

CHAPTER 6. CRANKING SYSTEM TESTS

6-1. DESCRIPTION. The Cranking System “turns over” the engine for starting purposes. This system consists of the battery, the cranking motor, the starter solenoid and/or relay, and associated wiring and connections. The following procedures check the operation of this system.

6-2. CRANKING VOLTAGE, STARTER CURRENT DRAW and BATTERY CONDITION.

A. Preparation:

1. Perform the instructions listed under “Electrical System — Preliminary Checks,” Chapter 5.
2. Disable the engine as explained in “Disabling Procedures,” Chapter 4, before continuing with this test.

B. Hookup Procedure:

Figure 2-2 shows a hookup procedure for most of the leads on the Sears 21045 Analyzer. Only the test leads listed below are required for the CRANKING VOLTAGE, STARTER CURRENT DRAW AND BATTERY CONDITION TEST although the other leads may remain connected.

1. Insert the BLACK 3 pin POWER/POINTS/DWELL/C-3 (11) connector in the 3 pin BLACK socket on the Analyzer. Connect the RED clip to the Positive (+) battery terminal and the BLACK clip to a secure ground connection on the engine, frame, or alternator bracket. The BLACK clip should be the last connection made and the first to be disconnected. (The GREEN clip is not used for this test.)

WARNING

Avoid connecting the BLACK POWER clip directly to the battery Negative (-) terminal in the event that hydrogen gases are present which could explode from sparking connections.

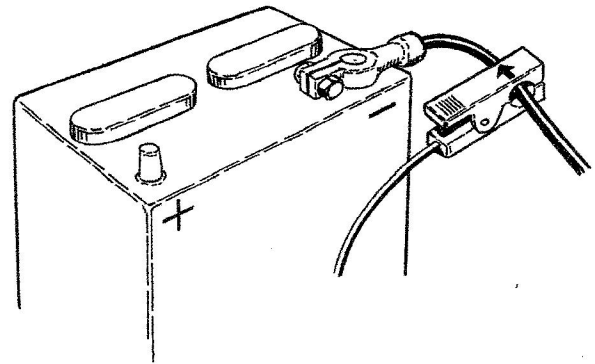
2. Insert the WHITE VOLTS/OHMS (14) connector into the WHITE socket on the Analyzer. Connect the RED clip to the Positive (+) battery terminal and the BLACK clip to the Negative (-) battery terminal.
3. Connect the 4 pin BLACK ALT/AMPS (10) connector into the 4 pin BLACK ALT/AMPS socket on the Analyzer.
4. Set the ANALOG FUNCTION SELECTOR (4) to the Amps position. Set the ANALOG RANGE SELECTOR (3) to the Low (120 Amps) position. If your vehicle's alternator is rated in excess of 120 Amps, set the ANALOG RANGE SELECTOR to the High (600 Amps) position. Using the Amps ZERO ADJUSTER control (5), set the meter to zero on the selected amps scale.
4. Set the ANALOG FUNCTION SELECTOR (4) to the Amps position. Set the ANALOG RANGE SELECTOR (3) to the High (600 Amps) position. Using the AMPS ZERO ADJUST control (5), set the meter to zero on the 600 Amps scale.

5. Clamp the AMPS pickup (10) around ALL the wires leading from the Negative (-) battery terminal with the arrow on the clamp pointing **towards** the battery. See Figure 6-1. If the Negative (-) battery terminal is hard to reach, use the Positive (+) battery terminal. Enclose ALL wires leading from the Positive (+) battery terminal with the arrow pointing **away** from the battery. In both cases, be sure the clamp closes completely. See Figure 6-2.

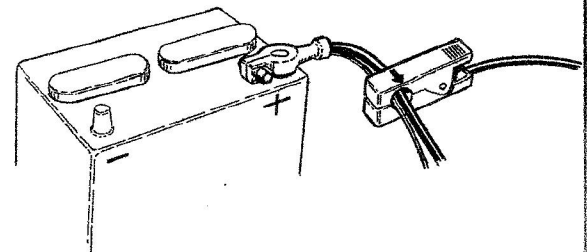
CAUTION

The Amps pickup measures a wide range of current (amperes). Large currents (such as those encountered in cranking) can offset the Amps Zero Adjustment and possibly produce false results when measuring low current levels (such as those in battery charging). To avoid inaccurate readings:

1. When the vehicle is started or restarted, remove the Amps pickup from around the wires to which it is connected. Allow the Amps pickup to close. If necessary, reset the Amps Zero adjustment to zero as directed in Chapter 2. Re-install the Amps pickup and continue the test procedure.
2. When clamping the Amps pickup around the alternator/generator output wire(s), keep it as far from the alternator/generator as is physically possible.



Amps Pickup, Arrow towards the Battery,
Negative Post Connection.
Figure 6-1

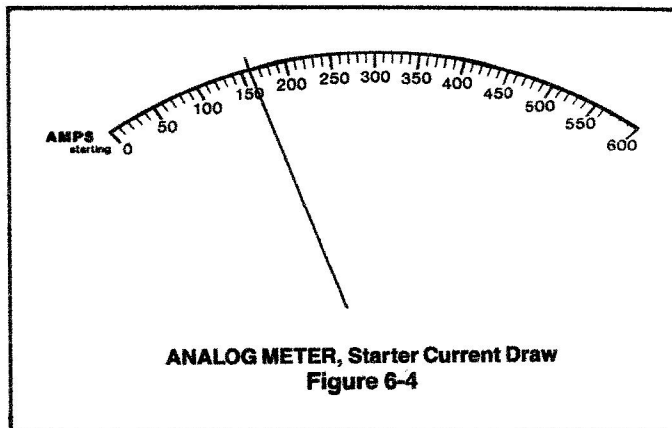
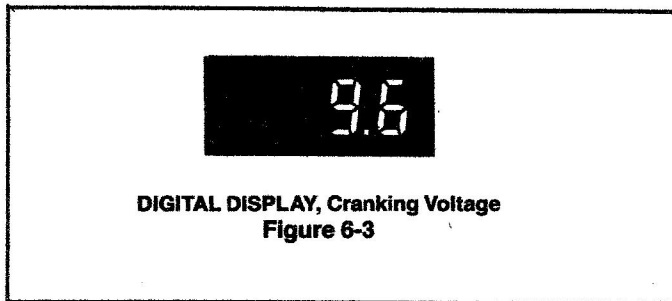


Amps Pickup, Arrow away from Battery,
Positive Post Connection.
Figure 6-2

6. Set the DIGITAL FUNCTION SELECTOR (7) to Volts.
7. Set the DIGITAL RANGE SELECTOR (8) to the 200 volts range.

C. Test Procedure:

1. Push the DIGITAL POWER (9) ON.
2. Turn the ignition key to the START position and operate the starter motor for 15 seconds.
3. Record the "Cranking Voltage" on the DIGITAL DISPLAY (6) and the Starter Motor Current Draw on the 600 Amp scale of the ANALOG METER (1) while the starter motor is cranking. Refer to Figures 6-3 and 6-4.



4. Return the ignition key to the OFF Position.
5. Push the DIGITAL POWER (9) OFF if testing is complete.

D. Test Results:

1. Normal
 - a. Voltage: 9.6 Volts or greater at 70° F or higher (battery temperature)
 - b. Current Draw: Approximately 80 to 300 Amperes

NOTE

The current draw on an engine is dependent on several factors: The number of cylinders, engine displacement (cubic inches or liters), temperature, and the engine's compression ratio. Consult your vehicle service manual for the cranking current of your specific engine.

- c. If Test Results are Normal, re-enable the ignition system by reversing the disabling procedure.
2. Abnormal.
The abnormal test results listed below will direct you to the most likely problem areas. These test results

may indicate a defect in the vehicle. Consult your vehicle service manual for the proper procedures to check these problem areas.

- a. Voltage high, current low and/or engine crank slowly or not at all (Refer to vehicle service manual for values.)
 - 1) Corroded connections in the cranking circuit (battery)
 - 2) Loose connections in the cranking circuit
 - 3) Defective battery/starter cables
 - 4) Starter motor not tightly mounted to the engine
 - 5) Defective starter solenoid
 - 6) Defective cranking motor

Refer to the vehicle's service manual for further test and perform the "Cranking Circuit Voltage Losses" test described in this manual, Chapter 6.

NOTE

The analyzer's Amps pickup provides the greatest accuracy when the vehicle's battery voltage is above 9.5 volts. If you encounter low voltage conditions such as those in the following Abnormal Results, it is advisable to power the Analyzer from a good 12 volt battery to confirm the abnormal condition encountered.

