Minuteman®
Excellence Meets Clean

Battery Charger Testing Guide

For Models 957727 and 957731
24 and 36 Volt
20 Amp. Chargers only

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Trouble Shooting the Minuteman Battery Chargers

About Chargers

Minuteman Chargers consist of the following items: Transformer, Timing Circuit (circuit board), Relay, Diodes, Capacitor, Ampere Meter, and Fuses.

Transformer: Transforms the incoming 115 volts AC to 30 volts AC, on 24 volt chargers or to 48 volts AC on 36 volt chargers.

The Timing circuit:

1. **Detects the presence of proper battery voltages in order to activate the charger relay. 24-volt chargers require a minimum of 16.8 volts to activate. 36-volt chargers require a minimum of 25.2 volts to activate.**
2. **Has a 16-hour back up timer, to prevent the over charging of the batteries. It turns the charger off after 16 hours regardless of condition of batteries. Battery voltage must reach 27 volts on the 24 volt chargers and 40.5 volts on 36 volt chargers in order for the back up timer feature to work.**
3. **During the charge cycle the timer monitors the battery voltage increases every 25 to 30 minutes. If the battery voltage has risen more than 1 Milli-Volt (.001 Volts) the timer circuit will keep the charger on. If no voltage rise is detected the charger is shut off.**

Relay: The relay acts as a remote controlled switch controlled by the control circuit to turn the charger on and off.

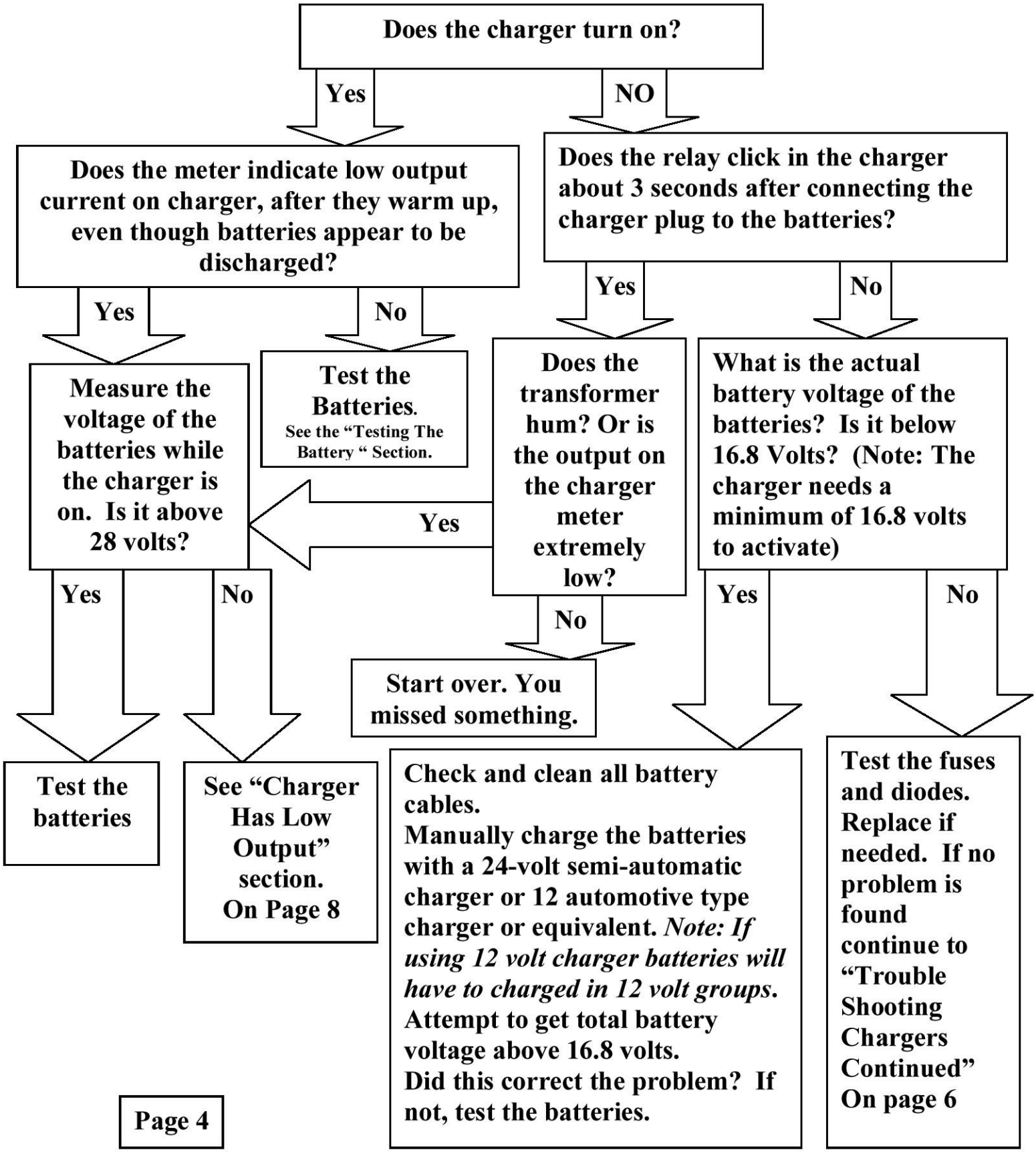
Diodes: Converts the AC (alternating current) output voltage to direct current (DC).

