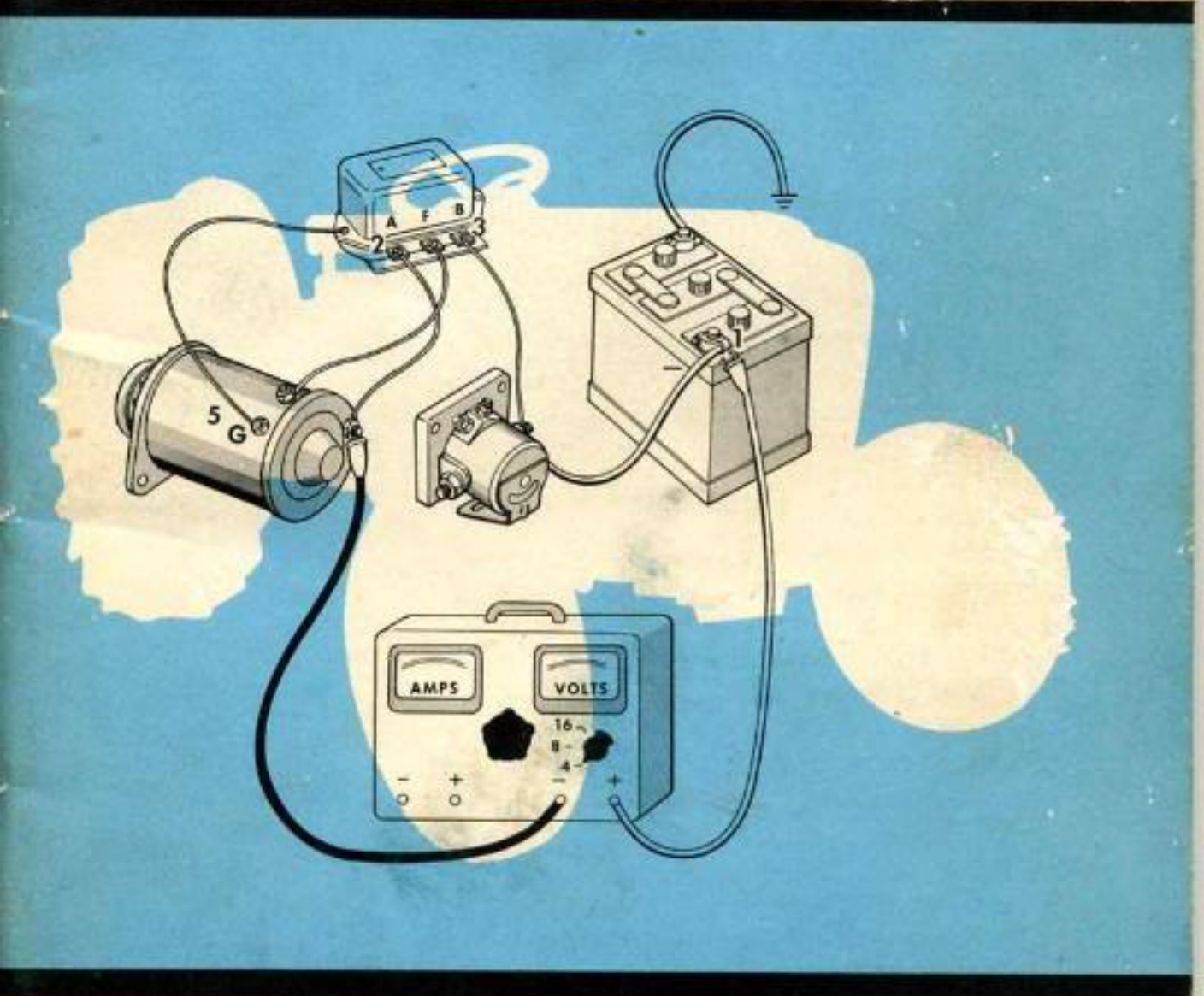
TRACTOR ELECTRICAL DIAGNOSIS

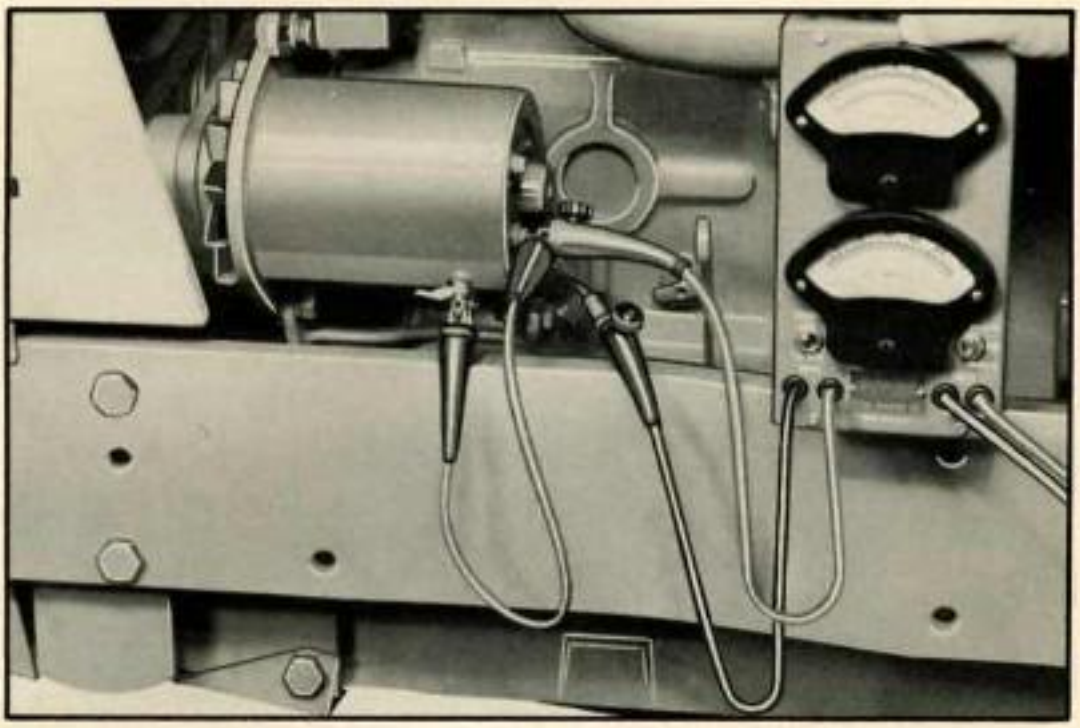
FORD TRACTOR SERVICE

MANUAL



TRACTOR AND IMPLEMENT OPERATIONS (U.S.)
FORD MOTOR COMPANY
BIRMINGHAM, MICHIGAN

INDEX



INTRODUCTION

This manual is presented to provide you with a permanent record of the schematic charts which were used in the training program on "Servicing the Tractor Electrical System." Directions for performing the tests illustrated by the charts are included in this Manual.

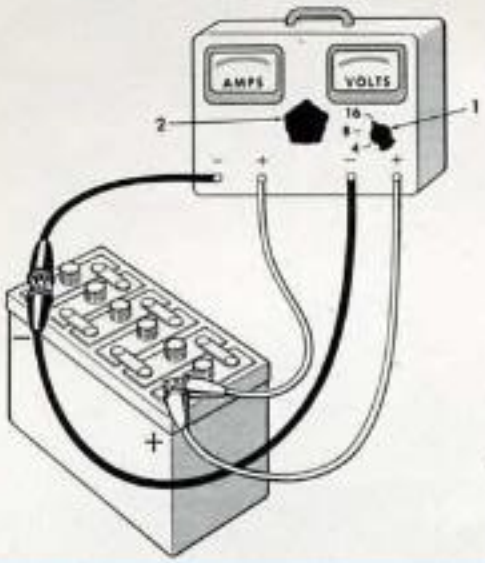
We urge you to become familiar with the contents of this Manual and with your test equipment. When you are servicing a tractor electrical system, use your test equipment and get the facts. You can save time on a job, and save money for your customer by doing a thorough job of testing. In addition, you can create good will and build the reputation of your service shop.

To the best of our knowledge, the specifications listed in this manual are correct at the time of printing. However, specifications are subject to change. As new specifications are released, you should record them in your manual.

Be sure to use test equipment of the proper range, or capacity, for the job you are doing. If a meter pointer moves backward from zero, at any time, you should reverse the connections of the two leads.

CHECKING THE BATTERY

BATTERY CAPACITY TEST



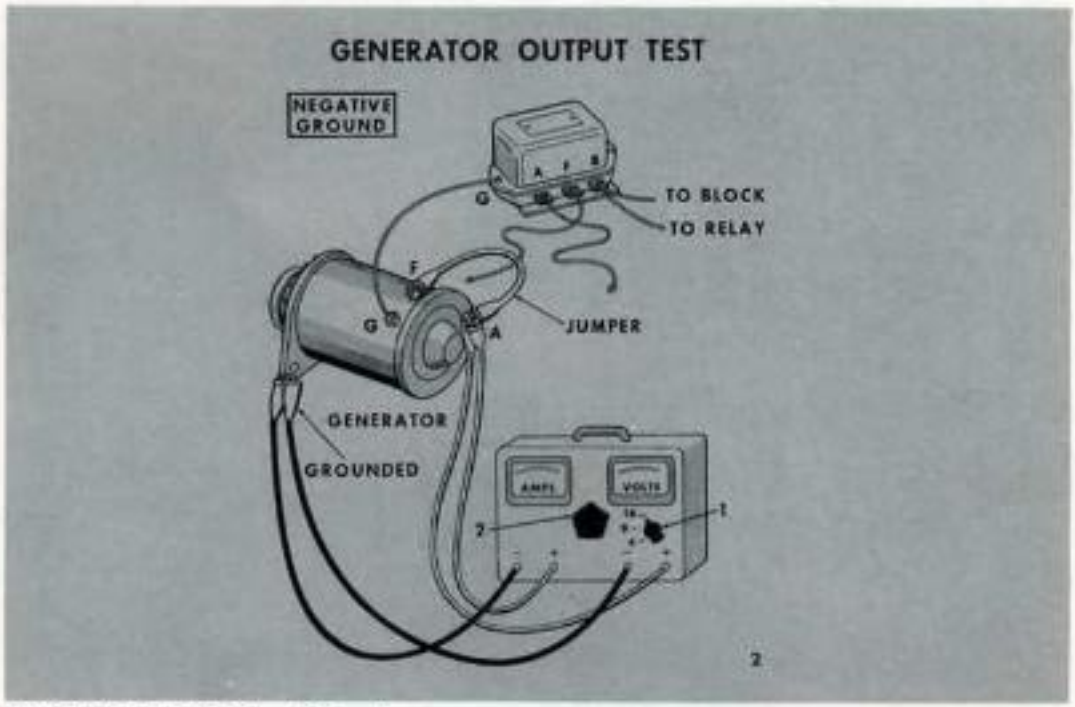
SPECIFICATIONS: 12-volt battery—9.6 volts or higher is satisfactory.
6-volt battery—4.8 volts or higher is satisfactory.

BATTERY MAY BE IN OR OUT OF TRACTOR

1. Turn control knob (2) to OFF position and set voltage selector switch (1) to 16 volts position (12-volt battery) or 8 volts position (6-volt battery).
2. Connect test leads as shown; make good contacts.
3. Turn control knob (2) until ammeter reading is three times the ampere-hour rating of battery.
4. Maintain load for 15 seconds; take voltmeter reading.
5. Turn control knob (2) to OFF position and disconnect the meters.

CONCLUSIONS

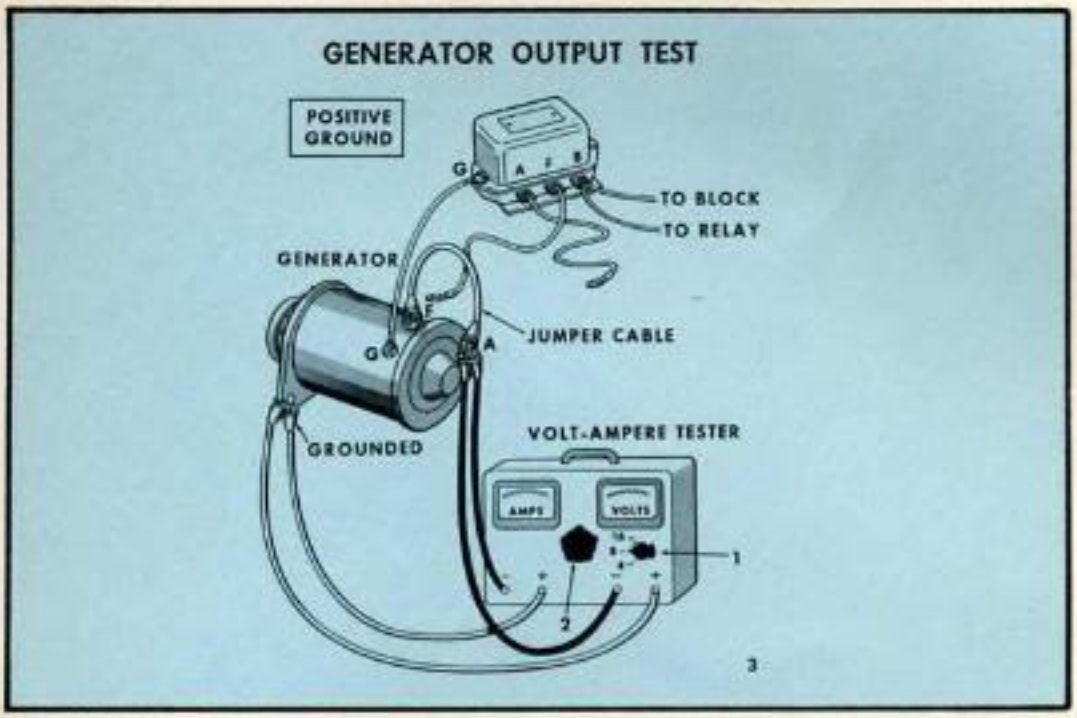
1. If voltmeter reading is 9.6 volts or higher (12-volt battery) or 4.8 volts or higher (6-volt battery), the battery has satisfactory capacity.
2. If voltmeter reading is unsatisfactory:
   a. Slow charge the battery to full charge, let stand for 24 hours, repeat capacity test. If reading is still low, the battery is worn out or defective. As an alternative, you may use the next step.
   b. Use a special Three-Minute Fast Charge Test if you have the equipment. Follow directions with charger-tester.



SPECIFICATIONS: 12-volt system—output should be 25 amperes or more.

GENERATOR ON TRACTOR

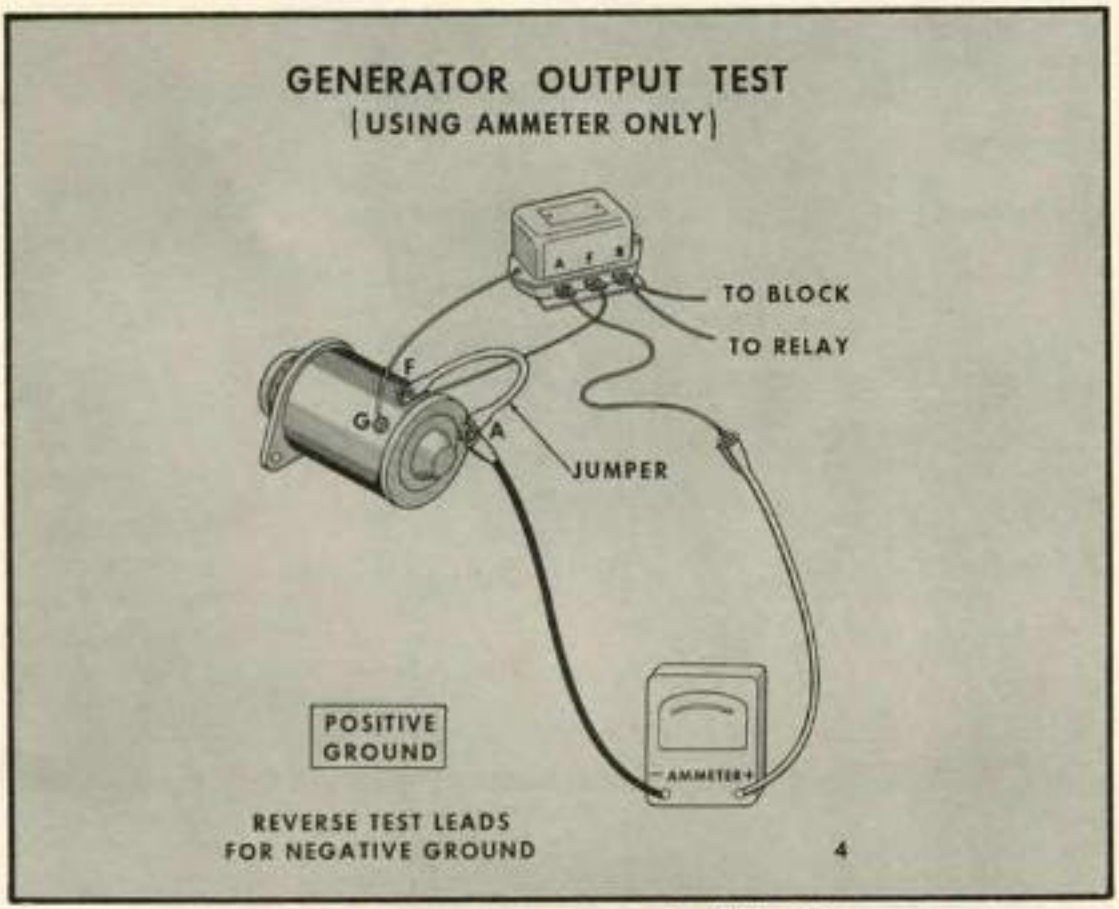
1. Disconnect wires from regulator at *generator* field and armature terminals.
2. Connect the generator field and armature terminals with a jumper wire.
3. Connect the positive leads of *ammeter and voltmeter* to the generator armature terminal.
4. Turn voltage selector switch (1) to 16 volts position for the 12-volt battery.
5. Ground the negative leads from *ammeter and voltmeter* to the generator housing or engine.
6. Turn control knob (2) away from the OFF position (all the way).
7. Start the engine and run it at a fast idle.
8. Adjust the control knob (2) to obtain a reading of 15 volts on the voltmeter.
9. Note the *ammeter* reading. (It may be necessary to increase engine speed to 1500 rpm to obtain rated output.)
10. Disconnect the meters.
11. The ammeter reading should be 25 amperes or more.



SPECIFICATIONS: 6-volt system—output should be 20 amperes or more.

GENERATOR ON TRACTOR

1. Disconnect wires from regulator at *generator* field and armature terminals.
2. Connect the generator field and armature terminals with a jumper wire.
3. Connect the negative leads of *ammeter and voltmeter* to the generator armature terminal.
4. Turn voltage selector switch (1) to 8 volts position for the 6-volt battery.
5. Ground the positive leads from *ammeter and voltmeter* to the generator housing or engine.
6. Turn control knob (2) away from the OFF position (all the way).
7. Start the engine and run it at a fast idle.
8. Adjust the control knob (2) to obtain a reading of 7 volts on the voltmeter.
9. Note the *ammeter* reading. (It may be necessary to increase engine speed to 1500 rpm to obtain rated output.)
10. Disconnect the meters.
11. The ammeter reading should be 20 amperes or more.