- b. Voltage low, current high and/or engine cranks slowly or not at all (Refer to vehicle service manual for values.)
 - 1) Tight engine
 - a) Low or no oil
 - b) Newly rebuilt engine
 - c) Mechanical problem
 - 2) Defective cranking motor
- c. Voltage and current measure normal at the beginning of the test but drop quickly during 15 seconds of cranking/voltage low, current low (Refer to vehicle service manual for values.)
 - 1) Undercharged or defective battery (Refer to Charging System Tests.)
 - 2) Battery too small for vehicle
 - 3) Defective cranking motor
- d. Voltage and current low during 15 seconds of cranking (Refer to vehicle service manual for values.)
 - 1) Undercharged or defective battery (Refer to Charging System Tests.)
 - 2) Battery too small for vehicle
 - 3) Defective cranking motor

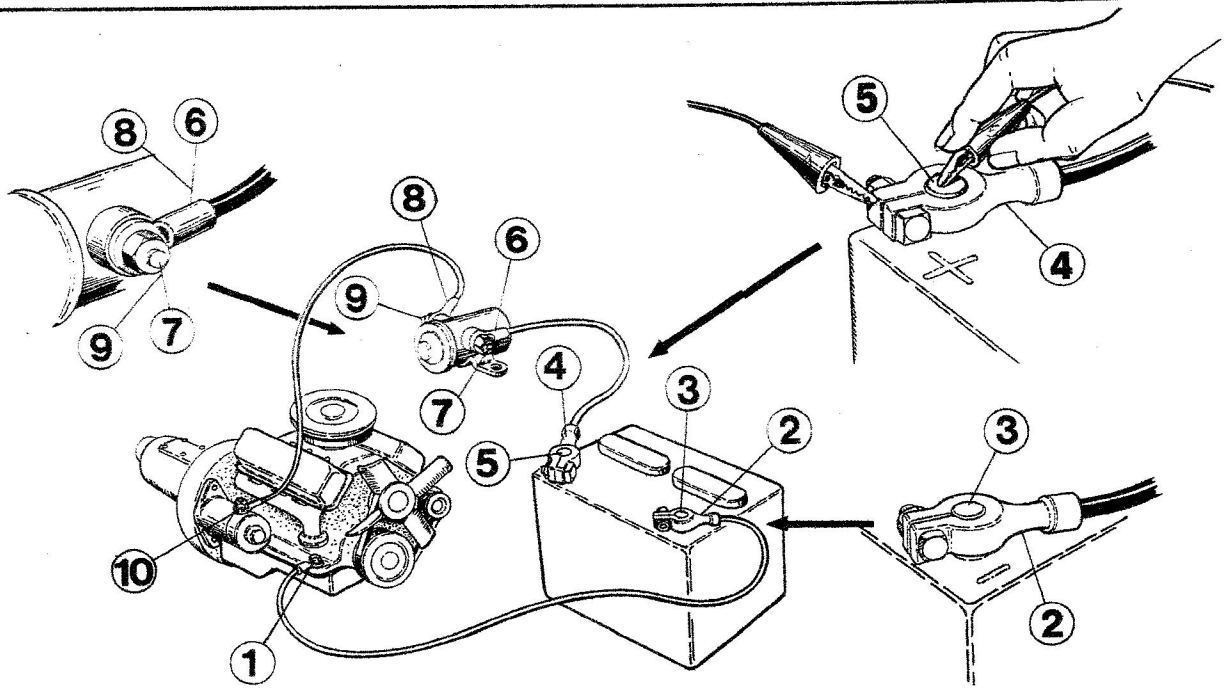
Consult your vehicle service manual for further testing and information.

6-3. CRANKING CIRCUIT VOLTAGE LOSS TEST.

THE CRANKING CIRCUIT VOLTAGE LOSS TEST checks for voltage losses in the cranking system.

A. Preparation:

1. Perform the instructions listed under "Electrical System—Preliminary Checks."
2. Disable the engine as explained in "Disabling Procedures" before continuing with this test.



**Cranking Circuit Voltage Loss, Typical Circuit
Figure 6-5**

NOTE

This is a representative sample of one type of cranking circuit. Your vehicle may use a different circuit with different components or locations. Consult your vehicle service manual.

B. Hookup Procedure:

Figure 2-2 shows a hookup procedure for most of the leads on the Sears 21045 Analyzer. Only the test leads listed below are required for the **CRANKING CIRCUIT VOLTAGE LOSS TEST** although the other leads may remain connected.

1. Insert the **WHITE VOLTS/OHMS (14)** connector into the **WHITE** socket on the Analyzer.
2. Set the **DIGITAL FUNCTION SELECTOR (7)** to **Volts**.
3. Set the **DIGITAL RANGE SELECTOR (8)** to **2 Volts**.

C. Test Procedure:

1. Push the **DIGITAL POWER (9)** **ON**.
2. Use the **RED** and **BLACK** clips of the **VOLTS/OHMS** lead (14) while referring to Figure 6-5. Connect the clips alternately between 1 and 2, 2 and 3, 4 and 5, 5 and 6, 6 and 7, 7 and 8, 8 and 9, and 8 and 10. Record the results at each point as read on the **DIGITAL DISPLAY (6)** with the engine cranking. See Figure 6-6.

3. During this test, no reading should be higher than **.200 volt**.

4. The **DIGITAL DISPLAY (6)** will read **Positive (+)** or **Negative (-)** numbers. Example: **.200** or **-.200**. For this test, ignore the polarity signs.

5. Push the **DIGITAL POWER (9)** **OFF** if testing is complete.

6. To restart the engine, reverse the "Disabling Procedure."

D. Test Results:

1. **Normal:** **.200** volt or less indicated at each of the points read.

2. **Abnormal**
If any reading is significantly higher than **.200** volt, check the cable or connections involved. Clean and tighten the connections. Replace broken, cracked or corroded parts when needed.

Consult your vehicle's service manual for further tests and information.



**DIGITAL DISPLAY, Voltage Loss
Figure 6-6**

CHAPTER 7. CHARGING SYSTEM TESTS

7-1. DESCRIPTION. The CHARGING SYSTEM keeps the battery charged when the engine is running. The system consists of the alternator or generator, the voltage regulator, the battery, and associated wiring and connections. The following procedures check the operation of this system.

CAUTION

The Sears 21045 Analyzer uses the battery of the vehicle under test as its power source for all functions except the digital OHMS, DWELL, and VOLTS. The digital section uses an internal 9 volt battery which allows OHMS and VOLTS tests to be performed on or off the vehicle. The Analyzer is capable of working on both 12 and 24 volt Negative (-) ground electrical systems. Before starting to troubleshoot, check the vehicle's battery voltage. If it is under 9.5 volts, use an auxiliary 12 volt battery.

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

- A. Faulty indicator lamp or dashboard gauge operation on the vehicle instrument panel
- B. An undercharged battery as evidenced by slow cranking or low hydrometer reading (dark dot on top of sealed battery with visual hydrometer)
- C. An overcharged battery as evidenced by excessive spewing of electrolyte from the vent, hot battery, or bubbling electrolyte, sometimes accompanied by a foul, pungent odor when excessively overcharged

CAUTION

To avoid damage to the charging system, observe the following precautions:

- Do not reverse connection to the alternator.
- Do not short across or ground any of the terminals in the charging circuit except as directed by the vehicle manufacturer's instructions.
- NEVER operate the alternator with the output terminal disconnected.
- When connecting a charger or booster battery to the car battery, see the vehicle manufacturer's Battery Charging Section of the manual.

7-2. CHARGING SYSTEM VOLTAGE AND BATTERY CHARGING CURRENT TEST

A. Preparation:

1. Perform the Instructions listed under "Electrical System—Preliminary Checks."
2. Inspect the alternator drive belt for wear and proper tension. Replace cracked and glazed belts.

3. An undercharged battery condition can be caused by accessories left on for extended times with the engine off. Make certain all accessories are off.

4. Check the firewall connectors and the battery connections for tightness and cleanliness at the battery, starter motor, engine ground and alternator.

B. Hookup Procedure:

Figure 2-2 shows a hookup procedure for most of the leads on the Sears 21045 Analyzer. Only the test leads listed below are required for the CHARGING SYSTEM VOLTAGE AND BATTERY CHARGING CURRENT TEST although the other leads may remain connected.

1. Insert the BLACK 3 pin POWER/POINTS/DWELL/C-3 (11) connector in the 3 pin BLACK socket on the Analyzer. Connect the RED clip to the Positive (+) battery terminal and the BLACK clip to a secure ground connection on the engine, frame, or alternator bracket. The BLACK clip should be the last connection made and the first to be disconnected. (The GREEN clip is not used for this test.)

WARNING

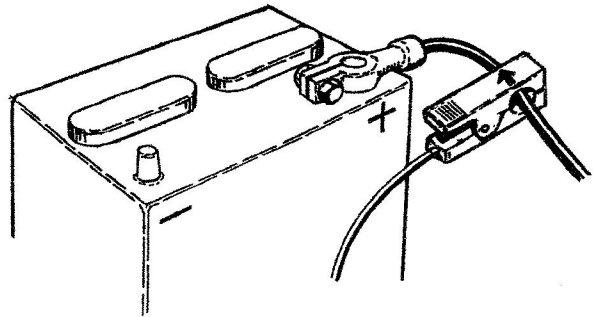
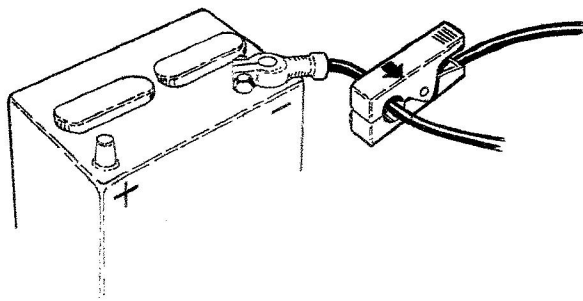
Avoid connecting the BLACK POWER clip directly to the battery Negative (-) terminal in the event that hydrogen gases are present which could explode from sparking connections.

2. Insert the WHITE VOLTS/OHMS (14) connector into the WHITE socket on the Analyzer. Connect the RED clip to the Positive (+) battery terminal and the BLACK clip to the Negative (-) battery terminal.

3. Insert the 4 pin BLACK ALT/AMPS (10) connector into the 4 pin BLACK ALT/AMPS socket on the Analyzer.

4. Set the ANALOG FUNCTION SELECTOR (4) to the Amps position. Set the ANALOG RANGE SELECTOR (3) to Low. Using the AMPS ZERO ADJUSTER control (5), set the meter to zero on the 120 Amps scale of the ANALOG METER (1). Set the ANALOG RANGE SELECTOR (3) to High.

