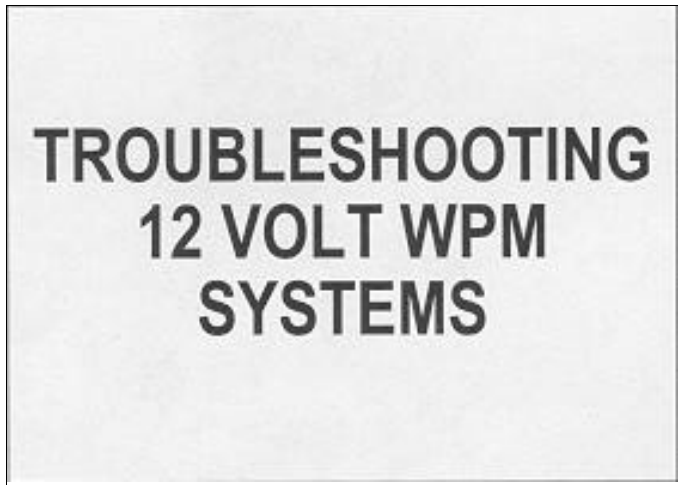


TROUBLESHOOTING 12 VOLT WPM SYSTEMS

WPM 12 Volt System Troubleshooting

This program covers troubleshooting the AC electric start systems used on Toro and Lawn-Boy walk power mowers in recent years. There are similarities and differences between the Toro and Lawn-Boy versions. We will point them out as we go along.



Test Equipment

There are two basic testers that are necessary to properly test the electric start system. A volt-ohm meter (VOM) and a Toro Key-Lectric tester.



Volt-Ohm Meter

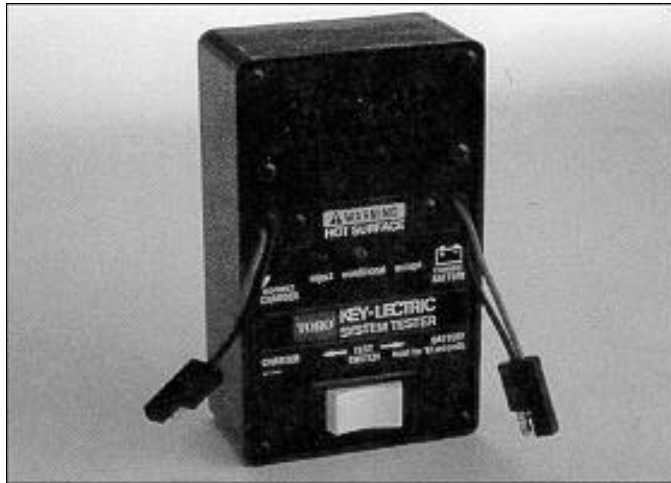
The VOM can be either a digital or analog type. The digital may be easier to read when there is only a small difference in readings. An option you may want is a function that will measure 500 milliamps. This will measure the current output of an alternator.



TROUBLESHOOTING 12 VOLT WPM SYSTEMS

Toro Key-Lectric Tester

This tester is PN 67-7970. It is intended to measure the output of the AC charger and test the battery. The main advantage of this tester is that it has a coil that applies a load to a battery, similar to the load of actually starting a mower. This tester is available to all Toro and Lawn-Boy service dealers.

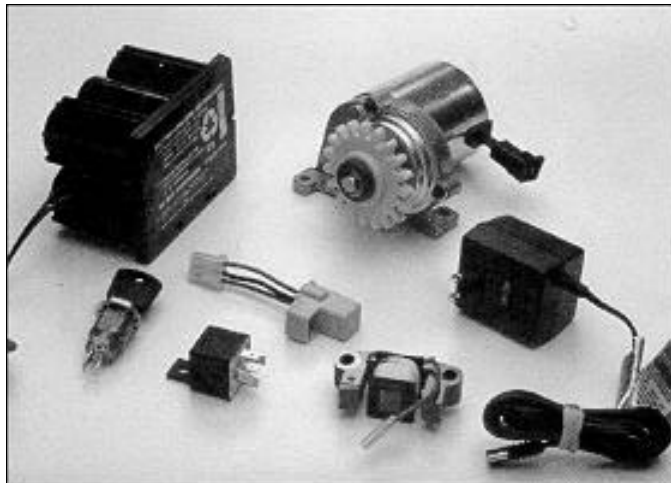


Components Covered

The components covered in this program include:

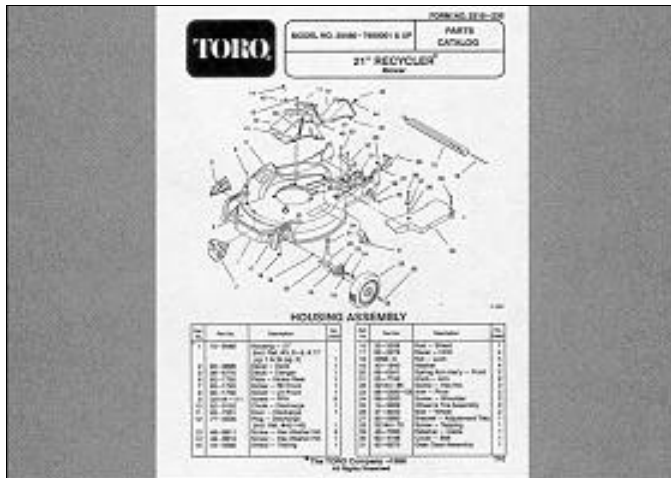
- Battery
- Wiring diagrams
- Starter motor
- AC charger
- Alternator
- Relay
- Cup assembly
- Switch

There is also a section on proper battery storage.



Wiring Diagrams

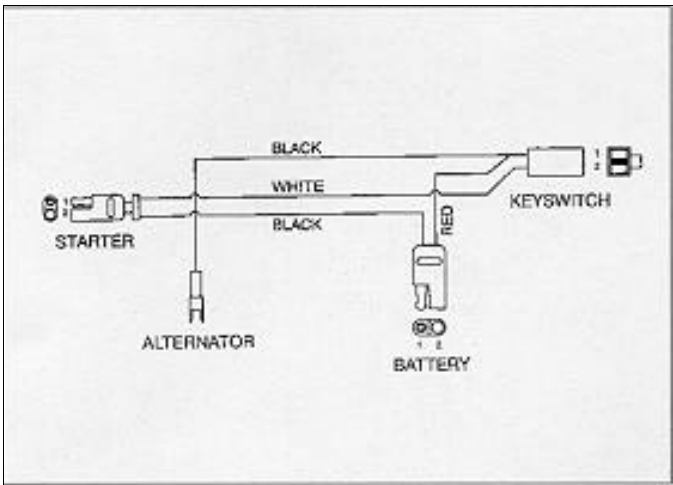
A wiring diagram is a critical tool in troubleshooting any electrical system. Generally the wiring diagram can be found in the parts catalog or owners manual for each model. Following are some examples of wiring diagrams used in recent years. The systems are slightly different so it is important to use the correct one.



TROUBLESHOOTING 12 VOLT WPM SYSTEMS

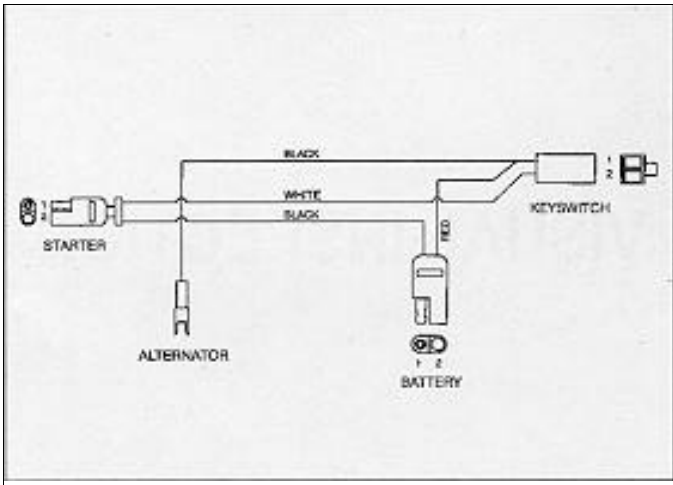
Wiring Diagrams (cont'd)

The wiring diagram is used to show the technician how each part is connected and shows the wire colors to assist in tracing them.