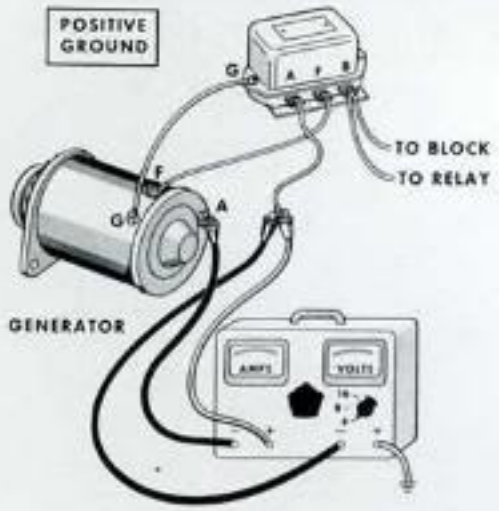


SPECIFICATIONS: 12-volt system—output should be 25 amperes or more.
6-volt system—output should be 20 amperes or more.

GENERATOR ON TRACTOR

1. Disconnect wire from regulator at generator armature terminal.
2. Connect the generator field and armature terminals with a jumper wire.
3. Connect the ammeter negative lead to the generator armature terminal.
4. Connect the ammeter positive lead to the generator armature *wire.*
5. Start the engine and gradually increase the speed (up to 1500 rpm) until the specified output is reached.
6. Disconnect the ammeter.
7. If the tractor has a negative ground, reverse the two ammeter leads.
8. The output should be:
   a. Twenty amperes, or more, for a 6-volt system.
   b. Twenty-five amperes, or more, for a 12-volt system.

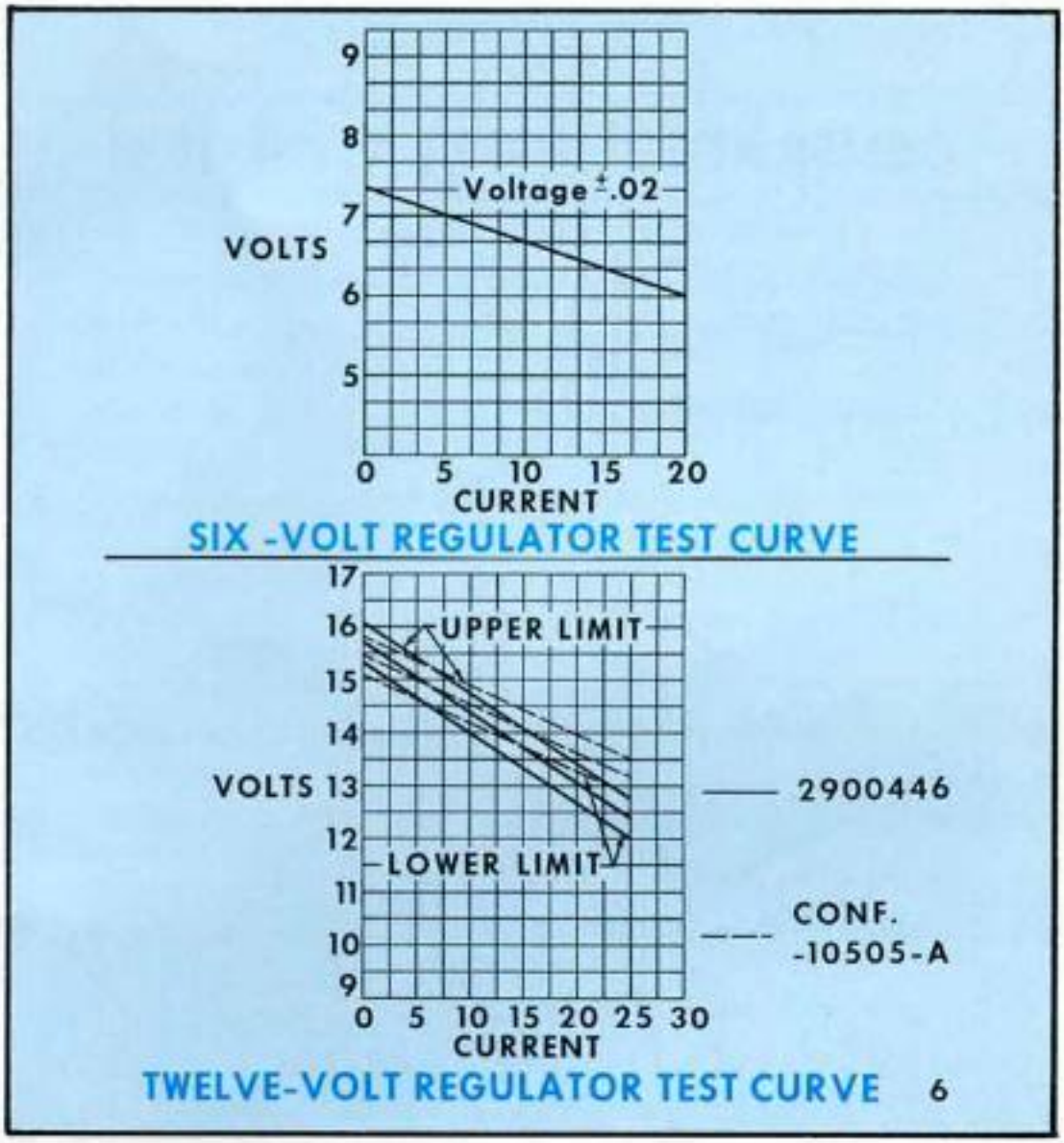
CHECKING THE REGULATOR



SPECIFICATIONS: 6-volt system—cutout closing should be at 6.0-6.6 volts.

1. Disconnect the wire attached to the generator armature terminal.
2. Connect ammeter negative lead to generator armature terminal.
3. Connect ammeter positive lead and voltmeter negative lead to the wire removed from the armature terminal (step 1).
4. Connect voltmeter positive lead to ground (on engine).
5. Start engine. Idle it for about 30 minutes to stabilize the heat of the regulator.
6. Adjust the engine speed to obtain an ammeter reading of 4.5 to 5.0 amperes during step 5.
7. Slowly increase engine speed while watching the meters.
8. The cutout closing point is indicated by a momentary "flick" or drop-back of the voltmeter pointer. The reading should be 6.0 to 6.6 volts. Reduce engine speed and repeat test, if necessary.
9. Next, increase the engine speed up to 2000 rpm and observe the highest voltmeter reading. Also, note the ammeter reading at the same time.
10. Disconnect meter, stop engine, and reconnect wire to generator armature terminal.
11. Refer to the discussion with the following chart (regulator test curve) to determine whether the voltage limiter is operating within specifications. Refer to the 6-volt chart.

CHECKING THE REGULATOR

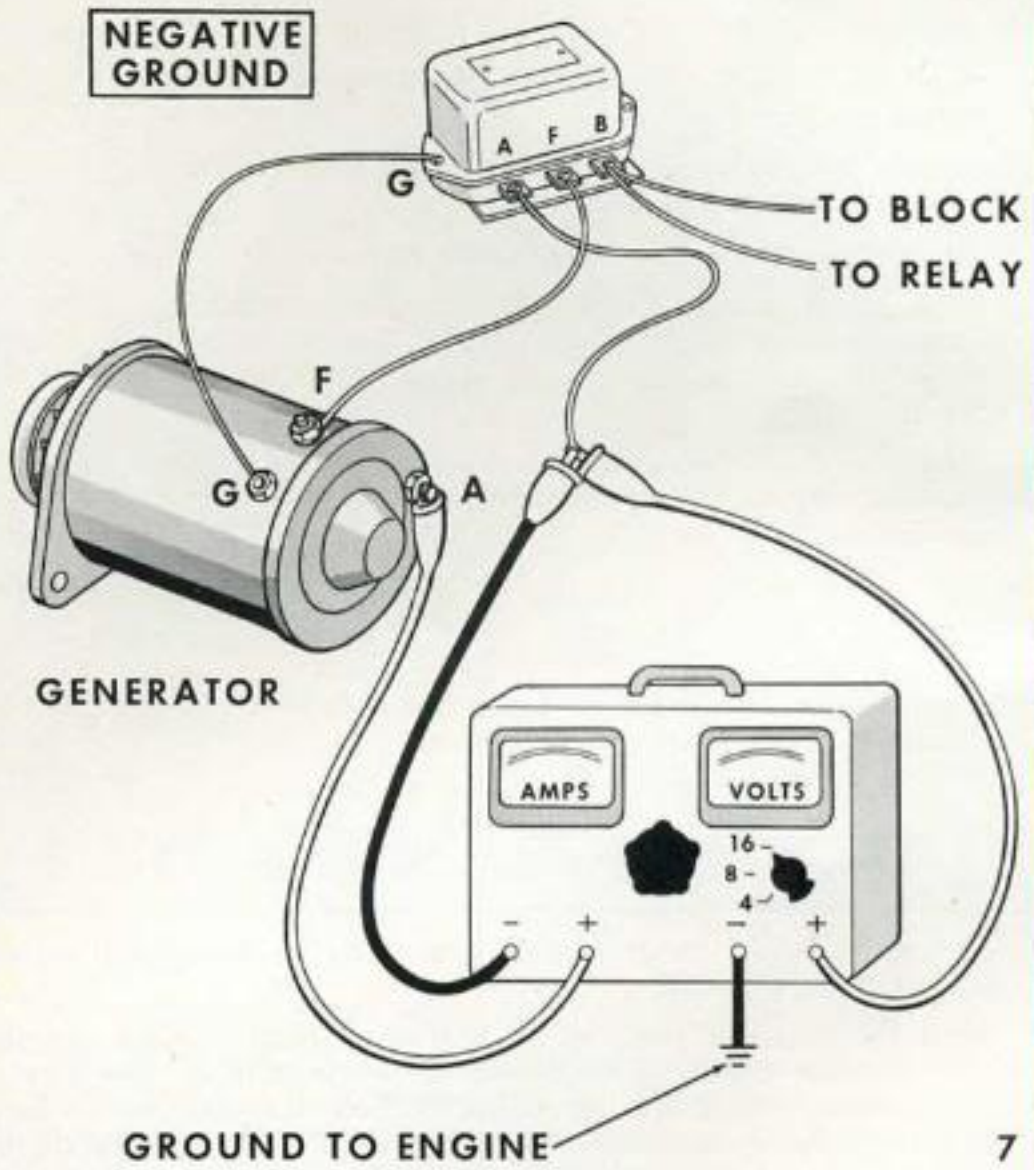


1. Use appropriate chart section according to size of battery on tractor being checked.

2. Find the ammeter reading (at bottom of chart) which was observed when checking regulator for voltage limit. Use a ruler (if necessary) to move up vertically from the ammeter reading to the diagonal line (either the center solid or broken line on the 12-volt chart). Now move horizontally to the left to find what the regulated voltage should be. Compare this with the observed voltage.

   NOTE: Allowable variation is ±0.02 volts for 6-volt system and is indicated by upper and lower limit lines for the 12-volt system. On the 12-volt chart, use the solid lines for Part No. 2900446 Regulator and the broken lines for Part No. CONF-10505-A Regulator. The ambient temperature around the regulator should be about 75° F.

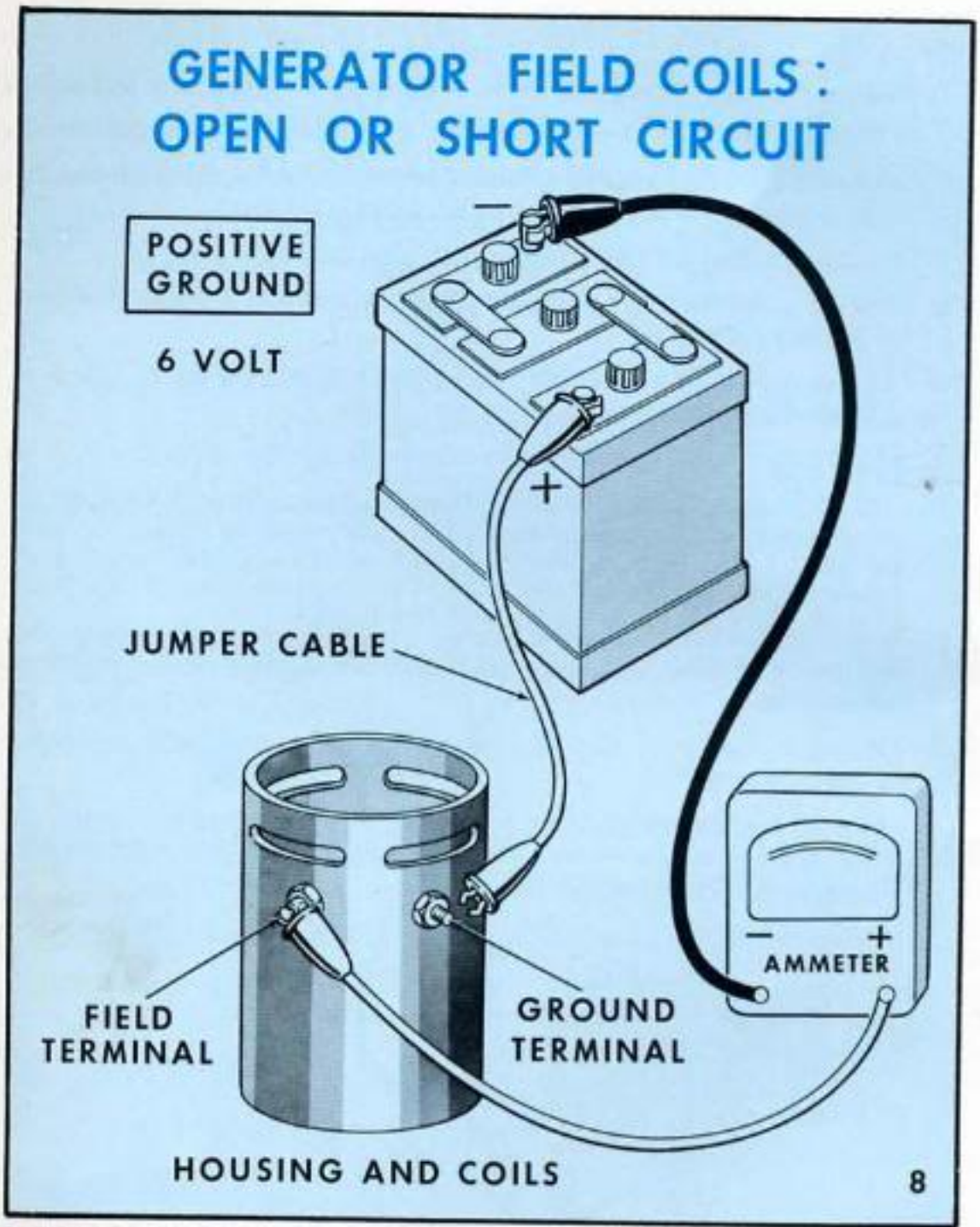
GENERATOR REGULATOR TEST



SPECIFICATIONS: 12- volt system— cutout closing should be at 12.2- 13.0 volts.

CHECKING THE REGULATOR

1. Disconnect the wire attached to the generator armature terminal.
2. Connect ammeter positive lead to generator armature terminal.
3. Connect ammeter negative lead and voltmeter positive lead to the wire removed from the armature terminal (step 1).
4. Connect voltmeter negative lead to ground (on engine).
5. Start the engine. Idle it for about 30 minutes to stabilize the heat of the regulator.
6. Adjust the engine speed to obtain an ammeter reading of 4.5 to 5.0 amperes during step 5.
7. Slowly increase engine speed while watching the meters.
8. The cutout closing point is indicated by a momentary "flick" or drop-back of the voltmeter pointer. The reading should be 12.2 to 13.0 volts. Reduce engine speed and repeat the test, if necessary.
9. Next, increase the engine speed up to 2000 rpm, and observe the highest voltmeter reading. Also, note the ammeter reading at the same time.
10. Disconnect meters, stop engine, and reconnect wire to generator armature terminal.
11. Refer to discussion with the preceding chart (regulator test curve) to determine whether the voltage limiter is operating within specifications. Refer to the 12-volt chart.



SPECIFICATIONS:

The coil circuit is open (broken)– if there is no ammeter reading.
The coil circuit is satisfactory– with an ammeter reading of 1.5-2.0 amperes.
The coil circuit is shorted– with an ammeter reading of more than 2.0 amperes.

CONNECTIONS SHOWN FOR POSITIVE GROUND

1. Connect ammeter negative lead to negative battery terminal.
2. Connect ammeter positive lead to generator field terminal
3. Connect a jumper cable to battery positive post and momentarily touch the other end to the generator ground terminal; observe the ammeter reading.

CONCLUSIONS

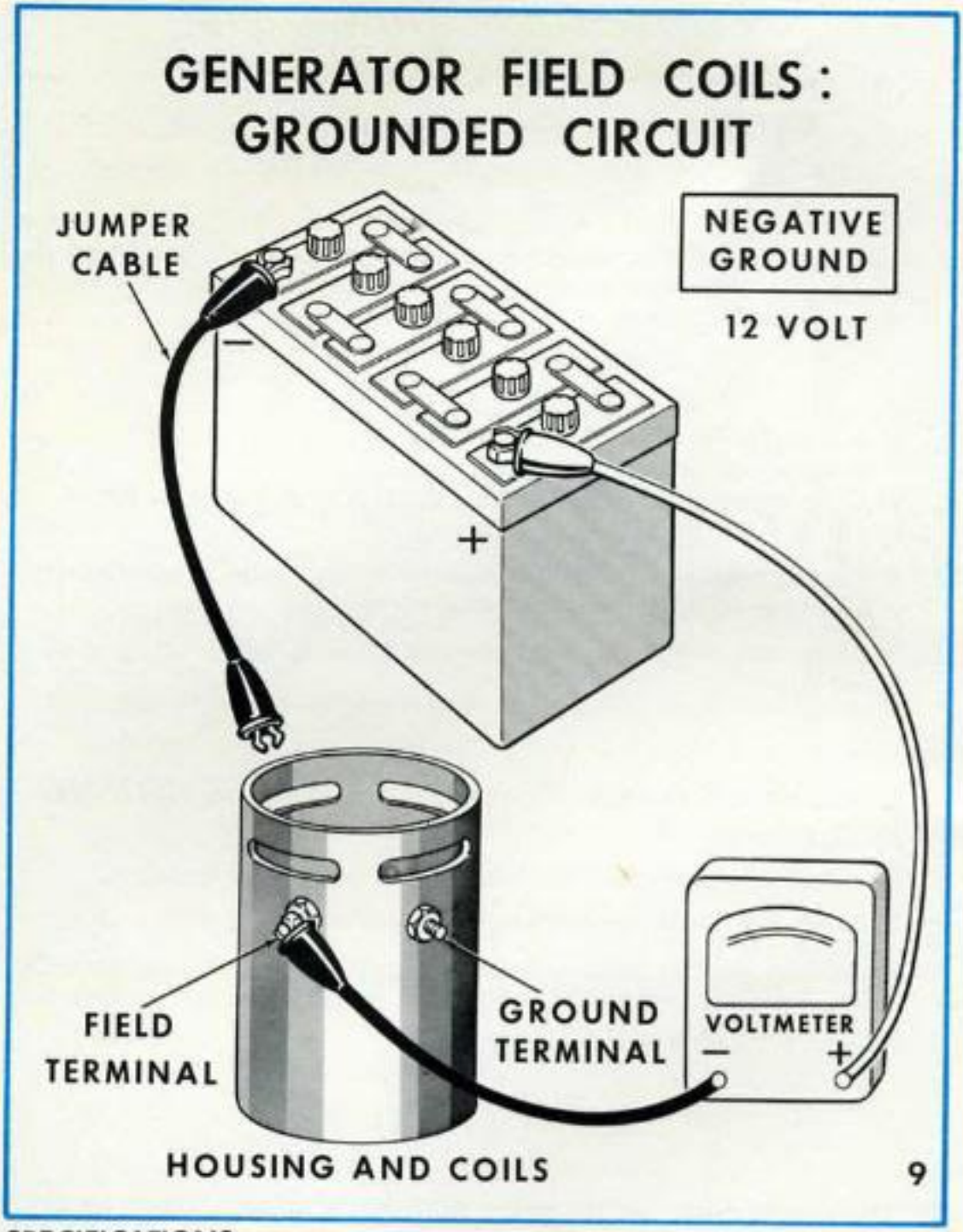
1. If there is no ammeter reading, the coil circuit is open (broken) or the coil has excessive resistance.
2. If the ammeter reads 1.5 to 2.0 amperes, the circuit is satisfactory. A higher reading indicates a short circuit.
3. Replace or repair the generator if there is either an open or a short circuit

CONNECTIONS FOR NEGATIVE GROUND

1. Connect ammeter negative lead to generator field terminal.
2. Connect ammeter positive lead to positive battery terminal.
3. Connect a jumper cable to battery negative post and momentarily touch the other end to the generator ground terminal; observe the ammeter reading.