5. Clamp the AMPS pickup (10) around ALL the wires leading from the Negative (-) battery terminal with the arrow on the clamp pointing away from the battery. See Figure 7-1. If the Negative (-) battery terminal is hard to reach, use the Positive (+) battery terminal. Enclose ALL wires leading from the Positive (+) battery terminal with the arrow on the clamp pointing towards the battery. See Figure 7-1.

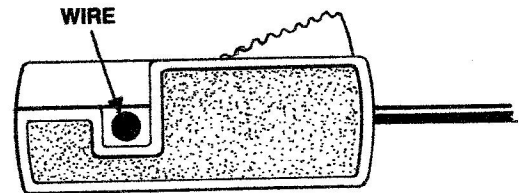


**Amps Pickup Connection, Negative OR Positive Post Connection,
Charging System and Battery Charging Current Test
Figure 7-1**

CAUTION

The Amps pickup measures a wide range of current (amperes). Large currents (such as those encountered in cranking) can offset the Amps Zero Adjustment and possibly produce false results when measuring low current levels (such as those in battery charging). To avoid inaccurate readings:

1. When the vehicle is started or restarted, remove the Amps pickup from around the wires to which it is connected. Allow the Amps pickup to close. If necessary, reset the Amps Zero adjustment to zero as directed in Chapter 2. Re-install the Amps pickup and continue the test procedure.
2. When clamping the Amps pickup around the alternator/generator output wire(s), keep it as far from the alternator/generator as is physically possible.



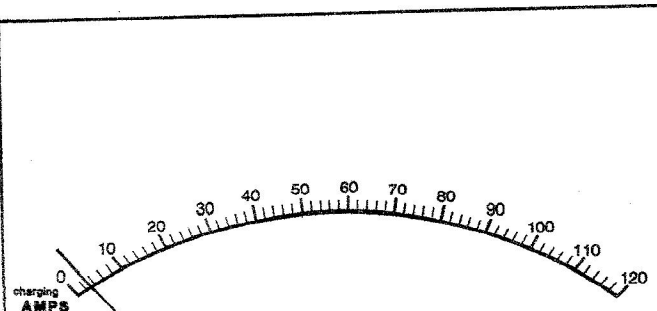
**RPM Pickup Closure, Complete; KV and Amps Pickup
Closure similar
Figure 7-2**

take several minutes to stabilize. On a close-to-fully charged, good battery, the stabilized reading occurs quickly.) See Figures 7-3 and 7-4.

6. Set the DIGITAL FUNCTION SELECTOR (7) to Volts.
7. Set the DIGITAL RANGE SELECTOR (8) to 200 Volts.
8. Connect the BLUE RPM pickup lead (13) to the BLUE socket on the Analyzer.
9. Clamp the RPM pickup around the No. 1 spark plug wire. The clamp must completely enclose the spark plug wire. See Figure 7-2.

C. Test Procedure:

1. Operate the engine at curb idle. Set the ANALOG RANGE SELECTOR to Low (120 Amps). Observe the voltage reading on the DIGITAL DISPLAY (6) and the amperage reading on the ANALOG METER (1) Low Amps scale (0-120). Under normal conditions, the ampere reading will fall as the voltage reading rises.
2. When the voltage reading stabilizes, record this reading and the amperage reading. (If the battery has been discharged by cranking tests or for other reasons, this voltage reading will climb slowly and may

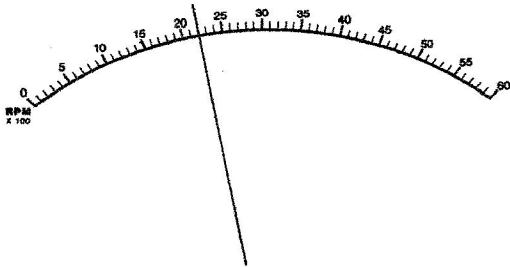


**Amperage Reading, ANALOG METER
Figure 7-3**



Voltage Reading, DIGITAL DISPLAY
Figure 7-4

3. Set the ANALOG FUNCTION SELECTOR (4) to RPM and the RANGE SELECTOR (3) to the HIGH (6000 RPM) position. Accelerate to a fast idle speed and hold it between 1800 and 2800 RPM as read on the ANALOG METER (1). The actual speed is not important, but should be maintained in this range. Hold this speed for Steps 4-8. See Figure 7-5.

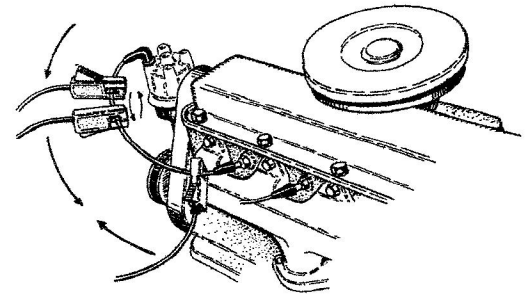


ANALOG METER, Fast Idle Indication
Figure 7-5

PRO-TIP

A defective ignition system may cause the tachometer to bounce around or show unsteady and intermittent readings. Low output spark voltage or defective ignition wires may be responsible. You may be able to steady the reading by sliding the RPM pickup along the ignition wire to a new location, or reversing the RPM pickup on the wires as shown in Figure 7-6. If erratic readings persist, move to another ignition wire in the event that the original one may be defective since the RPM pickup can be connected to any spark plug lead. Also, solid copper ignition wires radiate large amounts of radio frequency noise through the air which can interfere with the proper operation of the Analyzer and other electronic equipment. Replace solid copper ignition wire with resistance wire if only for the tests described in this manual.

4. Wait a few seconds and record the voltage shown on the DIGITAL DISPLAY (6). See Figure 7-7.



Positioning the RPM Pickup for Reliable Readings
Figure 7-6



DIGITAL DISPLAY, Fast Idle Voltage Increase, No Load — Typical
Figure 7-7

5. Turn the ANALOG FUNCTION SELECTOR (4) to the Amps position. Turn the ANALOG RANGE SELECTOR (3) to Low (120 Amps).
6. Hold the engine at fast idle and fully load the electrical system by turning on lights, HIGH fan, HIGH wipers, air conditioning and rear window defroster.
7. Wait a minute or two and record the voltage shown on the DIGITAL DISPLAY (6). See Figure 7-8



DIGITAL DISPLAY, Fast Idle Voltage, Full Load — Typical
Figure 7-8

8. Turn OFF all accessories.
9. Return the engine to curb idle.
10. Stop the engine.
11. Turn the Analyzer OFF if testing is complete.

D. Test Results:

1. Normal

- a. The voltage reading should stabilize between 13.2 and 15.2 volts or as specified in your vehicle service manual. Voltage should not change any more than about .5 volts when speed is changed from curb idle to fast idle. Voltage should not drop to less than about 13.0 at fast idle with all accessories on.
- b. The amperage reading is a "trickle charge" of approximately 0-5 amperes.

2. Abnormal

The abnormal test results listed below will direct you to the most likely problem areas. These test results may indicate a defect in the vehicle. Consult your vehicle service manual for the proper procedures to check these problem areas.

- a. Voltage High/Current High
 - 1) Defective voltage regulator
 - 2) Corroded, loose or otherwise defective connections in the battery or charging circuits
 - 3) Incorrectly set voltage regulator (mechanical type)
- b. Voltage Normal/Current High
Defective battery
- c. Voltage Low/Current Low
 - 1) Corroded, loose, or otherwise defective connections in the battery or charging circuits.
 - 2) Alternator drive belt slipping
 - 3) Defective voltage regulator
 - 4) Incorrectly set voltage regulator (mechanical type)
 - 5) Defective alternator/generator
- d. Voltage Low/Current "0" or below "0" (discharge, meter reads "backwards")
 - 1) Defective voltage regulator
 - 2) Open field wire from the voltage regulator to the alternator/generator (external voltage regulator systems only)
 - 3) Corroded or loose connections in the field circuit
 - 4) Defective alternator/generator
 - 5) Open voltage reference wire between battery and voltage regulator or integral (internal) regulator
- e. Voltage Low/Rises to Normal at engine fast idle
 - 1) Slipping alternator drive belt
 - 2) Corroded, loose or otherwise defective connections in the battery or charging circuits
 - 3) Defective alternator/generator
- f. Voltage Normal/Rises Significantly more than .5 volts and out of the normal range at engine fast idle—Voltage Regulator defective
- g. Voltage drops below about 13.0/Current drops below "0" at fast idle with accessories on, no other abnormal symptoms
 - 1) Slipping alternator/generator belt
 - 2) Defective alternator/generator
 - 3) Alternator/Generator too small (electrically) for vehicle as equipped

- a) Previous replacement alternator/generator incorrectly sized
- b) After market accessories were added to vehicle (rear window defroster, air conditioning etc.). Alternator/generator is no longer adequate for vehicle.