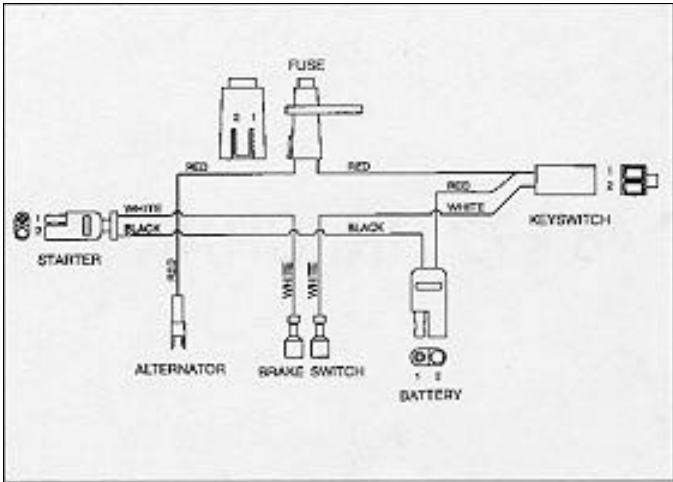
1997-1998 Toro Wiring 80-4790

This is the diagram of wire harness PN 80-4790. It is the system used on 1997 and 1998 Toro electric start walk mowers. It includes the battery, starter motor, switch, and alternator.



1999 Toro Wiring 99-6000

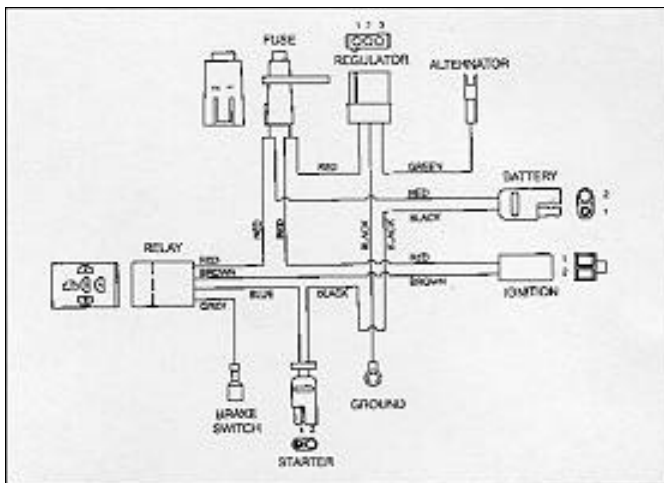
This wiring system is used on the 1999 Toro electric start models. It is the same as the older version, with the addition of a brake switch and a fuse. The brake switch prevents the battery from supplying power to the starter motor unless the switch is activated. This will prevent the battery from running down due to trying to start an engine with the flywheel brake on and the ignition grounded.