CONCLUSIONS

1. The conclusions are the same that apply to the positive ground system.



SPECIFICATIONS:

The coil circuit is grounded– if there is any voltmeter reading.

CONNECTIONS SHOWN FOR NEGATIVE GROUND

1. Connect voltmeter negative lead to generator field terminal.
2. Connect voltmeter positive lead to positive battery terminal.
3. Connect a jumper cable to negative battery terminal and momentarily touch the other end to the generator housing.

CONCLUSIONS

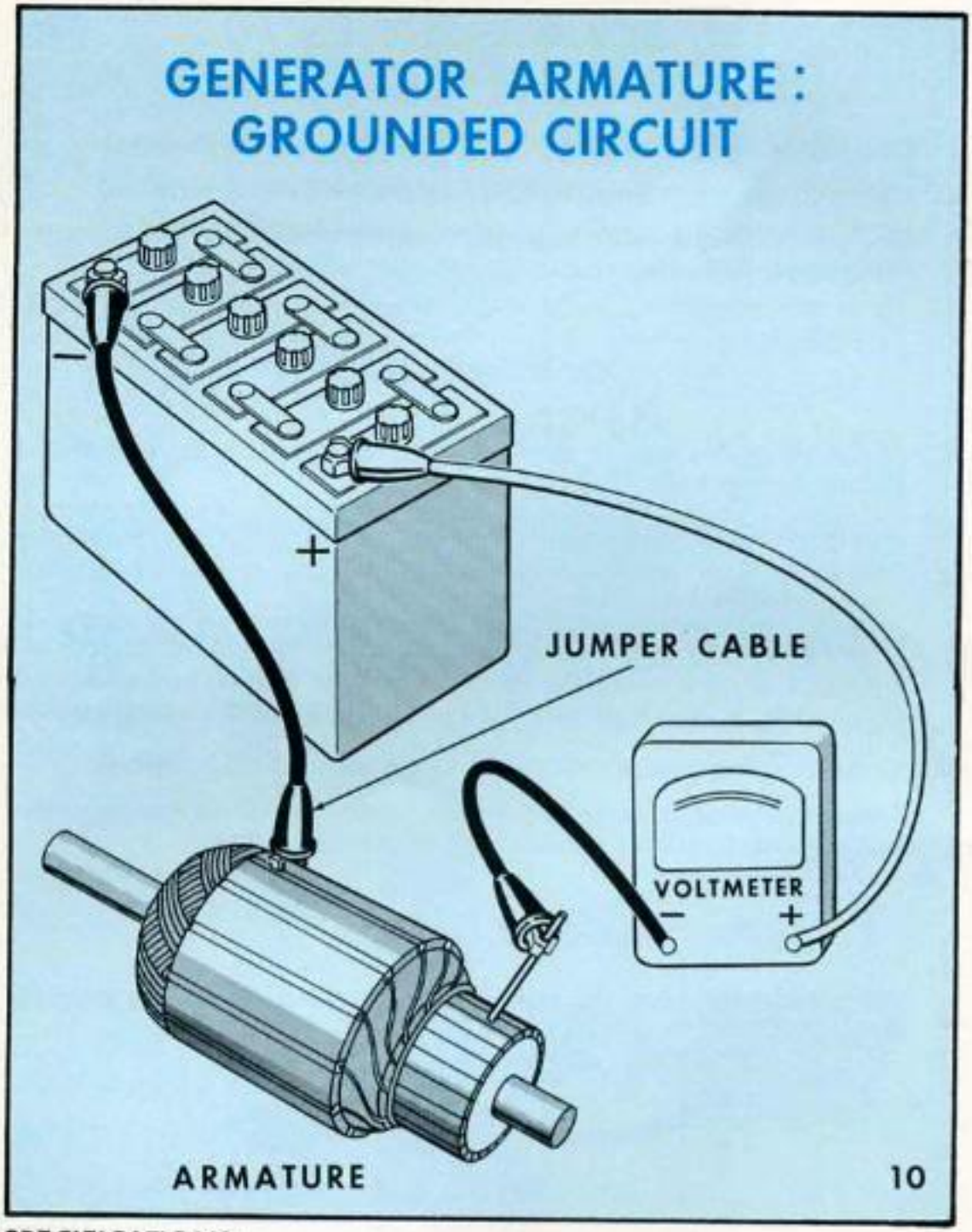
1. If the voltmeter shows any reading, the coils are grounded and should be replaced.
2. If there is no reading, the coils are not grounded.

CONNECTIONS FOR POSITIVE GROUND

1. Connect voltmeter negative lead to negative battery terminal.
2. Connect voltmeter positive lead to generator field terminal.
3. Connect a jumper cable to positive battery terminal and momentarily touch the other end to the generator housing.

CONCLUSIONS

1. The conclusions are the same that apply to the negative ground system.



SPECIFICATIONS:

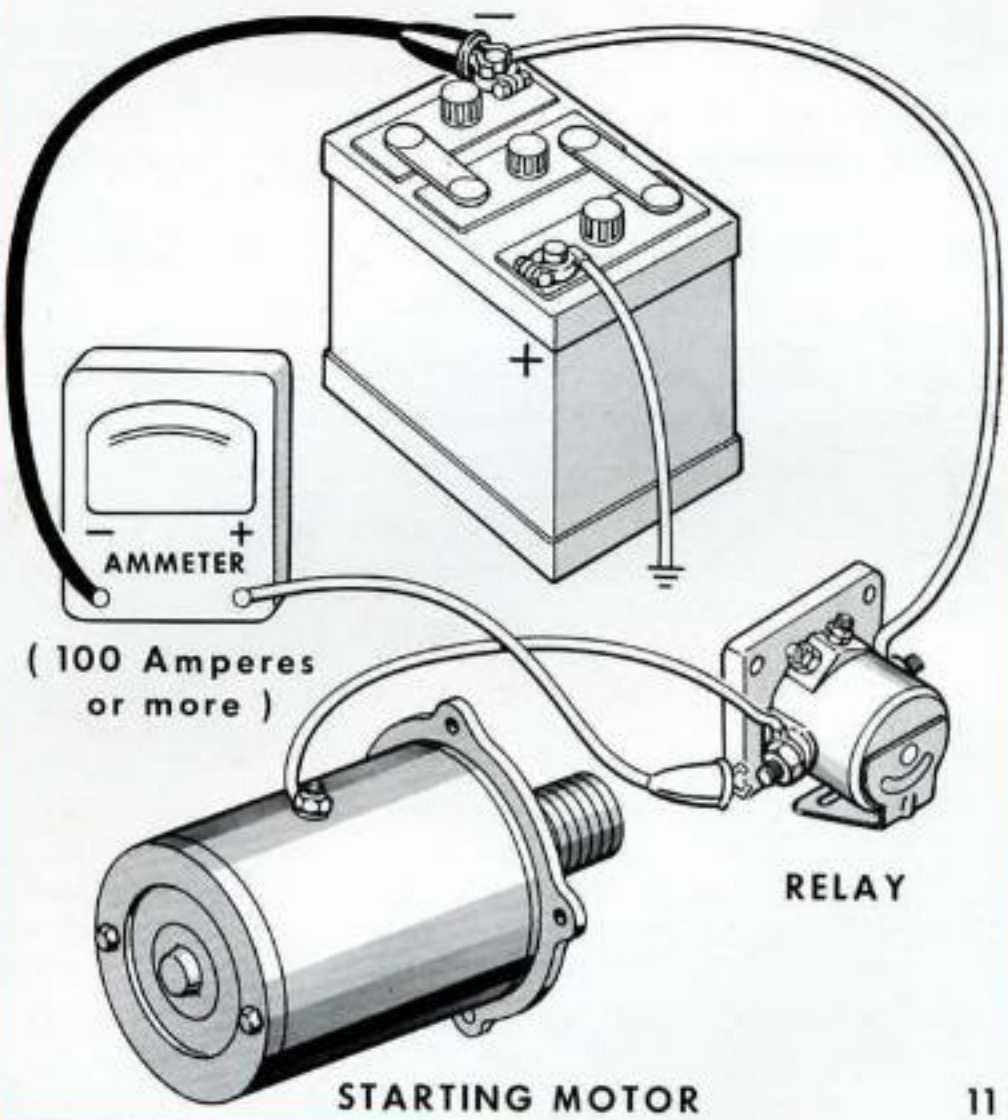
The armature circuit is grounded– if there is any voltmeter reading.

1. Connect a jumper cable to the negative battery terminal.
2. Connect the other end of the jumper to the armature, as shown.
3. Connect voltmeter positive lead to positive battery terminal.
4. Install a prod in the voltmeter negative lead terminal.
5. Check each commutator segment in turn by touching the segment with the prod.
6. If a voltmeter reading is obtained when testing any segment, the circuit is grounded. Replace the armature.

SAME TEST MADE WITH A TEST LAMP

1. If test is made with a test lamp connected to building electrical circuit, touch the armature core with one prod and each segment, in turn, with the other prod. If the lamp lights, the circuit is grounded.
2. If a battery is used as a source of power for the test lamp, use a jumper from the battery as in chart #10. Touch one prod to the free battery terminal and the remaining prod to each segment of the commutator in turn.

STARTING MOTOR : (ON TRACTOR) NO-LOAD CURRENT TEST



11

SPECIFICATIONS:

8N and NAA – current draw should be 45-60 amperes.
Other 4-cyl. tractors – current draw should be 100 amperes.
Series 6000 (gas) – current draw should be 100 amperes.
Series 6000 (diesel) – current draw should be 75 amperes.

STARTING MOTOR IN PLACE ON TRACTOR; POSITIVE GROUND

1. Connect ammeter negative lead to negative battery terminal or the battery relay terminal.
2. Start the engine and run at idle speed.
3. Connect ammeter positive lead to starter terminal of relay or to starting motor terminal.
4. The ammeter reading should be approximately 100 amperes.

STARTING MOTOR IN PLACE ON TRACTOR; NEGATIVE GROUND

1. Connect ammeter positive lead to positive battery terminal.
2. Start the engine and run at idle speed.
3. Connect ammeter negative lead to starting motor terminal.
4. The ammeter reading should be approximately 100 amperes (75 amperes on Series 6000 Diesel).

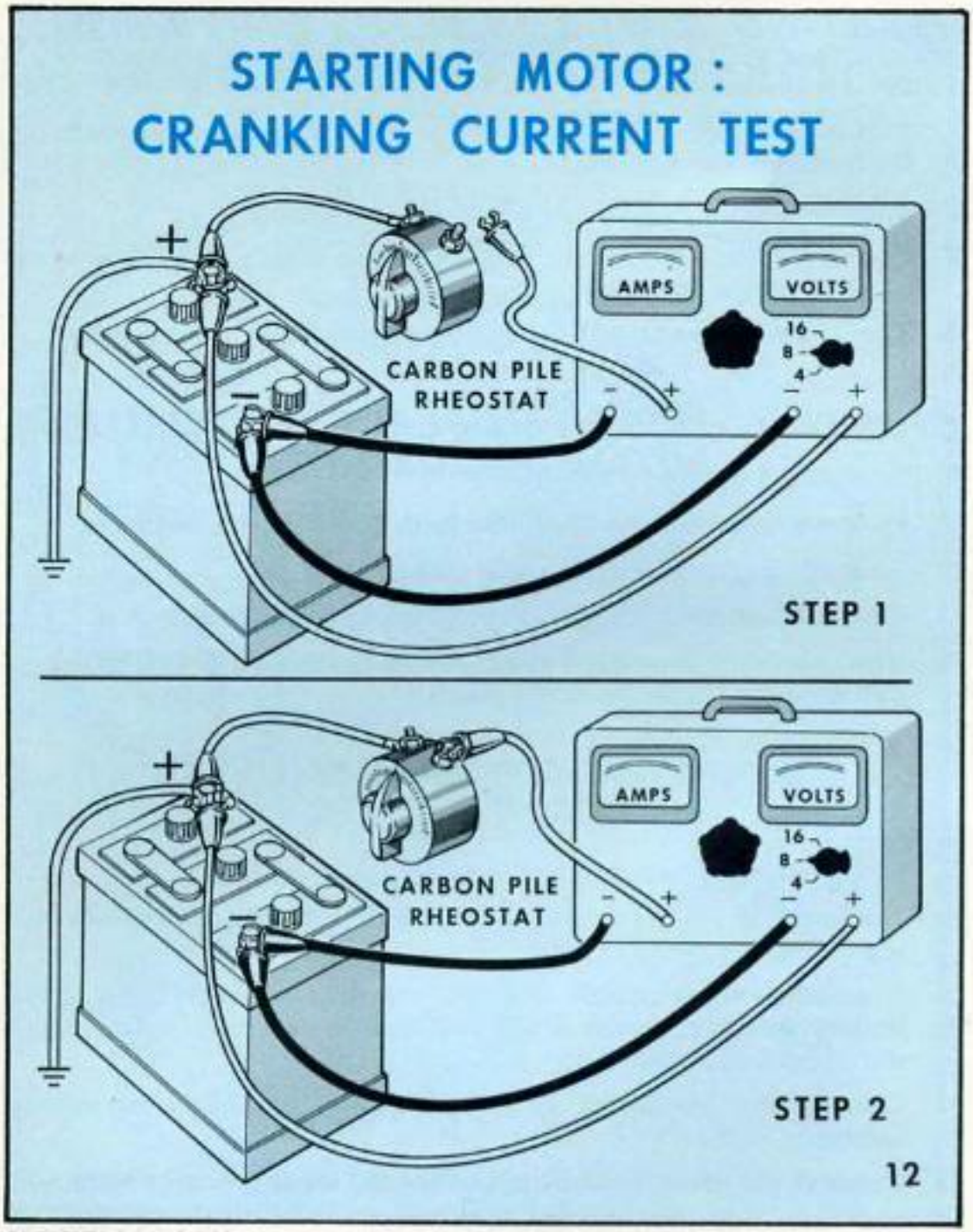
STARTING MOTOR REMOVED FROM TRACTOR

1. Secure starting motor in a vise or other arrangement.
2. Use a 6- or 12-volt battery, according to the starting motor being tested.
3. Connect a jumper cable from the starting motor housing to the battery (positive terminal on a 6-volt battery and negative terminal on a 12-volt battery).
4. Connect the remaining battery terminal to the corresponding ammeter lead (+ to +, - to -).
5. Connect the other ammeter lead to the starting motor terminal.
6. The ammeter reading should be approximately 100 amperes (75 amperes on Series 6000 Diesel).

CONCLUSIONS

(Assuming that battery is good and connections are clean and tight.)

1. Current draw definitely below specifications indicates high internal resistance; further tests are needed.
2. Current draw above specifications indicates tight bearings, a dragging armature due to a bent shaft, etc.



SPECIFICATIONS:

All 4-cyl. tractors (gas)– current draw should be 100-150 amperes.
All 4-cyl. tractors (diesel)– current draw should be 190-225 amperes.
Series 6000 (gas)– current draw should be 175 amperes.
Series 6000 (diesel)– current draw should be 150-200 amperes.

1. Connect the *ammeter and voltmeter* negative leads to the negative battery terminal or battery relay terminal.
2. Connect the carbon pile rheostat to the positive battery terminal. Do NOT connect rheostat to ammeter at this time.
3. Connect the voltmeter positive lead to the positive battery terminal; set voltage selector switch to 8 volts position for a 6-volt battery or to 16 volts position for a 12-volt battery.
4. Disconnect high tension wire from coil to prevent engine from starting.
5. Crank the engine and not the voltmeter reading.
6. Release the starter switch or button.
7. Connect the ammeter positive lead to the carbon pile rheostat and adjust the resistance control knob until the same voltmeter reading is obtained as in step 5. Read the ammeter; check with specifications.
8. Immediately disconnect ammeter from carbon pile rheostat to avoid discharging the battery.

NOTE: The starting motor is not actually used when the amperage reading is taken because even the small resistance of the ammeter would distort the result in this test.

