6

Charging systems

Engine models employ more than a dozen distinct alternators for use with lead-acid batteries. The Nicad system is recharged from house current through a step-down transformer and rectifier.

Storage batteries

Storage batteries can fail mechanically or electrically. The leading causes of mechanical failure are loose battery hold-down hardware, poor vibration insulation, and owner abuse. The battery straps—the internal busses that connect the cells—are cast as part of the terminals. Twisting the cables or overtightening the terminal bolts can fracture the straps.

Electrical failure is usually associated with chronic low states of charge. The plates become impregnated with sulphate crystals and are no longer capable to take part in the ion exchange that generates electrical potential. A partial cure is to trickle charge the battery for a week or more. Some of the sulphate dissolves into solution. However, the best cure is prevention. Distilled water should be added to cover the plates with electrolyte, and the state of charge should be held greater than 75 percent, or 1.1220 on a temperature-corrected hydrometer.

Deep-charge/discharge cycles encourage sulphation and, if the system is not properly regulated, can overheat the battery and melt holes in the plates. The extent and rate of discharge can be reduced by keeping the battery charged and the engine in tune. The less cranking the better, particularly if the battery shows signs of fatigue. Self-discharge can be controlled by frequent transfusions and by keeping the battery top and terminals clean. The

rate of charge is, practically speaking, beyond owner control, although it is wise to invest in an ammeter to keep an eye on the system.

Before turning to specific test procedures, it should be noted that the capacity of the battery has some bearing on its longevity. All things being equal, a larger battery will outlive one that delivers its last erg of energy each time the engine is cranked. But the capacity of the battery, usually measured in ampere hours (A or Amp), cannot compensate for long-term withdrawals. Ultimately, even the large battery must be recharged depending on the output of the alternator and the way the engine is used. A small alternator that is adequate for one start a day might not deliver the current for 20 starts a day.

The first evidence of charging-system failure is a low battery. The state of charge—how much potential is available in the battery—is easily measured with a hydrometer. While hydrometer results do not take the place of a performance test, the hydrometer is the instrument to be tried first.

A hydrometer consists of a squeeze bulb, a float chamber, and a precisely weighted float (Fig. 6-1A). The float is calibrated in units of specific gravity. Water has a specific gravity of 1.000. Sulphuric acid, the other ingredient of electrolyte, has a specific gravity of 1.830. In other words, sulphuric acid is 1.830 times heavier than an equal amount of water. The amount of acid in the electrolyte reflects the state of charge. The more acid in the electrolyte, the greater the charge and the heavier the electrolyte. Each cell in a fully

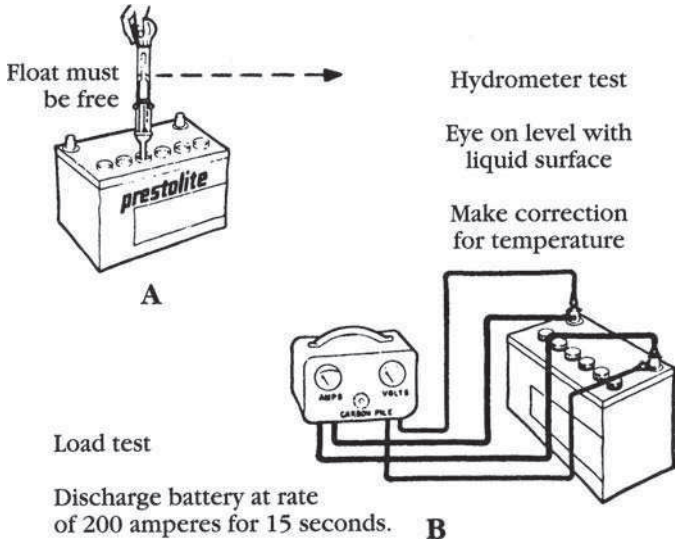

FIG. 6-1. *A battery hydrometer and rheostat OMC.*

charged battery should have a specific gravity of 1.240–1.280. A completely discharged battery will have a specific gravity of about 1.100.

