INSTRUCTION MANUAL

SUN

VOLT-AMPERE TESTER

MODEL VAT-20

SUN ELECTRIC CORPORATION
HARLEM AND AVONDALE • CHICAGO 31, ILLINOIS

INTRODUCTION

With the Sun Volt-Ampere Tester, Model VAT-20, the operator can quickly and accurately test the charging system of any passenger car and the majority of trucks using a 6 or 12 volt electrical system. By following the test procedure outlined in this manual, the entire charging system - generator, regulator and circuitry - can be tested in a matter of minutes. All tests can be performed at one engine speed with a minimum of lead and switch changes. This is an important time saving factor that every busy operator will appreciate.

The test procedure, as outlined in this manual, is detailed to the extent that the purpose of each test is fully described and includes a breakdown of results and test indications. It should also be noted, that as the operator becomes familiar with the test procedure and acquires skill in the application of the Volt-Ampere Tester, he need only refer to the illustrations and to the captions enclosed in a box which accompany each illustration.

TESTER INFORMATION

Meters--The meters used on the VAT-20 are of the D'Arsonval type and have jeweled pivot bearings. They are extremely rugged and can withstand a 400% overload without damage. Accuracy is guaranteed within 2% of full scale deflection. External zero correctors permit zeroing of meter pointers for greater accuracy.

The voltmeter has a 0 to 2 volt, a 0 to 8 volt and a 0 to 16 volt scale. The 0 to 2 volt scale which is used for circuit resistance tests, has divisions representing .1 volt each. The 0 to 8 and 0 to 16 volt scales which are used for regulator tests have .2 volt divisions. This arrangement provides the operator with a voltmeter scale which is specifically suited for each test of the charging system.

The ammeter has a -10 to 0 to 100 ampere scale with 2 ampere divisions which provides sufficient range for testing the latest high output type charging systems.

Controls--The VAT-20 has four easy-to-operate controls. These are the Ground Polarity Switch, Voltage Switch, Generator Field Control and Main Control Knob. The Ground Polarity Switch selects the correct polarity for the ammeter and the Voltage Switch selects the desired voltmeter scale. The Generator Field Control is used to control generator field current for Generator Output, Cutout Relay and Voltage Regulator tests. It is also used to "cycle" the regulator. It's use eliminates the need for changing engine speed during tests. The Main Control knob which has three basic positions, selects the correct ammeter circuitry for each test. These positions are: DIRECT for Generator Output, Cutout Relay and Circuit Resistance tests, 1/4 OHM for Voltage Regulator tests and LOAD for Current Regulator tests. By using this control, the switching of ammeter leads and the insertion and removal of resistance for each test is done automatically. Thus the correct condition for each test is established and accurate test results will be assured.

Leads--The simplified arrangement of the VAT-20's Ammeter, Voltmeter and Generator Field Control leads permits the operator to make test connections to the vehicle quickly and without confusion.

The three separate ammeter leads, marked BAT, REG and GRD provide connections to the regulator battery wire, regulator battery terminal and ground. This hook-up is the same for all vehicles regardless of ground polarity, permits all tests to be made without changing ammeter leads and eliminates the possibility of making a wrong hook-up.

The two separate voltmeter leads are color coded red for positive and black for negative for identification. Also the positive lead has a rubber collar at the clip end to further identify it.

The Generator Field Control has a twin-flex lead which provides the necessary connections to the field circuit.

THE CHARGING CIRCUIT

The purpose of the Charging System is to supply current for the lights, ignition, radio, heater and other electrical accessories and maintain the storage battery in a charged condition or to recharge it when it has become discharged. The Charging System consists of four important components: battery, generator, regulator and leads.

The BATTERY performs three necessary functions on the automobile. First it supplies electrical energy for the cranking motor and the ignition system until the engine starts. Second, it intermittently supplies current for the lights, radio, heater and other accessories when the electrical demand becomes greater than the output of the generator. Third, the battery acts as a voltage stabilizer in the electrical system.

The GENERATOR converts mechanical energy supplied by the engine into electrical energy. This energy is used to charge the battery and to supply power to the electrical system of the automobile. The generator supplies all the power for the load and also recharges the battery.

The REGULATOR is the control unit for the generator. Its function is to automatically control generator output to meet all conditions of speed and electrical load. The regulator assembly usually consists of three units, a CUTOUT or REVERSE CURRENT relay, a VOLTAGE control, and a CURRENT control.

The CUTOUT RELAY or circuit breaker is used to open and close the circuit between the generator and battery. When the generator voltage exceeds the battery terminal voltage, the contact points close thus completing the circuit between the generator and battery. If the engine is stopped or idling at a low speed, the contact points open and prevent the battery from discharging through the generator.

The VOLTAGE REGULATOR is used to limit the Generator Voltage to a predetermined value, thus protecting the battery and all vehicle electrical accessories.

When the voltage rises to a predetermined value, the voltage regulator contacts open thus inserting a resistance into the generator field circuit, which reduces generator voltage. The cycling of these contacts controls the voltage at this specified setting.

The CURRENT LIMITING REGULATOR is used to limit the generator output to a predetermined value, thus protecting the generator against overload. When the generator output reaches its predetermined maximum output, the regulator contacts are opened inserting a resistance into the field circuit which reduces the ampere output of the generator. These contacts cycle at a sufficiently high frequency to control the output to a specified value.

The LEADS are necessary to complete the circuitry between the charging system components and the vehicle. These leads should be conductors of sufficient size to efficiently carry the load. The insulation should be in good condition and not frayed. The connections must be tight and clean without signs of corrosion or oil.

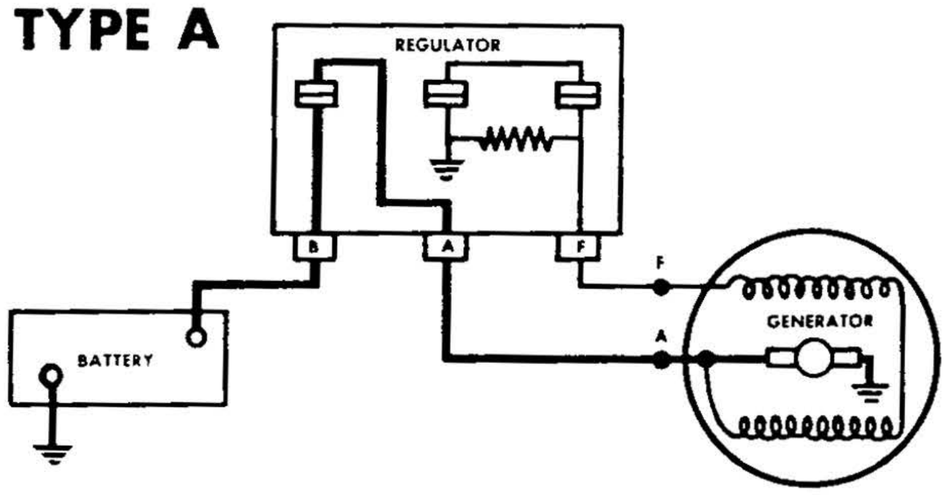
All components in a charging system are equally important. In order for the charging system to function properly, the generator must be capable of producing an output at least equal to its electrical rating. The regulator in turn must be able to limit the generator output at a predetermined setting. The leads should be in good condition and the connections tight and free of corrosion. With high resistance in the leads and connections the generator and regulator cannot perform properly.