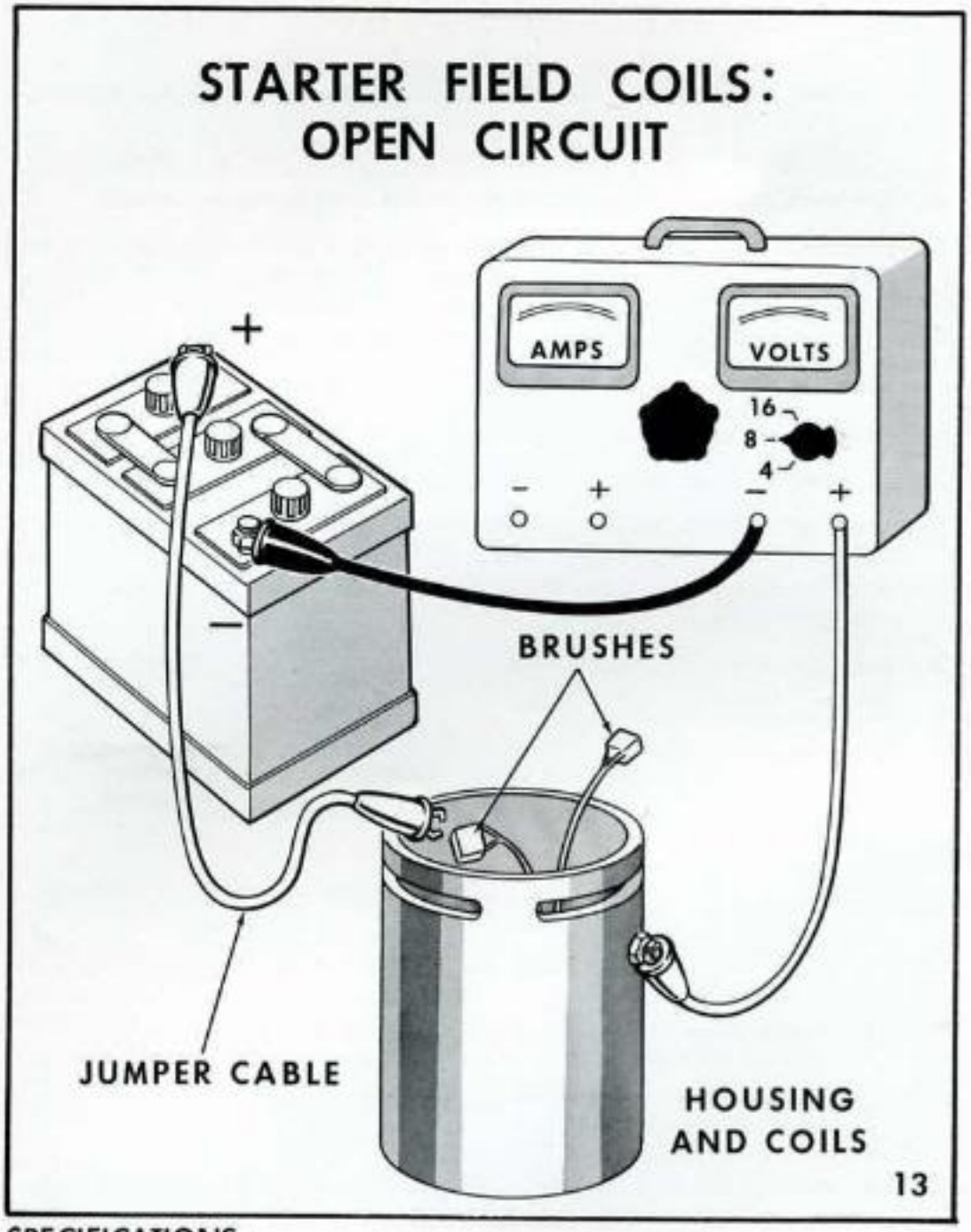
TEST CONDUCTED WITH COMBINATION BATTERY—STARTER-TESTER

1. Follow the directions included with the test unit.

CONCLUSIONS

(Assuming that battery is good and connections are clean and tight.) If both the no-load and cranking current tests are performed, certain deductions can be made.

1. If the current draw is excessive in both tests, the trouble is in the starting motor.
2. If the current draw is high in the cranking test but normal in the no-load test, excessive drag or friction in the engine or starter drive is indicated.
3. If the current draw is much below specifications in either test, the fault is in the starting motor. Check for a dirty commutator or weak brush springs.



SPECIFICATIONS:

The coil circuit is open (broken) – if there is no voltmeter reading.

CONNECTIONS SHOWN FOR POSITIVE GROUND

1. Connect voltmeter negative lead to negative battery terminal.
2. Connect voltmeter positive lead to starting motor terminal.
3. Connect a jumper cable to the positive battery terminal.
4. Touch each brush, in turn, with the free end of the jumper cable.
5. The circuit is good if there is a reading on the voltmeter.

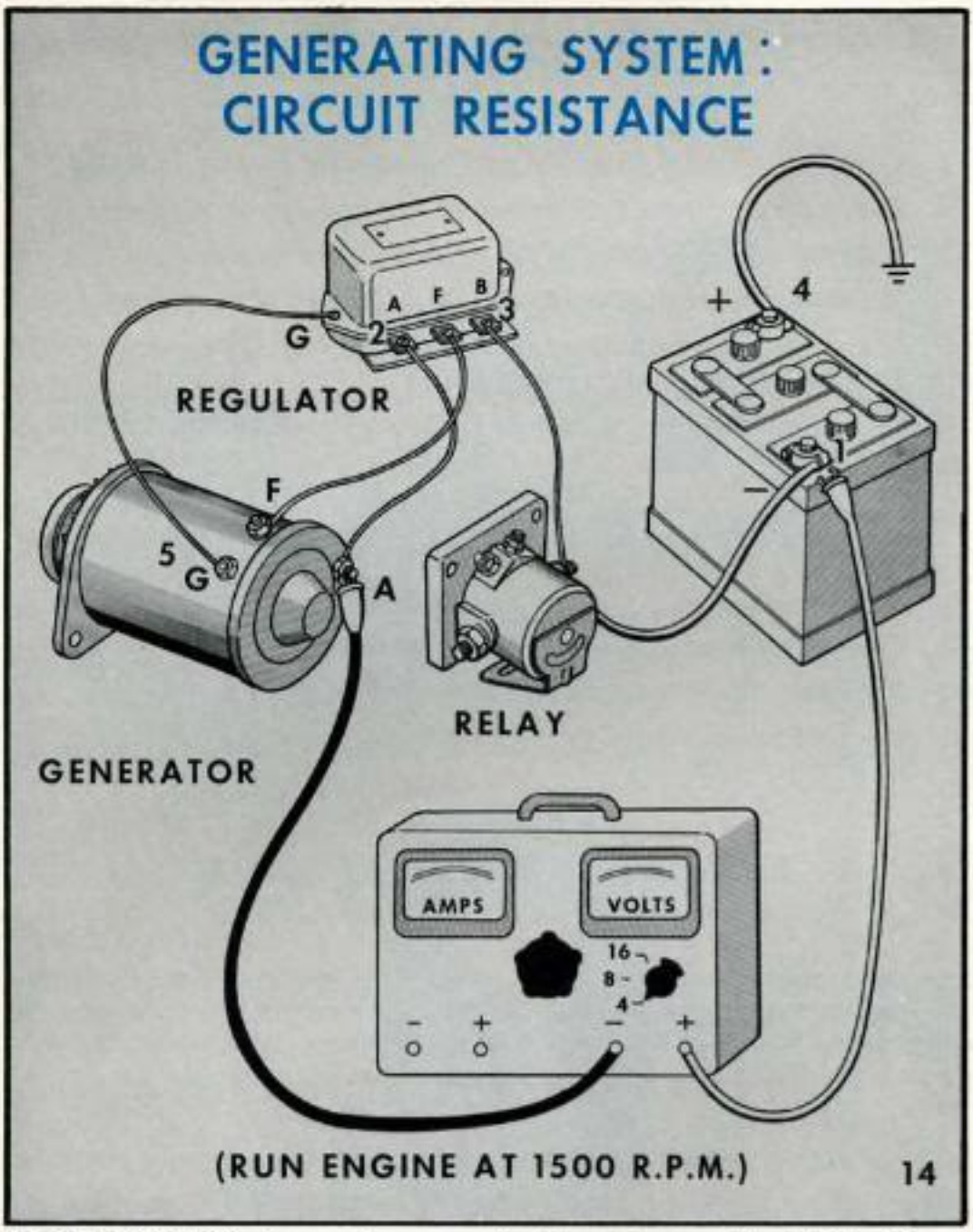
NOTE: The same test can easily be made with a test lamp. In either case, if there is no flow of current, replace the field coils.

CONNECTIONS FOR NEGATIVE GROUND

1. Connect voltmeter positive lead to positive battery terminal.
2. Connect voltmeter negative lead to starting motor terminal.
3. Connect jumper cable to negative battery terminal and make test as in step 4 (above).

TEST FOR STARTING MOTOR GROUNDED FIELD COIL

The connections are exactly the same as for testing the field coils for an open circuit (preceding test). In this case, however, touch the jumper cable to the housing. If there is a flow of current (reading on the voltmeter), the field coils are grounded and must be replaced.



SPECIFICATIONS: The maximum permissible voltage reading is 0.4 volts.

CONNECTIONS SHOWN FOR POSITIVE GROUND

1. Turn the voltage selector switch to the 4 volts position or use a low range voltmeter accurate to tenths of a volt.
2. Connect the voltmeter negative lead to the generator armature terminal.
3. Start the engine and bring it up to operating temperature.
4. Run the engine at 1500 rpm, touch the voltmeter positive lead to the ungrounded battery terminal or the battery relay terminal, and observe the voltmeter reading.

   NOTE: For a negative ground system, reverse the two voltmeter leads.

CONCLUSIONS AND FURTHER TESTS

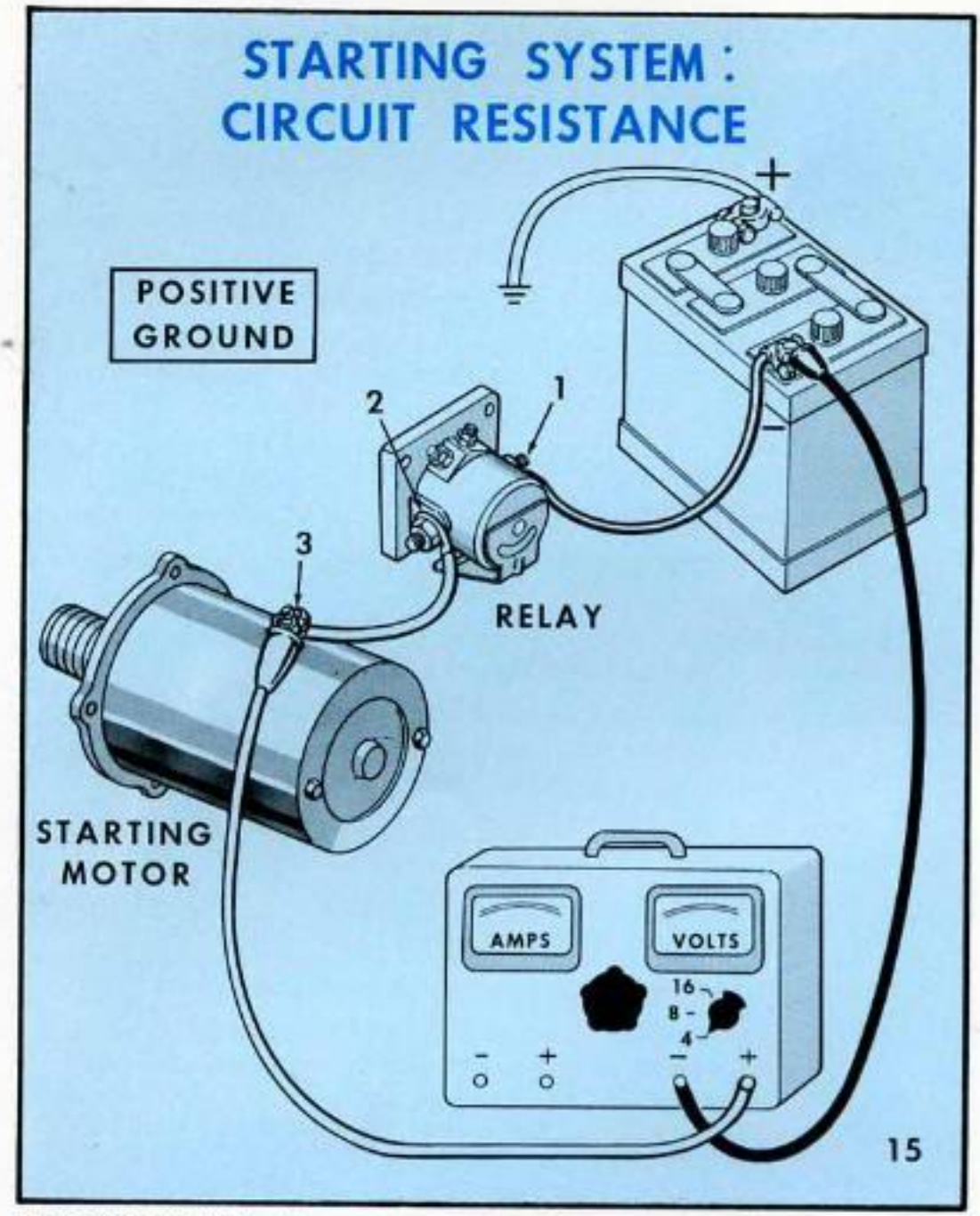
1. If the voltmeter reading is 0.4 volts or less, the circuit resistance is satisfactory. If reading is higher, proceed:
   a. Move the voltmeter lead from the battery terminal (or battery relay terminal) to the regulator armature terminal (2). Here, the voltage reading should not exceed 0.05 volts.
   b. Move the same lead (as in "a") to the regulator battery terminal (3).

   Be careful to touch only the one terminal. The voltage reading should not exceed 0.35 volts. If this reading is O.K. but the total circuit resistance is high, the excessive resistance must be in the circuit from the regulator to the battery.

GROUND CIRCUIT RESISTANCE

The total ground circuit resistance should not exceed 0.05 volts. From the preceding test:

1. Move the voltmeter lead from the generator to the grounded battery terminal (after removing the other lead).
2. Touch the other lead to the generator ground terminal. With the engine running, as in the first test, observe the voltmeter reading. Clean and tighten the battery ground and generator-to-engine connections, if the resistance is high.



SPECIFICATIONS: The maximum permissible voltage reading is 0.125 volts.

CONNECTIONS SHOWN FOR POSITIVE GROUND

1. Use a low range voltmeter, accurate at least to tenths of a volt.
2. To keep the engine from starting:
   a. Remove the high tension wire from the coil, or
   b. Ground the distributor primary circuit terminal, or
   c. Actuate the starter with a heavy cable to connect the two large relay terminals, leaving the ignition switch turned off.

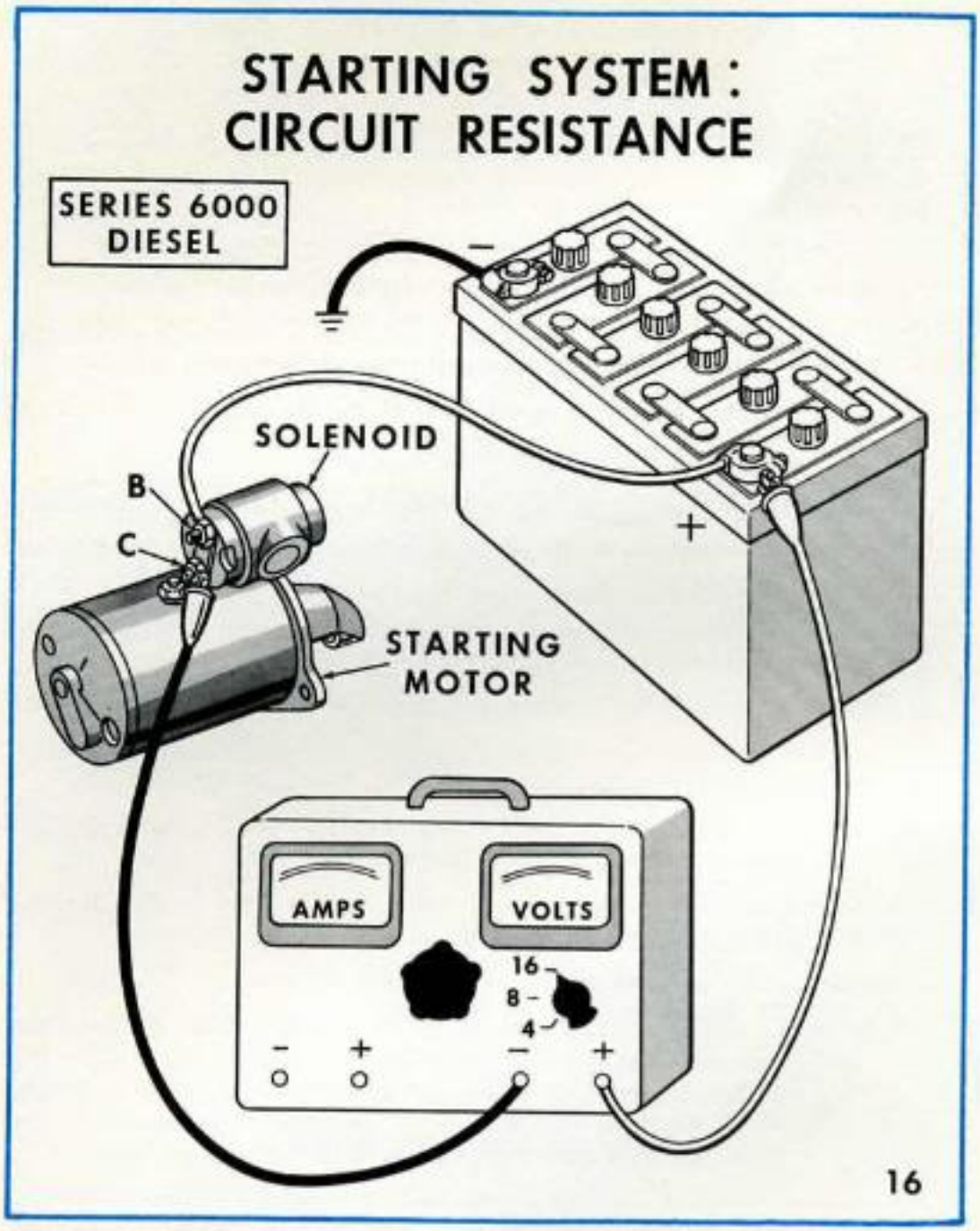
   (All three apply to spark ignition engines.)

   d. On diesel tractors, cut off the fuel supply.
3. Connect the voltmeter positive lead to the starting motor terminal.
4. Actuate the starter and touch the voltmeter negative lead to the negative battery terminal.
5. Stop the starting motor as soon as a voltmeter reading is obtained, which should not exceed 0.125 volts.
6. If the resistance is high, check the circuit parts:
   a. Move voltmeter lead from (3) to (1). Repeat test; maximum reading is 0.02 volts.
   b. Move positive lead to (2) and negative lead to (1). Repeat test; maximum reading is 0.10 volts.
   c. Move positive lead to (3) and negative lead to (2). Repeat test; cable resistance should be less than 0.05 volts.
7. Replace any part which shows excessive resistance.

   NOTE: If meter pointer moves in wrong direction, reverse the two voltmeter leads. If the leads are reversed in each instance above, the tests can be made with four-cylinder diesel engines and with Series 6000 gasoline and LP-gas tractors. For Series 6000 Diesel Tractors, see test #16.

GROUND CIRCUIT RESISTANCE

1. Connect the grounded battery terminal to the corresponding voltmeter lead (+ to +, - to -).
2. Actuate starter and touch remaining voltmeter lead to the starting motor housing. Maximum reading should be 0.05 volts.

