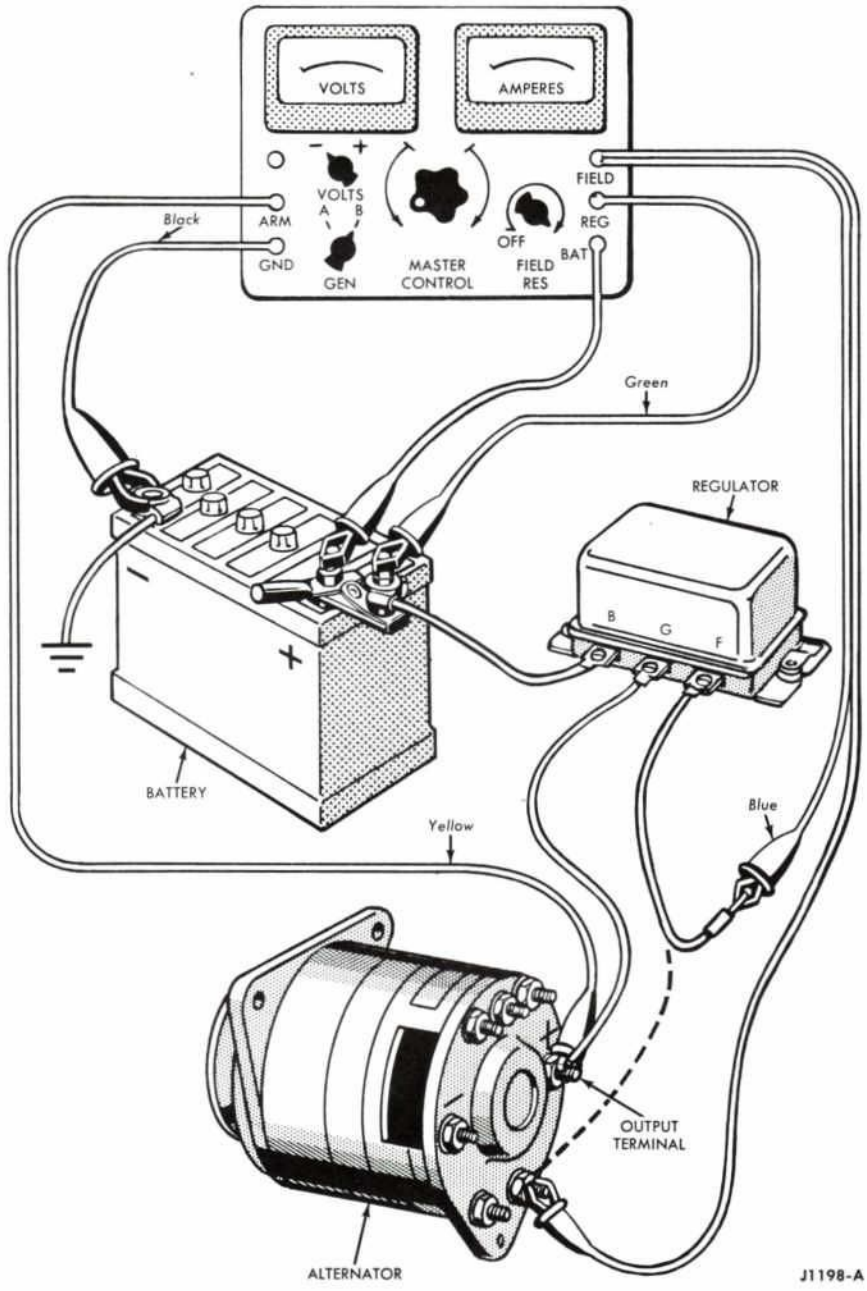

FIG. 38 — Alternator Output Test Connections

FIELD OPEN OR SHORT CIRCUIT TEST

If an alternator-rectifier output test shows the output to be less than that specified, make the following alternator tests to determine what part of the alternator-rectifier is at fault. First make certain that the regulator "G" terminal-to-alternator + lead and the regulator-to-battery lead are not defective.

Disconnect the field lead from the alternator terminal. Connect the volt-amp tester as shown in Fig. 39. The normal current draw, as indicated by the ammeter, should be to specifications. If there is little or no current flow, the field has a high resistance or is open. A current flow considerably higher than that specified indicates shorted or grounded turns. If the test shows that the field is shorted and the field brush assembly is not at fault, the entire rotor assembly must be replaced.

RECTIFIER TEST

The 60 ampere alternator can be tested either on or off the vehicle. The 40 ampere alternator can only be tested off of the vehicle.

OFF THE VEHICLE (40 AMPERE)

Remove the alternator from the vehicle. Disassemble the slip-ring end housing and stator assembly from the alternator.

Plug the rectifier diode tester into a 110 volt power supply (Fig. 40). Connect the black test lead to one of the heat sinks (for the positive diode case the black lead

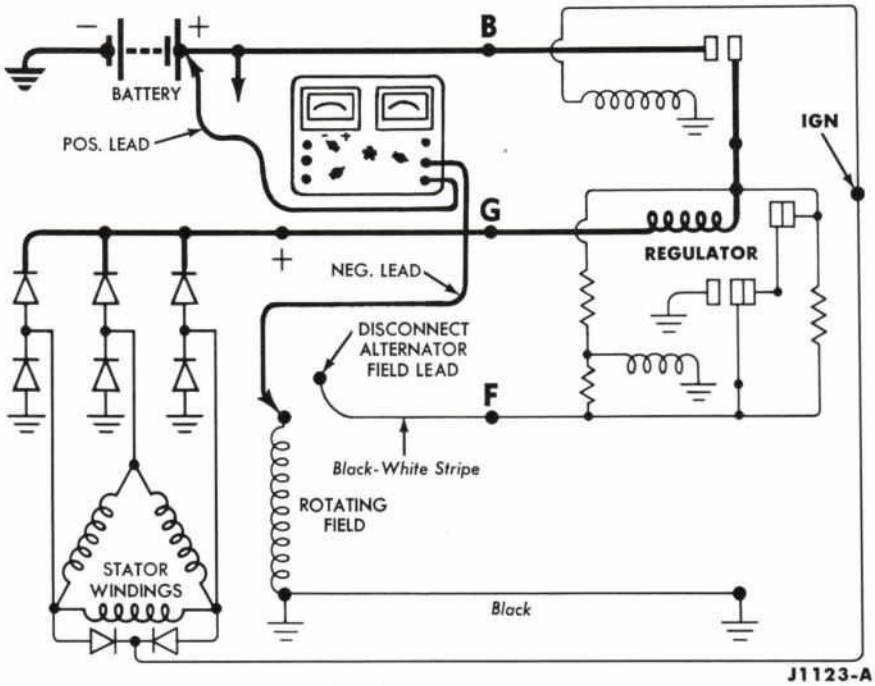

FIG. 39—Alternator Field Open or Short Circuit Test—Schematic

could be connected to the "B+" terminal, and for the negative diode case the black lead could be connected to the end housing casting). Now touch the red lead to the metal wire on each of the three corresponding diodes. If the meter readings are 2 amperes or more for each diode and the readings are within 2 scale divisions, the diodes are satisfactory. If a meter reading of 2 amperes or more is obtained for 2 diodes and a reading of 1 ampere or less is obtained on the third diode, the diode reading one ampere or less is defective. Repeat the test for the other diode case.