CHARGING SYSTEM TESTS - Whenever symptoms indicate that charging system irregularities are present, a thorough test of the system should be conducted to uncover the source of trouble. Proper operation of the system can only be guaranteed when every phase of the system has been tested and found to be in good working order. To completely test the charging system, it is recommended that all tests outlined in this manual be performed.

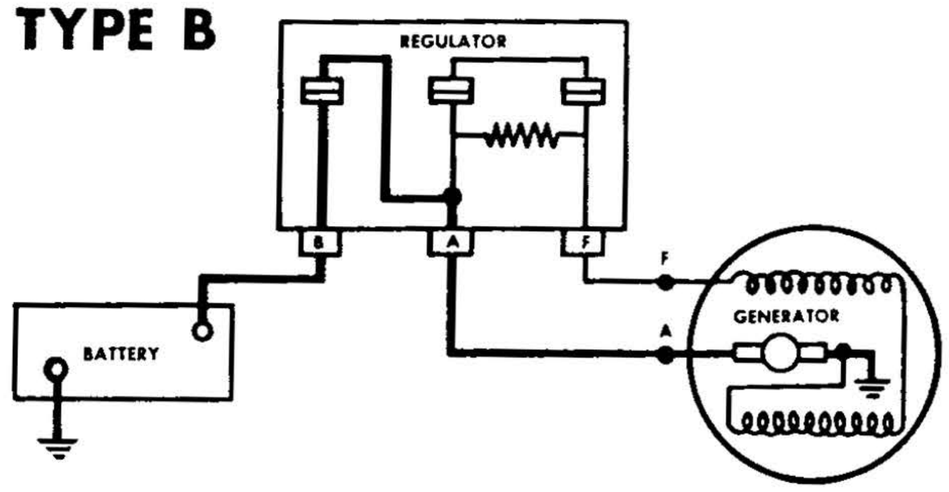
CHARGING SYSTEM TYPES

Basically there are two types of D.C. Charging Systems in use today. These differ only in the way in which the field circuit of the generator is connected and grounded. They are commonly classified and referred to in the following manner:

TYPE A



TYPE B



"A" circuit or externally grounded field--in which the field circuit is connected to the armature terminal in the generator, and is grounded outside the generator through the regulator contacts.

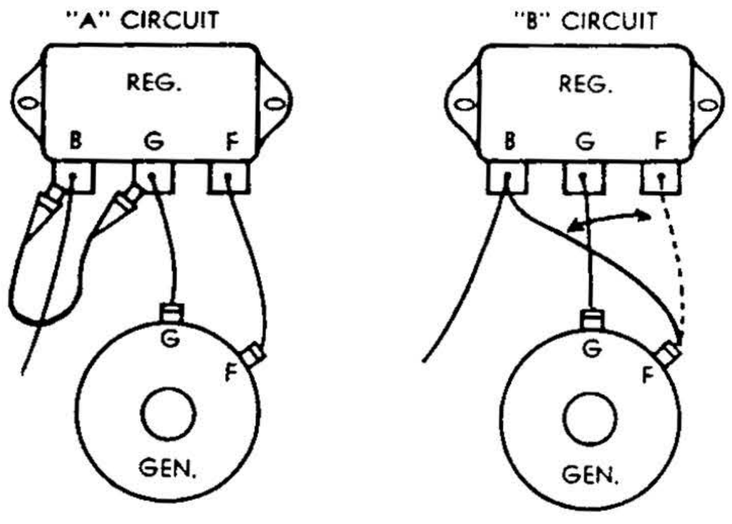
"B" circuit or internally grounded field--in which the field circuit is connected to the armature circuit in the regulator, and is grounded inside the generator.

Generally the methods used for testing the two systems are the same in every way except for the manner in which the "Field Control" is connected for generator output, cutout relay, insulated and ground circuit resistance tests.

GENERATOR POLARITY

The generator will build up voltage that will cause current flow in either direction depending upon the polarity of the residual magnetism in the pole shoes. The generator polarity must be in agreement with battery polarity in order for current to flow in the proper direction to charge the battery. After a generator has been repaired and installed on a vehicle or whenever a generator has been disconnected, it must be polarized. **IMPORTANT**: Polarize generator before starting engine.

The polarity of the generator pole shoes is determined by the direction of the current flow in the field coils. The polarity of the residual magnetism will remain the same as that induced by the field coil.



Generators using an "A" circuit are polarized by connecting a jumper lead from the Battery Terminal to the Armature Terminal of the regulator. A touch of the jumper lead is all that is required.

Generators used in a "B" circuit are polarized by disconnecting the Field Lead at the regulator and momentarily flashing this lead to the Battery Terminal of the regulator.

PREPARATION FOR TESTS

NOTE: Most vehicle manufacturers specify that the engine be operated at a medium speed for at least 15 minutes to bring the charging system components up to operating temperature before connecting tester and performing tests.