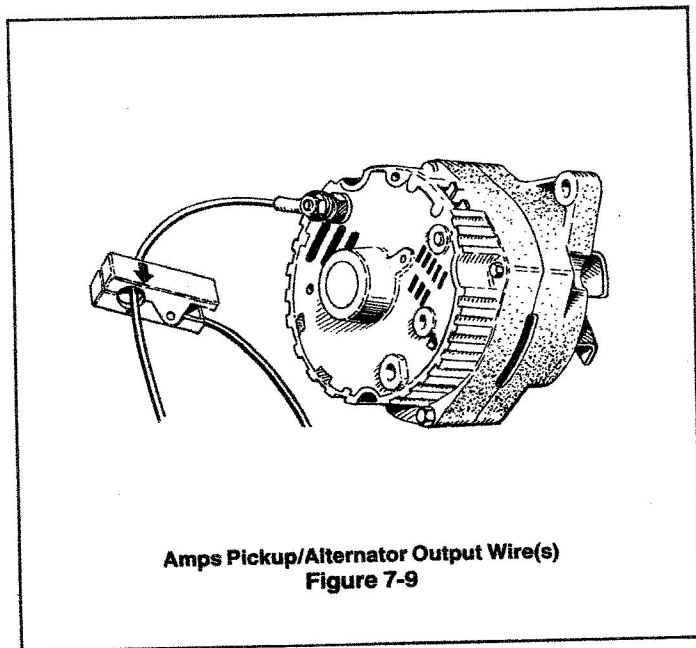
7-3. ALTERNATOR CONDITION TEST. The alternator in most vehicles is a three phase Alternating Current (AC) generator. The alternating current is "changed" to Direct Current (DC) for the vehicle's electrical system. This is accomplished by diodes in the alternator. The ALTERNATOR CONDITION TEST will check the operation of all three phase windings and the diodes of the alternator.

NOTE

Some alternators/generators are equipped with a diode trio in addition to the normal diodes used with the stator windings. This test may not detect a defective diode trio. Although many defects will illuminate the instrument panel (alternator/generator warning lamp), usually when the diode trio is defective, the warning lamp will glow dimly. This part is tested with an ohmmeter during off-the-vehicle bench testing. Consult your vehicle service manual for the proper test procedure. Refer to the OHM-METER section (Chapter 10) of this manual for instruction on using the Analyzer's built-in ohmmeter.

A. Hookup Procedure:

- Figure 2-2 shows a hookup procedure for most of the leads on the Sears 21045 Analyzer. Only the test leads listed below are required for the ALTERNATOR CONDITION TEST although the other leads may remain connected.
1. Insert the BLACK 3 pin POWER/POINTS/DWELL/C-3 (11) connector in the 3 pin BLACK socket on the Analyzer. Connect the RED clip to the Positive (+) battery terminal and the BLACK clip to a secure ground connection on the engine, frame, or alternator bracket. The BLACK clip should be the last connection made and the first to be disconnected. (The GREEN clip is not used for this test.)
 2. Insert the WHITE VOLTS/OHMS (14) connector into the WHITE socket on the Analyzer. Connect the RED clip to the Positive (+) battery terminal and the BLACK clip to the Negative (-) battery terminal.
 3. Connect the 4 pin BLACK ALT/AMPS (10) connector into the socket on the Analyzer.
 4. Clamp the AMPS pickup (10) around the heavy output wire(s) attached to the Positive (+) output stud at the rear or side of the alternator with the arrow on the clamp pointing **away** from the alternator. Do NOT enclose wires from other parts of the wiring harness in the AMPS pickup. They could affect the accuracy of the test results. Be sure the clamp closes completely. See Figure 7-9.



CAUTION

The Amps pickup measures a wide range of current (amperes). Large currents (such as those encountered in cranking) can offset the Amps Zero Adjustment and possibly produce false results when measuring low current levels (such as those in battery charging). To avoid inaccurate readings:

1. When the vehicle is started or restarted, remove the Amps pickup from around the wires to which it is connected. Allow the Amps pickup to close. If necessary, reset the Amps Zero adjustment to zero as directed in Chapter 2. Re-install the Amps pickup and continue the test procedure.
2. When clamping the Amps pickup around the alternator/generator output wire(s), keep it as far from the alternator/generator as is physically possible.

NOTE

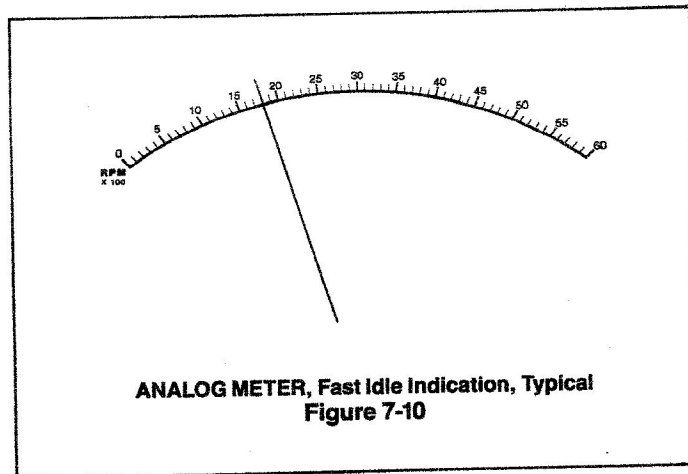
Some alternators/generators have a heavy ground wire between the alternator/generator and the vehicle or engine. Do not confuse this wire with the output wire(s).

5. Connect the BLUE RPM lead (13) to the BLUE socket of the Analyzer. Clamp the RPM pickup around the No. 1 spark plug wire. The clamp must completely enclose the spark plug wire. See Figure 7-2. (Previous Section)
6. Set the DIGITAL FUNCTION SELECTOR (7) to Volts.
7. Set the DIGITAL RANGE SELECTOR (8) to 200 Volts.

8. Set the ANALOG FUNCTION SELECTOR (4) to Amps. Set the ANALOG RANGE SELECTOR (3) to Low. Using the AMPS ZERO ADJUSTER control (5), set the meter to zero on the 120 AMPS scale.
9. Set the ANALOG FUNCTION SELECTOR (4) to the RPM position.
10. Set the ANALOG RANGE SELECTOR (3) to the High (6000 RPM) position.

B. Test Procedure:

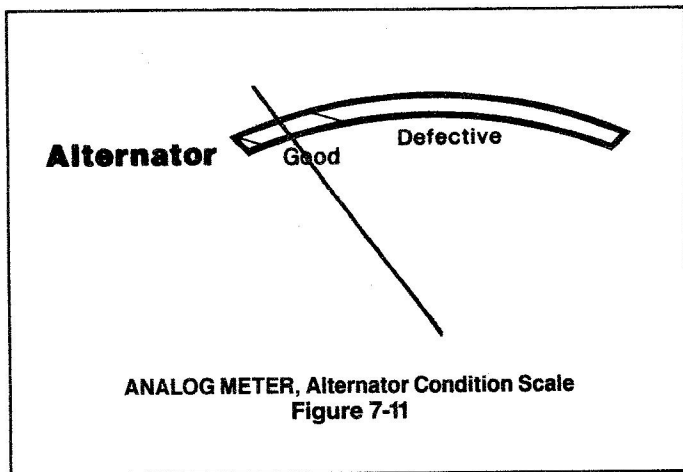
1. Have an assistant start the engine and maintain 1500 to 2000 RPM as read on the ANALOG METER RPM scale (1). See Figure 7-10.



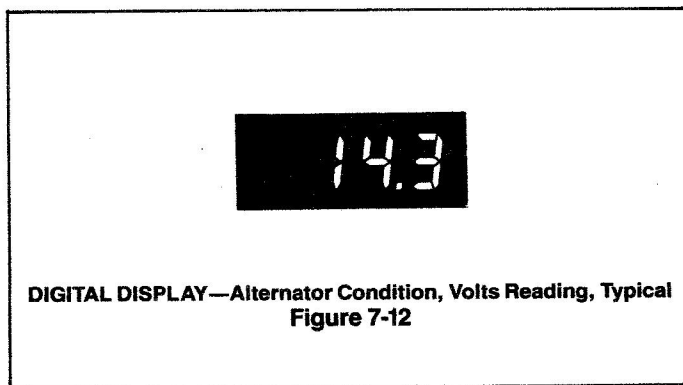
PRO-TIP

A defective ignition system may cause the tachometer to bounce around or show unsteady and intermittent readings. Low output spark voltage or defective ignition wires may be responsible. You may be able to steady the reading by sliding the RPM pickup along the ignition wire to a new location, or reversing the RPM pickup on the wires as shown in Figure 7-6. If erratic readings persist, move to another ignition wire in the event that the original one may be defective since the RPM pickup can be connected to any spark plug lead. Also, solid copper ignition wires radiate large amounts of radio frequency noise through the air which can interfere with the proper operation of the Analyzer and other electronic equipment. Replace solid copper ignition wire with resistance wire if only for the tests described in this manual.

2. Hold the engine speed of Step 1 and load the vehicle's electrical system: turn on the headlights, HI fan, and wipers.
3. Turn the ANALOG FUNCTION SELECTOR (4) to the Alternator position. Record the location of the ANALOG METER pointer on the alternator condition scale of the meter (1), downscale DEFECTIVE zone, GOOD zone or upscale DEFECTIVE zone. See Figure 7-11.



4. Record the voltage as indicated on the DIGITAL DISPLAY (6). See Figure 7-12.



5. Turn OFF all vehicle accessories (lights, fan etc.).
 6. Return the engine to curb idle.
 7. Stop the engine.
 8. Turn OFF the Analyzer if testing is complete.
- C. Test Results:
1. Normal
 - a. Voltage reading of 13.3-15.9 or as specified in the vehicle service manual
 - b. Alternator condition in the GOOD zone

NOTE

Any movement of the meter pointer across the Alternator Condition Scale indicates a functioning alternator. The downscale DEFECTIVE zone applies only if the pointer fails to move at all.