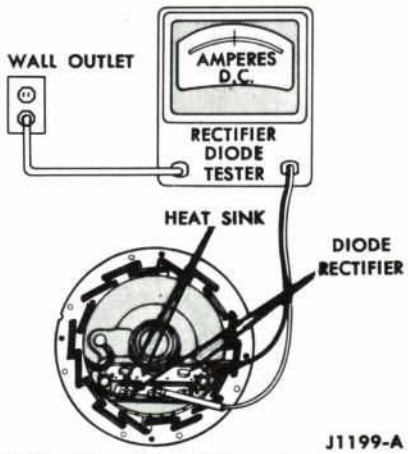

FIG. 40—Rectifier Test Connections

If the alternator test shows that the rectifier and field assemblies are all right, the stator is defective.

ON THE VEHICLE (60 AMPERE)

Plug the rectifier diode tester into a 110 volt power supply. Connect the black test lead to either the "+" terminal or the alternator case. Now touch the red lead to each of the 3 rectifier-diode terminals. If the meter reading is 2 or more amperes for 2 diodes and 1 ampere or less for the third diode, the diode reading 1 ampere or less is defective. Repeat the test with the black lead connected to the "–" terminal.

2 ALTERNATOR-RECTIFIER REGULATOR

The alternator regulator is composed of three control units mounted as an assembly (Fig. 41). The units are similar in operation to those used in the standard generator regulator. Because the reverse current through the diode rectifiers is small, a reverse current cut-out relay is not required.

LOAD RELAY

A load relay (Fig. 41), controlled by either the alternator generating windings (vehicles with a charge indicator light) or the ignition switch, connects the battery to the alternator output.

VOLTAGE LIMITER

The voltage limiter (Fig. 41) holds the alternator voltage below a predetermined setting by inserting resistance in the alternator field circuit.

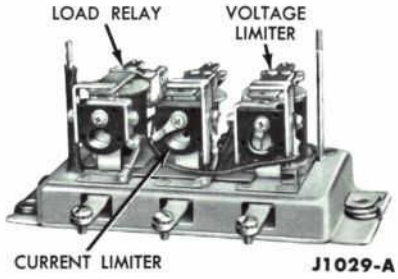

FIG. 41—Alternator Regulator

CURRENT LIMITER

The current limiter (Fig. 41) protects the alternator-rectifier by limiting the maximum amount of current supplied by the alternator-rectifier. Like the voltage limiter, the current limiter performs its function by limiting the voltage that is supplied to the alternator field coil and thus protects the alternator-rectifier when the system load demand is high.

ALTERNATOR-RECTIFIER REGULATOR AND CIRCUIT TESTS

The instruments and equipment for making the tests are listed below:

Battery adapter switch
Storage battery
Volt-amp tester

The four tests presented here are outlined for on-the-vehicle operation and should be conducted in the sequence indicated.

Be sure that the regulator is at "normal" operating temperature (equivalent to the temperature after 30 minutes of operation on the vehicle with 10-ampere load).

LOAD RELAY TEST

This test is performed with the volt-amp tester as follows:

1. Place the master control knob at the cutout relay test.
2. Connect the black (GND) lead to a good ground.
3. Connect the yellow (ARM) lead to the regulator G terminal.
4. With the ignition key off there should be a zero reading on the voltmeter.
5. Now turn the ignition key on and observe the voltmeter. If the voltmeter indicates that there is voltage in the circuit, the load relay is working properly.

VOLTAGE LIMITER TEST

The connections for this test are the same as the connections for the alternator output test (Fig. 38).

1. Turn the field resistance knob to its maximum position.
2. With the engine running at approximately 1600 rpm, turn the master control knob to the voltage regulator 1/4-ohm-resistance position.
3. Observe the voltmeter reading, which will indicate the setting of the voltage limiter. To retest the voltage limiter, stop the engine by turning the ignition key to the off position momentarily; then start the engine and increase the speed to 1600 rpm.

CURRENT LIMITER TEST

The connections for this test remain the same as for the voltage limiter test (Fig. 38).

1. Turn the field resistance knob to its maximum clockwise position.
2. Bring engine up to approximately 1600 rpm.
3. Turn the master control knob to the current regulator position.
4. Continue to adjust the master control knob in a clockwise rotation until the highest ammeter indication is reached.
5. The ammeter will indicate the setting of the current limiter. Refer to specifications for the correct setting.
6. After observing the ammeter reading, release the master control knob.

EXTERNAL RESISTANCE TEST

An excessive voltage drop in the alternator to battery ground circuit may be caused by a defective ground circuit between the alternator and battery ground.

1. Make the connections as shown in Fig. 42.
2. Turn the master control knob to the cutout relay position.
3. Bring the engine up to 1600 rpm and allow it to run there so that the battery voltage can stabilize; then turn the field resistance knob to produce an ammeter reading of 20 amperes.
4. If the voltmeter reading is less than 2 volts, turn the volts

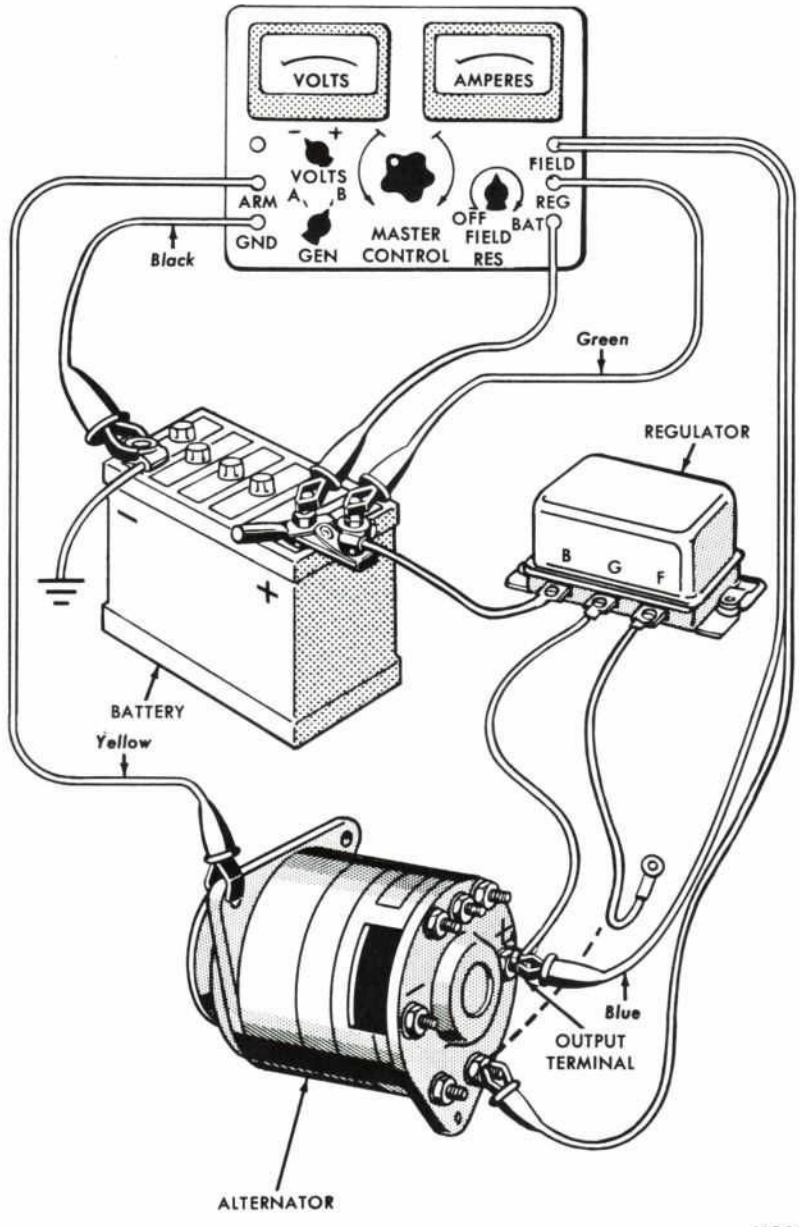

FIG. 42— Voltage Drop Test — Alternator to Battery Ground Terminal

switch to the -2 position. The voltage reading should be equal to or less than specifications.