TROUBLESHOOTING 12 VOLT WPM SYSTEMS

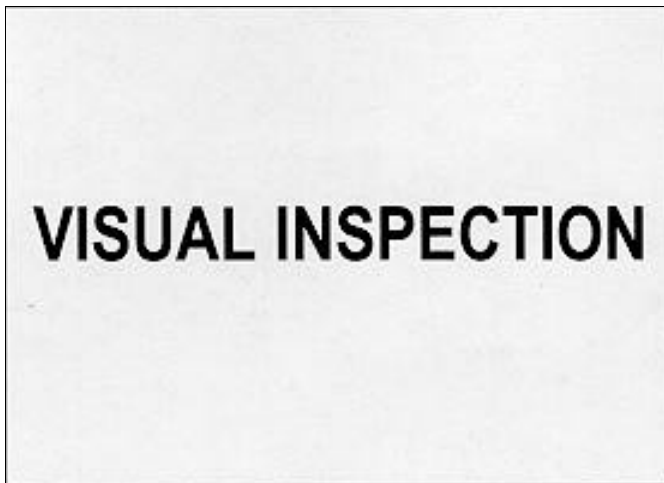
1998 Lawn-Boy Wiring 98-1550

This is a typical wiring diagram used on 1998 electric start Lawn-Boy models. Similar systems have been used for several years. It is basically the same as the Toro systems with a cup assembly and relay added.



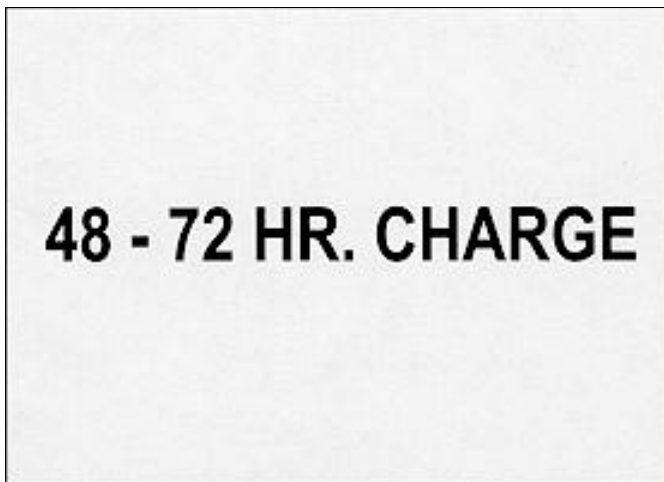
Troubleshooting

Start with a visual inspection. Are the wires undamaged; are they all connected? Look for damaged switches or other parts. Repair as needed. For those models that have a fuse, check to see if that has failed.



Charge The Battery

Use a known good charger and get the battery on charge. A full charge will take 48 - 72 hours. The battery can be charging while you test other things. A less than fully charged battery will affect your test results.



TROUBLESHOOTING 12 VOLT WPM SYSTEMS

Engine Turns Over But Doesn't Start

If you have a known good battery, attempt to start the machine electrically. One of three things will happen.

- A. The engine turns over but doesn't start.
- B. The starter motor doesn't run.
- C. The starter motor runs but does not turn the engine.



**TRY THE ELECTRIC
STARTER**

Engine Turns But Doesn't Start (cont'd)

For testing purposes, any 12 volt battery can be used. However, if you use a larger battery, be careful not to crank the starter too long. A larger capacity battery could run the starter so long that it might overheat. If the engine starts, the problem is likely the battery. If the engine does not start, proceed with testing other parts.



**TRY ANOTHER
BATTERY**

Engine Turns But Doesn't Start (cont'd)

Attempt to start with the rope. If the engine does not start easily, the problem may be within the engine. If the engine starts easily, proceed with testing the battery and starter motor. See component testing.



**START WITH
THE ROPE**

TROUBLESHOOTING 12 VOLT WPM SYSTEMS

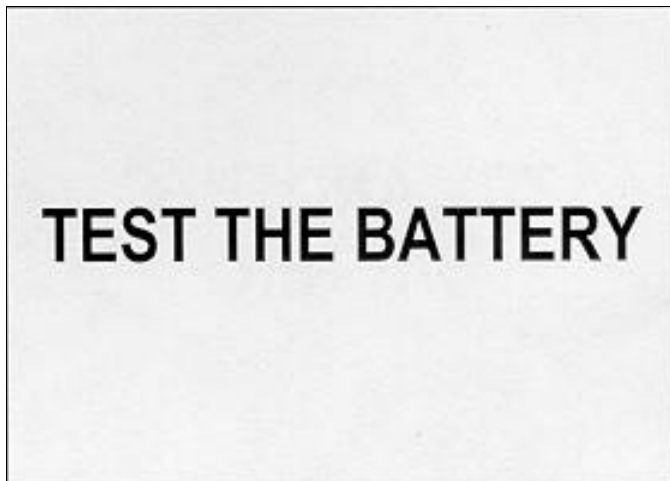
Engine Turns Over But Doesn't Start (cont'd)