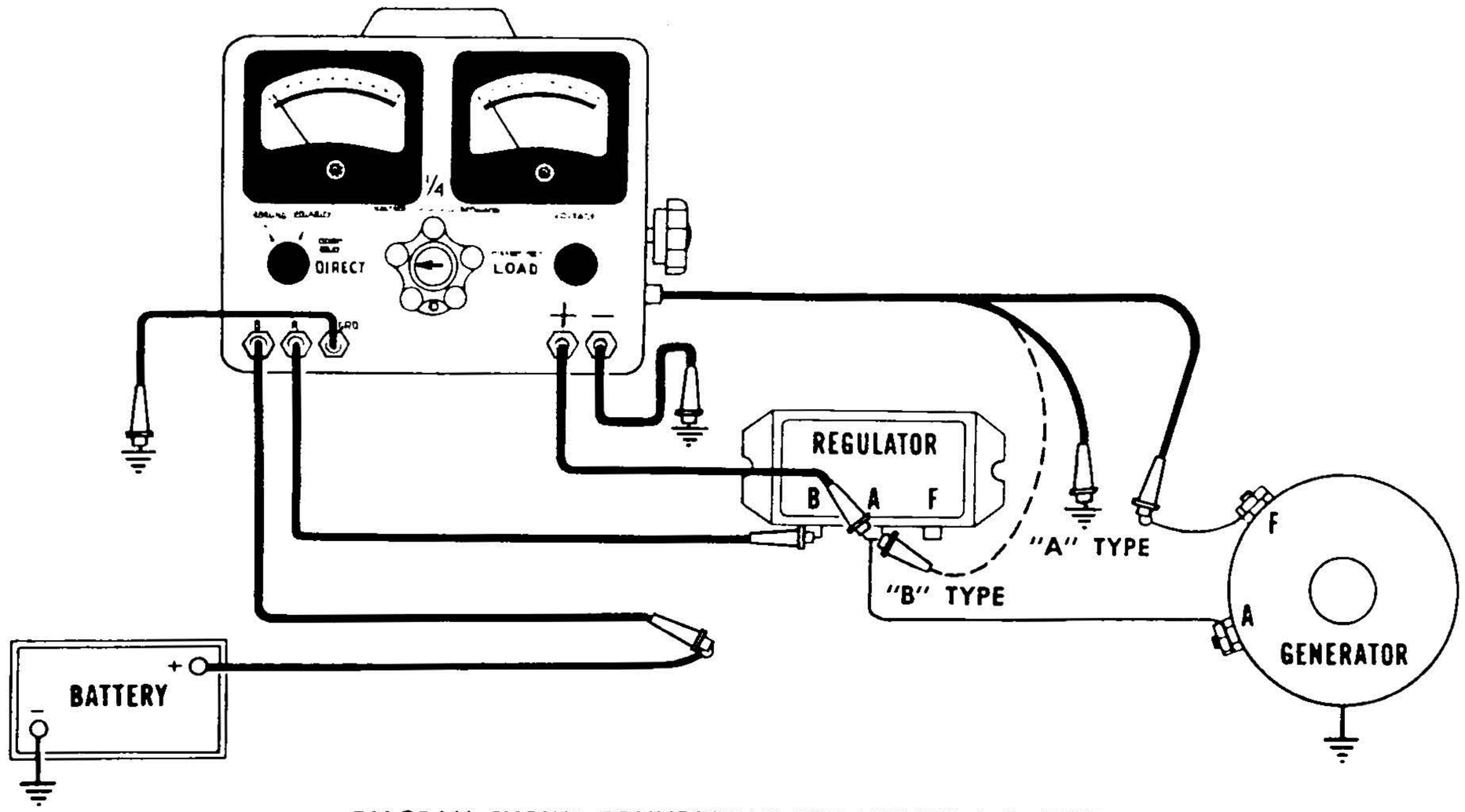


DIAGRAM SHOWS CONNECTIONS FOR NEGATIVE GROUND
REVERSE VOLTMETER LEADS FOR POSITIVE GROUND

TESTER SWITCHES

a. Set Polarity switch to correspond to the ground polarity of the system to be tested.

b. Set tester control knob to DIRECT position.

c. Set Voltage Switch to:
-16 VOLT position for 12 volt systems
- 8 VOLT position for 6 volt systems

d. Set Field Control to OPEN position.

VOLTMETER LEADS

a. Connect one lead to Armature Terminal of regulator and the other to a good ground. Voltmeter lead connected to ground must match ground polarity of vehicle being tested.

AMMETER LEADS

a. Disconnect the battery wire from the Battery Terminal of the regulator.

b. Connect "REG" lead of tester to the Battery Terminal of the regulator.

c. Connect "BAT" lead of tester to the battery wire that was disconnected from regulator in step "a".

d. Connect "GRD" lead of tester to a good ground on the vehicle.

GENERATOR FIELD CONTROL LEADS

a. Disconnect field wire from Field Terminal of Regulator.

b. Connect one lead of Field Control to field wire.

c. Connect other lead of Field Control:
-"A" type system--to ground
-"B" type system--to armature terminal of regulator

1. GENERATOR OUTPUT TEST

Generator Output Test is conducted first to determine if the generator has sufficient output to meet the demands of the vehicle's electrical system. A good generator is able to produce current equal to its rating or more and is capable of meeting electrical system demands and keeping the battery fully charged. A generator which does not meet specifications should be removed from the vehicle for further tests and reconditioning.

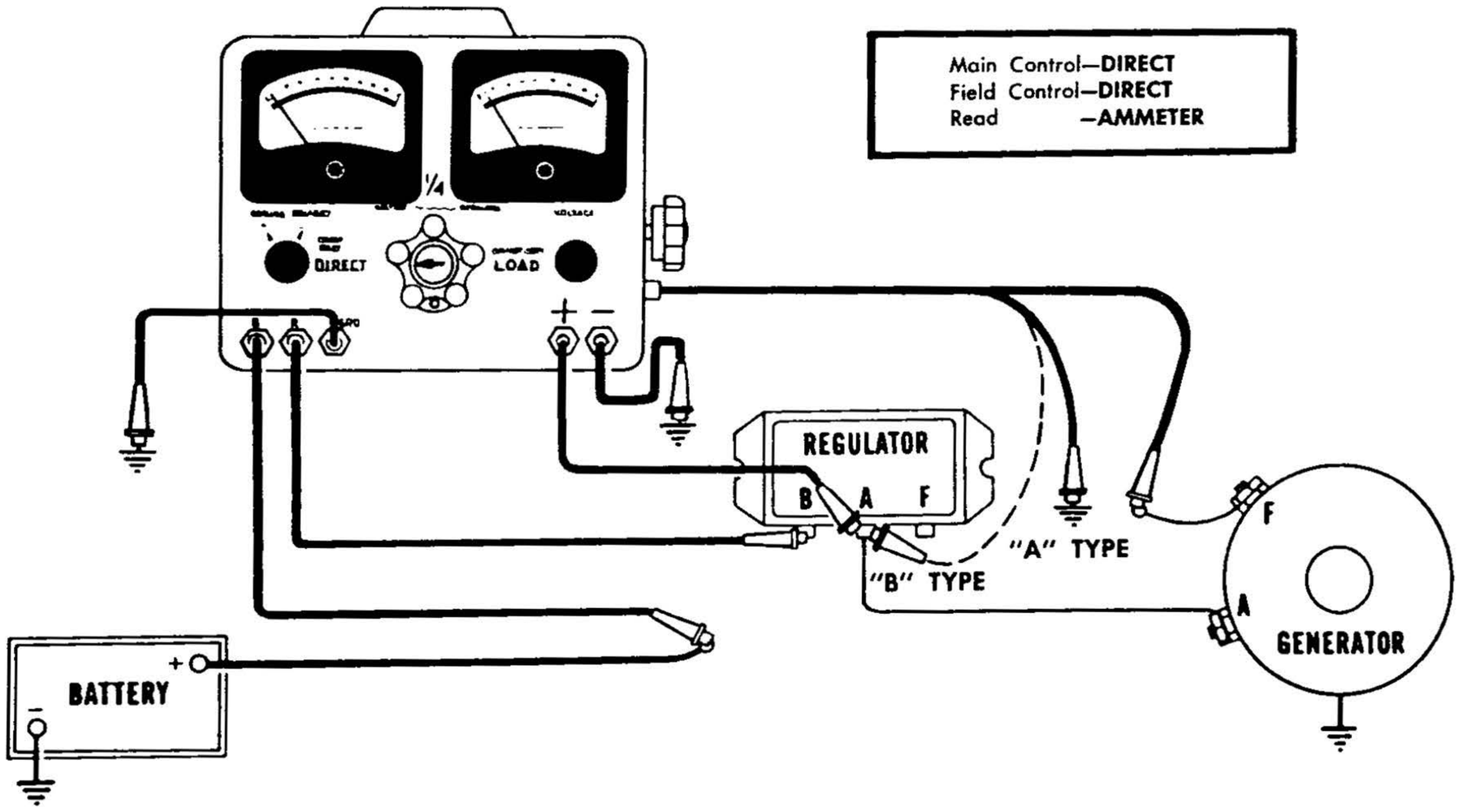


DIAGRAM SHOWS CONNECTIONS FOR NEGATIVE GROUND
REVERSE VOLTMETER LEADS FOR POSITIVE GROUND

a. Start engine and adjust engine speed to 1500 RPM, or to speed specified by vehicle manufacturer for Generator Output Test.

b. Set Generator Field Control to DIRECT position.

c. Observe ammeter reading. Reading indicated should be equal to rated output of generator or more. Refer to specifications.

d. Set Generator Field Control to OPEN position.