5. After the test is completed turn the volts switch back to the -20 position.

VOLTAGE DROP TEST—ALTERNATOR TO BATTERY POSITIVE TERMINAL

1. Refer to Fig. 43 for test connections.

2. Follow the procedure outlined under "EXTERNAL RESISTANCE TEST".

ALTERNATOR-RECTIFIER REGULATOR ELECTRICAL ADJUSTMENTS

Final adjustment of the regulator must be made with the regulator at normal operating temperature. For any of the adjustments given below, remove the cover by removing the two wing nuts.

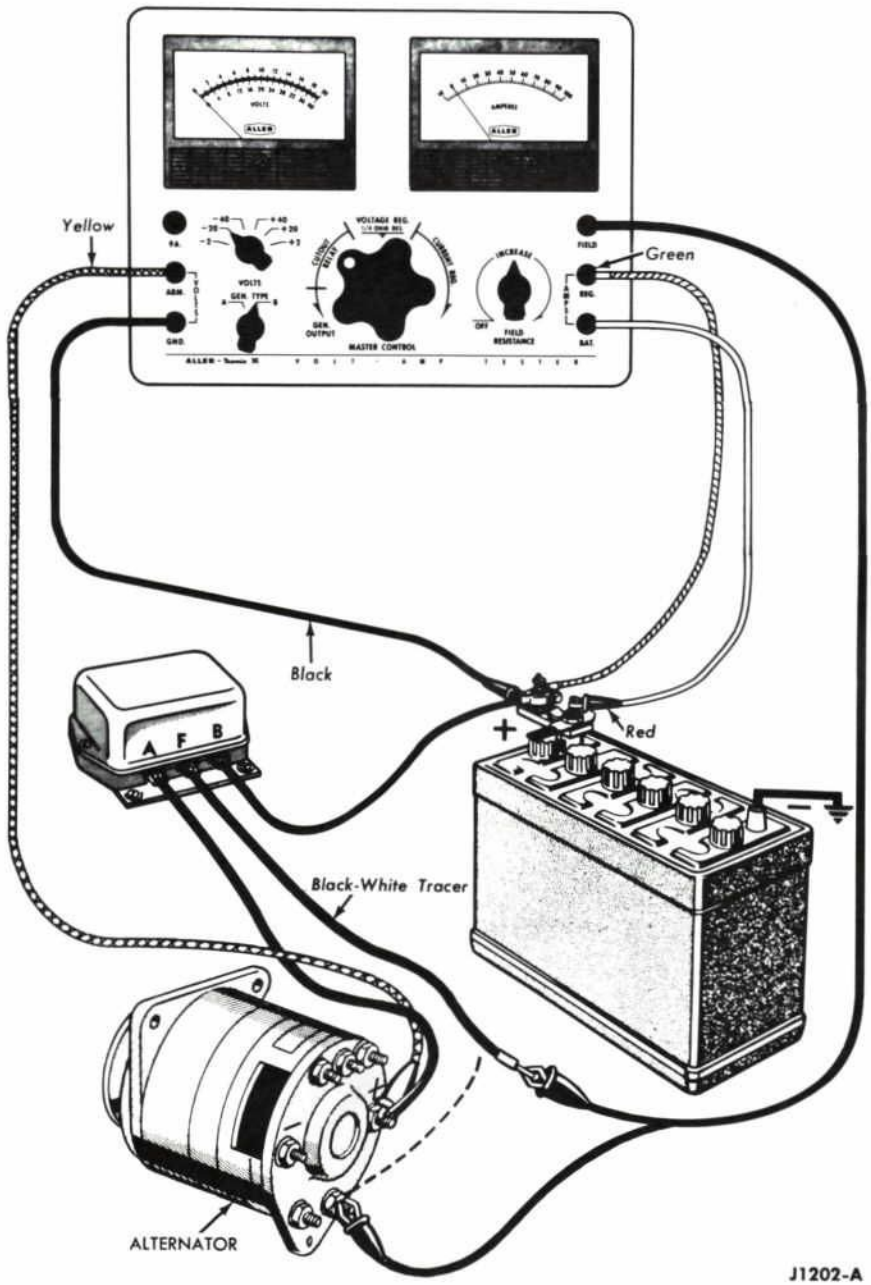

FIG. 43—Voltage Drop Test—Alternator to Battery Positive Terminal

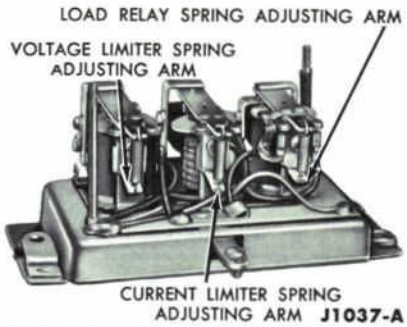

FIG. 44—Cut-In Voltage Adjustment

ADJUST VOLTAGE LIMITER

Make a voltage limit test. Adjust the voltage setting either up or down to bring the voltage limit to within the specified value.

To increase the voltage setting, bend the adjusting arm downward (Fig. 44). To decrease the voltage setting, bend the adjusting arm upward (Fig. 44). **Before setting the voltage and before making a final voltage test, the alternator speed must be reduced to zero and the ignition switch opened momentarily.**

ADJUST CURRENT LIMITER

Make a current limit test. Adjust the current setting either up or down to bring the current limit to within the specified value.

To increase the current setting, bend the adjusting arm downward (Fig. 44). To decrease the current setting, bend the adjusting arm upward (Fig. 44).

ALTERNATOR-RECTIFIER AND REGULATOR TROUBLE DIAGNOSIS

If a battery has failed, is low in charge, or requires water frequently, the reason for the condition must be found.

Possible causes for these conditions are given in the trouble diagnosis guide. Follow through the complete procedure to make sure that all possible causes have been checked and corrected. (The Alternator-Rectifier and Regulator Trouble Diagnosis Guide is combined with the Generator Guide, Part 3.)

PART 5
LIGHTING SYSTEM

1 HEADLIGHT ALIGNMENT

A typical circuit diagram for the exterior lights is shown in Fig. 45.