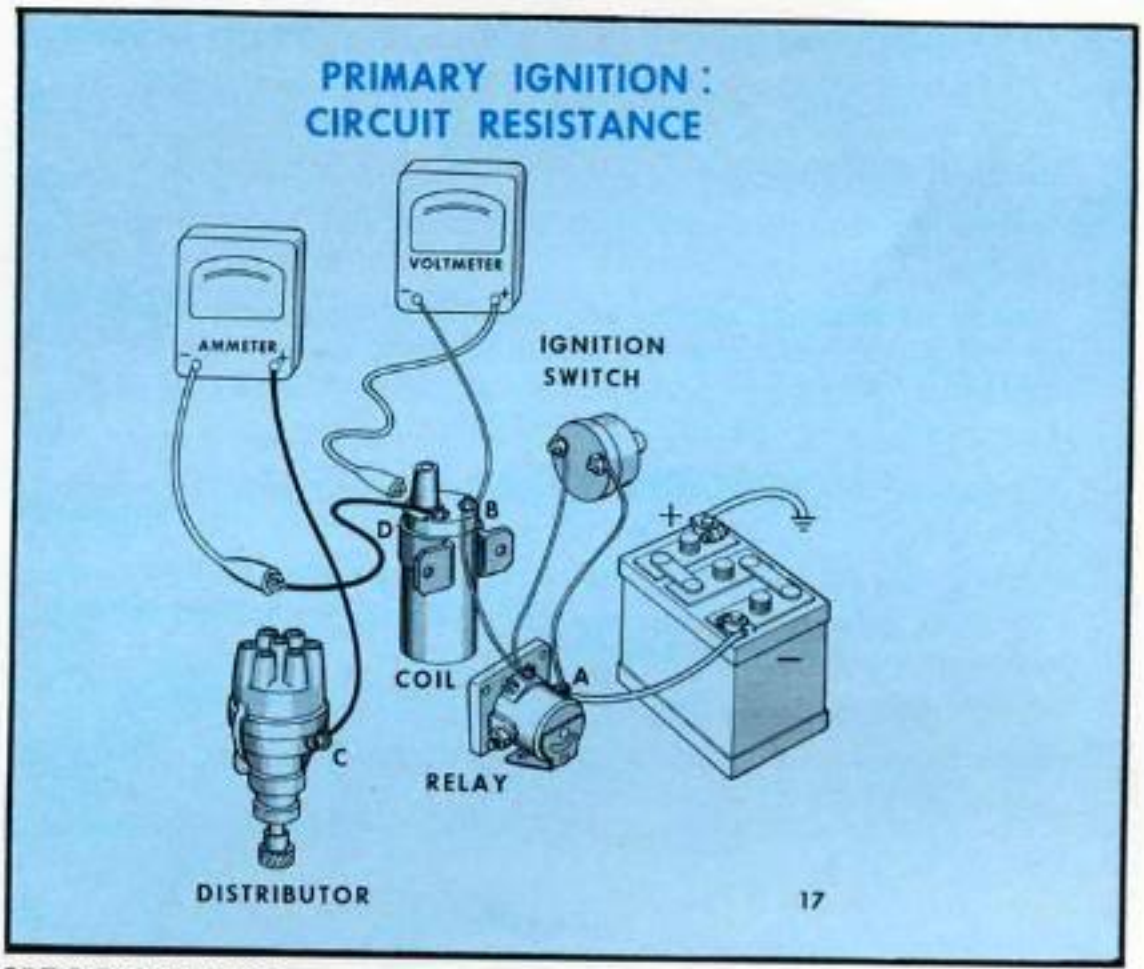


SPECIFICATIONS: The maximum permissible voltage reading is 0.125 volts.

CHECKING CIRCUIT RESISTANCE

CONNECTIONS SHOWN FOR SERIES 6000 DIESEL

1. Pull the fuel shut-off knob to the OUT position.
2. Connect the voltmeter negative lead to the starting motor terminal or to (C) on the solenoid.
3. Actuate the starting motor and touch the battery positive terminal with the voltmeter positive lead. Observe the reading and disengage the starter. The reading should not exceed 0.125 volts.
4. If the resistance is high, check circuit parts as follows:
   a. Move the negative lead to (B) and repeat the test. The reading should be less than 0.03 volts.
   b. Move the negative lead to (C) and touch the positive lead to (B) as you actuate the starter. The reading for the solenoid should be less than 0.10 volts.
5. For ground circuit resistance, see test #15.



SPECIFICATIONS:

Test #1 – the primary coil is shorted with an ammeter reading of more than 4.0 amperes.

Test #2 – the primary coil resistance should be between 1.06 and 1.17 ohms at 75° F.

Test #3 – the maximum permissible voltage reading is 0.20 volts.

TEST FOR A SHORTED PRIMARY COIL

1. Disconnect primary wire from coil at *distributor* terminal.
2. Connect low-range ammeter positive lead to distributor primary terminal.
3. Connect ammeter negative lead to primary wire disconnected from distributor in step 1.
4. Remove the high tension wire from the coil.
5. Turn on the ignition key. The ammeter reading should be approximately four amperes. If there is no reading, slowly turn the engine with the starter until there is a reading (distributor points will be closed).

6. Replace high tension wire in coil. Start and idle the engine. Ammeter reading should be about one ampere.
7. If the readings are appreciably higher than the above specifications, the coil primary windings are shorted. Replace the coil.

TEST RESISTANCE OF PRIMARY COIL

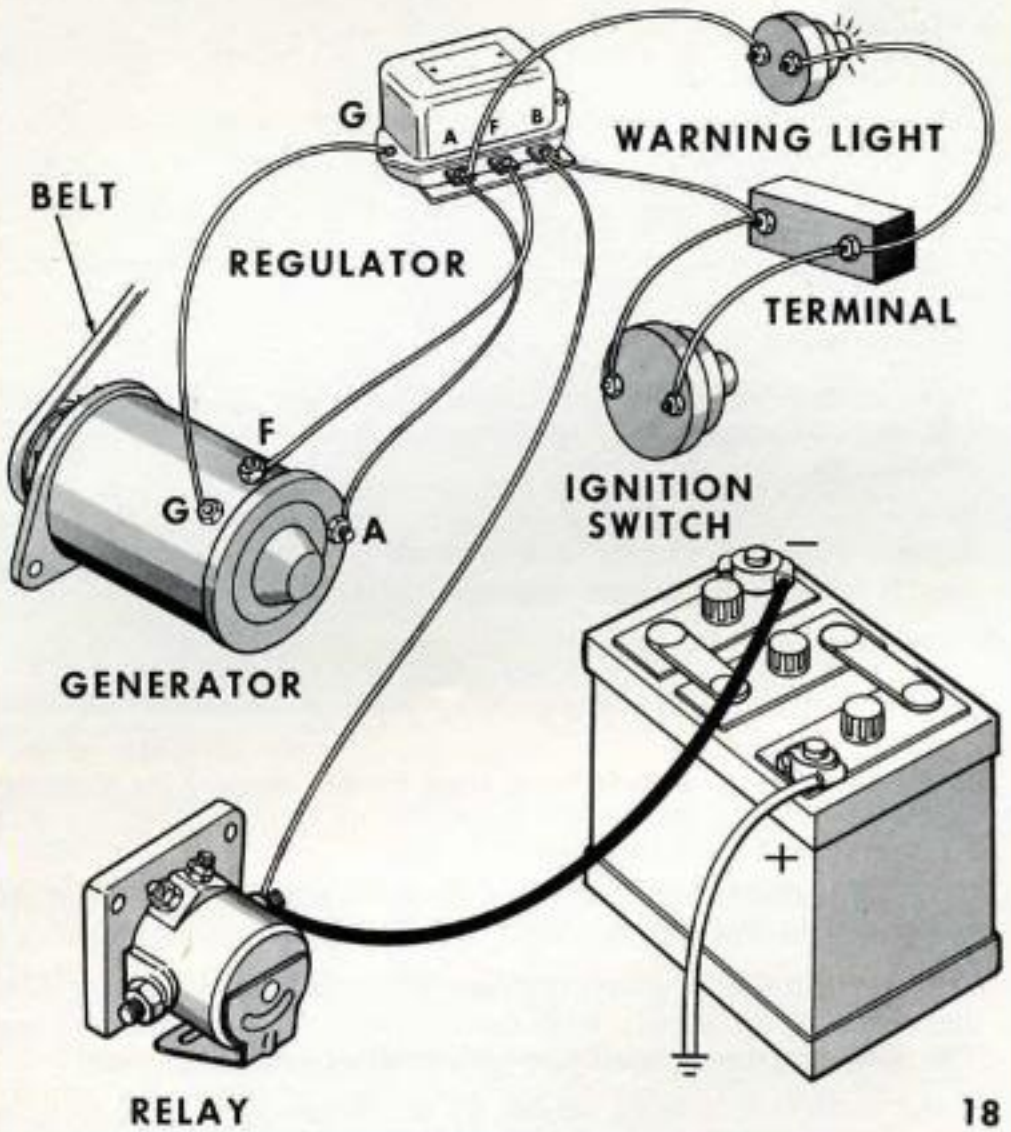
1. Leave ammeter connected as for testing for a grounded primary coil (preceding test).
2. Connect voltmeter negative lead to the battery terminal of the coil.
3. Connect voltmeter positive lead to the distributor terminal of the coil.
4. Remove the high tension wire from the coil.
5. Turn on the ignition key and record the readings of the ammeter and the voltmeter (turn engine over to close distributor points, if necessary). Turn off the key.
6. Divide the voltage reading by the amperage reading. The result is the resistance in ohms. Refer to the specifications. If the resistance is not within the specifications, replace the coil.

TEST CIRCUIT RESISTANCE; RELAY TO COIL

1. If the two previous tests have been made, remove the ammeter and connect the primary wire from the coil to the distributor (C). High tension wire is removed from coil.
2. Connect voltmeter positive lead to the coil battery terminal (B) and the voltmeter negative lead to the relay battery terminal (A).
3. Turn on the ignition key. If there is no voltmeter reading, turn the engine over slowly with the starter until there is a reading. The voltage drop or reading should not exceed 0.20 volts.
4. If the resistance is high, check all the connections from relay to coil for tightness and cleanness. Repeat the test. If resistance is still high:
   a. Check the voltage drop for the ignition switch. Use two connections on block where short leads from switch are connected. The voltage drop should not exceed 0.10 volts. Replace the switch if the reading exceeds 0.10 volts.
   b. If the switch is satisfactory, but the total resistance was high, replace the wiring harness.

   NOTE: Always check the condition of the spark plugs and the distributor points when you make any checks on the ignition system.

TROUBLE SHOOTING THE GENERATING SYSTEM



18

TROUBLE SHOOTING THE GENERATING SYSTEM

I. BATTERY LOW IN CHARGE

A. Indications of battery being low in charge.

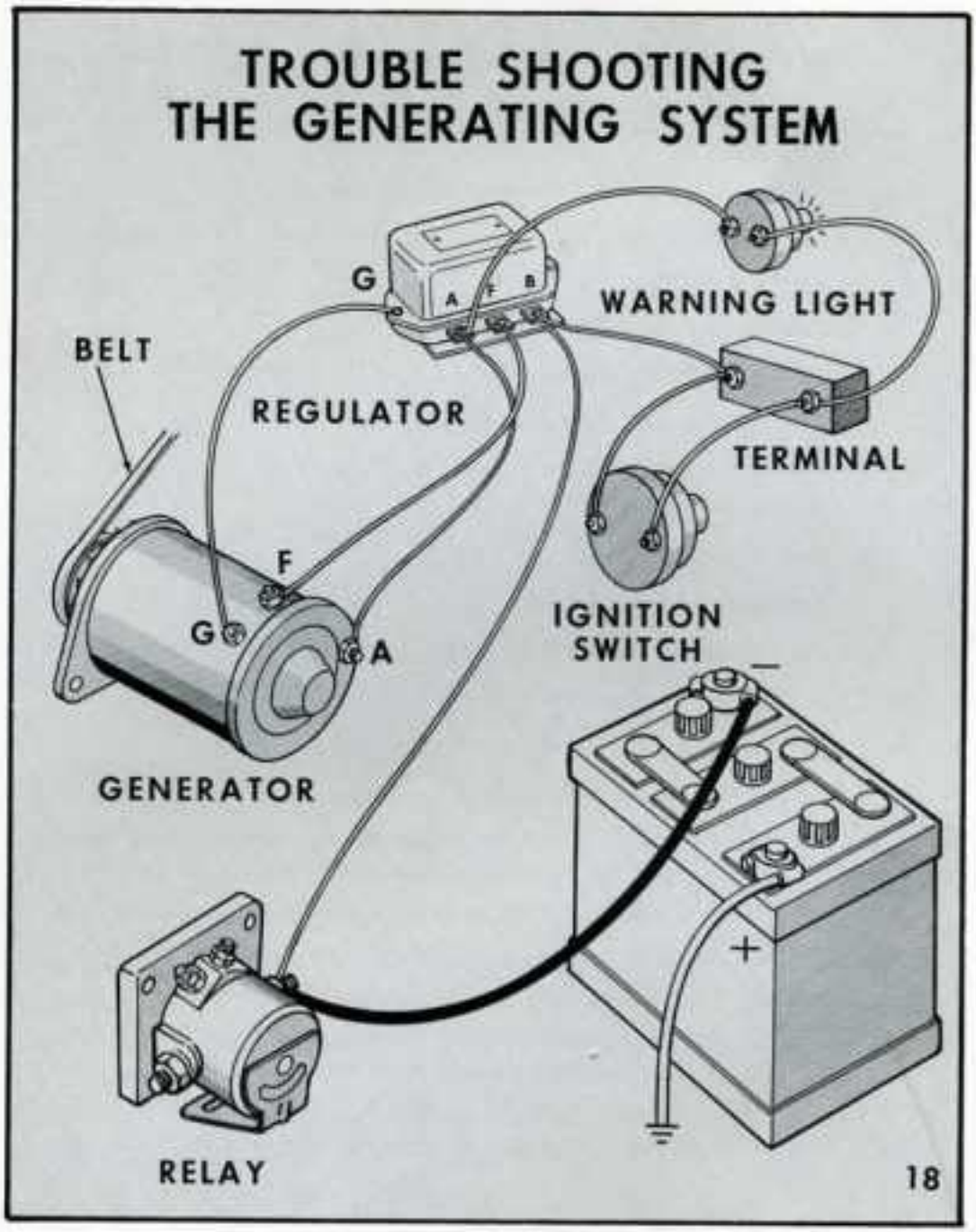
1. Slow cranking.
2. Hard starting.
3. Lights dim at idle speed.

B. Possible causes of battery being low in charge.

1. Loose or worn generator belt.
2. Battery worn out.
3. Defective generator.
4. Defective regulator.
5. Excessive resistance in:
   a. Armature to battery circuit.
   b. Battery to ground circuit.

C. Battery low in charge—trouble shooting.

1. Check the state of charge, if low—
2. Recharge battery and make capacity test; replace or recharge battery as necessary, and continue—
3. Check generator belt; tighten or replace, if necessary.
4. Make visual inspection of wiring and connections; replace defective wiring, clean and tighten connections.
5. Check the generator output; refer to test chart #2 or #3. If output is low, refer to step 6, otherwise to step 7.
6. Connect a heavy jumper cable from battery ground terminal to generator ground terminal and repeat the output test:
   a. If output is satisfactory, check and repair grounding of generator and battery.
   b. If output is still low, refer to Section II, "Generator Output Low" of Trouble Shooting.
7. Test the generator regulator; refer to test chart #4 or #6. Replace the regulator, if defective.
8. Check the resistance of the external (insulated) circuit of the generating system. Refer to test chart #14. If the resistance is high, check clean and tighten connections. Recheck resistance; if still high, locate the part at fault and replace.



II. GENERATOR OUTPUT LOW

A. Indications of low generator output.

1. Battery consistently not charged.
2. Ammeter or warning light indicating a discharging battery at operating speed.

B. Possible causes of low generator output.

1. Excessive resistance in generating system ground circuit.
2. Dirty commutator.
3. Open or short circuit in the field coils.
4. Open or short circuit in the armature.
5. Worn brushes, brushes stuck in holders, or shorted brush holders.

C. Generator output low—trouble shooting.

1. Squirt carbon tetrachloride on the commutator and recheck the output. If output is satisfactory, refer to step 2. If output is still low, refer to step 3.
2. Remove the generator and disassemble (leave field coils in place). Clean the commutator and slots. Turn down the commutator and undercut the mica, if necessary. (Refer to shop manual for tractor involved.)
3. Test the field coils for an open, short, or grounded circuit. Refer to test charts, #7 and #8. Repair or replace defective field coils.
4. Test the armature for a shorted coil with a growler. Replace, if defective.
5. Test the armature for a grounded circuit. Refer to test chart #9. Replace, if defective.
6. One or more burned segments on the commutator indicates an open circuit. Replace the armature.
7. Test the insulated brush and holder for a short circuit. Place one prod of a test lamp on the end plate and one on the brush holder. If the lamp lights, the holder is shorted. Also, check the brushes for correct length, good contact with the commutator, and for being stuck in the holder. Replace the brush, brush holder, or insulator, as necessary.

III. HIGH CHARGING RATE

A. Indications of high charging rate.

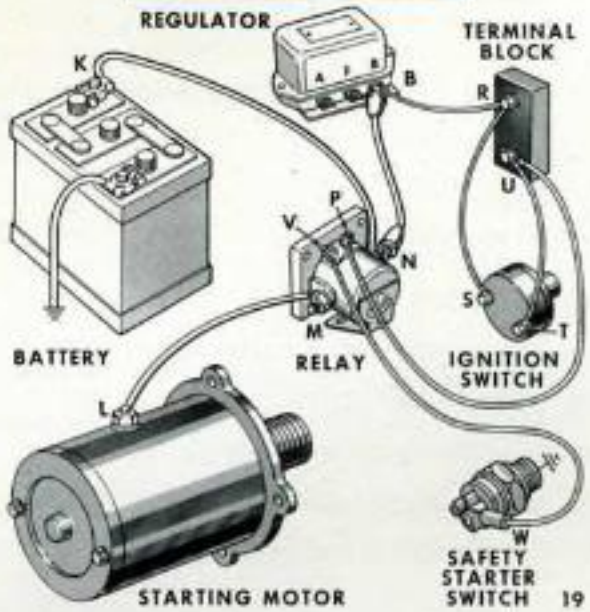
1. Lights and/or generator burn out prematurely.
2. Battery uses excessive amount of water.
3. Burned distributor contact points.

B. High charging rate—trouble shooting.

1. Any of the above indications points to the development of excessive voltage. Check the generator regulator for maximum voltage. Refer to test chart #4 or #6. If the regulated voltage is above the specifications, replace the regulator.

TROUBLE SHOOTING
THE STARTING SYSTEM

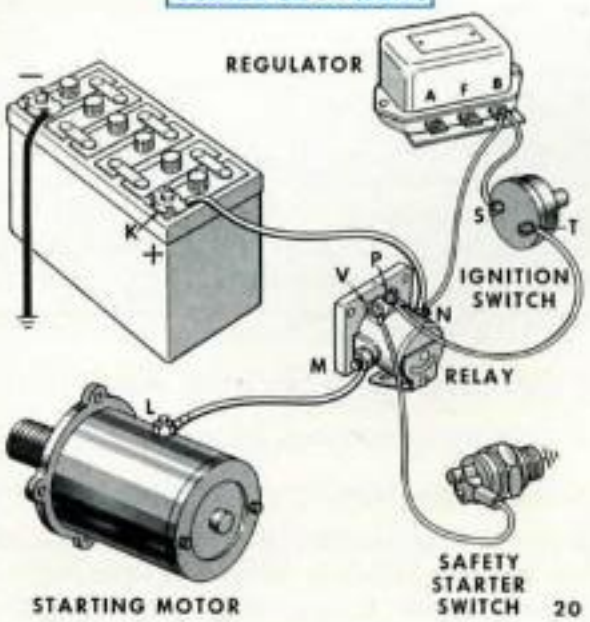
FOUR CYLINDER ENGINE



19

TROUBLE SHOOTING
THE STARTING SYSTEM

SERIES 6000 (GAS)



20

TROUBLE SHOOTING THE STARTING SYSTEM

If the engine cranks at good speed but will not start, the trouble is with the fuel or ignition systems, the valves, rings, etc. Make necessary repairs. If the engine will not crank satisfactorily, with the battery properly connected, refer to the appropriate trouble-shooting section which follows.