RESULTS AND INDICATIONS

Output increases steadily as Field Control is turned to Direct position but stops increasing before Direct position is reached... Generator drive belt is loose or worn.

Output is less than specified by manufacturer when Field Control is in the Direct position... Defective armature, shorted or grounded field coils, dirty commutator, poor brush contact, loose or defective field or armature wires or burned cutout relay contacts.

No output when Field Control is turned to Direct position... Defective armature, open field coil, open field or armature wire or cutout relay contacts failed to close. (See Cutout Relay Test.)

2. CUTOUT RELAY TEST

Cutout Relay Test is made to determine whether or not the cutout relay closes and opens properly with respect to generator voltage and battery current. Unless the relay is operating within manufacturers specifications, a discharged battery and/or damage to the charging system can result. A relay which is not operating within specifications should be removed from the vehicle for further tests and adjustment.

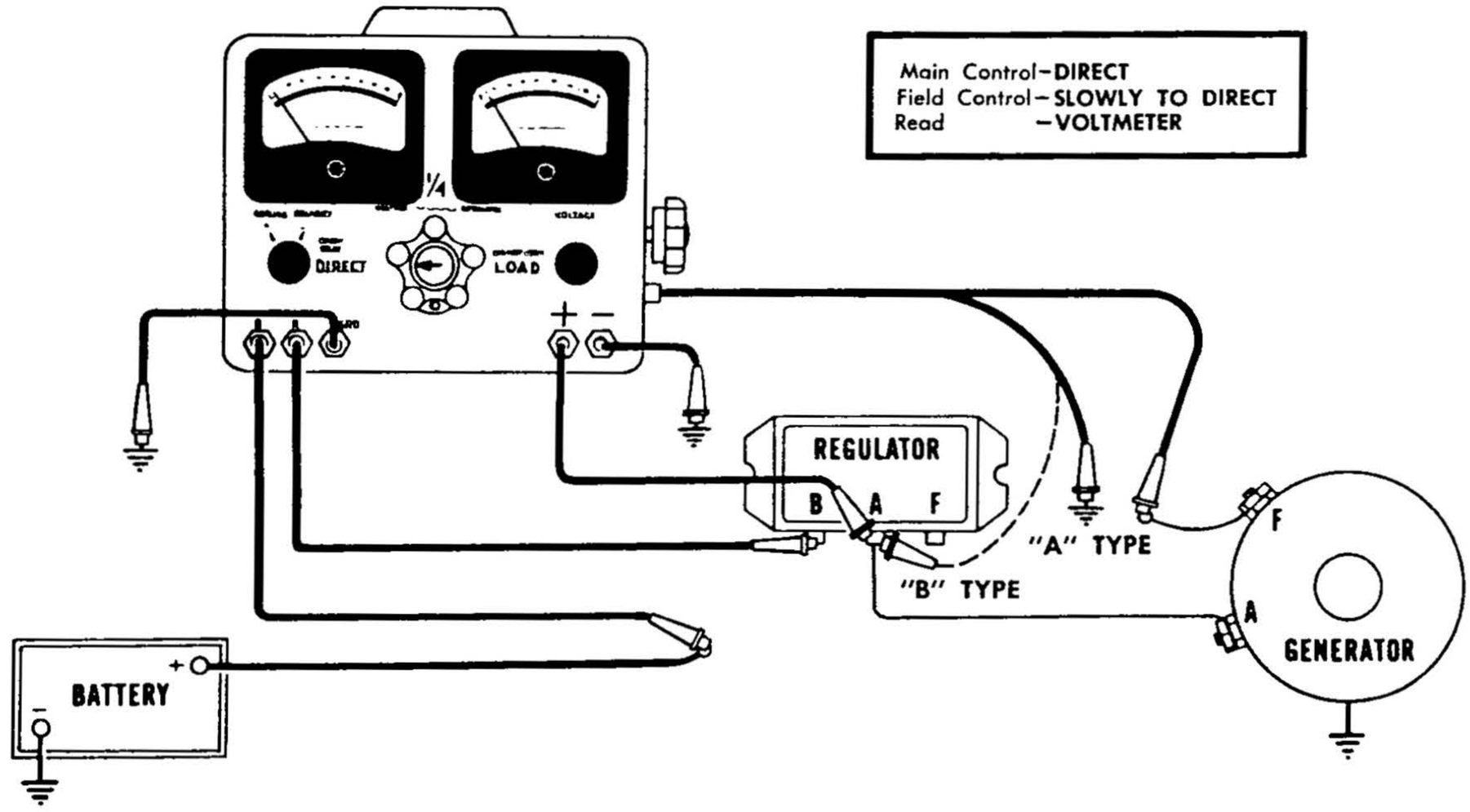


DIAGRAM SHOWS CONNECTIONS FOR NEGATIVE GROUND
REVERSE VOLTMETER LEADS FOR POSITIVE GROUND

a. Slowly rotate Generator Field Control clockwise while observing both Voltmeter and Ammeter.

b. Note the highest voltmeter reading just before the ammeter pointer begins to move.

c. Voltmeter reading observed in Step "b" indicates the CLOSING VOLTAGE of the Cutout Relay and should be within specifications.

d. Continue to rotate Generator Field Control clockwise until Ammeter reads approximately 10 amperes charge.

e. Slowly rotate Generator Field Control counter-clockwise while observing ammeter for greatest reading to left of zero just before pointer returns to zero.

f. Reading observed in Step "e" indicates the OPENING AMPERAGE of the Cutout Relay and should be within specifications.

RESULTS AND INDICATIONS

Cutout Relay fails to close as noted by high voltage and no current... Voltage winding on relay open, contacts badly burned, spring tension or air gap excessive.

Closing voltage too high... Spring tension, air gap or point gap excessive.

Closing voltage too low... Too little air gap, point gap or spring tension.

Opening Amperage too low... Excessive air gap or spring tension or insufficient point gap.

3. VOLTAGE REGULATOR TEST

Voltage Regulator Test is made to determine if the voltage regulator is operating properly and within manufacturer's specifications. A regulator setting which is higher than specified can cause battery overcharge and damage to lights and accessories. A lower than specified setting can result in a discharged battery. If the voltage regulator setting is not within the specified limits or is unstable or erratic it should be removed from the vehicle for further tests, service and adjustment.