All headlight adjustments are to be made with 1/2 a tank of fuel, an empty vehicle, and recommended pressure in all tires. Before each adjustment, bounce the vehicle by pushing on the center of both the front and rear bumpers to level the vehicle.

To align the headlights by means of a wall screen, select a level portion of the shop floor. Lay out the floor and wall as shown in Fig. 46.

Establish the headlight horizontal centerline by subtracting 20 inches from the actual measured height of the headlight lens center from the floor and adding this dimension (dimension "B," upper diagram, Fig. 47) to the 20-inch reference line obtained by sighting over the uprights. Then draw the headlight vertical centerlines on the screen as measured on the car (dimension "A," Fig. 47).

HEADLIGHT ADJUSTMENT (SINGLE HEADLIGHTS)

On vehicles using single headlights, draw a reference line parallel to and 2 inches to the right of each headlight vertical centerline (Fig. 48). Now adjust the low

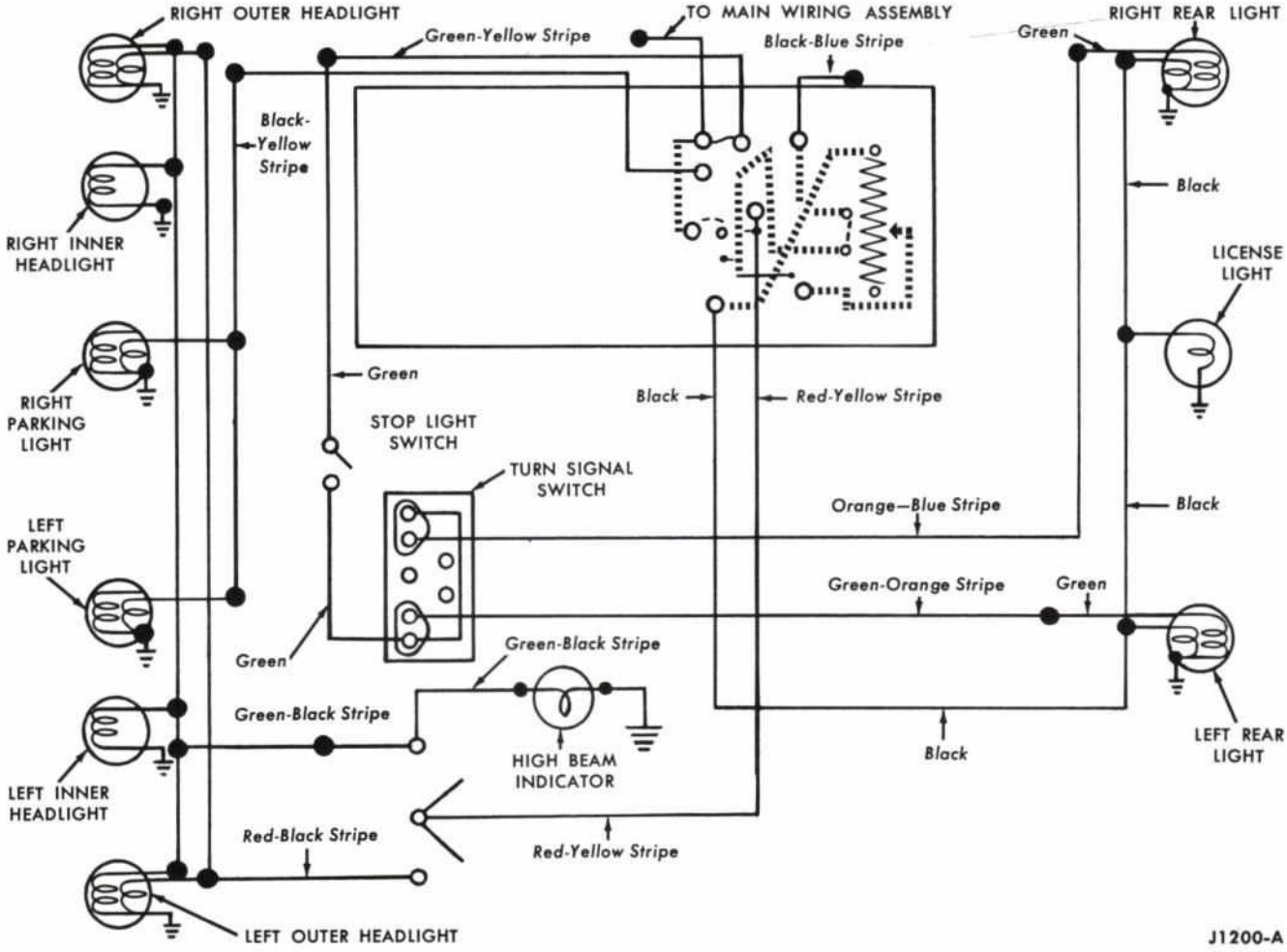

FIG. 45— Typical Exterior Light Circuit

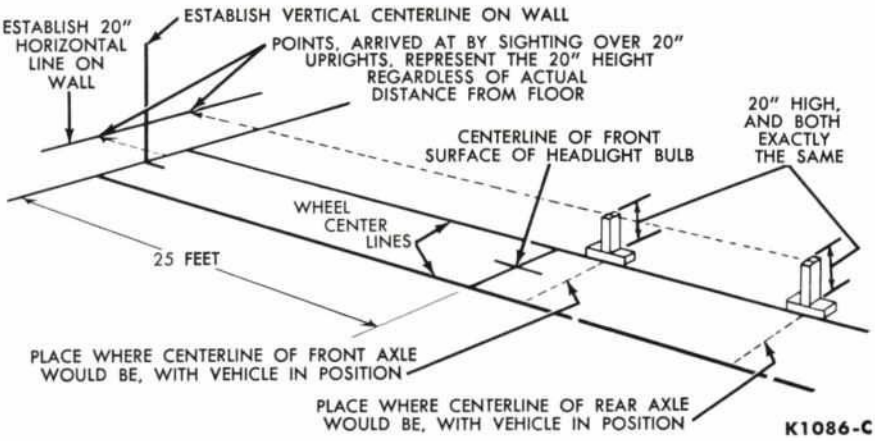

FIG. 46—Floor and Wall Layout

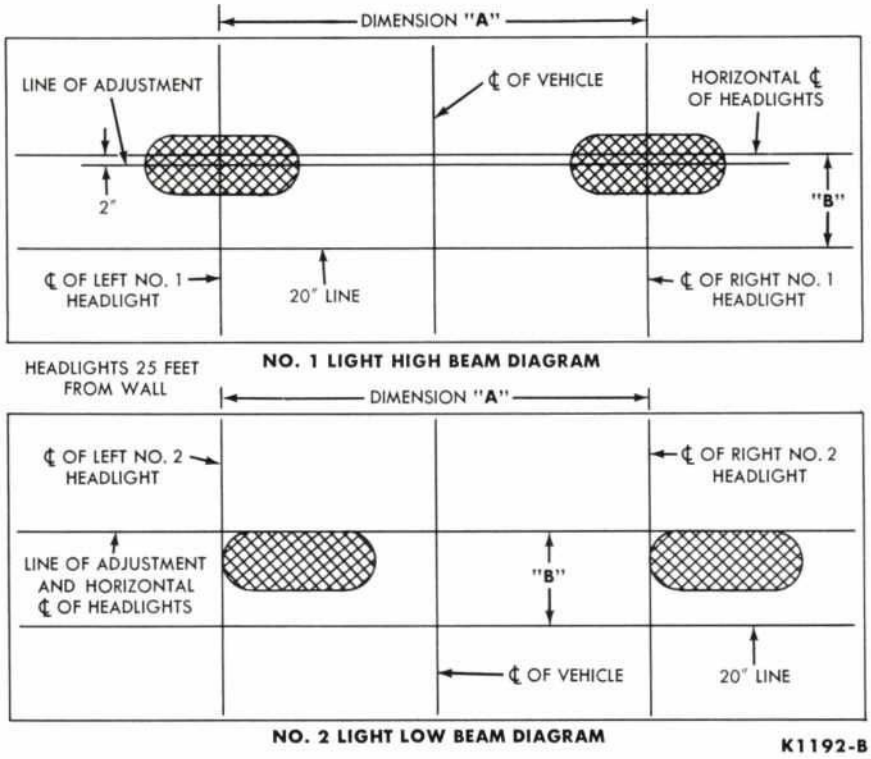

FIG. 47—Headlight Wall Screens—Dual Headlights

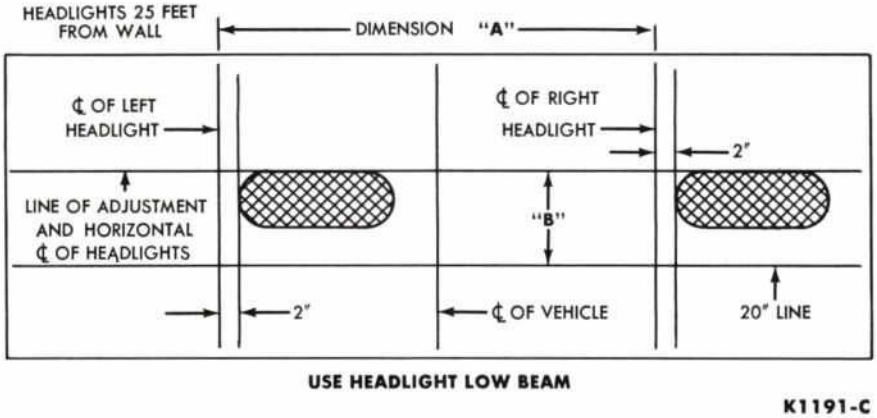

FIG. 48—Headlight Wall Screen—Single Headlights

beam, using the diagram (Fig. 48).

Each headlight is adjusted by means of two screws located under the headlight trim ring as shown in Fig. 49. **Always bring each beam into final position by turning the adjusting screws clockwise so that the headlights will be held against the tension springs when the operation is completed.**

HEADLIGHT ADJUSTMENT (DUAL HEADLIGHTS)

To align the No. 1 headlights (inner lights), draw a horizontal line 2 inches below and parallel to the headlight horizontal centerline (upper diagram, Fig. 47). Adjust each No. 1 headlight high beam as shown in the upper diagram of Fig. 47. **Cover the No. 2 lights when making this adjustment.**