I. ENGINE WILL NOT CRANK WHEN STARTER SWITCH IS ACTUATED

A. Possible causes of engine not cranking.

1. Battery low in charge, or defective.
2. Starter motor is defective.
3. Starter drive is defective.
4. Wiring or switch is defective.
5. Relay or solenoid is defective.
6. Engine is seized.

B. Engine will not crank — trouble shooting.

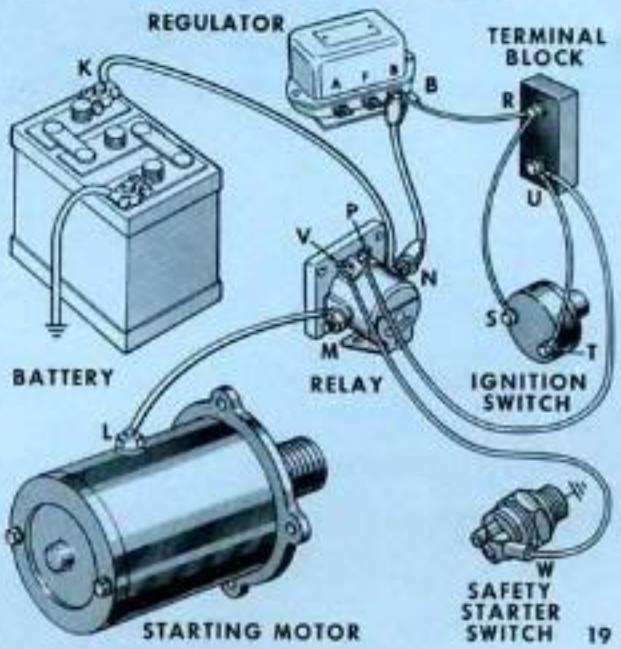
1. Make a visual inspection of the cables, wires and connections. Correct any defects noticed.
2. Make sure that transmission is in neutral or in park on Select-O-Speed transmissions.
3. Bypass the safety switch on Select-O-Speed transmissions.
   a. On four-cylinder models, use a jumper with clamp-type terminals to ground end of safety switch wire *at* the starter. (Under sheet metal on right.)
   b. On Series 6000 tractors, disconnect the wire (black lead) from the transmission cover at the bullet connection. The external portion has a female connection. Insert a cotter pin into this connection and ground it.
4. Check the battery as to charge and capacity. Recharge, or replace, as necessary.

(THE FOLLOWING APPLIES TO FOUR-CYLINDER AND SERIES 6000 GAS MODELS. FOR SERIES 6000 DIESEL, SEE THE CONTINUATION AFTER THIS PORTION.)

(Refer to charts #19 and #20.)

TROUBLE SHOOTING
THE STARTING SYSTEM

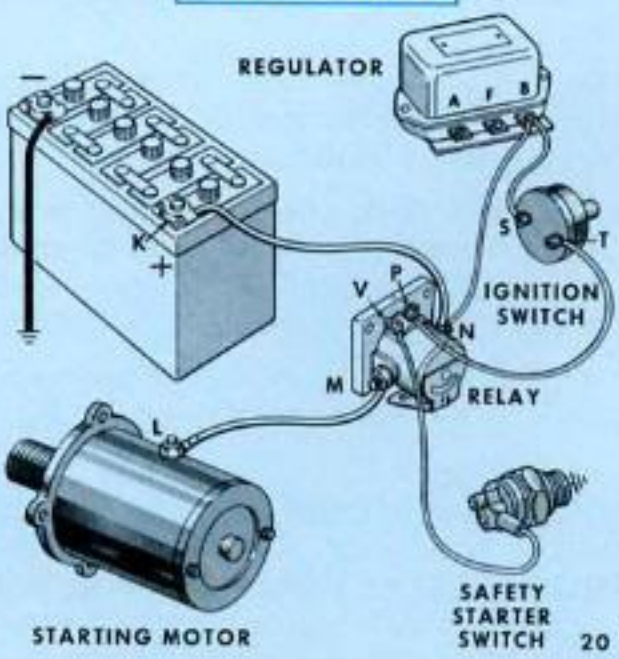
FOUR CYLINDER ENGINE



19

TROUBLE SHOOTING
THE STARTING SYSTEM

SERIES 6000 (GAS)



20

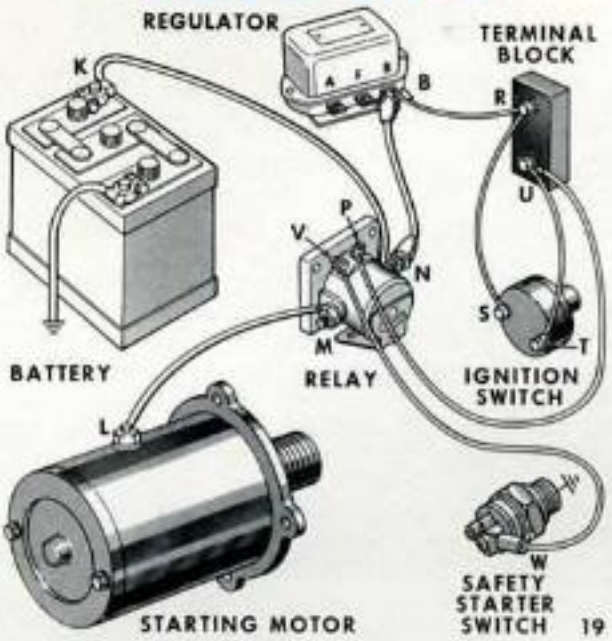
5. Connect a heavy jumper cable from K to L.
   a. If it doesn't crank, the trouble is in the starter motor, starter drive, or the engine. See step 13.
   b. If it cranks, see step 6.
6. Connect the jumper from K to M.
   a. If it doesn't crank, replace the relay to starter cable. Recheck.
   b. If it cranks, see step 7.
7. Connect the jumper across the relay terminals, M to N.
   a. If it doesn't crank, replace the battery to relay cable. Recheck; see step 7-b.
   b. If it cranks, remove the jumper; see step 8.
8. Operate the starter switch with ignition key on (four-cylinder models).
   a. If relay clicks, replace the relay and recheck. It should crank, as main cables, relay circuit, and relay are O.K.
   b. If relay does not click, see step 9.
9. Use a jumper to connect (K or N) to P, and ground terminal V. Move jumper to V and ground P, as it is impossible to tell one terminal from the other.
   a. If it does not crank, replace the relay. Recheck.
   b. If it cranks, remove the jumper and see step 10 or 12.
10. (4-CYL. ONLY) Ground relay to starter wire at starter, W, with ignition switch ON.
    a. If it cranks, replace the starter switch. Recheck.
    b. If it does not crank, see step 11.
11. (4-CYL. ONLY) Ground the relay terminal V with ignition switch ON. Also ground the other terminal (can't distinguish).
    a. If it cranks, replace the wire from the relay to the starter switch.
    b. If it doesn't crank, see step 12.

(REMAINDER APPLIES TO ALL 4-CYLINDER AND 6-CYLINDER GAS MODELS.)

12. Trouble is now limited to remote control circuit from relay to regulator, to switch to relay. Check the circuit for continuity by using a test lamp or an ammeter.

TROUBLE SHOOTING THE STARTING SYSTEM

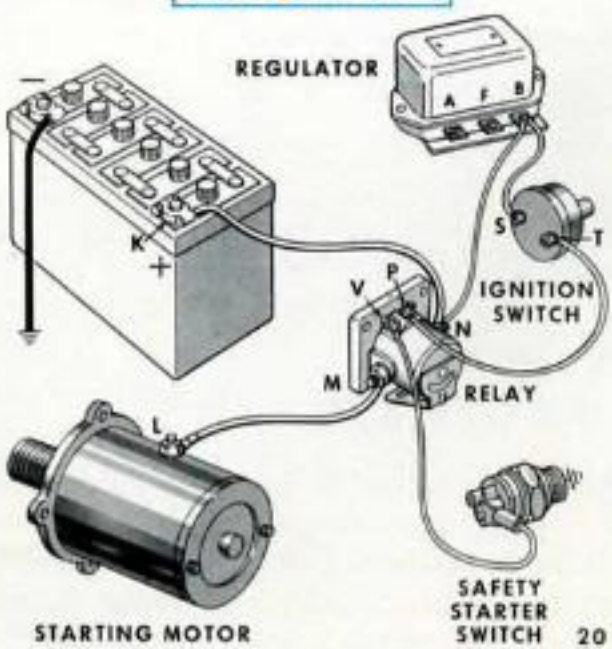
FOUR CYLINDER ENGINE



19

TROUBLE SHOOTING THE STARTING SYSTEM

SERIES 6000 (GAS)



20

a. Connect one lead to ground and the other lead to the ignition switch terminal, S.

1. If there is no current flow, replace the main wiring harness; then see step 12-b.

2. If there is a current flow, see step 12-b.

b. Turn ignition switch key to full on position; move test lead from S to T.

1. If there is no current flow, replace the ignition switch assembly. Recheck. See step 12-c.

2. If there is a current flow, see step 12-c.

c. If main harness has been correctly replaced, the system should now work. Actuate the starter.

1. If it cranks, the trouble is over.

2. If it doesn't crank, replace the main harness. Recheck.

13. (From step 5, engine does not crank with a jumper connected from battery to starter motor.) Loosen the starting motor mounting bolts and check for a locked starter drive.

a. If drive is locked, remove motor and examine pinion for burred or worn teeth. Same applies to flywheel. Repair, or replace, as necessary. Recheck and see step 14.

b. If starter is not locked, see step 14.

14. Remove the starter and run a no-load test. See chart #10.

a. If the current draw is much above or below specifications, the motor should be repaired or replaced. Recheck.

b. If the current draw is normal, see step 15.

15. Check for hydrostatic lock. Remove spark plugs, or injectors, and attempt to crank engine.

a. If engine now cranks, fluid has leaked into cylinders. Repair engine.

b. If engine still does not crank and motor runs freely (step 14), the engine is seized and must be repaired.

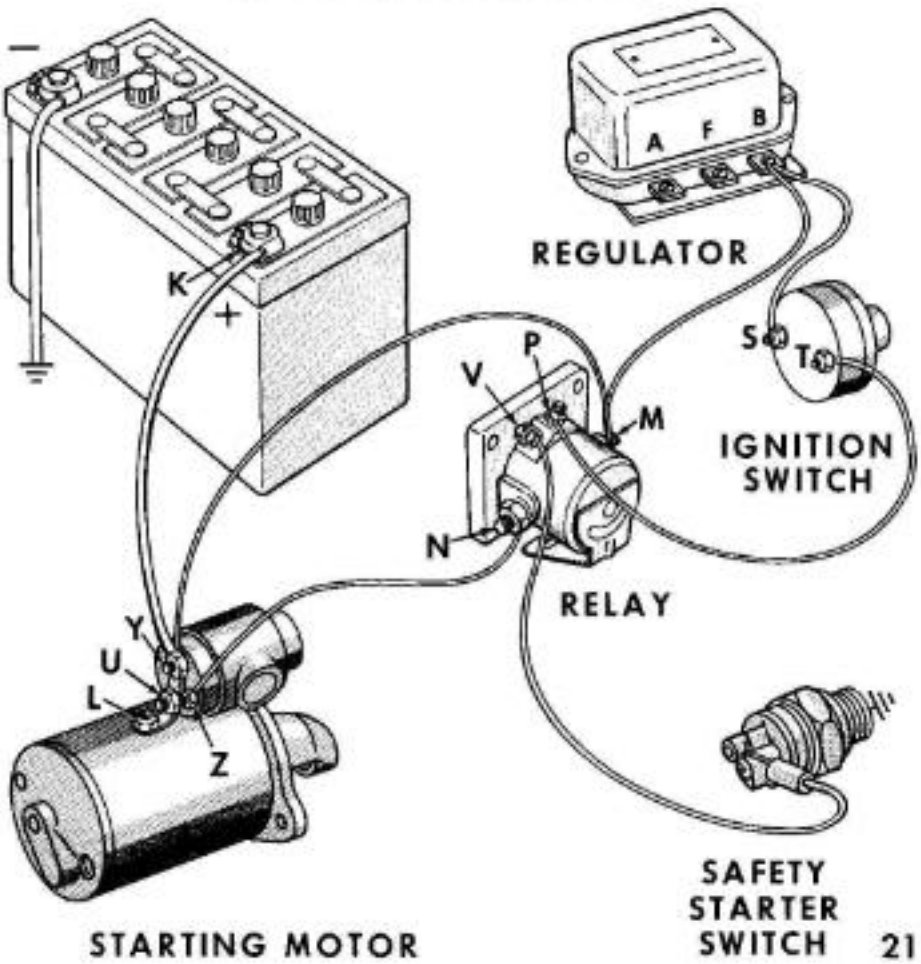
16. On tractors with Select-O-Speed transmissions, remove the ground used to bypass the safety starter switch (step 3), reconnect wires, and check the starter again.

a. If the engine cranks, the trouble is over.

b. If it does not crank, replace the safety starter switch and/or the wiring.

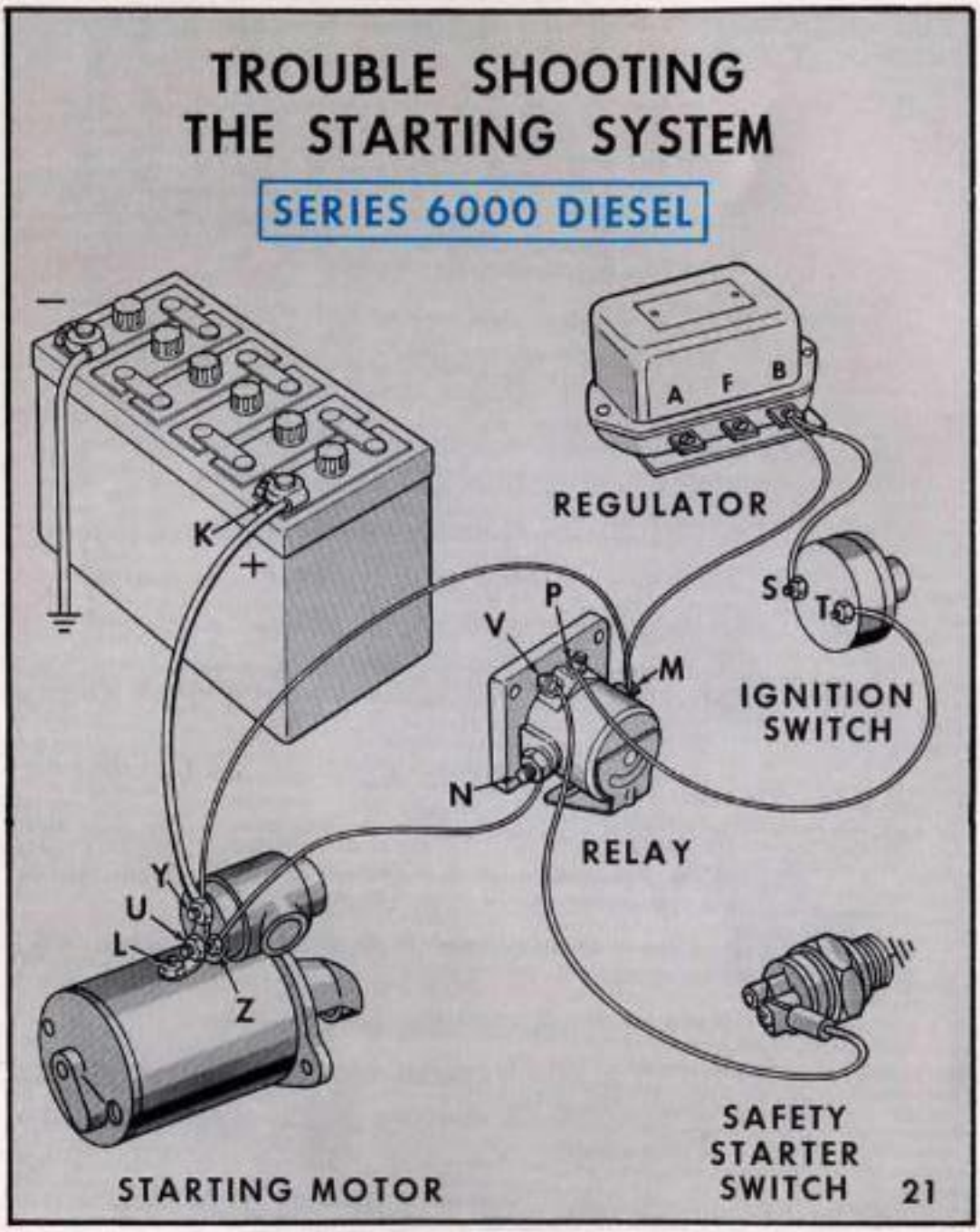
TROUBLE SHOOTING THE STARTING SYSTEM

SERIES 6000 DIESEL



(THE FOLLOWING PORTION REFERS TO THE SERIES 6000 DIESEL; IT CONTINUES FROM STEP 4. SEE CHART #21.)

5. Connect a heavy jumper cable from K to (L or U).
   a. If engine doesn't crank, the trouble is in the engine, starter drive, or starter motor. See step 10.
   b. If it cranks, see step 6.
6. Connect a heavy jumper from Y to (L or U).
   a. If it doesn't crank, replace the cable from battery to solenoid. Recheck; see step 7.
   b. If it cranks, remove jumper and see step 7.
7. Connect a jumper from Y to Z.
   a. If it cranks, the solenoid is O.K. See step 8.
   b. If it doesn't crank, replace solenoid. See step 8.
8. Use a test lamp to check circuit continuity.
   a. Check the circuit from Y to M (M has yellow lead from solenoid). Also check from Z to N.
      1. If there is no current flow, *in either case,* replace the starting motor solenoid harness assembly.
      2. If there is current flow in *both* cases, see step 8-b.
   b. Check the circuit from M to S. Try both terminals on relay if you are not sure which one is M.
      1. If there is no current flow, replace the main wiring harness.
      2. If there is current flow, see step 8-c.
   c. Turn on ignition key and check the switch.
      1. If there is no current flow, replace the ignition switch and recheck.
      2. If there is current flow through the switch, see step 8-d.
   d. Check the circuit from T to P (unless the main harness has been replaced. If so, see step 9).
      1. If there is no current flow, replace the main harness. Recheck; see step 9.
      2. If there is a current flow, see step 9.
9. Ground first V, then P, and at the same time actuate the starter switch.



a. If the engine does not crank, replace the starter relay. Recheck; see 9-b.

b. If engine cranks, the wire from V to ground (safety starter switch circuit) is defective. Replace the main harness. (Trouble should be over)

10. (From step 5, engine does not crank with a jumper connected from battery to starter motor.) Loosen the starting motor mounting bolts and check for a locked starter drive.

a. If drive is locked, remove motor and examine pinion for burred or worn teeth. Same applies to flywheel. Repair or replace, as necessary. Recheck and see step 11.

b. If starter is not locked, see step 11.