2. Abnormal

The abnormal test results listed below will direct you to the most likely problem areas. These test results may indicate a defect in the vehicle. Consult your vehicle service manual for the proper procedures to check these problem areas.

- a. Voltage low—Alternator/Generator condition downscale DEFECTIVE zone (Meter pointer does not move)
 - 1) Defective voltage regulator (open)
 - 2) Open Alternator/Generator field wire (external voltage regulator systems only)
 - 3) Corroded or loose connections in the alternator/generator field circuit
 - 4) Defective or worn out alternator/generator field brushes
 - 5) Defective alternator/generator (open field winding—rotor)
- b. Voltage low to normal—Alternator/Generator condition in the upscale DEFECTIVE zone

Defective alternator:

 - 1) Open or shorted diode(s)
 - 2) Open or shorted stator winding(s)

NOTE

Diode(s) or winding(s) failure(s) often will drive the meter pointer well into the upscale DEFECTIVE zone. If the vehicle electrical system under test drives the meter **just past** the GOOD zone into the lower part of the DEFECTIVE zone, proceed to the next test, ALTERNATOR OUTPUT, before removing, repairing or replacing the alternator.

7-4. ALTERNATOR OUTPUT TEST. If you have not performed the Battery Charging, Electrical System—Preliminary Checks, and Alternator Condition Tests, it is recommended that they be done before this procedure. This test is necessary only if the vehicle has failed one or more of the above tests or if you suspect that alternator output is not up to specification.

Read ALL directions for this test before beginning. Parts of this test must be done quickly and accurately to avoid possible damage to the system.

This procedure tests the alternator to determine whether or not it is capable of providing its rated output. Alternator output is rated in amperes (amps). Because of the wide range of vehicle size and optional equipment, alternator output current (amperes) varies significantly from vehicle to vehicle.

The alternator output can often be found on a colored tag or stamped on the alternator housing with the capital letter "A" (for amperes) immediately following. For example, 60A or 78A indicate a 60 ampere or 78 ampere capacity alternator. Since the method of identification varies among manufacturers and model years, consult your vehicle service manual for exact identification method.

CAUTION

The Alternator Output Test drives the alternator to full electrical output. This test is safe when properly performed. When the test is improperly performed, system voltages can reach potentially damaging levels to vehicle electrical components (headlamps, radios, on-board computers etc.). It is strongly recommended that you consult your vehicle service manual and follow any precautions and procedures listed. If there is any conflict between this test procedure and the one in your vehicle service manual, follow the recommendations of the vehicle service manual. Be especially careful with high output alternators (greater than 60A).

A. Preparation:

Follow the instructions listed under "Electrical System—Preliminary Checks."

B. Hookup Procedure:

Figure 2-2 shows a hookup procedure for most of the leads on the Sears 21045 Analyzer. Only the test leads listed below are required for the ALTERNATOR OUTPUT TEST although the other leads may remain connected.

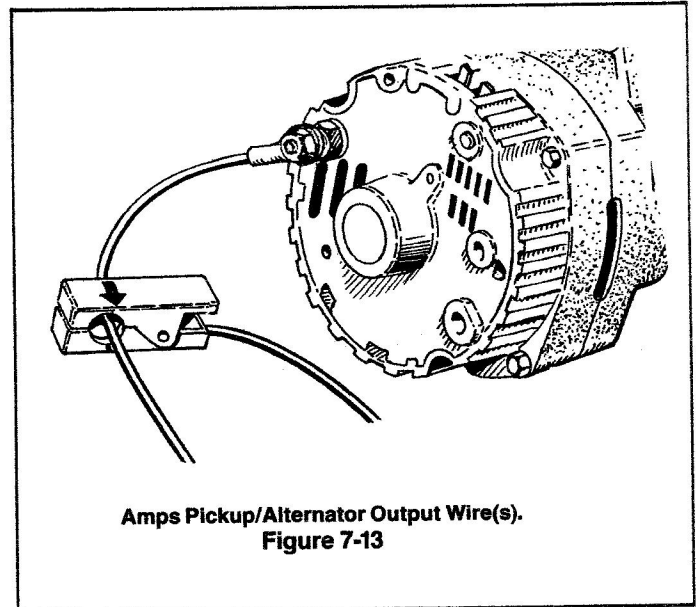
1. Insert the BLACK 3 pin POWER/POINTS/DWELL/C-3 (11) connector in the 3 pin BLACK socket on the Analyzer. Connect the RED clip to the Positive (+) battery terminal and the BLACK clip to a secure ground connection on the engine, frame, or alternator bracket. The BLACK clip should be the last connection made and the first to be disconnected. (The GREEN clip is not used for this test.)

WARNING

Avoid connecting the BLACK POWER clip directly to the battery Negative (-) terminal in the event that hydrogen gases are present which could explode from sparking connections.

2. Insert the WHITE VOLTS/OHMS (14) connector into the WHITE socket on the Analyzer. Connect the RED clip to the Positive (+) battery terminal and the BLACK clip to the Negative (-) battery terminal.
3. Connect the 4 pin BLACK ALT/AMPS (10) connector into the 4 pin BLACK ALT/AMPS socket on the Analyzer.
4. Set the ANALOG FUNCTION SELECTOR (4) to the Amps position. Set the ANALOG RANGE SELECTOR (3) to the Low (120 Amps) position. If your vehicle's alternator is rated in excess of 120 Amps, set the ANALOG RANGE SELECTOR to the High (600 Amps) position. Using the Amps ZERO ADJUSTER control (5), set the meter to zero on the selected amps scale.

5. Set the DIGITAL RANGE SELECTOR (8) to the 200 Volts position. Set the DIGITAL FUNCTION SELECTOR (7) to Volts.
6. Clamp the AMPS pickup (10) around the HEAVY output wire(s) attached to the Positive (+) output stud at the rear or side of the alternator with the arrow on the clamp pointing **away** from the alternator. Do NOT enclose wires from other parts of the wiring harness in the AMPS pickup. They could affect the accuracy of the test results. Be sure the clamp closes completely. See Figure 7-13.



CAUTION

The Amps pickup measures a wide range of current (amperes). Large currents (such as those encountered in cranking) can offset the Amps Zero Adjustment and possibly produce false results when measuring low current levels (such as those in battery charging). To avoid inaccurate readings:

1. When the vehicle is started or restarted, remove the Amps pickup from around the wires to which it is connected. Allow the Amps pickup to close. If necessary, reset the Amps Zero adjustment to zero as directed in Chapter 2. Re-install the Amps pickup and continue the test procedure.
2. When clamping the Amps pickup around the alternator/generator output wire(s), keep it as far from the alternator/generator as is physically possible.

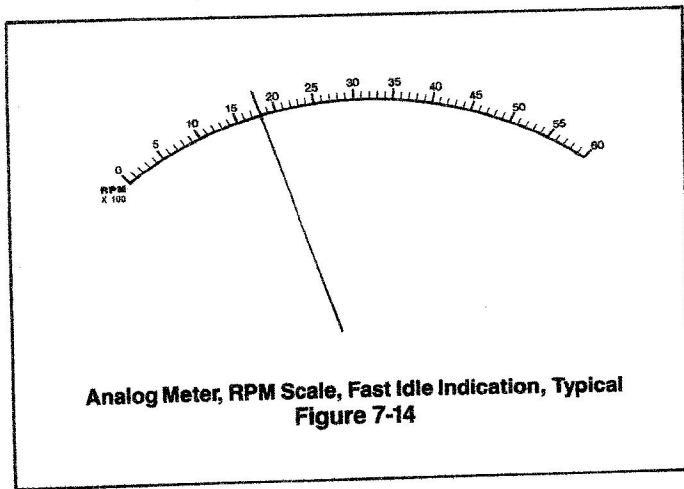
NOTE

Some alternators have a heavy ground wire between the alternator and the vehicle or engine. Do not confuse this wire with the output wire(s).

7. Connect the BLUE RPM pickup lead (13) around the No. 1 spark plug wire. The clamp must completely enclose the spark plug wire. See Figure 7-2. (Previous Section)
8. Turn the ANALOG FUNCTION SELECTOR (4) to the RPM position and the ANALOG RANGE SELECTOR (3) to High (6000 RPM).

C. Preliminary Check:

1. Have an assistant start the engine and maintain 1500-2000 RPM as read on the ANALOG METER RPM scale (1). Read the ANALOG METER RPM scale, Figure 7-14.



PRO-TIP

A defective ignition system may cause the tachometer to bounce around or show unsteady and intermittent readings. Low output spark voltage or defective ignition wires may be responsible. You may be able to steady the reading by sliding the RPM pickup along the ignition wire to a new location, or reversing the RPM pickup on the wires as shown in Figure 7-6. If erratic readings persist, move to another ignition wire in the event that the original one may be defective since the RPM pickup can be connected to any spark plug lead. Also, solid copper ignition wires radiate large amounts of radio frequency noise through the air which can interfere with the proper operation of the Analyzer and other electronic equipment. Replace solid copper ignition wire with resistance wire if only for the tests described in this manual.