Check the engine compression. Excessive compression may be hard to detect just by pulling the rope. However, excessive compression may slow the starter motor to the point where the ignition cannot fire. On 2-cycle engines, verify that the compression release hole is open and the exhaust is not plugged. On 4-cycle engines so equipped, check that the compression release is opening a valve.



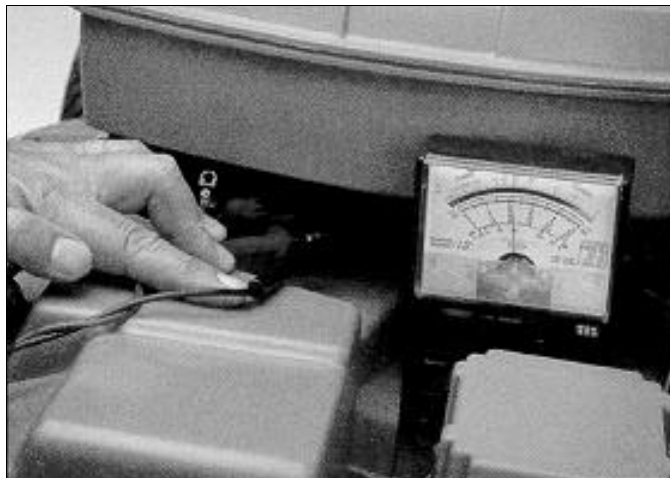
The Starter Motor Does Not Run

Test the battery using the Toro Key-Lectric tester. Try a substitute battery using the suggestions and cautions previously discussed.



The Starter Motor Does Not Run (cont'd)

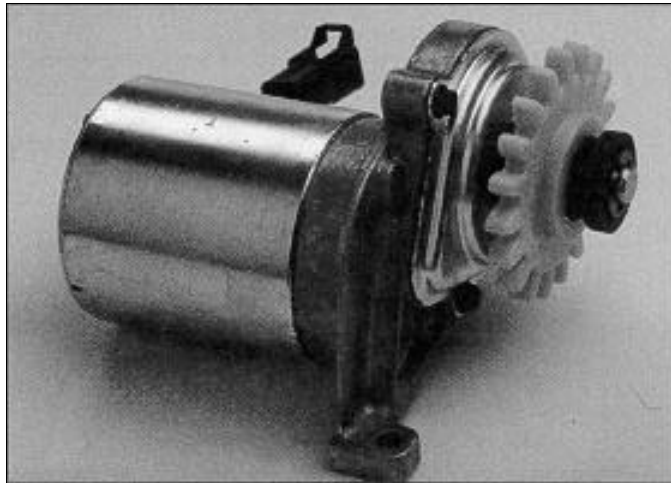
Unplug the wire harness from the starter motor. Attach a DC voltmeter to the harness terminals and turn the key to start. 12VDC should be present. If you read 12VDC, the problem is in the starter motor. If there is no voltage, work your way back to the battery (remember, some models have a fuse), until you find voltage. The problem is between that point and the point where there was no voltage.



TROUBLESHOOTING 12 VOLT WPM SYSTEMS

Starter Runs But Engine Does Not Turn

The starter pinion is damaged or stuck on the pinion shaft. Repair or replace as needed.