To align the No. 2 headlights (outer lights), use the chart as shown in the lower diagram of Fig. 47. **Note that the line of adjustment of the No. 2 lights is the horizontal centerline of the No. 2 lights.** Turn the headlights to low beam, and adjust each No. 2 light as shown in Fig. 47.

NOTE: Some states may not approve of the 2-inch dimension for the No. 1 headlights. Check the applicable state law, as a 3-inch dimension may be required.

HEADLIGHT BULB REPLACEMENT

1. Remove the retaining screws and the headlight trim ring.

2. Loosen the retaining ring screws (Fig. 49), rotate the re-

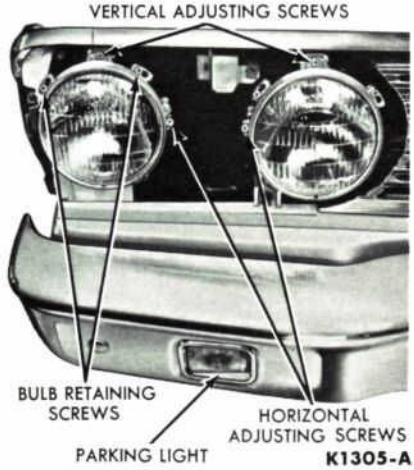

FIG. 49—Headlight Adjustment

taining ring counterclockwise, and remove it.

3. The headlight bulb may now be pulled forward far enough to disconnect the wiring assembly plug.

4. Plug in the new bulb, and place it in position, making sure that the locating tabs are placed in the positioning slots.

5. Install the headlight bulb retaining ring, rotating it clockwise under the screws, and tighten the screws.

6. Position the trim ring and install the mounting screws.

CIRCUIT BREAKER AND FUSES

A combination headlight switch, dome light switch, and circuit breaker assembly is used. The circuit breaker protects the headlight circuit.

The fuse panel, mounted under the headlight switch, contains the following fuses: parking, rear and dome light fuse, radio, back-up light, and heater fuses. The various types of fuse blocks are shown in Figs. 50, 51, and 52.

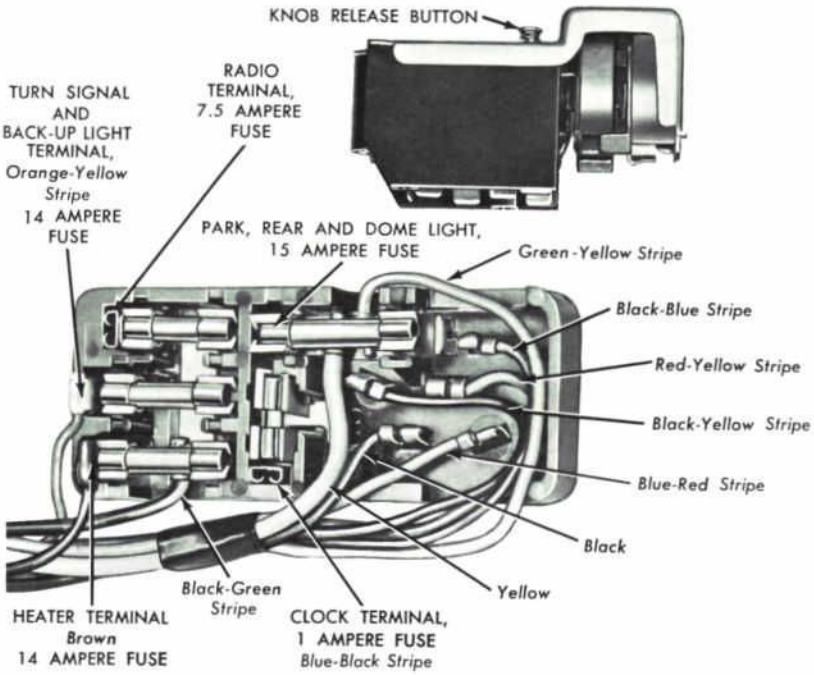

FIG. 50 — Typical Headlight and Dome Light Switch

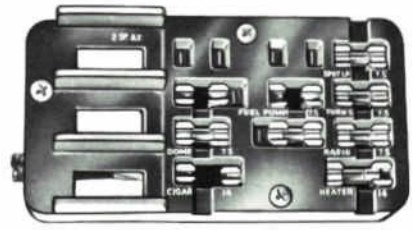

FIG. 51 — Typical Truck Fuse Block

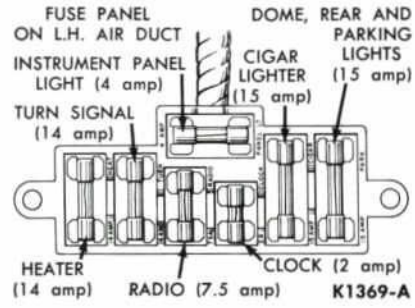

FIG. 52 — Thunderbird Fuse Block

2 LIGHTING SYSTEM TROUBLE DIAGNOSIS

Problems of the lighting system are covered in the following trouble diagnosis guide. The guide lists many of the sources of trouble encountered in the electrical system. The items listed are not in the order of the probable occurence. Individual circumstances and experience will dictate which items to check first.