Draw enough electrolyte into the hydrometer to set the float adrift. The float must not touch the sides of the instrument. Sight across the main level of the instrument. Disregard the meniscus that clings to the sides of the chamber and record the specific gravity for that cell. Repeat the operation on the other cells. The battery should be suspected of malfunctioning if any of the cells fall five points (0.005) below the average of the others.

While raw, uncorrected readings are generally adequate, it should be remembered that acid and water expand when heated. The higher the temperature of the electrolyte, the lower the apparent specific gravity. Expensive hydrometers sometimes incorporate a thermometer in the barrel and a temperature-compensating scale. Any accurate thermometer will work. For each 10 degrees above 80 degrees Fahrenheit add four points (0.004) to the reading. Subtract four points for each 10 degrees less than 80 degrees Fahrenheit.

The most reliable field test requires a carbon pile (Fig. 6-1B) or a rheostat and a voltmeter. The temperature-compensated specific gravity should be at least 1.220 to prevent battery damage. Connect the voltmeter across the terminals and adjust the load to three times the ampere-hour rating. For example, the carbon pile should be adjusted to discharge a 30 A battery at the rate of 90 amps. Continue to discharge for 15 seconds. At no time during the test should the voltmeter register less than 9.6 V. If it does, the battery should be suspected of malfunctioning.

Alternators

Briggs & Stratton provides battery-charging current with an engine-driven alternator and solid-state rectifier. The rectifier converts alternating current into pulsating direct current. The more sophisticated systems include a solid-state voltage regulator to protect the battery from overcharging and to extend headlamp life. Optional features include an ammeter and an isolation diode. All systems employ a lead-acid storage battery.

System 3 & System 4 alternators

Model 90000 and 110000 engines currently use System 3 and 4 alternators, which employ two coils and a full-wave rectifier on a dedicated stator. Versions available are 6 Vdc and 12 Vdc. Output should be 0.5 A at 2800 rpm, as measured between the battery lead and engine ground. Replace the alternator if the output is under specification. Set the stator-to-flywheel air gap for ignition coils at 0.010 in., as described in chapter 3.

The 0.5 A alternator

The 0.5 A alternator is the peewee of the series, consisting of a single charging coil and integral rectifier. Found on model 120000 vertical and horizontal crankshaft engines, the unit should deliver 0.5 A at 2800 rpm. If it fails to produce its rated output, replace the assembly. The early version used a pinch bolt, since discarded, for air gap adjustment, which is set at 0.07 in.

The 1.5 A alternator

The three-coil 1.5 A alternator is used on 130000 series engines (Fig. 6-2) where it is coupled to a 12 A or 24 A battery. Note that there are two styles of connector, both of which contain a soldered-in rectifier, available as a replacement part. Other than the resistance provided by the battery, the circuit has no voltage or current regulation.

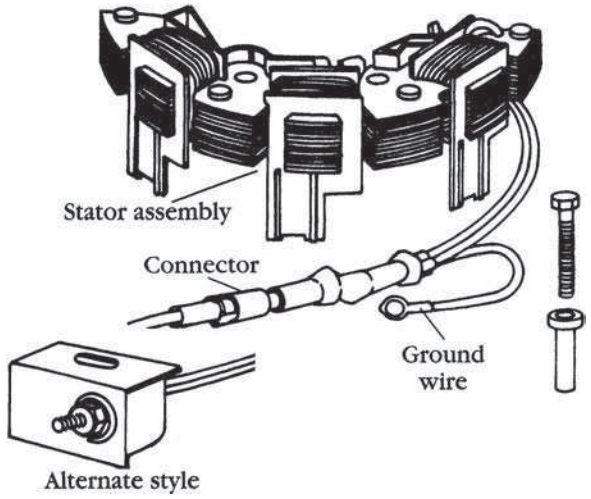

FIG. 6-2. *1.5 A alternator found on 130000 engines. Note the variance in rectifier type.* Briggs & Stratton Corp.