Capacitor: Regulates the charger's output current based on the actual battery voltage during charging. The higher the battery voltage the lower the output current of the charger is.

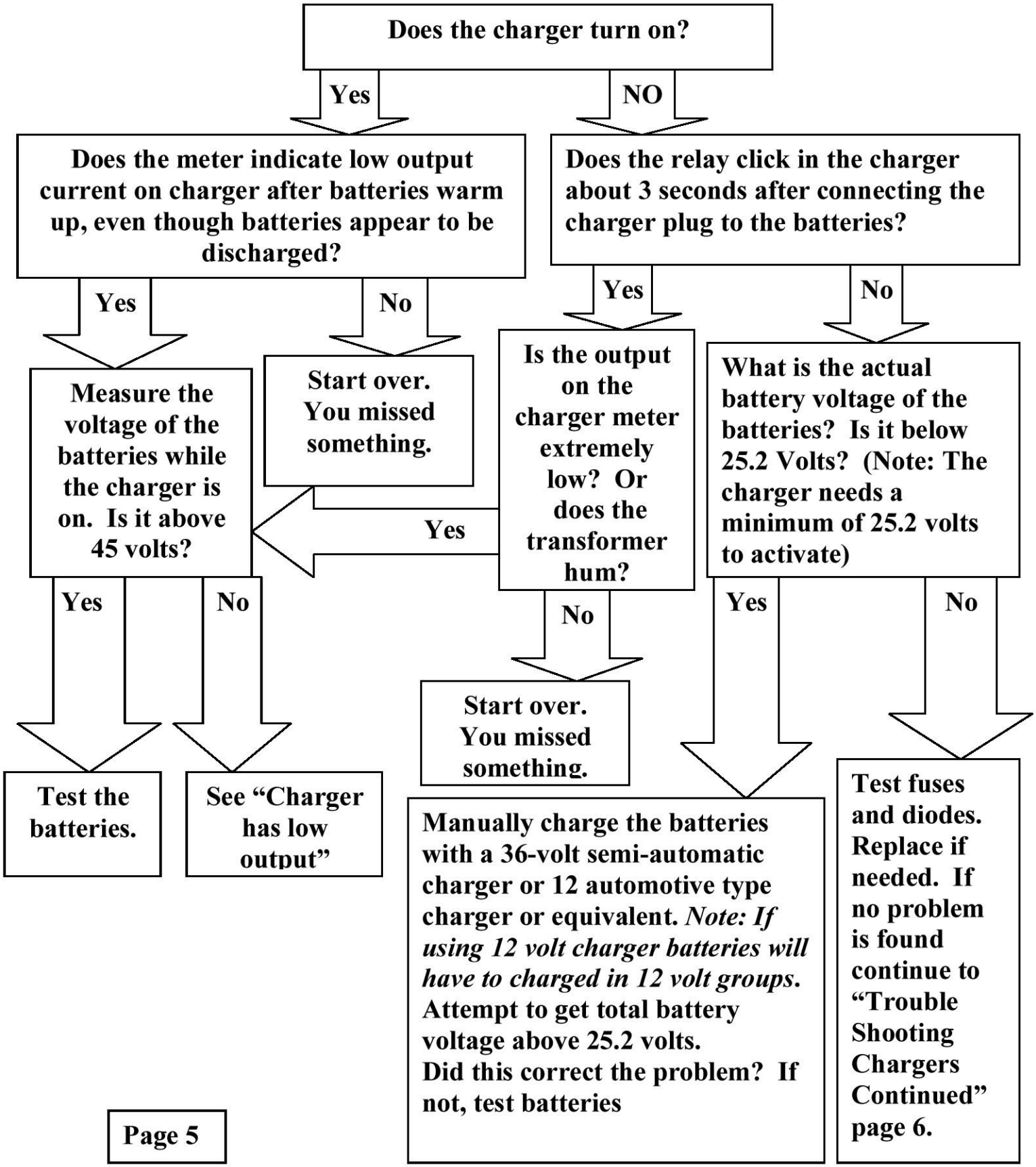
Ampere Meter: Measures the output current of the charger.