TABLE 4—Lighting System Trouble Diagnosis Guide

SYMPTOM	PROBABLE CAUSE	TESTS TO PERFORM	ALTERNATE TESTS
HEADLIGHTS DO NOT LIGHT	Loose Battery Cable	Clean and tighten battery cable connections.	
	Loose quick disconnect or broken wire from the battery to the headlight switch	Repair or replace quick disconnect or wire.	
	Defective Headlight switch.	Substitute a known good switch.	
	Disconnected or broken wire from the headlight switch to the beam selector switch.	Install or replace the wire.	

TABLE 4—Lighting System Trouble Diagnosis Guide (Cont.)

SYMPTOM	PROBABLE CAUSE	TESTS TO PERFORM	ALTERNATE TESTS
HEADLIGHTS DO NOT LIGHT (Cont.)	Defective Beam selector switch	Substitute a known good switch.	
	Burned out headlight bulbs (too-high voltages in the electrical system)	Adjust voltage limiter to specifications (See Generator Regulator Voltage Limiter Adjustment, Part 3, or Alternator Regulator Voltage Limiter Adjustment, Part 4). Replace the bulb.	
	Loose or Broken Wires to the Bulb	Clean, tighten, or replace the wires.	
	Poor Ground	Clean and tighten headlight mounting screws.	
	Loose or corroded Electrical Connections	Clean, tighten, repair, or replace wires and connectors.	
	Excessive Vibration	Tighten mounting screws, replace broken or distorted bodies or sockets.	

PART 6 SERVICE SPECIFICATIONS AND SPECIAL TOOLS

BATTERY SPECIFICATIONS

BATTERY FREEZING TEMPERATURES

Specific Gravity	Freezing Temp.
1.280	−90°F.
1.250	−62°F.
1.200	−16°F.
1.150	+ 5°F.
1.100	+19°F.

ALLOWABLE FAST CHARGE TIME (domestic only)

Specific Gravity	Maximum Fast Charge Time
1.150 or less	1 hour
1.150 to 1.175	¾ hour
1.175 to 1.200	½ hour
1.200 to 1.225	¼ hour
Above 1.225	Slow Charge Only

The fully charged specific gravity of all the batteries listed below should be from 1.270 to 1.290.

ALL

Ground	Volts
Negative	12

100-800 SERIES TRUCKS

Engine Displacement	Filler Cap Color	Plates	Amp-Hours
223, 262, 292, 302, 332, parcel delivery	Red	66	55
School bus, optional on conventional and tandem 223, 262, 292, 302 and 332	Yellow	66	70
Optional on school bus, parcel delivery, and 262, 292, and 302 tilt cabs	Yellow	78	70

FALCON, FAIRLANE, AND ECONOLINE

Filler Cap Color	Plates	Amp-Hours
Yellow	54	40
Red	54	55*
Red	66	55†

*R.P.O. (all models).
†Available as a regular production option in the Falcon only.

GALAXIE AND STATION WAGON

Engine and Transmission	Filler Cap Color	Plates	Amp-Hours
All Six and 292 V-8 Engine 352 and 390 V-8 with Manual-Shift Transmissions	Red	66	55
352 and 390 V-8 with Automatic Transmissions	Gray	78	65
OPTION All Engines	Yellow	66	70
All Six and 292 V-8 Engine 352 and 390 V-8 with Manual-Shift Transmissions	Gray	78	65

THUNDERBIRD

Filler Cap Color	Plates	Amp-Hours
Gray	78	65
Yellow	66	70

850-1100 SERIES TRUCKS

401, 477, and 534 tilt cab engines	Yellow	78	70
401, 477, and 534 conventional and tandem axle	Yellow	66	70
Diesel		114	150

STARTER SPECIFICATIONS

Vehicle and Engine Displacement		Part Number	Current Draw Under Normal Load (Amperes)	Normal Engine Cranking Speed (rpm)	Minimum Stall Torque @ 5 Volts (Foot-Pounds)	Maximum Load (Amperes)	No-Load Amperage
Falcon	144	C2DF-11001-E	100-150	250-290	8	450	70
	170	C2DF-11001-F	100-150	250-290	9.6	500	70
Fairlane	170	C2DF-11001-F	100-150	250-290	9.6	500	70
	221	C2DF-11001-D	100-150	250-290	9.6	500	70
Galaxie & Station Wagon		C2AF-11001-B	155-190	150-180	14.8	580	110
Thunderbird		C2SF-11001-B	155-190	150-180	14.8	580	110
Econoline	144	C1DF-11001-A	100-150	250-290	15.5	670	70
		C2DF-11001-E	100-150	250-290	8	450	70
	170	C2DF-11001-F	100-150	250-290	9.6	500	70
		C1DF-11001-A	100-150	250-290	15.5	670	70

@ With factory-installed SelectAire.

STARTER SPECIFICATIONS (Continued)

Vehicle	Part Number	Min. Torque @ 5 Volts		Maximum No-Load Amperage @ 12 Volts	Normal Current Draw Under Load	Type of Drive
		Foot-Pounds (Min.)	Load (Amp.) (Max.)			
100-800 Trucks	Delco 2700006	14.2	525	80	210	Positive Action
	Autolite FAH-11000-A	15.5	550	85	210	Positive Action
	Ford C2AF-11001-B	14.8	580	110	210	Folo-Thru
	Delco B9TF-11001-A	17.5	525	60	210	Folo-Thru
850-1100 Trucks	Autolite 2700011	17.2	525	60	210	Folo-Thru
	Delco B9TF-11001-A	17.5	525	60	210	Folo-Thru
Cummins	Leece-Neville C1TF-11001-B			90		