To test the alternator output, connect a number 4001 headlamp between the rectifier output and a paint-free engine ground (Fig. 6-3). The battery must be out of the circuit. Under no circumstances should the output of this or any other alternator be grounded. To do so is to invite burned coils and fried diodes.

If the lamp refuses to light, the fault is in the rectifier or the alternator. Test the rectifier first because it is the more likely failure point. With the engine stopped, touch the probes of a low-voltage ohmmeter to the output

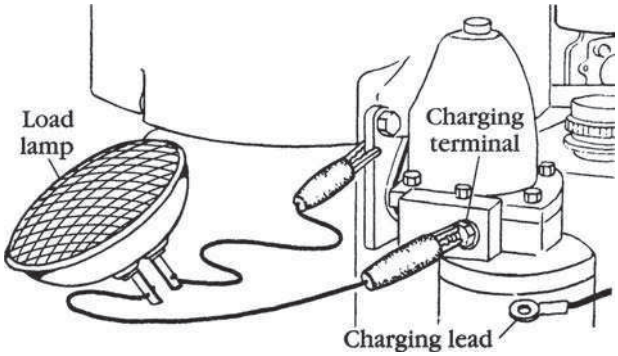

FIG. 6-3. *Testing output of the 1.5 A alternator.* Briggs & Stratton Corp.

terminal and ground as shown in Fig. 6-4. You should get continuity in one direction and high resistance in the other. If not, replace the rectifier box.

Test the stator with a 4001 headlamp connected across the output leads (Fig. 6-4). The lamp should burn. If not, check the leads to the stator for possible fouling. Before deciding that the stator is defective, compare the magnetic strength of the flywheel ring against one known to be good. Failure is exceedingly rare but not impossible.

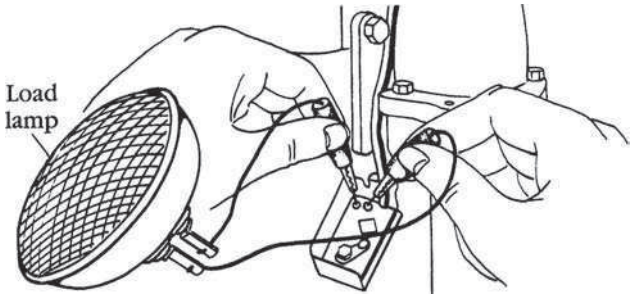

FIG. 6-4. *Testing stator of the 1.5 A alternator.* Briggs & Stratton Corp.

Install a replacement stator and torque the cap screws 18 to 24 lb/in. See that the output leads are snug against the block and well clear of the flywheel.

Dc-only & ac-only alternators

The dc-only alternator is found on 170000 and larger engines; the ac version on 190000 and larger engines. An identical four-coil stator produces 5 A for the ac version and, because of rectifier resistance, 4 A for the dc unit

(Fig. 6-5). The ac alternator should produce 14 Vac no-load at 3600 rpm. If not, replace the stator. Current output from the dc version, as measured by an ammeter in series with the charging lead, should range between 2 A and 4 A, depending on battery voltage. If no or low output is indicated, test the in-line diode with an ohmmeter. It should register low resistance in one direction and high resistance in the other. If the diode tests okay, the stator is at fault.

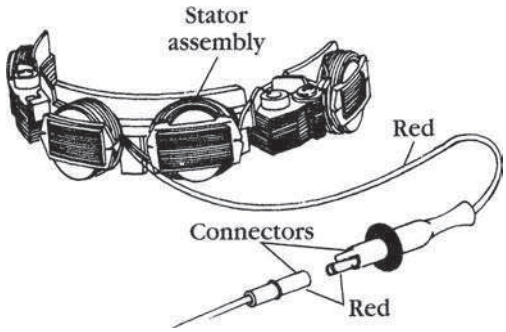

FIG. 6-5. *The dc-only rectifier can be distinguished from its ac-only twin by the bulge in the connector, signaling the presence of a diode rectifier.* Briggs & Stratton Corp.