2. Return to curb idle.
3. Stop the engine.

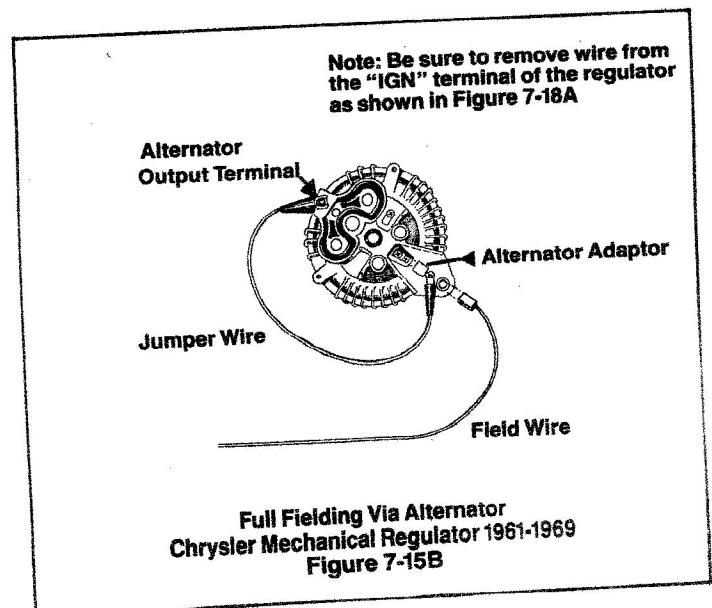
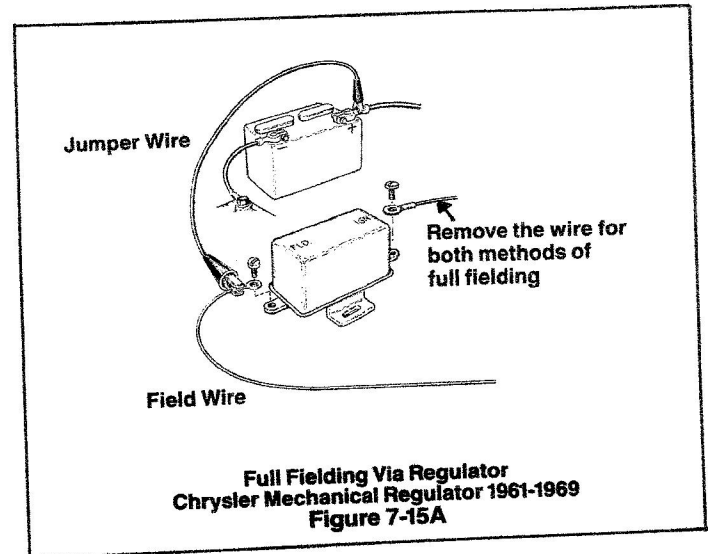
D. Test Procedure:

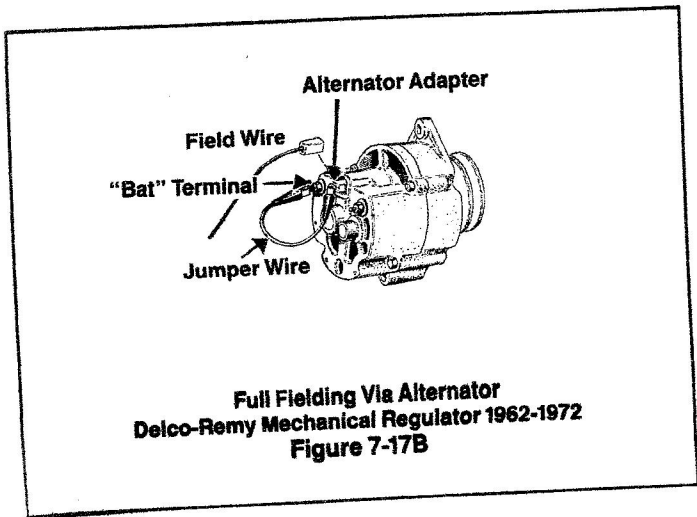
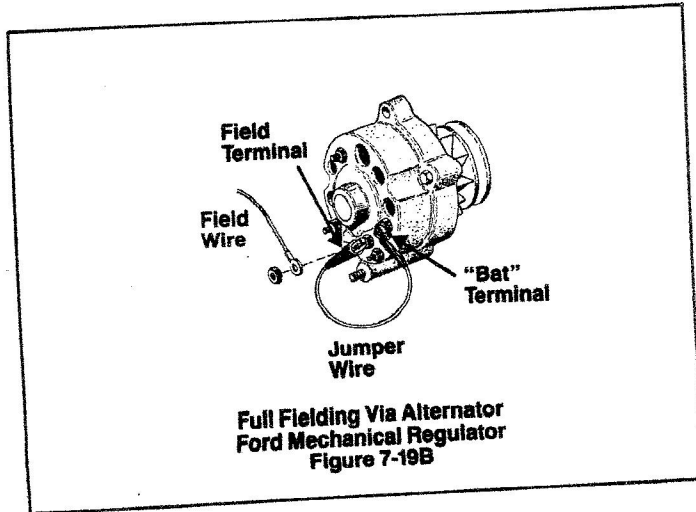
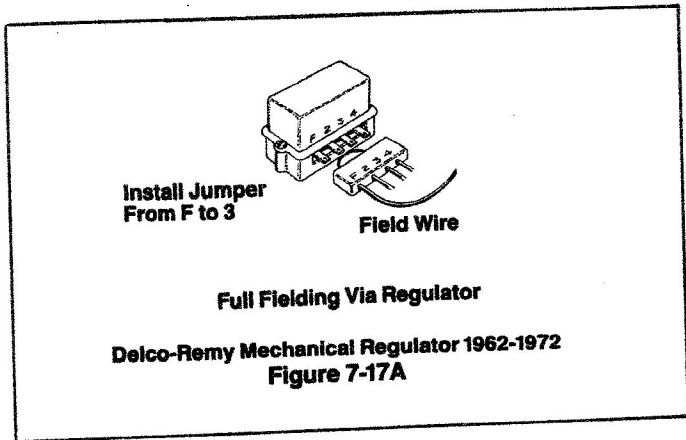
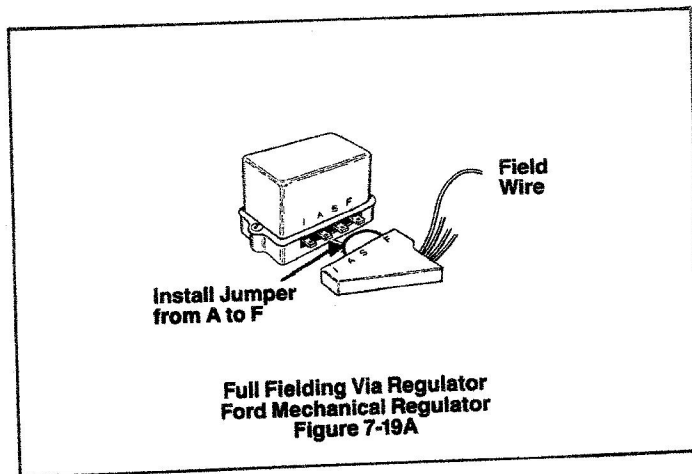
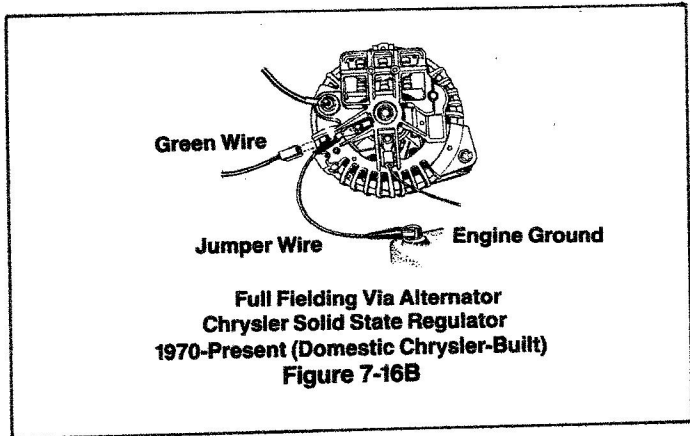
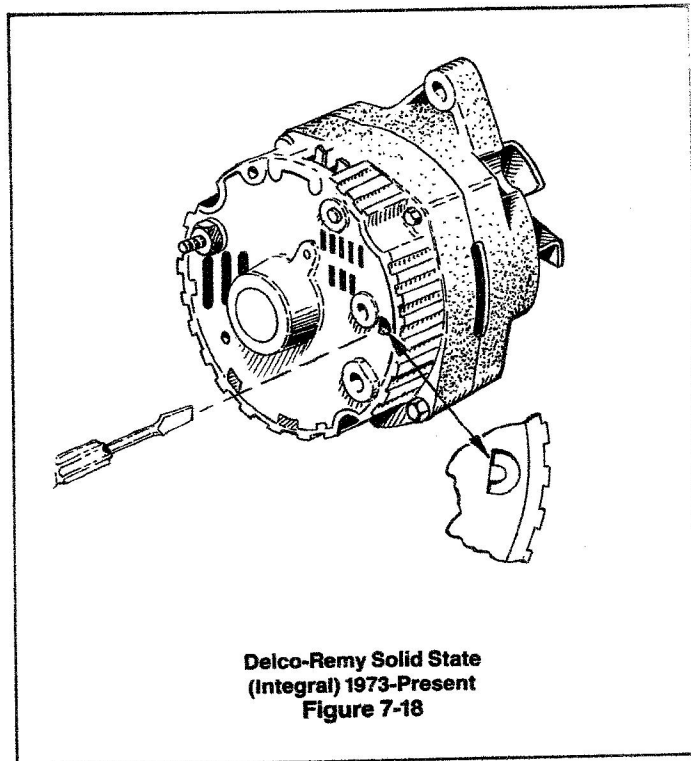
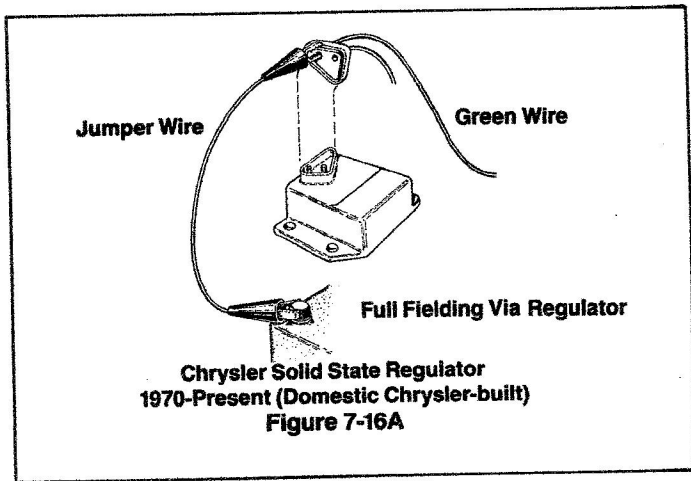
1. For this test, the voltage regulator must be bypassed and the alternator "full-fielded." Full-fielding is defined as applying full electrical system voltage (13-15 Volts) directly across the field winding (rotor) of the alternator. This causes the alternator to put out its maximum current (Amperes). Figures 7-15A through 7-21 illustrate some of the more common charging system configurations in use today. If your particular