11. Remove the starter and run a no-load test. See chart #11.

a. If the current draw is much above or below specifications, the motor should be repaired or replaced. Recheck; see step 12.

12. Check for hydrostatic lock. Remove the spark plugs, or the injectors, and attempt to crank engine.

a. If engine now cranks, fluid has leaked into cylinders. Repair engine.

b. If engine still does not crank, and motor runs free (step 11), the engine is seized. Repair the engine.

13. Remove the ground used to bypass, reconnect the wires, and check the starter again.

a. If the engine cranks, the trouble is over.

b. If it does not crank, replace the safety starter switch and/or the wiring.

II. STARTING MOTOR SPINS BUT DOES NOT CRANK ENGINE

A. Possible causes of starting motor spinning.

1. Motor drive is dirty.

2. Motor drive is worn or broken.

B. Starting motor spins—trouble shooting.

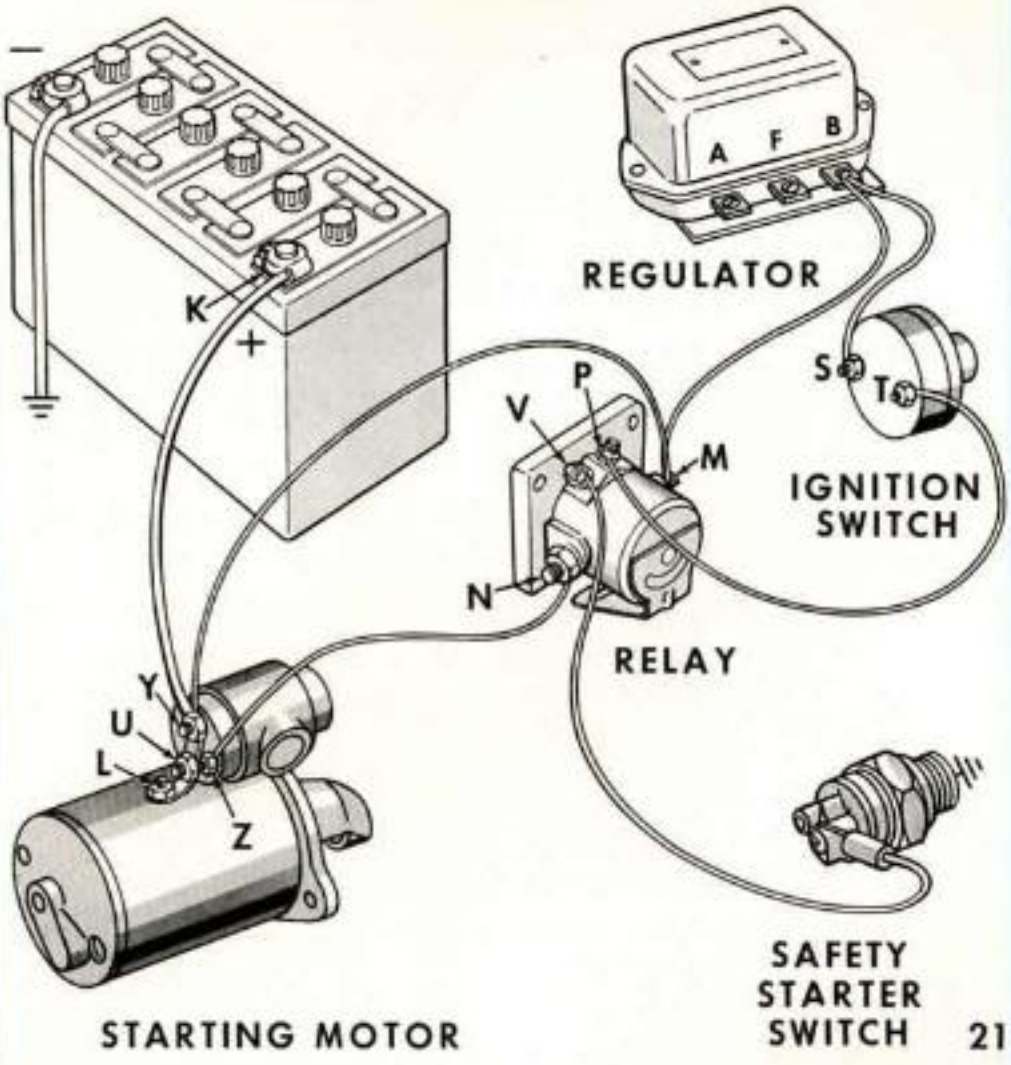
1. Remove the motor and inspect the drive.

2. Clean or replace the drive, as necessary. (Do *NOT* lubricate the starter drive.)

3. Install starter on engine and recheck.

TROUBLE SHOOTING THE STARTING SYSTEM

SERIES 6000 DIESEL



21

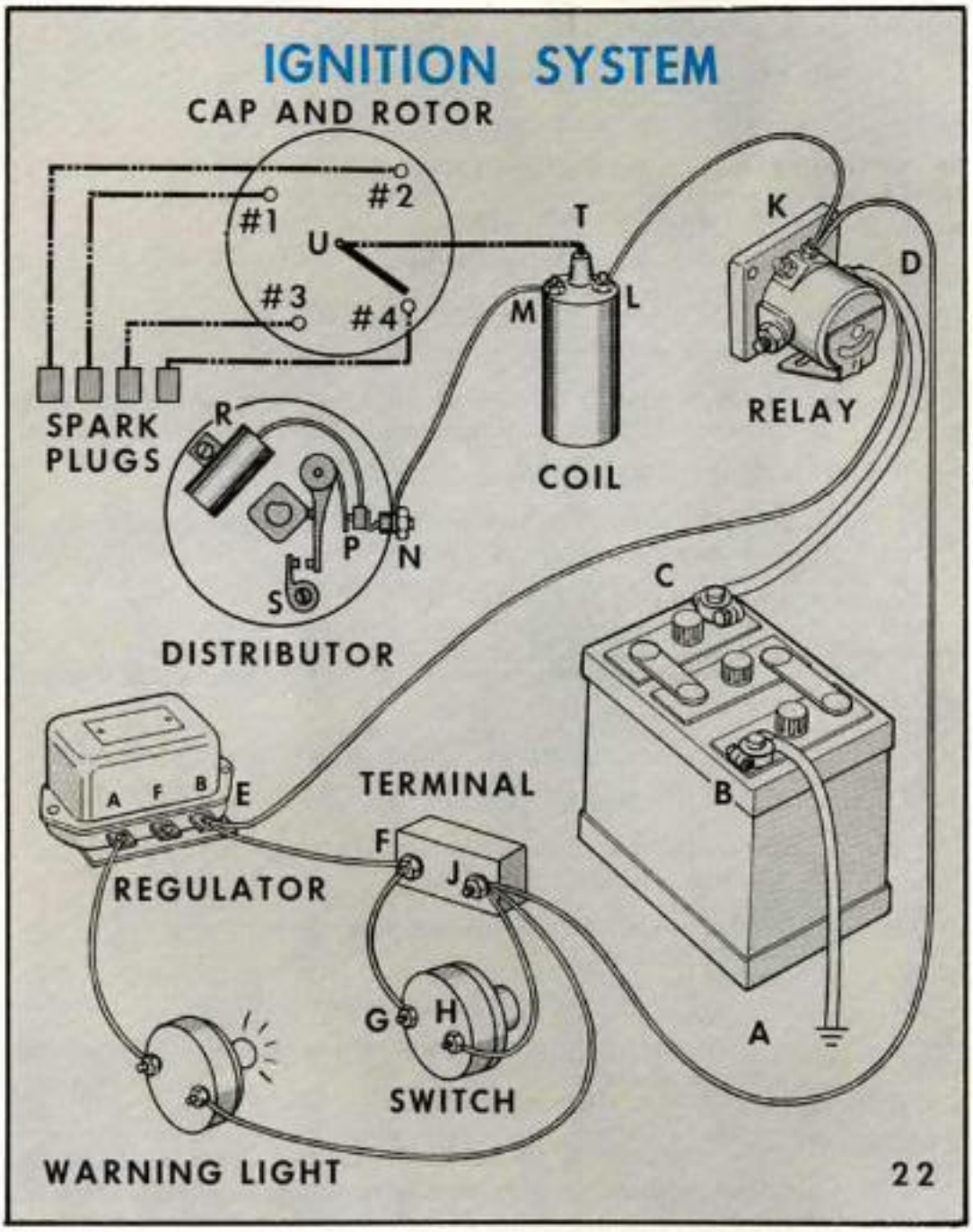
III. ENGINE CRANKS SLOWLY

A. Possible causes of engine cranking slowly.

1. Battery low in charge, or defective.
2. Excessive resistance in starting circuit.
3. Starter motor defective.
4. Engine has excessive friction.
5. Viscosity of lubricating oil too high.

B. Engine cranks slowly—trouble shooting.

1. Make a visual inspection of all cables, wires and connections. Clean and tighten connections, as necessary.
2. Check the battery state of charge.
   a. If the battery is low in charge, recharte it and make a capacity test (refer to test chart #1). Replace the battery if under capacity or worn out.
   b. If the battery is charged, refer to step 3.
3. Check the external circuit voltage drop (refer to test chart #14).
   a. If the voltage drop is more than 0.30 volts, see step 4.
   b. If the voltage drop is not excessive, see step 5.
4. Check the parts of the external circuit; replace any part offering excessive resistance.
5. Test the starting motor current draw under load (refer to test chart #12).
   a. If the current draw is normal or excessive, see step 7.
   b. If the current draw is low, the motor has high resistance; see step 6.
6. Remove the starting motor and disassemble it. Check for dirty commutator, worn brushes, or defective brush leads. Make necessary repairs, reassemble, replace starter on engine, and recheck. If necessary, replace the starter motor.
7. Test the starting motor at no-load. Refer to test chart #11.
   a. If the current draw is above or below normal, remove the starting motor. Disassemble, clean, inspect and repair. Reassemble the motor, install it on the engine, and recheck. Replace the motor, if necessary.
   b. If the current draw is normal, the starter is O.K. and the trouble is in the engine. It has excessive friction and must be repaired.



TROUBLE SHOOTING THE IGNITION SYSTEM

The ignition system is the most complicated part of the electrical system because it consists of a low voltage circuit and a high voltage circuit. In order to check the high voltage or high tension circuit components, it is necessary to use special test equipment which is rather expensive. This equipment is found rather commonly in high volume automobile repair shops, but is not common in most farm equipment service shops.

We might refer to a combination test unit which can check the ignition system, and other units, as a motor tester. A motor tester can check the following items:

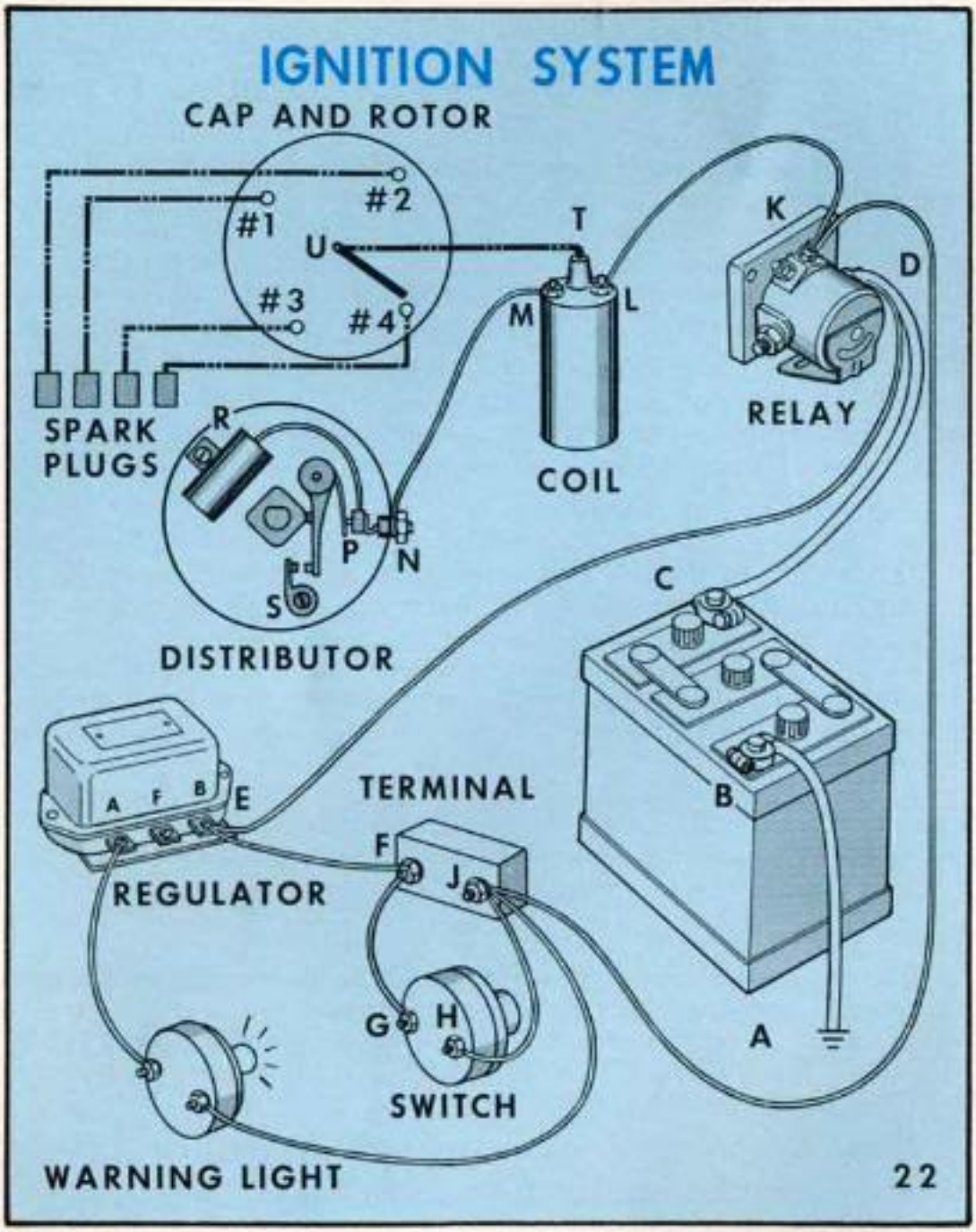
1. Coil capacity and continuity
2. Secondary circuit resistance
3. Distributor resistance
4. Distributor point dwell
5. Condenser resistance, capacity, and leakage
6. Timing.

If you have a motor tester, follow the directions supplied by the manufacturer. If you do not have such special equipment, it is still possible to do considerable trouble shooting on the ignition system.

The first thing to do is to make a careful visual inspection of the entire ignition system. This inspection should include:

1. Checking all wiring and terminals for worn insulation, broken strands, and loose or corroded connections.
2. Checking the coil for leaks or bends in the case.
3. Checking the distributor, as follows:
   a. Free action of centrifugal advance mechanism.
   b. Cap and rotor should be free from chips, cracks, or carbonized paths.
   c. Contact points should be properly aligned, points in good condition, and point gap properly set.

   (DO NOT USE EMERY CLOTH OR SANDPAPER TO CLEAN THE POINTS, AS PARTICLES MAY CAUSE ARCING AND BURNING OF POINTS. USE A FINE-CUT CONTACT FILE.)



Check the contact point spring tension.

NOTE: If the contact points are burned, it may indicate trouble in another area. The trouble may be due to:

1. High voltage, due to defective regulator.
2. Oil or crankcase vapors in the distributor. Check for a plugged breather pipe.
3. Contact spacing too small.
4. High resistance in the condenser circuit. Pitted contact points usually indicate a defective condenser.

4. Cleaning and inspecting the spark plugs; check for cracks or chips in the porcelain, badly burned or oxidized electrodes, and for proper electrode gap.

Before starting the trouble-shooting section, there are some tests which should be made, if possible. First, check the primary circuit resistance. Refer to test chart #16. Make any repairs necessary. Secondly, check the polarity of the secondary circuit. This should always be positive ground (spark from center electrode to ground electrode), regardless of which battery terminal is grounded. This is true because it requires a higher voltage for the spark to jump in the opposite direction.

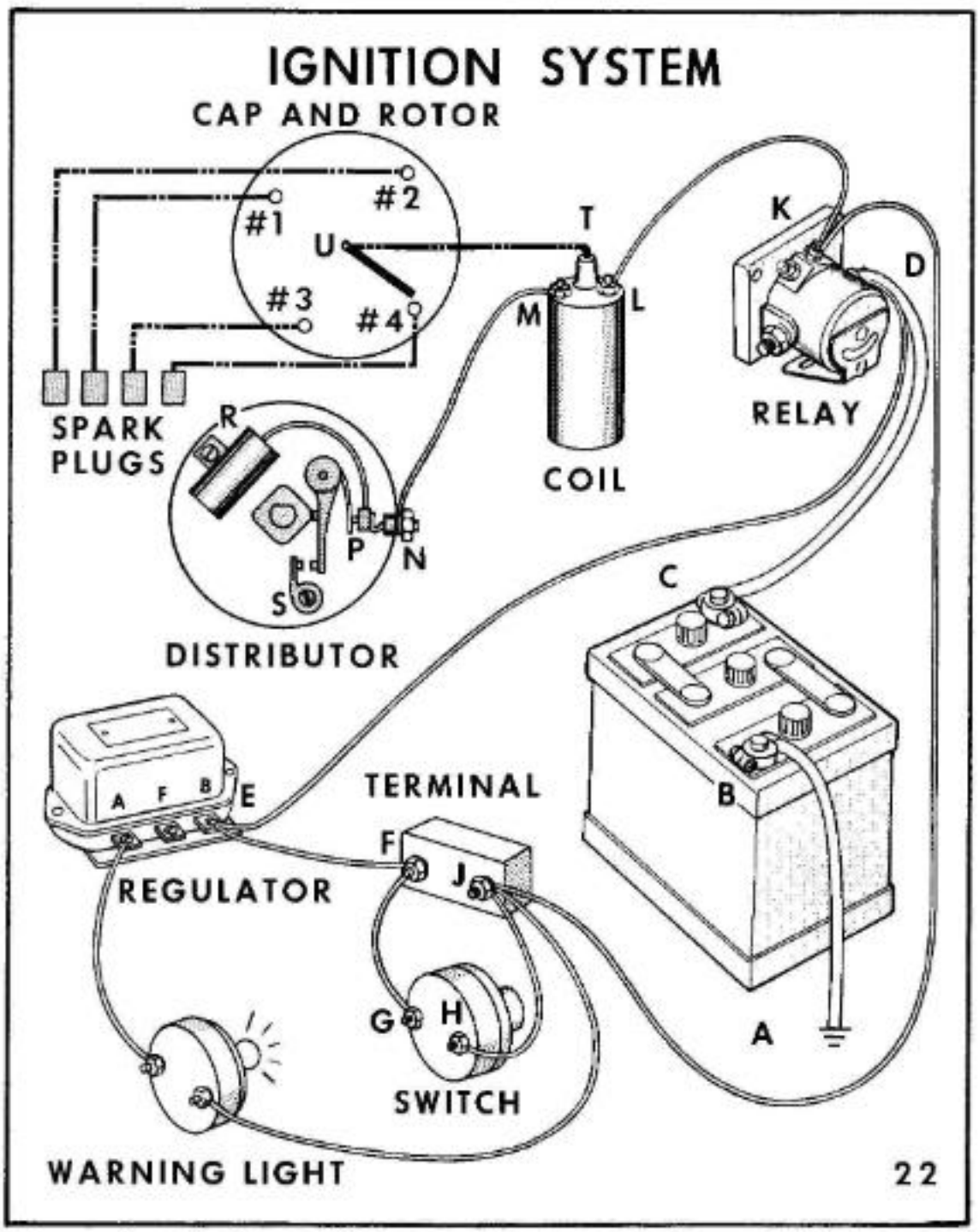
The secondary polarity can be checked, as follows:

1. Connect a voltmeter (of appropriate range for the battery) positive lead to a ground on the engine.
2. Start the engine and run it at idle.
3. Touch the terminal of a spark plug with the terminal of the voltmeter negative lead. A reverse voltmeter reading indicates a reverse polarity in the coil. Check to see that the battery is correctly installed. If the battery is O.K., reverse the primary wires to the coil.