The 4 A alternator

Used on 17 and 190000 engines, the 4 A alternator has eight charging coils arrayed on a 360 degree stator. This alternator does not include a regulator, but is otherwise identical to the 7 A type illustrated in Fig. 6-5.

Troubleshooting procedures begin with a short-circuit test. Connect a 12 V test lamp between the rectifier output and the positive terminal of a charged battery (Fig. 6-6). If the lamp lights, battery current is being fed back to ground through the charging circuit. Unplug the rectifier connection under the blower housing. If the lamp goes out, the rectifier is okay and the problem lies in the alternator and associated wiring. If the lamp continues to burn, the rectifier is at fault and must be replaced.

Inspect the output leads from the alternator for frayed insulation or other evidence of shorts before you replace the stator assembly. Make necessary repairs with electrical tape and silicone cement.

This alternator has four distinct windings, each involving two coils. A break in one of the windings drops output by a third. Check each of the four pins with the fuse-holder lead as shown in Fig. 6-7. Each pair of pins supplies current to a diode in the rectifier. Should a diode blow, a quarter of the output is lost. Check each of the four rectifier terminals with an ohmmeter. One probe should be on a good (paint-free and rust-free) ground on the

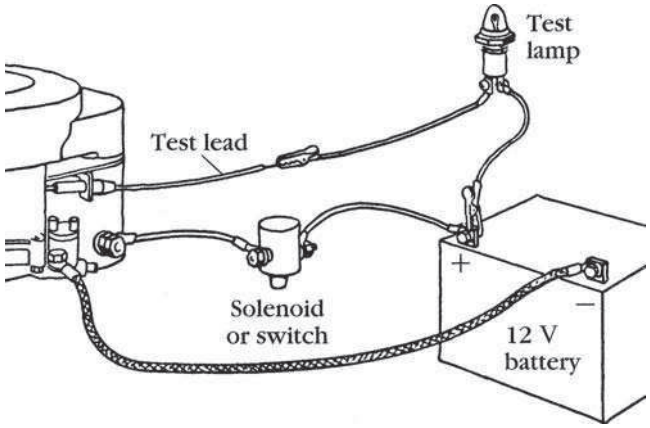

FIG. 6-6. *Testing for shorts in the 4 A, 7 A, and dual-circuit alternators.* Briggs & Stratton Corp.

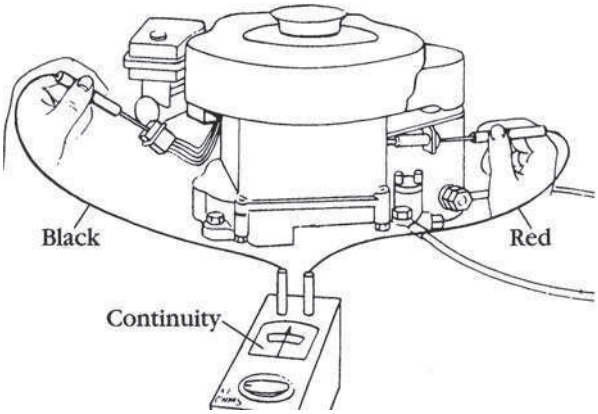

FIG. 6-7. *Testing the stator in the 4 A and 7 A alternator.* Briggs & Stratton Corp.

underside of the blower housing; the other probe should be on one of the diode connection points. Observe the meter and reverse the test connections. If the diode in question is functional, it will have continuity in one direction and very high resistance in the other. Repeat the test for the remaining three connection points.

The 7.0 A alternator

The 7.0 A alternator is used on series 140000, 170000, and 190000 engines and can be easily recognized by the connector plug, which is flanked by a

regulator on one side and the rectifier on the other (Fig. 6-8). Some installations employ an isolation diode in a tubular jacket on the outside of the shroud. The purpose is to block current leakage from the battery to ground by way of the alternator windings. Applications that do not have this diode isolate the battery at the ignition switch.