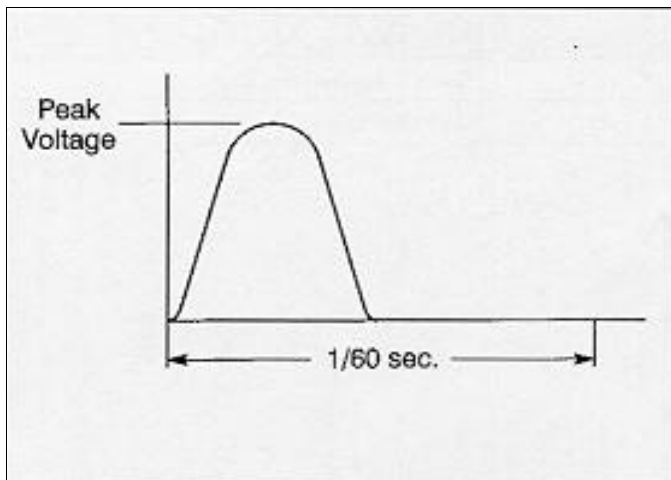
Component Testing

In this section we will look at testing the individual components in the starter system.



AC Charger

There are two methods to test the AC charger, but first you must understand how they work. The output of these chargers is pulsing. There is a pulse of current, then a pause where there is no current, then another pulse. Electrical testers cannot react to these rapid pulses so they average out the voltage.



TROUBLESHOOTING 12 VOLT WPM SYSTEMS

2 - AC Chargers

There are two different chargers used depending on the age of the mower. Read the printing on the charger. The older ones had a peak output of 14.5 VDC and the newer ones peak at 13.2 VDC.



Charger Testing

The testers will read an average of the output of the charger. If you use a DC voltmeter use these numbers. Note: Some variation is normal due to error factors between different voltmeters.

Charger Rating	DC Voltmeter Reading
13.2 VDC	6-7 VDC approximately
14.5 VDC	8-9 VDC approximately

Charger Testing With The KL Tester

The current Toro Key-Lectric tester uses different colored lights to indicate good and bad parts. When this tester is in the charger test mode, it is a voltmeter with an indicator light. Use the following as a guideline. Note: Due to the nature of these components, they either work or they don't. It is unlikely there would be a failure that the voltage is present but low.

Charger Rating	Tester Reading
13.2 VDC	Green or yellow is good.
14.5 VDC	Green is good.

TROUBLESHOOTING 12 VOLT WPM SYSTEMS

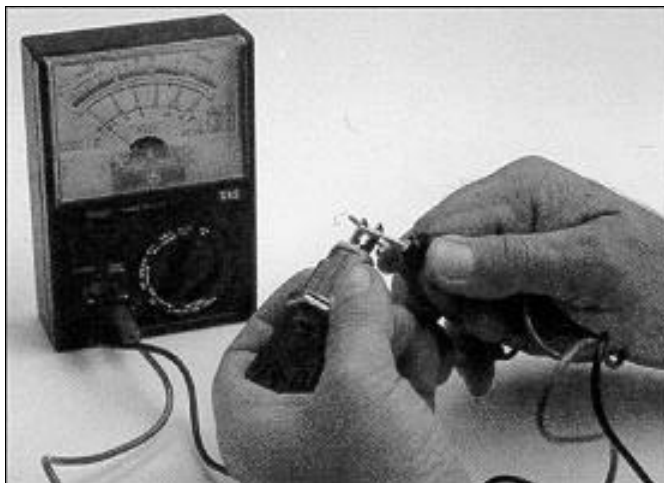
KL Battery Testing

The only reliable method of testing the battery is using the Toro Key-Lectric tester. Fully charge the battery and allow an hour or so cool down time. A less than fully charged battery may fail the test. Connect the tester and follow the instructions provided with the tester. This tester contains a heating coil that will draw approximately 30 amps from the battery. This simulates the load applied by a starter motor.



Key Switch Testing

The current key switches only have two positions, on and off, as they only control the current flow to the starter motor. Disconnect the wiring harness from the switch. Attach an ohmmeter or continuity light to the switch terminals. When the key is on, there should be continuity; when off, there should be no continuity. Move one test lead to the switch body. There should be no continuity with the switch either on or off.