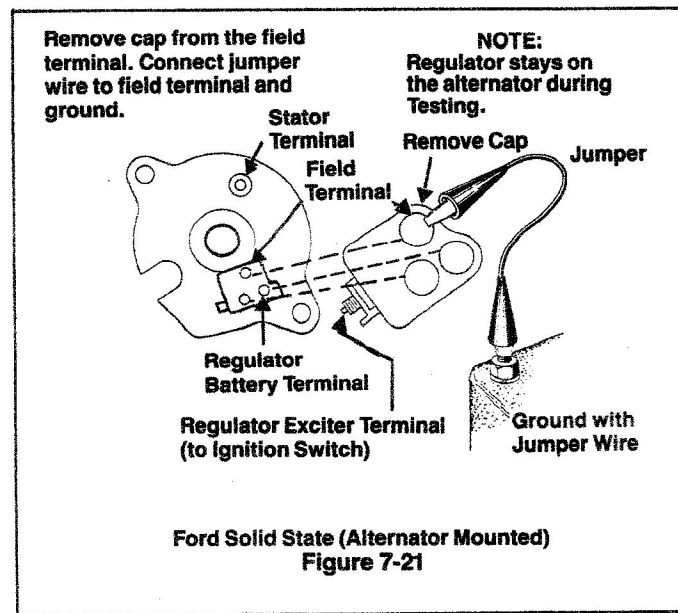
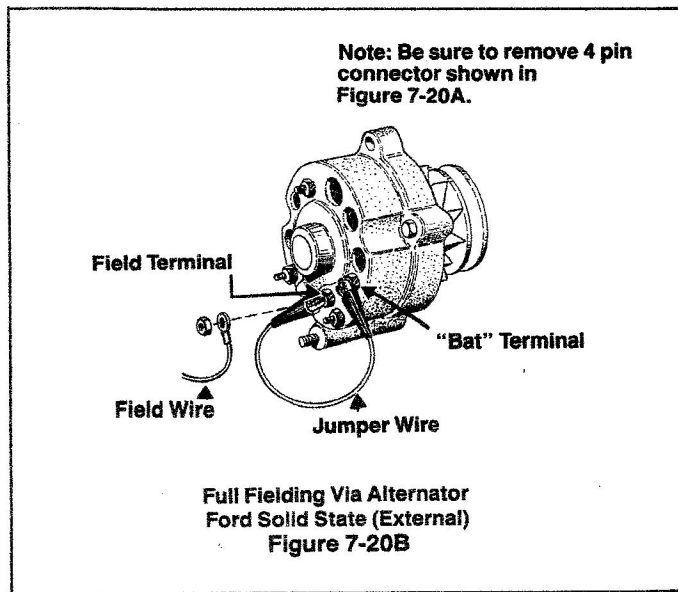
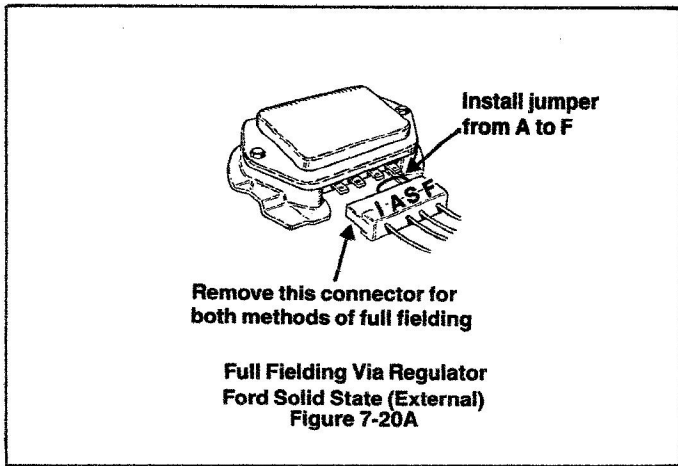
system is not illustrated consult your vehicle service manual for assistance. As these illustrations show, the alternator may be full-fielded at the alternator or at the voltage regulator, whichever is more convenient. (The Delco-Remy Solid State Charging System has only one possible full-fielding connection method. See Figure 7-18.) Refer to the proper figure or your vehicle service manual while following the procedure below.

NOTE

The Delco-Remy Solid State (integral) Charging System is full-fielded after the engine is running. Refer to Figure 7-18 and go to Step 16.







- a. Disconnect the negative (-) battery cable.
- b. Determine the most convenient location for full-fielding (alternator or regulator).
- c. Remove the connector at the voltage regulator (for

full-fielding at the regulator) or remove the field wire at the alternator (for full-fielding at the alternator). Note that with the Chrysler Mechanical System (Figures 7-15A & B) that the ignition (IGN) wire at the voltage regulator must be removed regardless of the full-fielding method selected. Note also that with the Ford Solid State External Regulator System the voltage regulator connector must be removed regardless of the full-fielding method selected. These precautions must be observed to prevent damage to the vehicle's electrical system.

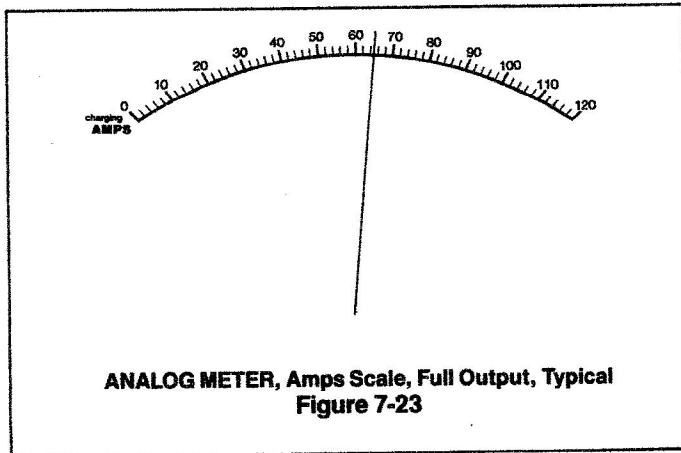
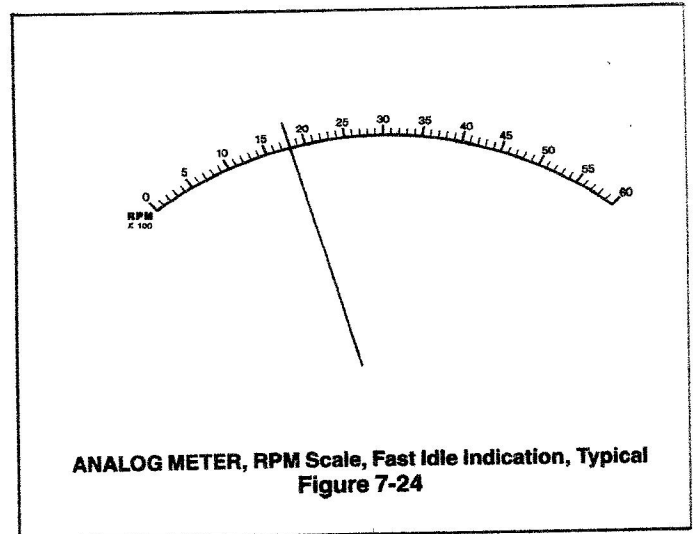
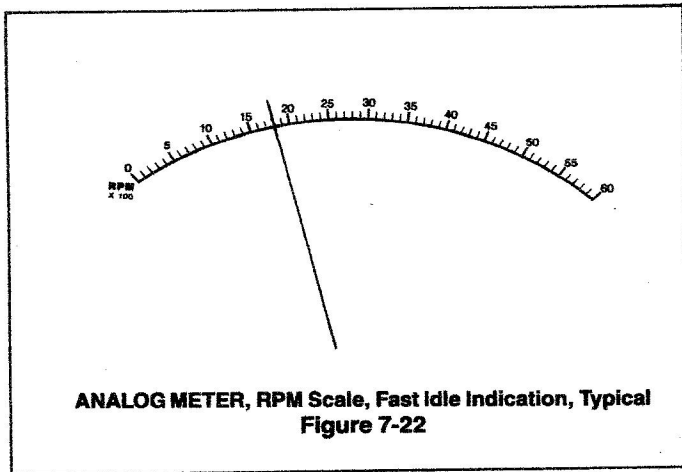
- d. When full-fielding from the alternator, remove the field wire as shown and using the jumper wire provided and the alternator adapter when necessary connect the field terminal at the alternator to either the "BAT" terminal or ground as indicated in the illustration.
- e. When full-fielding from the voltage regulator remove the connector from the regulator as shown in the appropriate figure. Using a suitable jumper wire connect the terminals indicated together at **the removed connector** or connect the field wire terminal from the removed connector to either the positive (+) battery post or ground as indicated by the proper illustration.