Fuses: Protects the output circuit from shorts and over loads.

Testing 24 Volt Battery Chargers Model #957731

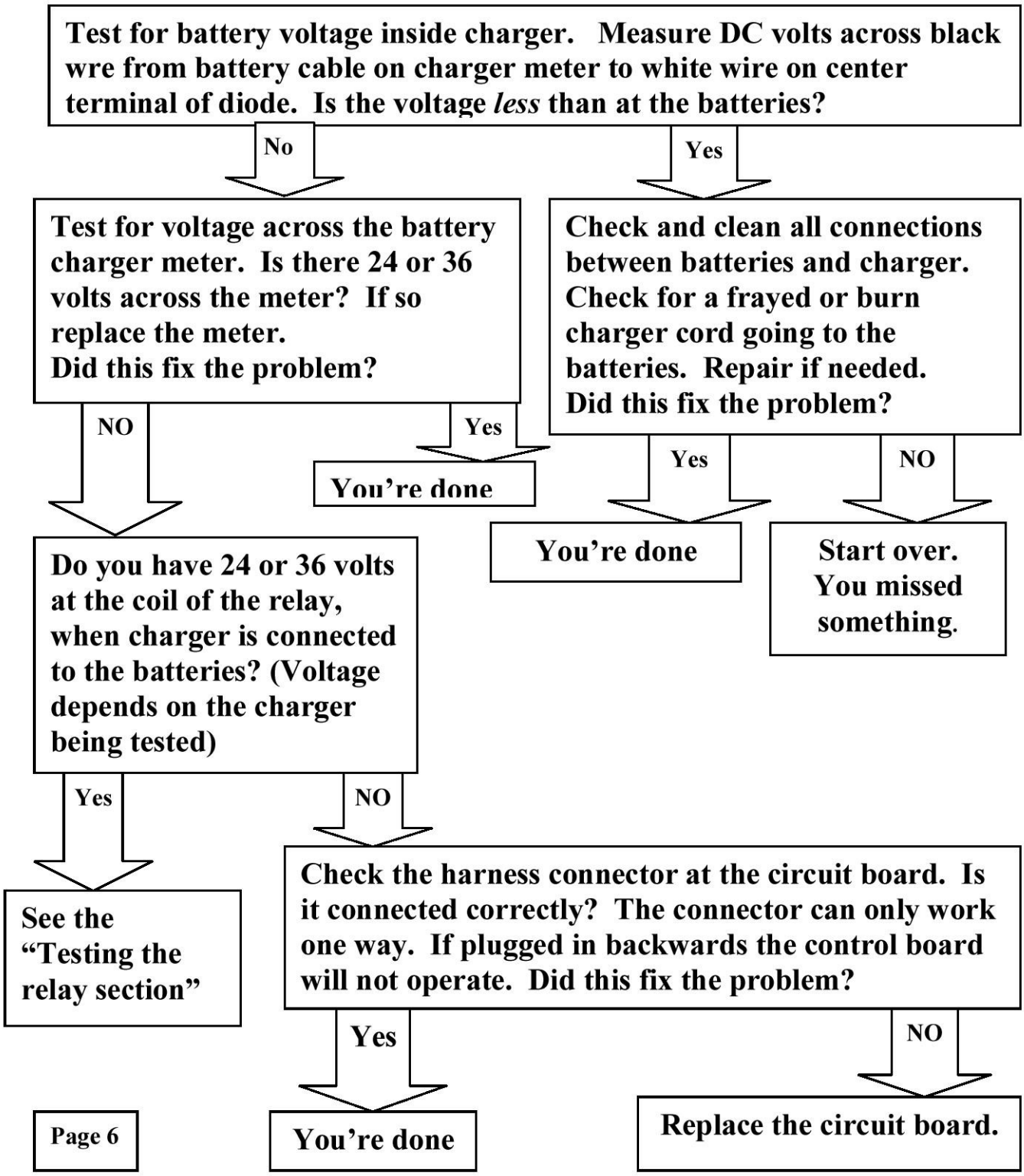