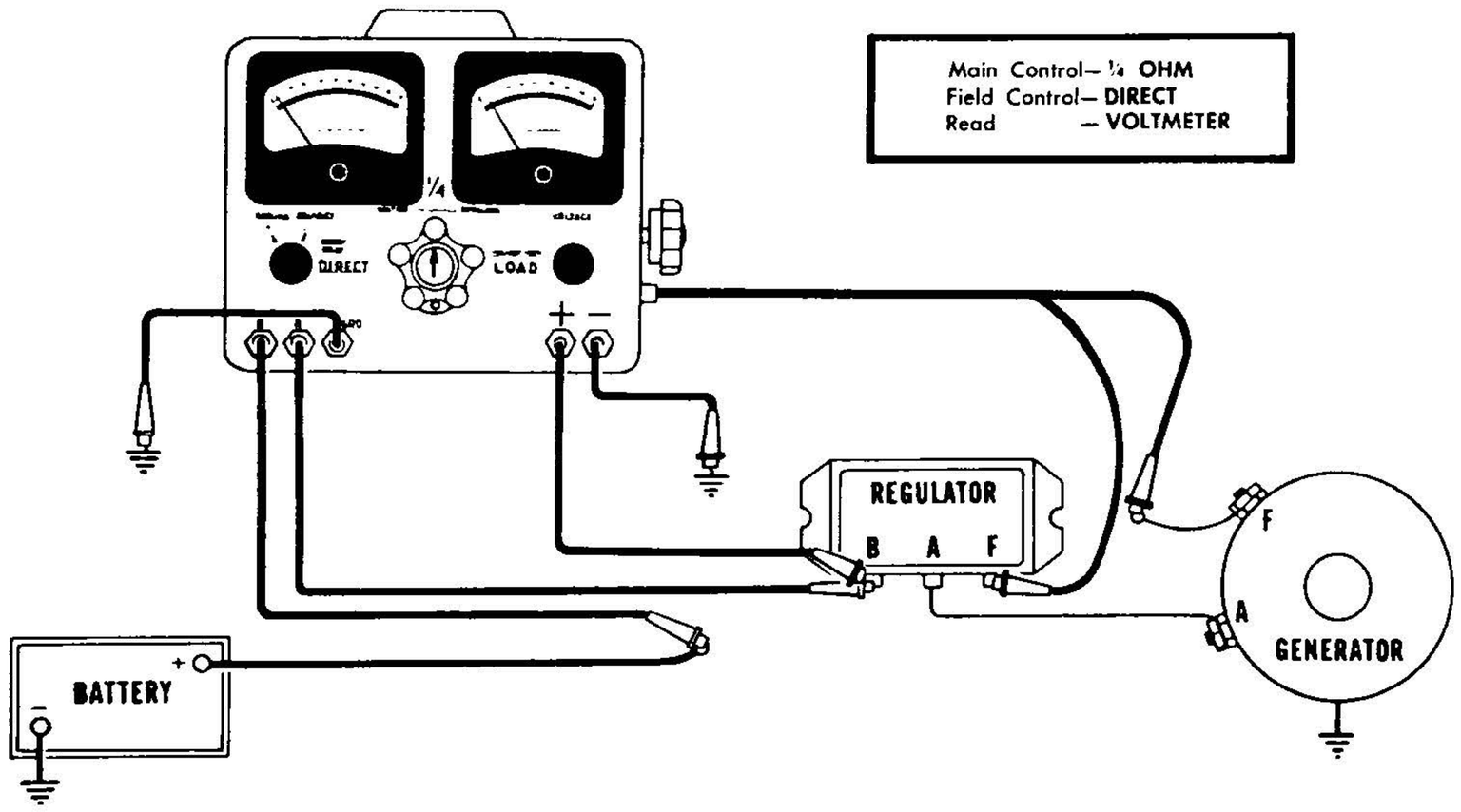


DIAGRAM SHOWS CONNECTIONS FOR NEGATIVE GROUND
REVERSE VOLTMETER LEADS FOR POSITIVE GROUND

a. Connect Generator Field Control leads as shown above.

b. Observing polarity, connect one voltmeter lead to ground and the other voltmeter lead to the Battery Terminal of the regulator.

c. Set Tester Control Knob to the 1/4 OHM position.

Single Contact Type Regulators:

d. With engine operating at 1500 RPM, rotate Generator Field Control counter-clockwise to OPEN position and then clockwise to DIRECT position to "cycle" regulator.

e. Note voltmeter reading. Reading indicated on voltmeter is the Voltage Regulator Setting and should be within specifications.

Double Contact Type Regulators:

d. With engine operating at 2200 RPM, rotate Generator Field Control counter-clockwise to OPEN position and then clockwise to DIRECT position to "cycle" regulator.

e. Note voltmeter reading. Reading indicated on voltmeter is the Voltage Regulator Setting of the "Shorting" contacts and should be within specifications.

f. Maintaining engine speed, slowly rotate Generator Field Control counter-clockwise while observing voltmeter. The Voltmeter reading should drop off slightly and then remain steady. This indicates the Voltage Regulator Setting of the "Series" contacts. The voltage difference between the settings of the two contacts should be within specifications.

RESULTS AND INDICATIONS

Regulator setting too high... Excessive spring tension or armature air gap.

Regulator setting too low... Insufficient spring tension or armature air gap.

Regulator setting erratic or unstable... Burned or oxidized regulator contacts, improper armature air gap or broken resistor on back of regulator.

4. CURRENT REGULATOR TEST

Current Regulator Test is made to determine if the current regulator is operating properly and within manufacturer's specifications. A regulator setting which is higher than specified can allow the generator to exceed its rated output and consequently damage from overheating can result. A regulator setting which is lower than specified will not allow the generator to produce the current demanded by the electrical system when loads are great and as a result the battery can become discharged. If the current regulator setting is not within the specified limits or is unstable or erratic, the regulator should be removed from the vehicle for further tests, service and adjustment.