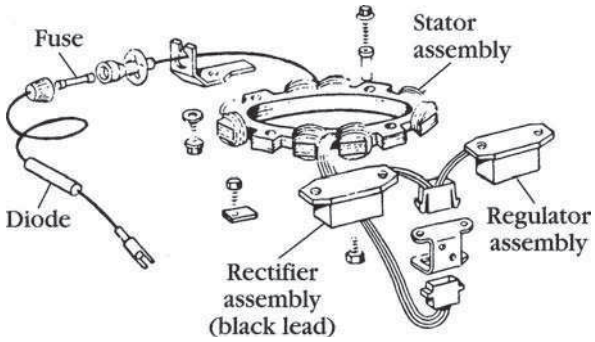

FIG. 6-8. *The 7.0 A alternator configuration*. Briggs & Stratton Corp.

Test the isolation diode by connecting a 12 V lamp in series with the output (Fig. 6-9). The lamp should not light. If it does, the diode is shorted and must be replaced. Check diode continuity with an ohmmeter connected between the two diode leads. The meter should show zero resistance in one direction and high resistance when the leads are reversed.

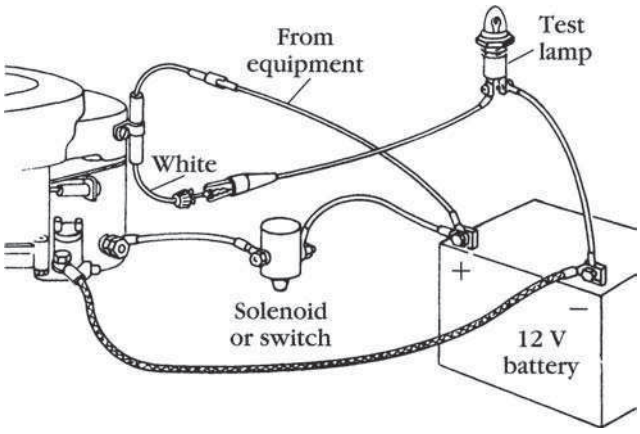

FIG. 6-9. *Testing the isolation diode on the 7.0 A alternator*. Briggs & Stratton Corp.

To test the stator, regulator, or rectifier, connect a test lamp as shown previously in Fig. 6-6. Do not start the engine. If the lamp lights, one of the three is shorted. Disconnect the rectifier-regulator plug under the blower housing and remove the stator from the circuit. If the lamp continues to burn, the regulator or rectifier is shorted. Test these two components individually to determine which is at fault.

Test the rectifier as described previously. Two black leads, joined by a connector, go to the rectifier. Each lead services two pins on the rectifier side of the connector. Without removing the rectifier assembly from the shroud, connect ohmmeter leads between each of the four pins and a paint free ground on the underside of the shroud. Observe the meter reading at each pin and reverse the leads. The pins should conduct in one direction and not in the other. If current flows in both directions, the rectifier is shorted. If no current passes, the rectifier is open. In either event, the assembly must be replaced. Instructions are packaged with the new part.

The regulator is distinguished by one red and one white lead. Test as above. The white lead pin must show some conductivity in one direction and none, or almost none, in the other. The red lead pin should give no reading in either direction. If it is necessary to replace the regulator, instructions are supplied with the replacement part.

Check stator continuity as shown previously in Fig. 6-7. Each of the four pins must be contiguous with the lead at the fuse holder. If not, check the visible wiring for defects before you invest in a new stator.

The dual-circuit alternator The dual-circuit alternator is one of the most interesting alternators used on Briggs & Stratton engines. Two stator windings are provided, one for the headlights and the other for the battery. Battery output is rectified and rated at 3 A. Headlight output is alternating and can deliver 5.8 A at 12 V at wide-open throttle. Two versions of this alternator, one with a single plug and the other with separate ac and dc output lines, are used on 170000 and Lorgen engines.

The battery circuit is protected by a 7.5 A type AGC or 3AG automotive fuse and might be supplied with an ammeter. The ac circuit is independent of the charging circuit, although good practice demands that both be grounded at the same engine mounting bolt. Each circuit is treated separately here.