Starter Motor Testing

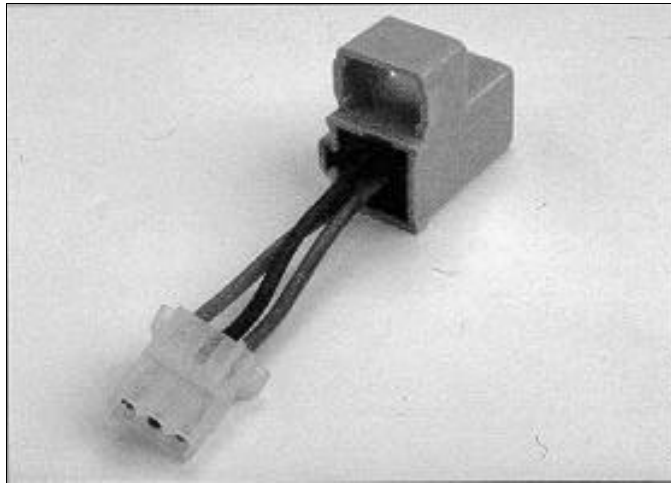
Often technicians connect a battery directly to a motor and if the motor runs, pronounce it good. While this gives some indication, it cannot detect all failure modes. To properly test a motor, disconnect the wiring harness. Connect a continuity light or ohmmeter to the motor terminals. SLOWLY rotate the motor shaft and watch the meter or light. There should be continuity for the full rotation of the shaft. Note: As you turn the shaft, the motor becomes a generator and will disrupt your reading. Turning slowly minimizes that effect.

No Continuity	No Continuity In One Spot	High Resistance For 360 Degrees
Brush failure	Commutator has a bad bar or one of the windings has broken	Look for burned or damaged brushes or commutator

TROUBLESHOOTING 12 VOLT WPM SYSTEMS

Cup Assembly Testing

The cup assembly (on some models only) serves two functions. One is to convert AC to DC by means of a diode. The other is to actually increase the voltage put out by the alternator. This allows the use of a less powerful alternator.



Cup Assembly Test

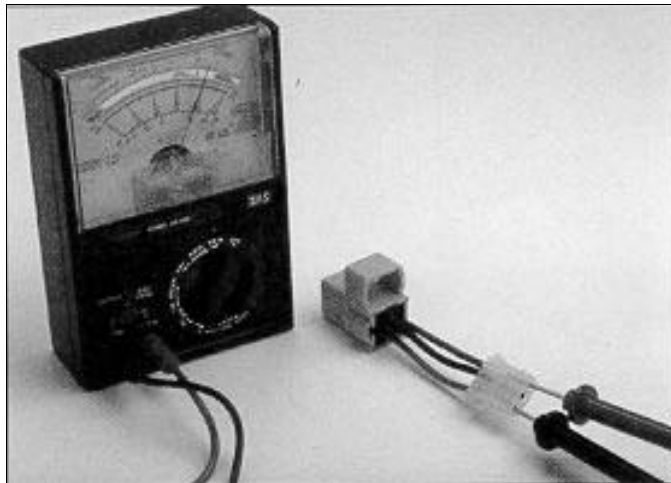
Disconnect the cup assembly from the wiring harness. Use an ohmmeter set on the RX1 scale. Measure the resistance, then reverse the test leads and measure again.

Specification:

Red wire - Green wire

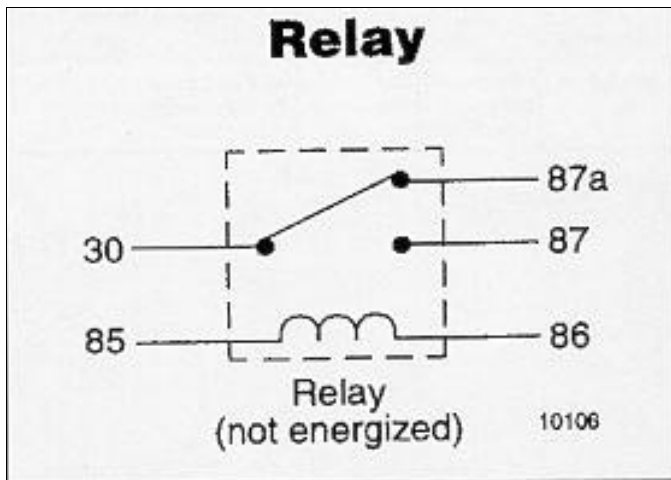
Green wire - Red wire

The readings should be opposite; a high resistance one way and a low resistance the other. If they are similar or there is no reading either way, the cup assembly must be replaced.