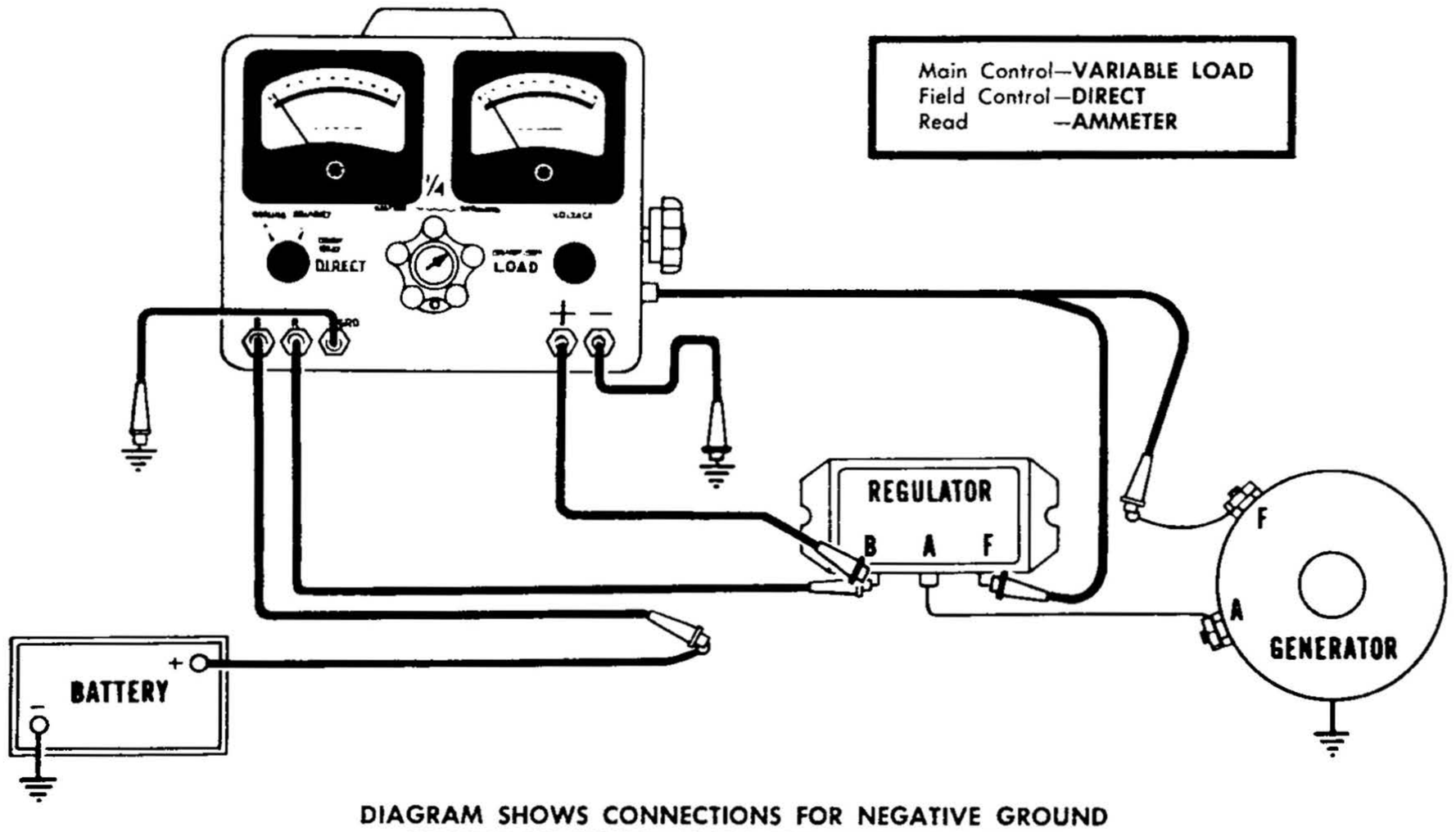


DIAGRAM SHOWS CONNECTIONS FOR NEGATIVE GROUND
REVERSE VOLTMETER LEADS FOR POSITIVE GROUND

a. With engine operating at 1500 RPM, rotate Generator Field Control clockwise to DIRECT position.

b. Turn Tester Control Knob clockwise to LOAD position and adjust knob until voltmeter indicates system voltage; i.e., 6 or 12 volts.

c. Ammeter reading now indicates the Current Regulator Setting and should be within specifications.

d. Turn Tester Control Knob counter-clockwise to DIRECT position.

e. Rotate Generator Field Control to OPEN position.

RESULTS AND INDICATIONS

Regulator setting too high... Excessive spring tension or armature air gap.

Regulator setting too low... Insufficient spring tension or armature air gap.

Regulator setting erratic or unstable... Burned or oxidized regulator contacts, improper armature air gap or broken resistor on back of regulator.

5. CHARGING SYSTEM CIRCUIT RESISTANCE TESTS

Insulated and Ground Circuit Resistance tests are made to determine the amount of voltage loss occurring between the armature terminal of the generator and the insulated battery post, and between the generator housing and the ground battery post respectively. Any voltage loss caused by high resistance in these circuits will reduce the overall charge rate and can lead to eventual battery discharge.

Insulated Circuit Resistance Test

a. With ammeter and field control connected as shown at the right, adjust field control until ammeter reads exactly 20 amperes.

b. Observing polarity, connect one voltmeter lead to the armature terminal of the generator and the other voltmeter lead to the insulated post of the battery.

c. With voltage switch set to the 2 VOLT position, note voltmeter reading. **NOTE**: Unless otherwise specified, voltage loss should not exceed 1.0 VOLT.

Ground Circuit Resistance Test

d. Observing polarity, connect one voltmeter lead to the grounded post of the battery and the other lead to the housing of the generator.

e. Note voltmeter reading. **NOTE**: Unless otherwise specified, voltage loss should not exceed .1 VOLT.

RESULTS AND INDICATIONS

Voltage loss exceeds specified amount... loose or corroded connections at armature terminal of generator, armature terminal of regulator, back of ammeter or battery terminal of starter solenoid. Faulty wiring from generator to regulator armature terminal, battery terminal of regulator to ammeter or ammeter to starter solenoid, burned or oxidized cutout relay contacts, loose or corroded battery cable connections or a poor electrical connection between the generator and the engine.

6. REGULATOR GROUND CIRCUIT TEST

Regulator Ground Circuit Resistance Test determines the amount of voltage loss occurring between the generator housing and the regulator base. Excessive voltage loss due to high resistance will cause the cutout relay and the voltage regulator to operate at a higher than actual setting. In addition if voltage loss becomes extremely high, reversed generator polarity and consequently, damage to the charging system may result.

Regulator Ground Circuit Test

a. Set Generator Field Control to OPEN position.

b. Connect Generator Field Control; one lead to vehicle's field wire, the other lead to Field Terminal of Regulator.

c. Observing polarity, connect voltmeter leads; one lead to generator housing, other lead to regulator base.

d. Turn ON vehicle's headlights and all accessories.

e. Turn Generator Field Control clockwise to DIRECT position and observe voltmeter for highest reading. Reading indicated is the voltage loss in the regulator ground circuit and should be within specifications.

NOTE: Unless otherwise specified, voltmeter reading should not exceed .1 VOLT, and should preferably stay on ZERO.

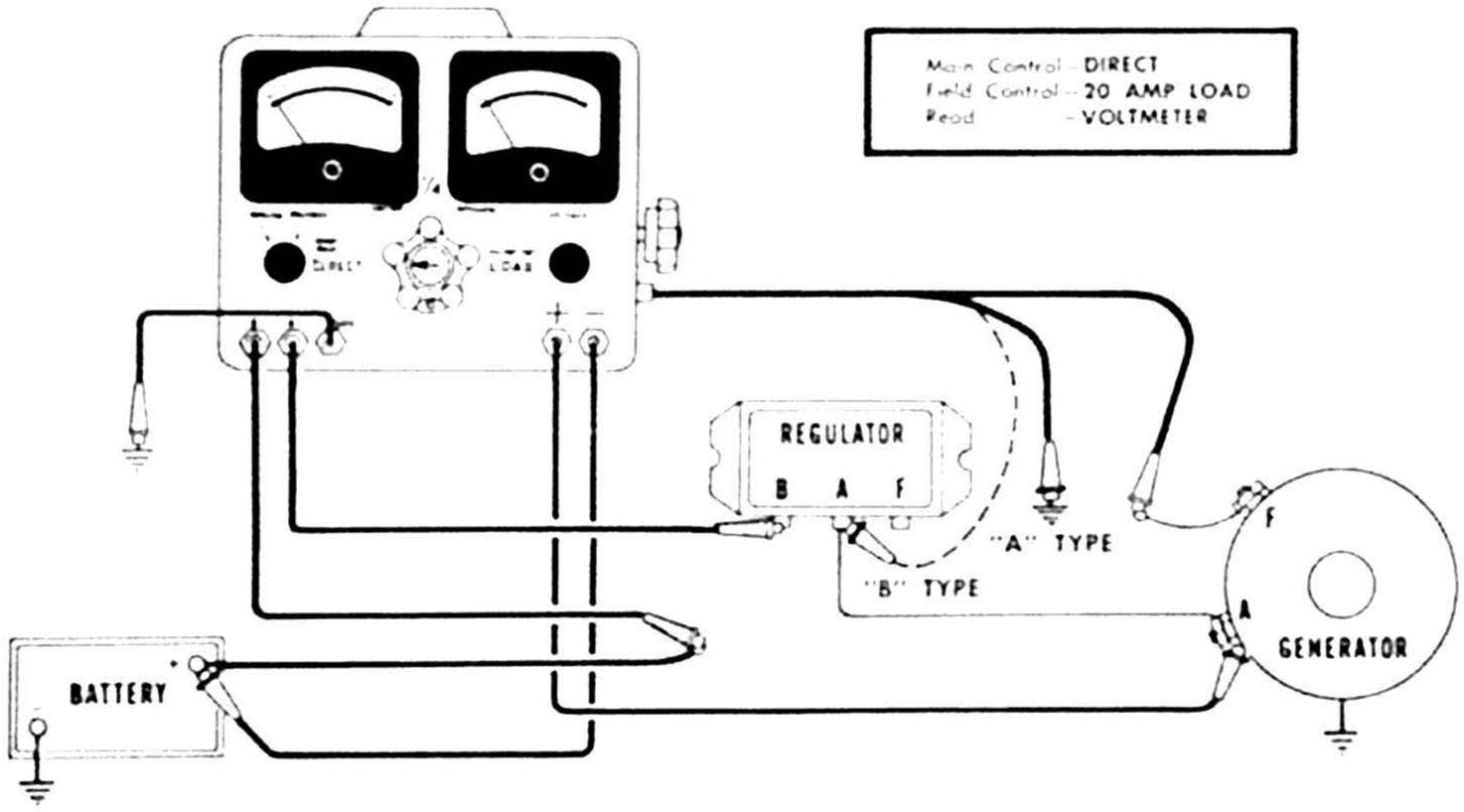
f. Turn Field Control to OPEN, reduce engine speed to idle, and turn ignition, lights and all accessories OFF.