Charging circuit Check output with an ammeter in series with the positive battery terminal (Fig. 6-10). The meter should show some output at medium and high engine speeds. No charge indicates a blown fuse, shorted or open wiring, or a failed rectifier or alternator.

Connect a 12 V test lamp between the battery and the charging section as illustrated in Fig. 6-6. The lamp should not light. If it does, the alternator

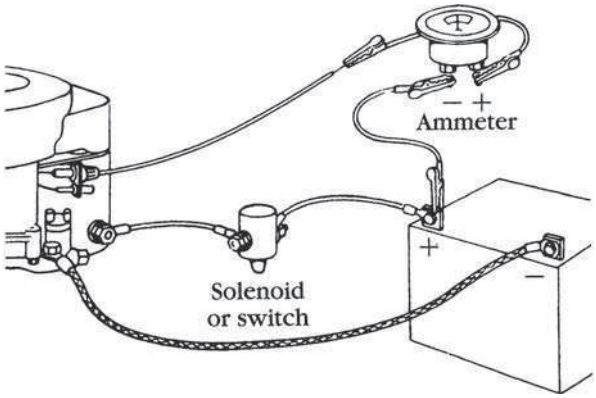

FIG. 6-10. *Testing dc output on the dual-circuit alternator.* Briggs & Stratton Corp.

or rectifier is defective. To isolate the problem, disconnect the plug under the shroud. If the light goes out, the rectifier is good and the difficulty is in the alternator or its external circuitry. If the light continues to burn, the rectifier is shorted to ground and must be replaced.

To test the stator, remove the starter motor, shroud, and flywheel. Inspect the red output lead for frayed or broken insulation. Repair with electrical tape and silicone, being careful to route the lead away from moving parts. Test the stator by connecting an ohmmeter between the terminal at the fuse holder and the red lead pin in the connector. The meter should show continuity. If not, the stator is open and must be replaced.

Test for shorts by connecting the ohmmeter between a good ground and each of the three black lead pins in sequence (Fig. 6-11). Test for continuity by holding the probes against the two black pins (Fig. 6-12). If the circuit is open, the stator is good. If the meter shows continuity, the stator must be replaced.

The rectifier mounts under the fan shroud where it is serviced by a three-prong connector plug. Open the plug and connect one test lead from an ohmmeter to the red lead pin and the other to the underside of the shroud. Observe the meter and reverse the test leads. The meter should report high resistance in one direction and no resistance in the other. Do the same for each black lead pin.

The lighting circuit should be tested with a number 4001 headlamp connected between the output terminal and a reliable engine ground. The lamp should burn brightly at medium engine speeds. If it does burn brightly, the problem is in the external circuit between the engine and the vehicle lights. If the lamp does not light or burns feebly, the problem is in the alternator. Check coil continuity with an ohmmeter as shown in Fig. 6-13. High or infinite resistance means a defective stator.

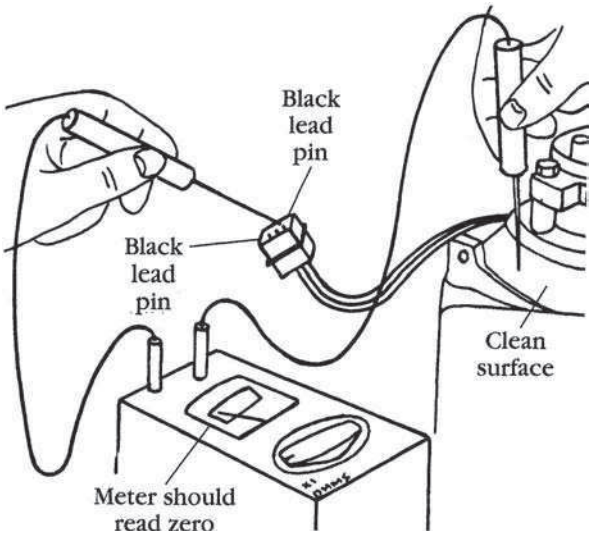

FIG. 6-11. *Testing for a shorted charging coil on the dual-circuit alternator.* Briggs & Stratton Corp.