GENERATOR SPECIFICATIONS

Model	Part Number	Watts @ 15 Volts	Generator rpm (Charge Starts)*	Maximum Charge Rate		Field Current Amps @ 12 volts, hot
				Amps	Gen. rpm*	
Falcon	Autolite B9FT-10000-D	600	960	40	1800	1.2-1.8
	C1DF-10000-C	375	1420	25	2610	
	Delco CODF-10000-G	525	1000	35	1850	2.7-3.0
	Ford C1DF-10000-D	450	1300	30	2525	1.2-1.8
Fairlane	Ford C2OF-10000-B	450	1300	30	2525	1.2-1.8
	Ford C1DF-10000-D	450	1300	30	2525	1.2-1.8
Galaxie	Ford C1AF-10000-C	450	1300	30	2525	1.2-1.8
	Ford C1AF-10000-D	525	1460	35	2670	1.2-1.8
Thunderbird	Ford C2SF-10000-B	525	1460	35	2670	1.2-1.8
	Ford C2SF-10000-A	600	1550	40	2650	1.2-1.8
Econoline	Ford C1DF-10000-C	375	1420	25	2610	1.2-1.8
	Ford C1DF-10000-D	450	1300	30	2525	1.2-1.8
100-800 Trucks	Ford C1TF-10000-BM, BK, BN, DA, BL, BV, BY	450	1300	30	2525	1.2-1.8
	Autolite C1TF-10000-BZ	600	960	40	1800	1.2-1.8
	Ford C1TF-10000-J	600	1550	40	2500	1.4-1.5
	Leece-Neville C1TF-10300-C, E	840**	740	60	2600	2.4-3.0
	Leece-Neville C2AF-10300-B, C	560**	—	40	—	3.0

* To find the equivalent engine rpm, divide the generator rpm by the crankshaft pulley diameter and then multiply by the generator pulley diameter.

** @ 14 volts.

REGULATOR SPECIFICATIONS

MAXIMUM EXTERNAL CIRCUIT RESISTANCE (GENERATOR ARMATURE TERMINAL TO THE BATTERY POSITIVE TERMINAL)

Model	Amps	Volts
Falcon, Fairlane, Econoline	20	0.46
Galaxie, Thunderbird	20	0.48
F100, F250, F350, F500, F600, F700 and F750	20	0.15
F100, F250, F350, F500 and F600 (6 cyl.)	20	0.21
F800 and T800	20	0.305
F850, F950, F1000, F1100, T850 and T950	20	0.29
T700 and T750	20	0.27
B500 and B600 (6 cyl.)	20	0.46

Model	Amps	Volts
B500 and B600	20	0.41
B700 and B750	20	0.33
N500 and N600 (6 cyl.)	20	0.24
N500, N600, N700 and N750	20	0.13
N850-N1100, NT850 and NT950	20	0.30
C550-C800, CT750 and CT800	20	0.40
C850-C1100	20	0.38
CT850, CT950, H1000 and HT950	20	0.56

ALTERNATOR DATA

Alternator Variation Between Phases
- Maximum-Under Load ..... 0.3 volt
- Maximum-No Load ..... 1.5 volts

Alternator Pulley Nut Torque ..... 40 foot-pounds

GENERATOR REGULATOR

Regulator	Current Rating	Cut-In Voltage	Reverse Amperage To Open	Voltage Regulation 75°F	Current Limiter (Amperes)
Ford CODF-10505-A	25	12.4-13.2	8	14.6-15.4	23-27
Bosch 2700015	30	12.0-12.8	8	14.6-15.4	28-32
Ford 2900424	30	12.0-12.8	8	14.6-15.4	28-32
Ford C2SF-10505-C	35	12.4-13.2	8	14.6-15.4	33-37
Delco CODF-10505-E	35	11.8-13.0	8	14.6-15.4*	35-39
Ford C2SF-10505-B	40	12.4-13.2	8	14.6-15.4	38-42
Ford C1TF-10505-C	40	12.4-13.2	10	14.6-15.4	38-42
Autolite C1TF-10505-D	40	12.5-13.8	8	14.3-15.1	43-47

* Upper Contacts Only, Lower Contacts 0.1 to 0.3 Below Upper Contacts.

ALTERNATOR REGULATOR

Regulator	Current Rating	Load Relay Closing Volts	Voltage Regulation	Current Limiter (Amperes)
Leece-Neville C1TF-10316-C†	40/60	2.0-2.2	14.8	**
Leece-Neville B9AF-10316-A‡	40/60	5.8-6.2	14.2	**
Leece-Neville C2TF-10316-B	60	5.6-6.4	13.5-14.3	58-62

* Upper Contacts Only, Contacts 0.1 to 0.3 Below Upper Contacts.
** Used With Self Current Limiting Alternators.
† For Use With Charge Indicator Light.
‡ For Use With Ammeter Charge Indicator.

VOLTAGE REGULATION SETTING VERSUS AMBIENT AIR TEMPERATURE

Ambient Temperature °F	Voltage Regulation Setting (Volts)	
	Standard Regulator (Ford and Bosch)	40-Amp. Low Cut-In (Autolite)
25	15.1-15.9	14.3-15.2
35	15.0-15.8	14.3-15.2
45	14.9-15.7	14.3-15.1
55	14.8-15.6	14.3-15.0
65	14.7-15.5	14.3-14.9
75	14.6-15.4	14.2-14.9
85	14.5-15.3	14.1-14.8

Ambient Temperature °F	Voltage Regulation Setting (Volts)	
	Standard Regulator (Ford and Bosch)	40-Amp. Low Cut-In (Autolite)
95	14.3-15.1	14.1-14.7
105	14.2-15.0	14.0-14.7
115	14.1-14.9	14.0-14.6
125	13.9-14.7	13.9-14.5
135	13.8-14.6	13.8-14.4
145	13.6-14.4	13.8-14.4

LIGHTING SYSTEM SPECIFICATIONS

Exterior Lamp	Candle Power or Watts	Trade Number
Headlamp (single)	50/40w	6012
Headlamp (inner)	37.5w	4001
Headlamp (outer)	50/37.5w	4002

FUSE AND CIRCUIT BREAKER SPECIFICATIONS

CIRCUIT	PROTECTIVE DEVICE	LOCATION
FALCON		
Headlights	Circuit Breaker	Integral with headlight switch
Instrument Panel, Dome and All External Lamps except Headlights	3AG-15 Fuse	Fuse Panel on light switch
Turn Signals	SFE-14 Fuse	Fuse Panel on light switch
Radio	SFE-7.5 Fuse	Fuse Panel on light switch
Heater Blower	SFE-14 Fuse	Fuse Panel on light switch

FUSE AND CIRCUIT BREAKER SPECIFICATIONS (Continued)