2. Double check your full fielding procedure for accuracy and connection security. If in doubt, consult your vehicle service manual.
3. Make sure all vehicle accessories are OFF.
4. Be sure that the ANALOG FUNCTION SELECTOR (4) is in the RPM position and the ANALOG RANGE SELECTOR (3) is in the High RPM position. An assistant may be needed for Steps 5-12.

CAUTION

Observe the DIGITAL DISPLAY (6) while performing Steps 5-12. Do NOT allow electrical system voltage to exceed 16.0 volts for more than a few seconds at a time.

5. Reconnect the battery negative (-) terminal. Start the engine. Return to curb idle quickly.
6. Electrically load the vehicle quickly. Turn on the following accessories in the order listed:
 - a. HI speed wipers
 - b. HI speed fan
 - c. Air conditioning
 - d. Rear window defroster
 - e. HI beam headlights
7. While observing the RPM scale on the ANALOG METER (1), accelerate and hold the engine at 1500-2000 RPM. See Figure 7-22.
8. Quickly turn the ANALOG FUNCTION SELECTOR (4) to the Amps position and the ANALOG RANGE SELECTOR (3) to Low (120 Amps) or High (600 Amps) to match the output of the alternator.
9. Record the Amps reading as displayed on the ANALOG METER (1). See Figure 7-23.



the Amps position and the ANALOG RANGE SELECTOR (3) to Low (120 Amps) or High (600 Amps) to match the output of the alternator.

22. Insert a small, clean screwdriver about $\frac{3}{4}$ " (but not more than 1") straight into the D-shaped hole at the rear of the alternator as shown in Figure 7-18. The screw driver must make contact between the small tab inside the D-shaped hole and the alternator case. See Figure 7-18. You may see a small spark when contact is made; this is normal.

10. Return the engine to curb idle.
11. Turn OFF all accessories in the reverse order from which they were turned on.
12. Shut off the engine.
13. Shut OFF the Analyzer if testing is complete.
14. Reverse the procedure used in Steps 1 and 2 and Figures 7-15 to 7-21 to restore the charging system to normal regulated operation.
15. Proceed to Test Results.

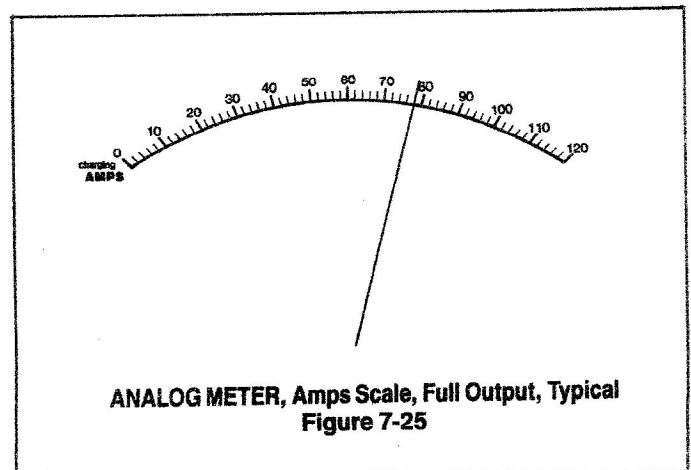
Delco-Remy Integral Charging System Test Procedure:

- (An assistant may be needed for this test.)
16. Make sure all vehicle accessories are OFF.
 17. Be sure that the ANALOG FUNCTION SELECTOR (4) is in the RPM position and the ANALOG RANGE SELECTOR (3) is in the High (6000 RPM) position.
 18. Start the engine.
 19. While observing the RPM scale on the ANALOG METER (1), accelerate and hold the engine to 1500-2000 RPM. See Figure 7-24.
 20. Electrically load the vehicle. Turn on the following accessories in the order listed:
 - a. HI speed wipers
 - b. HI speed fan
 - c. Air conditioning
 - d. Rear window defroster
 - e. HI beam headlights
 21. Turn the ANALOG FUNCTION SELECTOR (4) to

CAUTION

Observe the DIGITAL DISPLAY (6) while performing Step 23. Do NOT allow electrical system voltage to exceed 16.0 volts for more than a few seconds at a time.

23. When contact is made, record the Amps reading on the ANALOG METER (1) on the selected Low (120 Amps) or High (600 Amps) scale. See Figure 7-25.



24. Remove the screwdriver.
25. Turn OFF all accessories in the reverse order from which they were turned on.
26. Return the engine to curb idle, and shut the engine off.
27. Turn OFF the Analyzer if testing is complete.
28. Proceed to Test Results.

E. Test Results:

1. **Normal**—Output current (amperes) is equal to alternator nameplate specification within the tolerance limits specified in the vehicle service manual.
2. **Abnormal**
The abnormal results listed below will direct you to the most likely problem areas. These test results may indicate a defect in the vehicle. Consult your vehicle service manual for the proper procedures to check these problem areas.

NOTE

The alternator must be removed from the vehicle for bench testing in accordance with the vehicle service manual. Refer also to the Ohmmeter Tests section of this manual.

- a. Output current reads below specified limits
 - 1) Shorted or open diodes in alternator
 - 2) Open or shorted windings in alternator
- b. Output current reads above specified limits—alternator nameplate marking incorrect

NOTE

An alternator that is above specified limits is not a cause for concern. The alternator is acceptable if it was designed for the vehicle in which it is installed and has passed all tests up to and including this one. Voltage regulator action will maintain proper system operating levels.

CHAPTER 8. IGNITION SYSTEM TESTS

8-1. DESCRIPTION. The basic ignition system of any vehicle consists of:

- the battery (electrical system)
- ignition coil (primary side)
- ballast resistor (when equipped)
- breaker points with cam-type distributor OR
- electronic ignition module with reluctor, pickup coil or Hall-effect unit type distributor
- primary wiring and necessary connectors
- ignition coil (secondary side)
- distributor rotor
- distributor cap
- ignition (spark plug) wires
- spark plugs

For the engine to run efficiently, each of these components must be in good condition and functioning properly. The Troubleshooting Chart in Chapter 3 of this manual or the vehicle service manual may lead the technician to perform specific ignition system test procedures. The ignition system test procedures outlined in the next several pages are presented in a logical sequence to completely check the ignition system.

Section 1. Primary Circuit

8-2. PRIMARY COIL VOLTAGE (BALLAST RESISTOR EQUIPPED VEHICLES ONLY).

NOTE

This test is necessary only if one or more of the following conditions exists:

- 1) Engine cranks but will not start
- 2) Engine cranks excessively before starting
- 3) Engine starts but dies immediately upon releasing the ignition key

Primary Coil Voltage is measured between the Positive (+) terminal of the ignition coil and engine ground. For the ignition coil to function efficiently, proper voltage must be present at this point during engine cranking and running. Typically the Ballast Resistor is bypassed (shorted out) during engine cranking. This bypass puts full cranking system voltage (which is less than RUN voltage) on the ignition coil to insure a "hot" spark at the spark plugs for quick starting. When the ignition key is released and returns to the RUN mode, the ballast resistor is electrically returned to the circuit. In the RUN mode, the ballast resistor limits the voltage at the primary side of the ignition coil to a safe operating value thereby preventing damage to the ignition coil, breaker points, and possibly the electronic ignition module if equipped. This test checks primary coil voltage and thus the operation of the ballast resistor.

A. Preparation:

Disable the engine as explained in "Disabling Procedures" before continuing with this test. In ALL cases be sure to ground the ignition coil tower wire to ground as illustrated in Figures 4-1, 4-6, 4-8 and 4-10. Use of any other ignition disabling method will cause incorrect results.

B. Hookup Procedure:

Figure 2-2 shows a hookup procedure for most of the leads on the Sears 21045 Analyzer. Only the test leads listed below are required for the PRIMARY COIL VOLTAGE (BALLAST RESISTOR EQUIPPED VEHICLES ONLY) TEST although the other leads may remain connected.

1. Insert the WHITE VOLTS/OHMS (14) connector into the WHITE socket on the Analyzer. Connect the RED clip to the Positive (+) battery terminal and the BLACK clip to the Negative (-) battery terminal.
2. Set the DIGITAL FUNCTION SELECTOR (7) to Volts.
3. Set the DIGITAL RANGE SELECTOR (8) to 200 Volts.

C. Test Procedure:

1. Crank the engine for a few seconds. Record the voltage shown on the DIGITAL DISPLAY (6), Figure 8-1.

A digital display showing the number 10.2 in white digits on a black background.

DIGITAL DISPLAY, Battery Cranking Volts, Typical
Figure 8-1

2. Release the ignition key to the ON (RUN) position. Record the voltage shown on the DIGITAL DISPLAY (6), Figure 8-2. Turn the ignition key OFF.

A digital display showing the number 12.6 in white digits on a black background.

DIGITAL DISPLAY, "Key ON" Battery Volts, Typical
Figure 8-2

3. Disconnect the VOLTS/OHMS RED clip from the Positive (+) battery terminal and connect it to the Positive (+) terminal of the ignition coil. Leave the BLACK clip connected to the Negative (-) battery terminal or if necessary move to a clean, secure ground connection. See Figure 8-3.