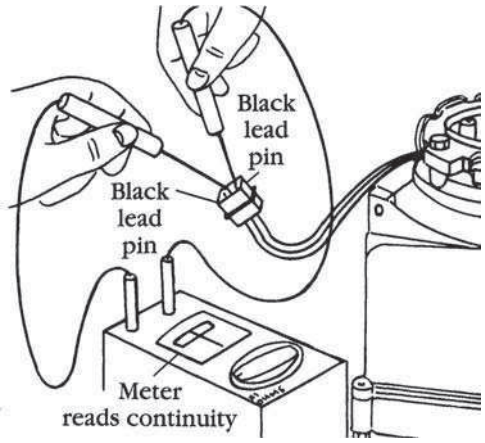

FIG. 6-12. *Testing charging-coil continuity on the dual-circuit alternator.* Briggs & Stratton Corp.

The 10 A alternator

Used on the series 200400 and 320400 engines, the 10 A alternator is a heavy-duty device delivering better than 4 A at 2000 rpm and a full rating at

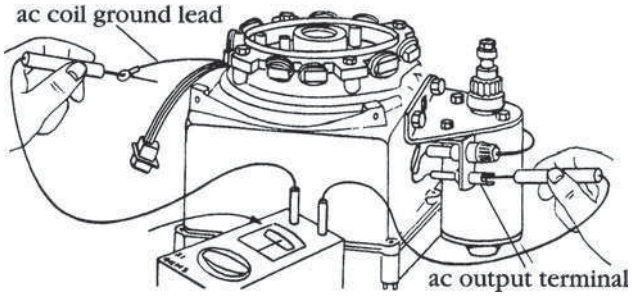

FIG. 6-13. *Testing ac circuit continuity on the dual-circuit alternator.* Briggs & Stratton Corp.

3600 rpm. The regulator is more flexible than those used on the smaller engines and can handle large loads without overcharging the battery.

Check voltage across the battery terminals with the engine turning at full-governed rpm. Less than 14 V on a fully charged battery means stator or regulator rectifier problems.

Disconnect the plug at the regulator rectifier and connect an ac voltmeter to each of the two outside plug terminals (Fig. 6-14). A reading of less than 20 V per terminal means a defective stator. Check the regulator rectifier by default. That is, if the system fails to deliver sufficient charging voltage and the stator appears okay, replace the regulator rectifier.

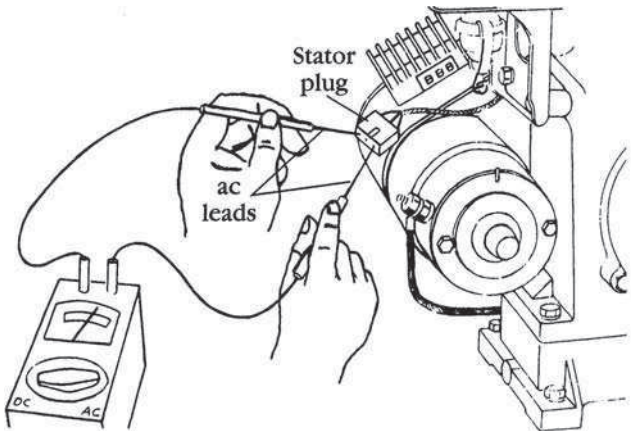

FIG. 6-14. *Testing the stator on the alternator.* Briggs & Stratton Corp.

The Nicad system

An option on 92000 and 110900 engines, the Nicad system consists of a gear-driven starter motor, starter-ignition switch, plug-in battery charger, and a 12 V nickel-cadmium battery. Nicad systems are intended for rotary lawnmower applications so the starter-ignition switch is mounted on the handlebar where it is electrically isolated from the engine. The switch stops the engine by grounding the magneto primary circuit through the connector clipped on the engine shroud. If the connector comes free of its clip, the magneto will be denied ground but the engine will continue to run regardless of the switch setting.