g. Disconnect all tester leads, and make sure vehicles wiring and connections are secure.

RESULTS AND INDICATIONS

Voltage loss exceeds specified amount... Regulator ground wire loose or defective or poor electrical connection between regulator base and body or between body and engine.

Insulated Circuit Resistance Test



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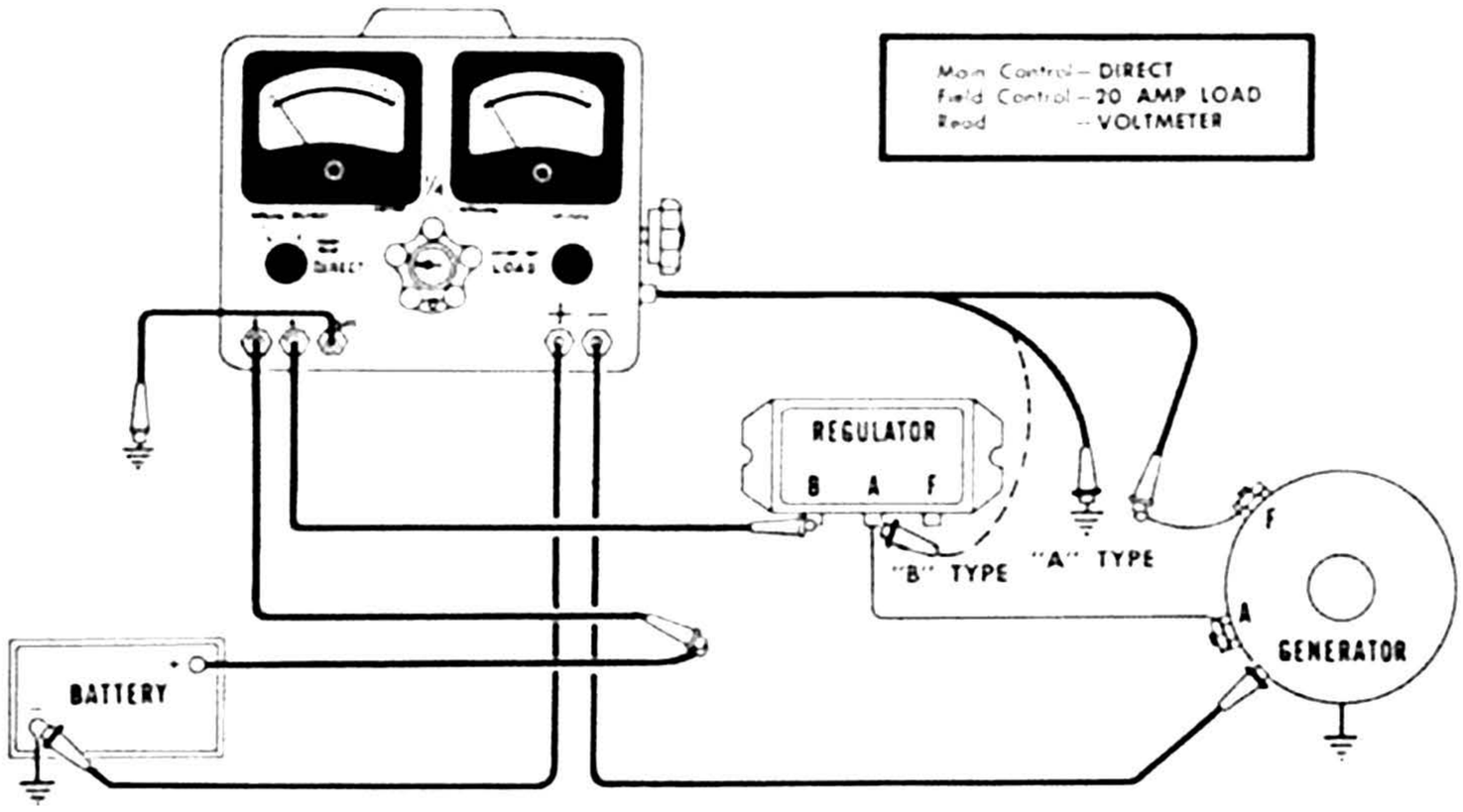
REVERSE VOLTMETER LEADS FOR POSITIVE GROUND