Relay Testing

A relay is nothing more than a switch that is activated electrically. Look on the side of the relay, the diagram is imprinted in it. Terminals 85 and 86 are connected to an electromagnet. When the relay is not energized (off), there is continuity between terminals 30 and 87a; the connection between terminals 30 and 87 is open. When the relay is energized, these conditions are reversed. The relay is energized, or turned on when 12 VDC is applied across terminals 85 and 86.



TROUBLESHOOTING 12 VOLT WPM SYSTEMS

Alternator

The alternator charges at a low rate and, therefore, does not need a regulator. If an engine starts normally, the alternator will replace the current used in about 5 minutes of running at full throttle. Frequent starts and stops or running the engine at less than full throttle will slowly run the battery down.



Alternator Test (Toro and Lawn-Boy)

Partially unplug the battery from the wiring harness. You only need to separate the terminals enough to be able to reach the terminals with the probes from your voltmeter. Set the voltmeter on the smallest scale that will read at least 13 VDC. With the engine off, read the voltage at the terminals. A normal reading for a fully charged battery will be about 12.5 VDC. Start the engine and run it at full throttle. The voltage should increase about one volt, indicating the alternator is working. Note: Your ability to read this will depend on the quality of your voltmeter.



Alternator Amperage Test (Lawn-Boy Only)

Note: You must have an ammeter that will read at least 500 milliamps or you will damage your tester.

Start the engine, unplug the battery from the wire harness, and reconnect as shown. Read the amperage at FULL throttle. A normal reading would be between 190-450 milliamps.

CAUTION: DO NOT stop and re-start the engine with the ammeter connected in this manner. About 90 amps will be drawn through your tester, resulting in tester damage.



TROUBLESHOOTING 12 VOLT WPM SYSTEMS

Battery Storage

Improper storage and charging are the most common causes of battery failure. The following rules apply to all lead acid batteries.

Within reason, cold storage is best. All batteries self-discharge during storage. Cold temperatures slow the discharge process. Warmer temperatures accelerate the process.

Storage Temperature	Time To Lose 50% Charge
92F	3 Months
75F	6 Months

Battery Freezing

Although you need to be concerned about a battery freezing in storage, proper charging greatly reduces the risk. The following temperatures are the point where ice crystals will just begin to form in a lead acid battery.

Charge Level	Freezing Temperature
100%	-92F
75%	-62F
0%	+19F

Questions

I have a battery that was stored too long without charging. Can I save it?

Possibly, a battery that was stored without charging has likely had the sulfur move from the solution onto the plates (sulfation). If this process is complete, the battery is scrap. If not, a long slow charge may bring it back. Use the Toro charger and plug it in for a week. If the battery comes back, the owner should be able to get more use out of it. If it does not come back, it was too far gone to salvage.



TROUBLESHOOTING 12 VOLT WPM SYSTEMS

Questions (cont'd)

Do not substitute other chargers to charge these batteries. A higher rate (higher amps) charger may buckle the plates. Another charger with different voltage may boil or otherwise damage the battery.

**DO NOT SUBSTITUTE
OTHER CHARGERS**

Questions (cont'd)

While batteries fail for a number of reasons, most premature failures are due to lack of care. The battery used in our electric start mowers will generally last about as long as a car battery, in the neighborhood of 3 to 5 years when properly cared for.

**HOW LONG WILL A
BATTERY LAST?**