CIRCUIT	PROTECTIVE DEVICE	LOCATION
FALCON (Continued)		
Electric Windshield Wiper	Circuit Breaker	Right Side of Instrument Cluster
Cigar Lighter	Sulphur Disc	On Back of Cigar Lighter
Tailgate Control Circuit	Circuit Breaker	On Starter Relay
Tailgate Motor Ground	Circuit Breaker	Right Taillight Vicinity
FAIRLANE		
Headlights	18-Amp Circuit Breaker	Integral with Headlight Switch
Interior, Park, Tail, and Stop	3AG-15 Fuse	Fuse Block on Headlight Switch
Back-up Turn Indicator	SFE-14 Fuse	Fuse Block on Headlight Switch
Radio	SFE-7.5 Fuse	Fuse Block on Headlight Switch
Heater Blower	SFE-14 Fuse	Fuse Block on Headlight Switch
Air Conditioner	3AG-15 Fuse	Cartridge in Feed Wire
Spotlight	SFE-7.5 Fuse	Cartridge in Feed Wire
Cigar Lighter	Sulphur Disc or Reset C.B.	Back of Cigar Lighter
Overdrive	3AG-15 Fuse	On Overdrive Relay
Windshield Wiper Motor	6-Amp Circuit Breaker	Lower Left Instrument Panel
GALAXIE		
Spotlight	SFE-7.5 Fuse	Cartridge in Feed Wire
Windshield Washer Pump	SFE-14 Fuse	Cartridge in Feed Wire
Clock	1AG-2 Fuse	Junction Block on Headlight Switch
Back-up and Turn Signals	SFE-14 Fuse	Junction Block on Headlight Switch
Park, Tail, Dash, and Dome Lights	3AG-15 Fuse	Junction Block on Headlight Switch
Radio	SFE-7.5 Fuse	Junction Block on Headlight Switch
Heater Blower	SFE-14 Fuse	Junction Block on Headlight Switch
Cigar Lighter	Sulphur Disc or Reset Circuit Breaker	Back of Lighter Socket
Overdrive	3AG-15 Fuse	On Overdrive Relay
Headlights	Circuit Breaker	Integral with Headlight Switch
Air Conditioner		
SelectAire	20-Amp Circuit Breaker	Lip of Instrument Panel to Left of Steering Column
PolarAire	3AG-15 Fuse	Cartridge in Feed Wire
Electric Seat	30-Amp Circuit Breaker	On Starting Motor Relay
Convertible Top Motor	30-Amp Circuit Breaker	On Starting Motor Relay
Electric Windshield Wipers	12-Amp Circuit Breaker	On Instrument Panel Left of Steering Column
Electric Window Regulator		
Power Circuit	30-Amp Circuit Breaker	On Starting Motor Relay
Ground Circuit		
Front Doors	15-Amp Circuit Breaker	Cowl Panels—Right and Left
Rear Doors	15-Amp Circuit Breaker	Inner Door Panels, Right and Left
Rear Quarters	15-Amp Circuit Breaker	Right or Left Rear Floor Panels
THUNDERBIRD		
Headlights	18-Amp Circuit Breaker	Integral with Headlight
Park, Tail, Dash, and Dome	3AG-15 Fuse	Fuse Panel on Left Cowl
Back-up Lights and Turn Signals	SFE-14 Fuse	Fuse Panel on Left Cowl
Radio	SFE-7.5 Fuse	Fuse Panel on Left Cowl
Heater Blower	SFE-14 Fuse	Fuse Panel on Left Cowl
Clock	1AG-2 Fuse	Fuse Panel on Left Cowl
Cigar Lighter Feed Circuit	3AG-15 Fuse	Fuse Panel on Left Cowl

FUSE AND CIRCUIT BREAKER SPECIFICATIONS (Continued)

CIRCUIT	PROTECTIVE DEVICE	LOCATION
THUNDERBIRD (Continued)		
Windshield Washer Pump	SFE-14 Fuse	Fuse Panel on Left Cowl
SelectAire Conditioner	20-Amp Circuit Breaker	Lower Left of Instrument Panel
Windshield Wiper Motor	12-Amp Circuit Breaker	Lower Left of Instrument Panel
Cigar Lighter	Sulphur Disc or Reset Circuit Breaker	Back of Lighter Socket
Electric Seat	30-Amp Circuit Breaker	On Starting Motor Relay
Electric Window Regulator		
Power Circuit	30-Amp Circuit Breaker	On Starting Motor Relay
Ground Circuit		
Front Door	15-Amp Circuit Breaker	Cowl Panel—Left and Right Side
Rear Quarter	15-Amp Circuit Breaker	Right and Left Rear Floor Pan
Convertible Top System		
Power Circuit	50-Amp Circuit Breaker	On Starting Motor Relay
Control Circuit	10-Amp Circuit Breaker	Near Right Air Deflector
Ground Circuit		
Luggage Compartment Lock Motor	15-Amp Circuit Breaker	Luggage Compartment Door Panel
TRUCKS		
Headlights	Circuit Breaker	Integral with Headlamp Switch
Instrument, Dome, Park, and Rear Lights		
Light-Duty Truck	3AG-15 Fuse	Fuse Panel
Heavy-Duty Truck	Circuit Breaker	Integral with Headlight Switch
Turn Signals		
Trucks	SFE-7.5 Fuse	Fuse Panel
Econoline	SFE-14 Fuse	Fuse Panel
Radio	SFE-7.5 Fuse	Fuse Panel
Heater Blower	SFE-14 Fuse	Fuse Panel
Electric Fuel Pump	SFE-7.5 Fuse	Fuse Panel
Electric Windshield Wiper	Circuit Breaker	Integral with Wiper Switch
Spotlight		
Econoline	SFE-14 Fuse	Cartridge in Feed Wire
Light-Duty Truck	SFE-7.5 Fuse	Cartridge in Feed Wire
Heavy-Duty Truck	SFE-7.5 Fuse	Fuse Panel
Pump Assembly (W/S Wiper Vacuum)	3AG-10 Fuse	Cartridge in Feed Wire
Cigar Lighter		
Light-Duty Truck	Sulphur Disc	Back of Lighter Socket
Heavy-Duty Truck	SFE-14 Fuse	Fuse Panel
Overdrive	3AG-15 Fuse	On Overdrive Relay
Two-Speed Axle	Circuit Breaker	Fuse Panel

SPECIAL TOOLS

SPECIAL TOOLS	
T56L-10505-A	Belt Tension Tool
T62L-8620-A	Voltage Regulation Setting Thermometer Allen Battery Starter Tester Allen Volt-Amp Tester Sun Battery Adapter Switch Sun Rectifier and Diode Tester

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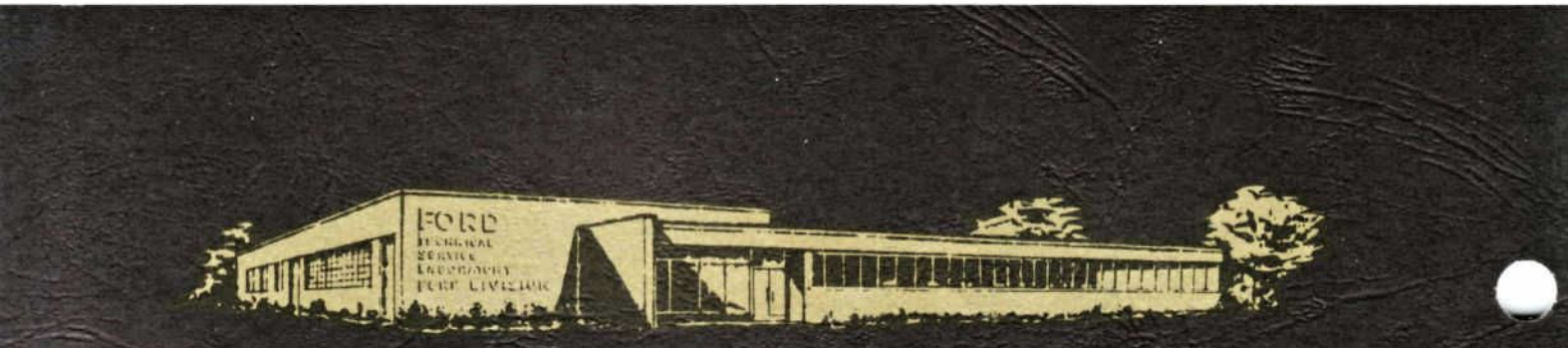

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