Ground Circuit Resistance Test



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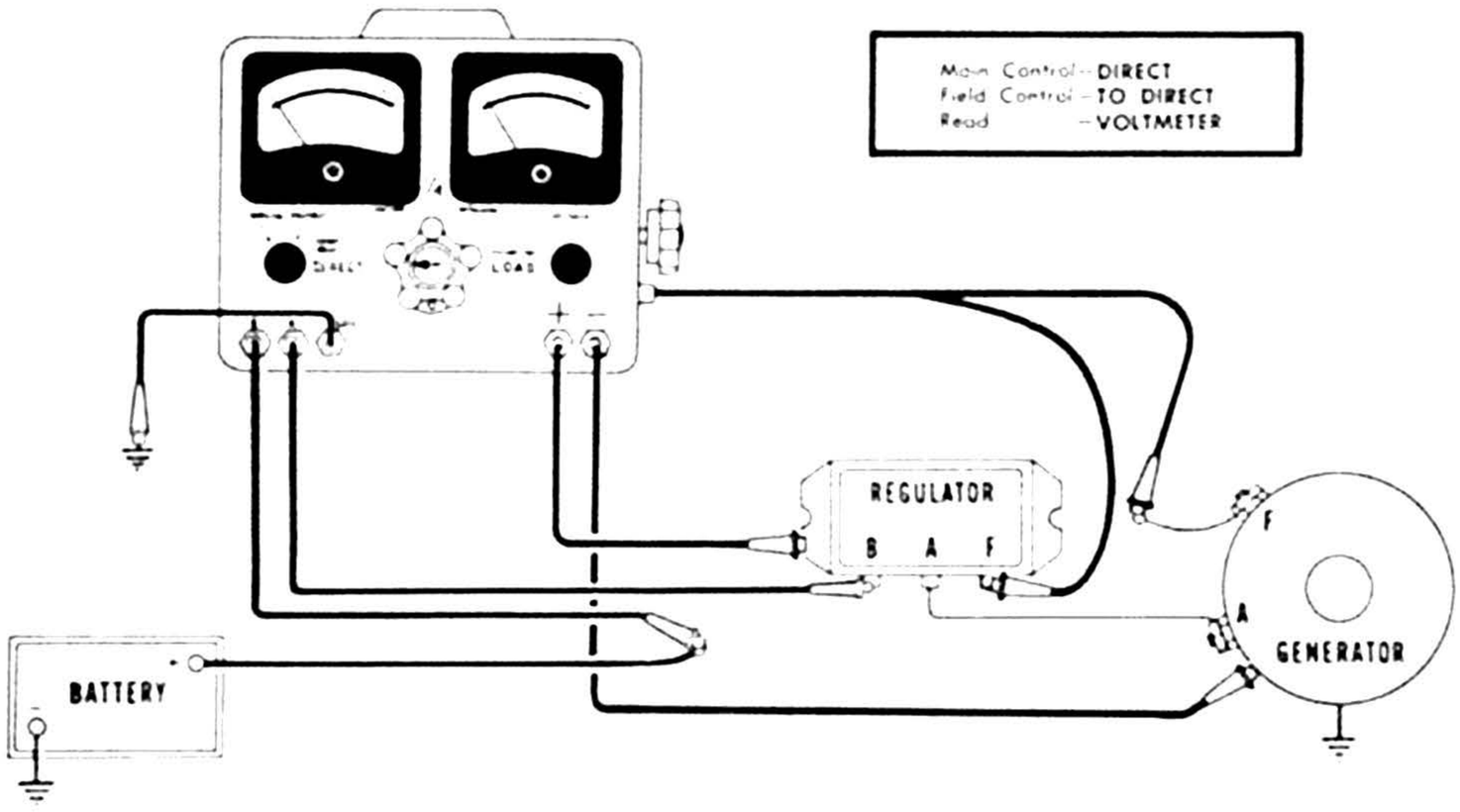
Regulator Ground Circuit Test



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REVERSE VOLTMETER LEADS FOR POSITIVE GROUND

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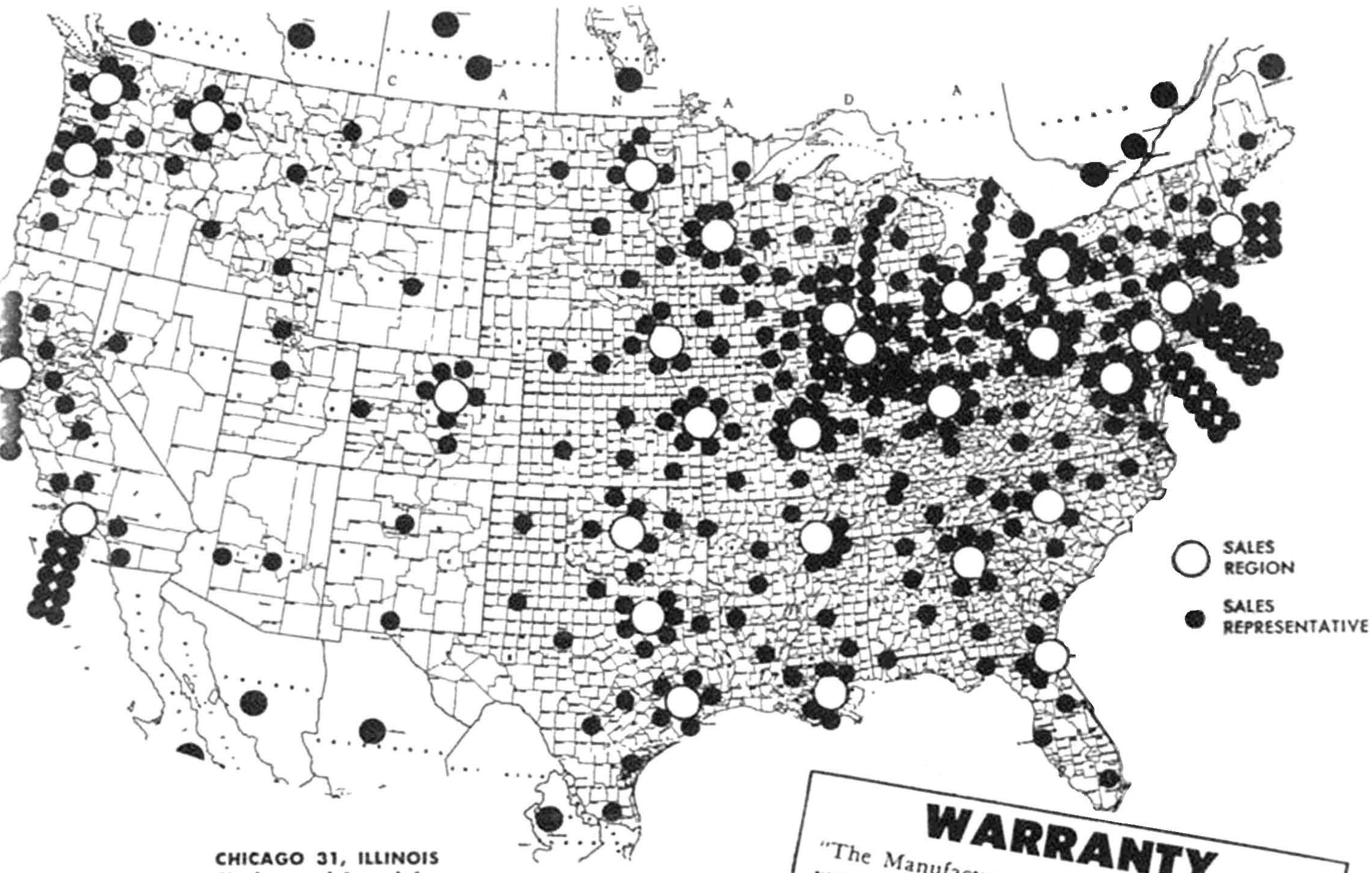

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SUN'S 24 HOUR SERVICE

Sun testers are built to be used and kept in constant service. To insure that Sun testers will always be ready for use, Sun's sales and service representatives are always available. No part of the United States is more than 24 hours from your Sun Service Man.

WARRANTY

"The Manufacturer, Sun Electric Corporation, warrants each piece of equipment manufactured by it to be free from defects in material and workmanship under normal use, its obligation under this warranty being limited to replacing or repairing any part or parts which shall have been returned to the Manufacturer at its factory or any branch, transportation charges prepaid, within one year after purchase and delivery of such equipment to the original purchaser and which the Manufacturer's examination shall disclose to its satisfaction to have been thus defective. This warranty shall not apply to equipment which shall have been repaired or altered by others than the Manufacturer in a manner which in the judgment of the Manufacturer has adversely affected its operation. The Manufacturer reserves the right to make changes at any time in the design and price of its equipment. This warranty is in lieu of all other warranties, expressed or implied, and the Manufacturer neither assumes, nor authorizes any other person to assume for it, any other liability in connection with the sale of its products."

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