The first place to check if trouble arises on these engines is the battery. Nickel-cadmium cells are by no means immortal. Load the battery with two G.E. number 4001 sealed-beam headlamps connected in parallel (Fig. 6-15).

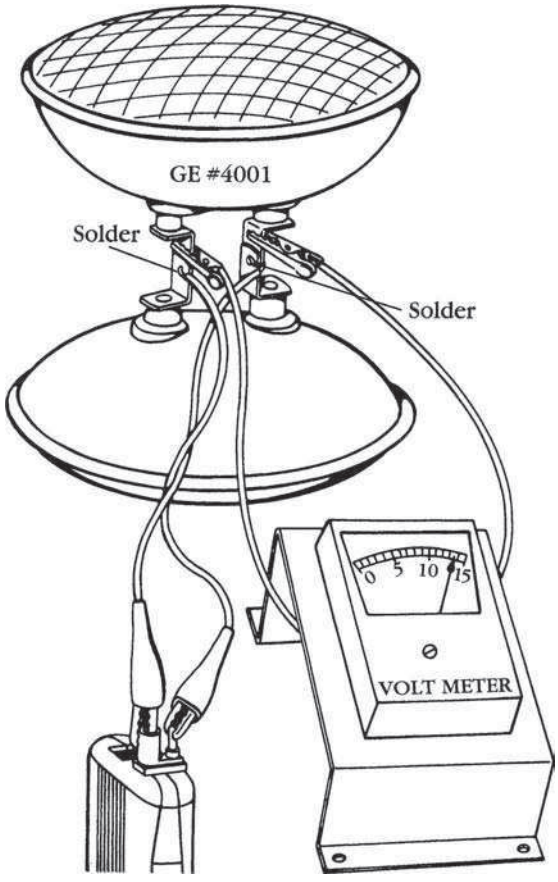

FIG. 6-15. *Testing the Nicad battery.* Briggs & Stratton Corp.

Monitor the voltage. The meter should show at least 13.6 V after one minute of draw. Readings of 13 V and less mean that one or more of the cells are defective. The lights should burn brightly for at least five minutes.

The half-wave rectifier supplied with this system should be capable of recharging a fully depleted battery over a period of 16 hours. An inexpensive tester can be constructed from the following materials:

- 1 1N4005 diode
- 1 red lamp socket (Dialco No. 0931-102)
- 1 green lamp socket (Dialco No. 0932-102)
- 1 neon bulb, No. 53
- 1¾-in. machine screw, No. 6-32
- 1¾-in. machine screw, No. 3-48

Wire the components as shown in Fig. 6-16. If neither bulb lights, the transformer or charger diode is open. If both bulbs light, the charger diode is open and passing alternating current. A properly working charger will light only the green bulb.

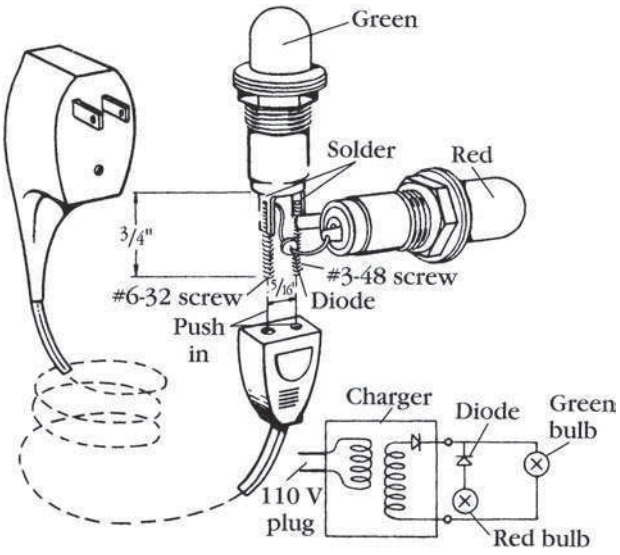

FIG. 6-16. *A homemade rectifier tester*. Briggs & Stratton Corp.