   Since the above test requires running the engine, it may have to be done *after* some trouble shooting and repair work have been done.

As a preliminary to trouble shooting, it is necessary to check the spark at the end of each spark plug wire. Turn on the ignition key and hold the end of the spark plug wire about 3/16" from the block while cranking the engine. Observe the condition of the spark. Do this with each spark plug wire. Then proceed to the appropriate trouble-shooting section.

On the Series 6000 Tractor, it is necessary to check the carburetor solenoid. This is not actually a part of the ignition system, but it must operate correctly before the engine will run.



I. NO SPARK AT ANY SPARK PLUG WIRE

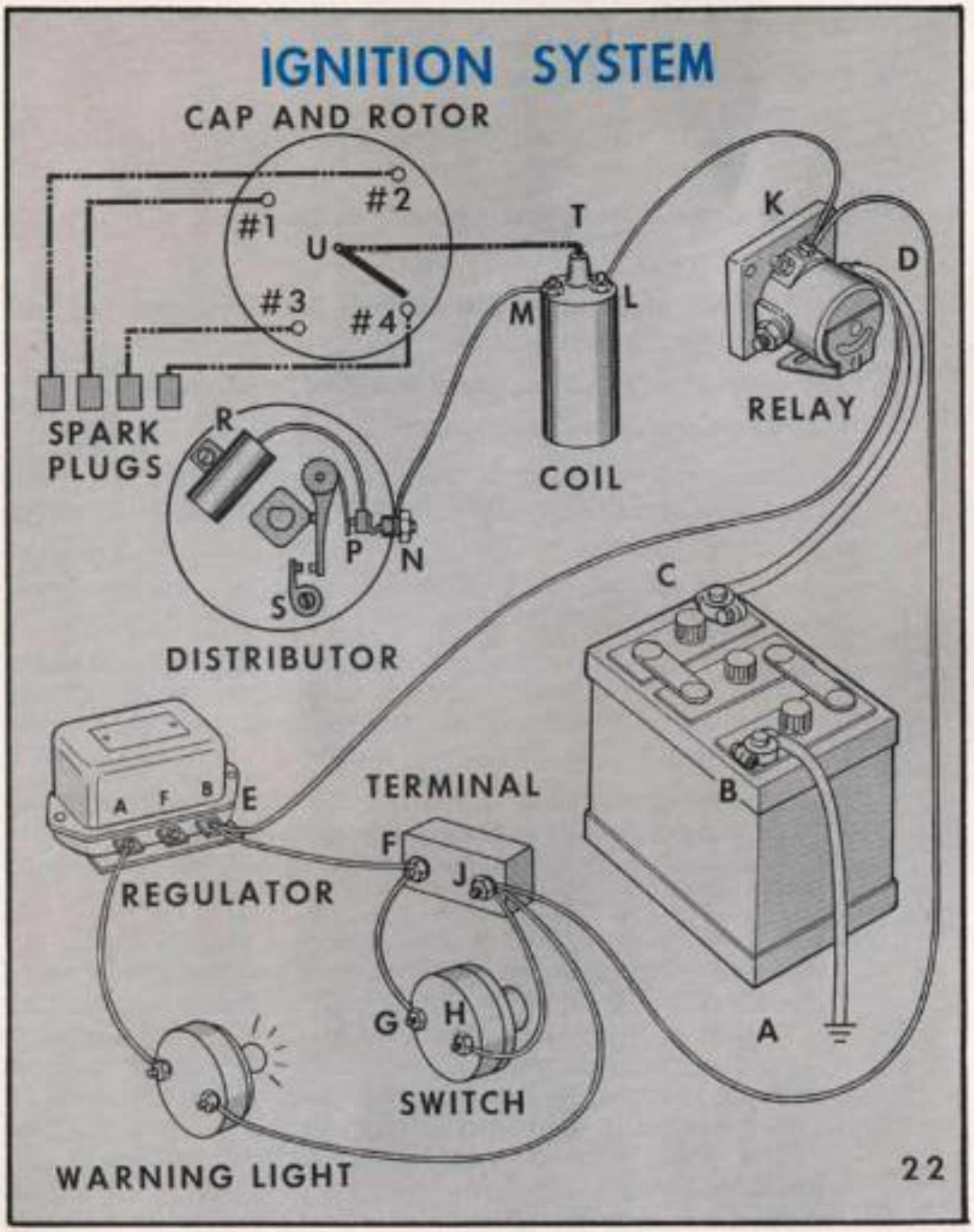
A. Possible causes of having no spark.

1. Defects in primary circuit.
2. Defective condenser.
3. Defective distributor rotor.
4. Defective coil.
5. Defective high tension wire; coil to distributor cap, or distributor to spark plugs.

B. No spark at any spark plug wire—trouble shooting.

(Refer as necessary to chart #22)

1. Connect an ammeter between the battery (C) and the coil (L). Crank the engine with the starter, noting the ammeter reading.
   a. If the engine starts, the trouble is in the primary circuit from the relay (D) to the coil (L). See step 2.
   b. If the ammeter reading is zero as the engine is cranked, the trouble is in the primary circuit from the coil (L) to the grounded side of the distributor contact points (S). See step 3.
   c. If the engine does not start, but there is a reading of two or more amperes on the ammeter as the engine is cranked, the trouble is in the condenser or the secondary circuit. See step 4.
2. (Engine starts when ammeter is used in circuit, step 1-a.) Disconnect ammeter to stop engine. If reading is now zero, turn engine slowly with starter until a reading is obtained like that in step 1. Disconnect the battery-to-coil circuit at L. Connect the ammeter at terminal (L) (lead depends on battery ground). Turn on the ignition switch. Connect the other ammeter lead successively to H, G, and D. The faulty part of the circuit is the wiring between the coil terminal (L) and the relay (D), or in the switch, and lies between (L) and the first point where an ammeter reading is obtained. Replace the harness or the switch, as necessary, and recheck.
3. (Ammeter reading is zero as engine is cranked, step 1-b.) Ground the condenser insulated terminal (P).
   a. If the reading is still zero, and the primary wire from coil to distributor (M-N) and connections are good, replace the coil. Recheck.
   b. If the reading is two or more amperes, the trouble is in the breaker points or the insulated terminal (N). Replace or repair, one at a time, and recheck.



4. (Engine does not start, reading of two or more amperes, step 1-c.) Tighten the condenser terminal screws (R and P). Remove the high tension wire, coil to distributor (T-U). Install a high tension jumper in the coil (T). Hold the other end of the jumper 3/16" from the block as the engine is cranked.

   a. If there is no spark, replace the condenser and recheck.

      1. If trouble still exists, replace the coil.

   b. If the spark is satisfactory, replace the rotor and recheck.

      1. If trouble still exists, replace the rotor cap.

   NOTE: If preceding checks and repairs have not remedied the difficulty, replace the high tension cables (coil to distributor and distributor to spark plugs).

II. SATISFACTORY SPARK FROM SOME BUT NOT ALL SPARK PLUG WIRES

A. Possible causes of satisfactory spark at some, but not all, spark plug wires.

   1. Defective distributor cap or rotor.

   2. Defective wires from distributor cap to spark plugs.

B. Satisfactory spark from some, but not all, spark plug wires —trouble shooting.

   1. Recheck all the spark plug wires, terminals and connections. Replace, as necessary, and recheck.

   2. Recheck the distributor cap. Replace it if it is burned, cracked, or has carbon tracks.

   3. Check the rotor for proper fit on the shaft, and good condition.

III. INTERMITTENT SPARK AT ALL SPARK PLUG WIRES

A. Possible causes of intermittent spark at all spark plug wires.

   1. Defective primary circuit.

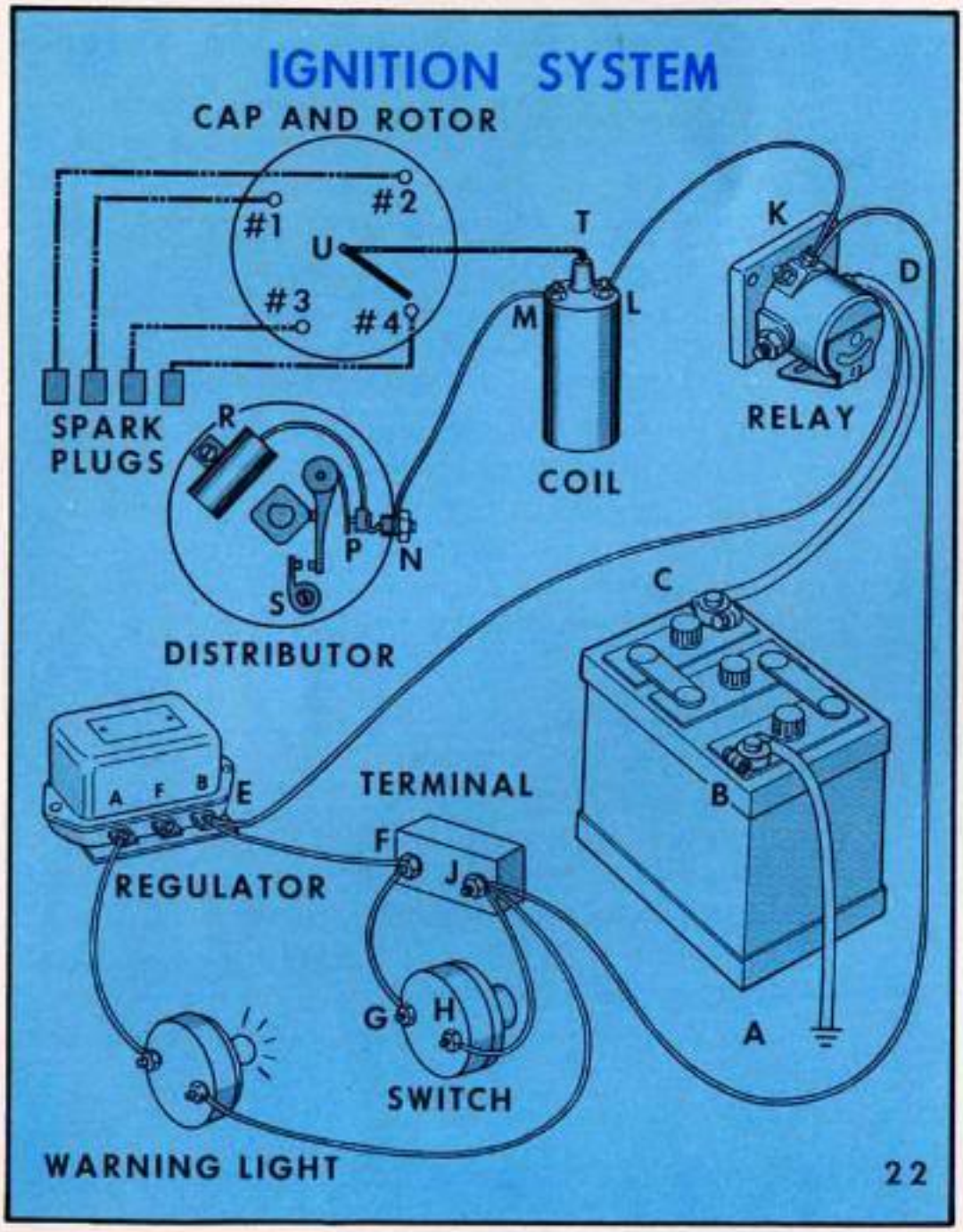
   2. Defective coil to distributor high tension wire.

   3. Defective coil or condenser.

B. Intermittent spark at all spark plug wires—trouble shooting.

   1. Recheck and tighten all connections in the primary circuit. Include both terminals of the switch, condenser, and battery.

   2. Replace the high tension wire from the coil to distributor (T-U). Recheck.



3. If you have special equipment to test coils and condensers, test them and take proper action. If you do not have such test equipment, replace the condenser and then the coil. Recheck after each replacement.

IV. WEAK SPARK AT ALL SPARK PLUG WIRES

A. Possible causes of weak spark at all spark plug wires.

1. Defective primary circuit.
2. Defective distributor rotor.
3. Defective high tension wire, coil to distributor.
4. Defective coil or condenser.

B. Weak spark at all spark plug wires—trouble shooting.

1. Recheck the resistance of the primary circuit; make necessary repairs.
2. If you have the test equipment, measure the distributor point dwell. Otherwise, recheck the breaker points as to condition and spacing.
3. If you have the proper test equipment, completely check the coil and the condenser. If not, use a jumper wire installed in the coil high tension socket. Hold the other end 3/16" from the block as the engine is cranked.
   a. If the spark jumps the gap *regularly,* both the coil and condenser are satisfactory. See step 4.
   b. If the spark does not jump the gap regularly, install a new condenser and recheck as above.
      1. If the spark is satisfactory, the trouble is over.
      2. If the spark is still unsatisfactory, replace the coil. Recheck.
         a. Spark O.K.—trouble is over.
         b. Spark not O.K.—see step 4.
4. Check the distributor cap and rotor. Clean the cap; replace parts, as necessary. Recheck.
5. If the trouble has not been remedied at this point, replace all the high tension wires.

TRACTOR ELECTRICAL SPECIFICATIONS

BATTERY

Tractor	Volts	Total Plates	Ampere Hours	Ground
8N; NAA; 5, 6, 7, 8, 9 & 1800 Gasoline	6	39	80	Positive
5, 6, 7, 8, 9 & 1800 Diesel	12	90	135	Negative
Series 6000 Gas	12	54	55	Negative
Series 6000 Diesel	12	90	135	Negative

STARTING MOTOR

Tractor	Amperes No Load	Ampere Load Cranking Warm Engine	Cranking Speed
8N & NAA	45-60	100-150	100 rpm
5, 6, 7, 8, 9 & 1800 Gas	100	100-150	100 rpm
5, 6, 7, 8, 9 & 1800 Diesel	100	190-225	180 rpm
Series 6000 Gas	100	175	150 rpm
Series 6000 Diesel	75	150-200	150 rpm

GENERATOR

Tractor	Engine RPM Voltage Test	Brush Wear Minimum Length	Rated Output Amperes	Brush Spring Tension
8N & NAA	1200	0.50"	20 at 1650	26-34 oz.
5, 6, 7, 8, 9 & 1800 Gas	1200	0.50"	20 at 1500	26-34 oz.
5, 6, 7, 8, 9 & 1800 Diesel	1500	0.50"	20 at 1500	32-40 oz.
Series 6000	1500	0.50"	25 at 1500	32-40 oz.

GENERATOR REGULATOR

Tractor	Cutout Voltage Closing at 75° F.	Regulated Maximum Amperage	Regulated Maximum Voltage	Reverse Current
8N; NAA; 5, 6, 7, 8, 9 & 1800 Gas	6.0 - 6.6	20	7.1 - 7.5	6 amps.
5, 6, 7, 8, 9 & 1800 Diesel	12.2 - 13.0	25	15.0 ± 0.4	8 amps.
Series 6000	12.6 ± 0.4	25	15.0 ± 0.4	8 amps.

DISTRIBUTOR

Tractor	Basic Timing A-RPM	Point Spacing	Breaker Arm Spring Tension	Deg. of Dwell	Rotation
8N	4° BTDC at 350	.024-.026"	20-24 oz.	35-38	Clockwise
NAA	8° BTDC at 475	.024-.026"	17-20 oz.	32-35	Clockwise
5, 6, 7, 8, 9 & 1800	4° BTDC at 450-475	.024-.026"	17-20 oz.	27-31	Clockwise
Series 6000	4° BTDC at 450-500	.024-.026"	17-20 oz.	28-32	Clockwise

COIL

Tractor	Primary OHMS Resistance	Secondary OHMS Resistance
4-Cylinder	1.06 - 1.17 at 75° F.	3800 - 4300 at 75° F.
6-Cylinder	3.35 ± 0.15 at 75° F.	3900 ± 250 at 75° F.

disconnect field & batt wire at regulator touch both together, engine not running and replace

SPARK PLUGS

Tractor	Type	Size	GAP	Torque
8N & NAA	H10 or AL-7A	14mm.	.025-.028"	24-30 ft. lbs.
5, 6, 7, 8, 9 & 1800	H10 or AL-7A	14mm.	.028-.031"	24-30 ft. lbs.
5, 6, 7, 8, 9 & 1800 LPG	H8 or ATL-3A	14mm.	.028-.031"	24-30 ft. lbs.
Series 6000	860 or BTF-6A	18mm.	.028-.032"	30-35 ft. lbs.
Series 6000 LPG	BTF-3	18mm.	.028-.032"	30-35 ft. lbs.

GENERATING SYSTEM CIRCUIT RESISTANCES

Circuit	Maximum Allowable Voltage Drop
External (insulated) — total	0.40
Generator to regulator armature terminal	0.05
Generator to regulator battery terminal	0.35
Ground	0.05

STARTING SYSTEM CIRCUIT RESISTANCES
(For all but Series 6000 Diesel)

Circuit	Maximum Allowable Voltage Drop
External (insulated) — total	0.125
Battery-to-relay cable	0.010
Relay	0.050
Relay-to-starter cable	0.050
Ground	0.050

STARTING SYSTEM CIRCUIT RESISTANCES
(For Series 6000 Diesel)

Circuit	Maximum Allowable Voltage Drop
External (insulated) — total	0.125
Battery-to-solenoid cable	0.020
Solenoid	0.100
Ground	0.050

IGNITION SYSTEM CIRCUIT RESISTANCES

Circuit	Maximum Allowable Voltage Drop
Battery-to-coil (battery side)	0.20
Battery-to-switch (battery side)	0.05
Battery through switch	0.15

BATTERY SPECIFIC GRAVITY CHARGE

State of Charge (At 80° F.)	Specific Gravity
Fully charged	1.280
75% charged	1.250
50% charged	1.225
25% charged	1.200
Discharged	1.175

There is no substitute for quality service.

Use genuine replacement parts.

Prepared by
TRACTOR AND IMPLEMENT OPERATIONS (U.S.)
FORD TRACTOR DIVISION FORD MOTOR COMPANY
BIRMINGHAM, MICHIGAN

SE B722-1

PRINTED IN U.S.A.