Testing 36 Volt Battery Chargers Model #957727

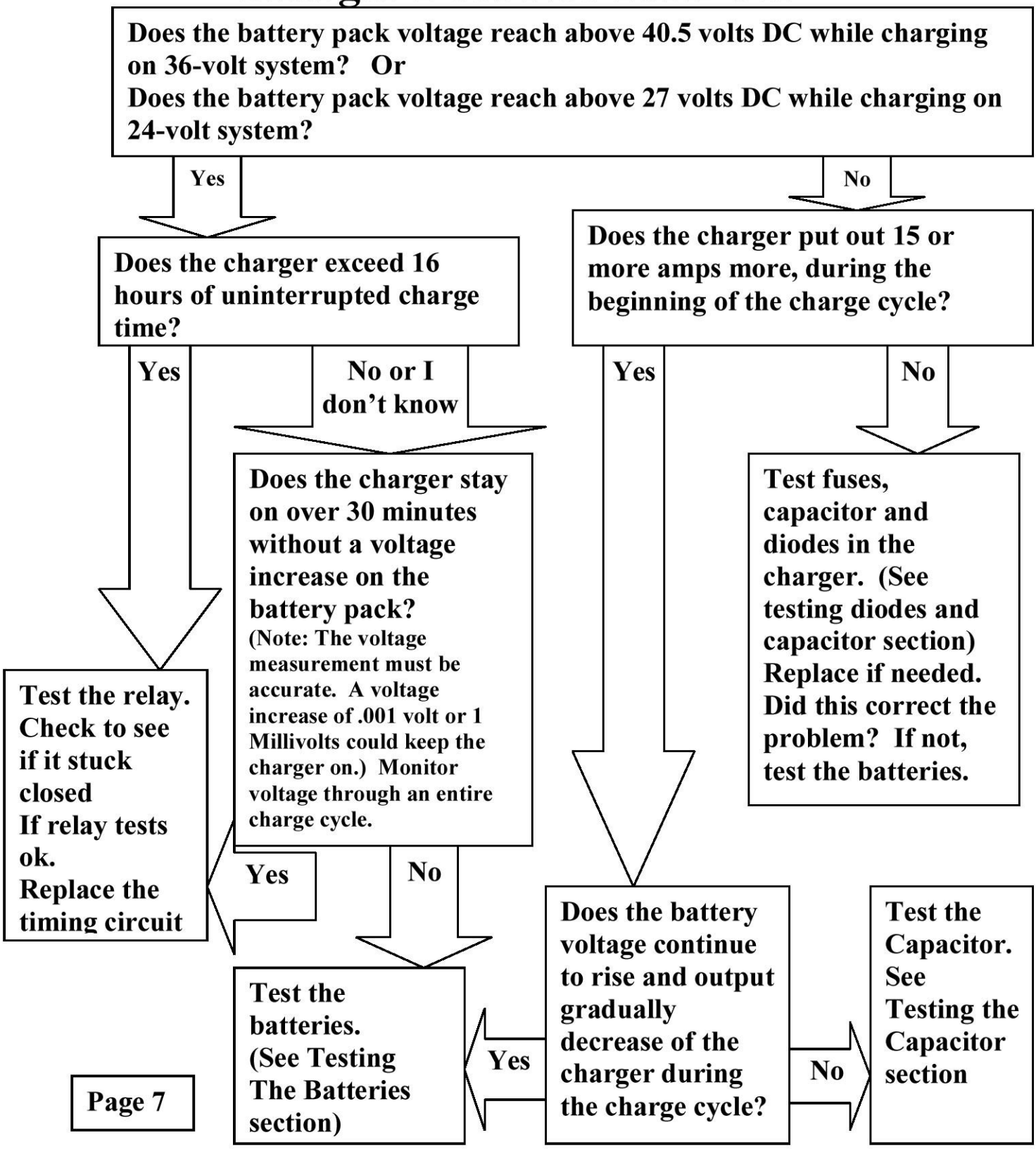


Trouble Shooting Chargers Continued

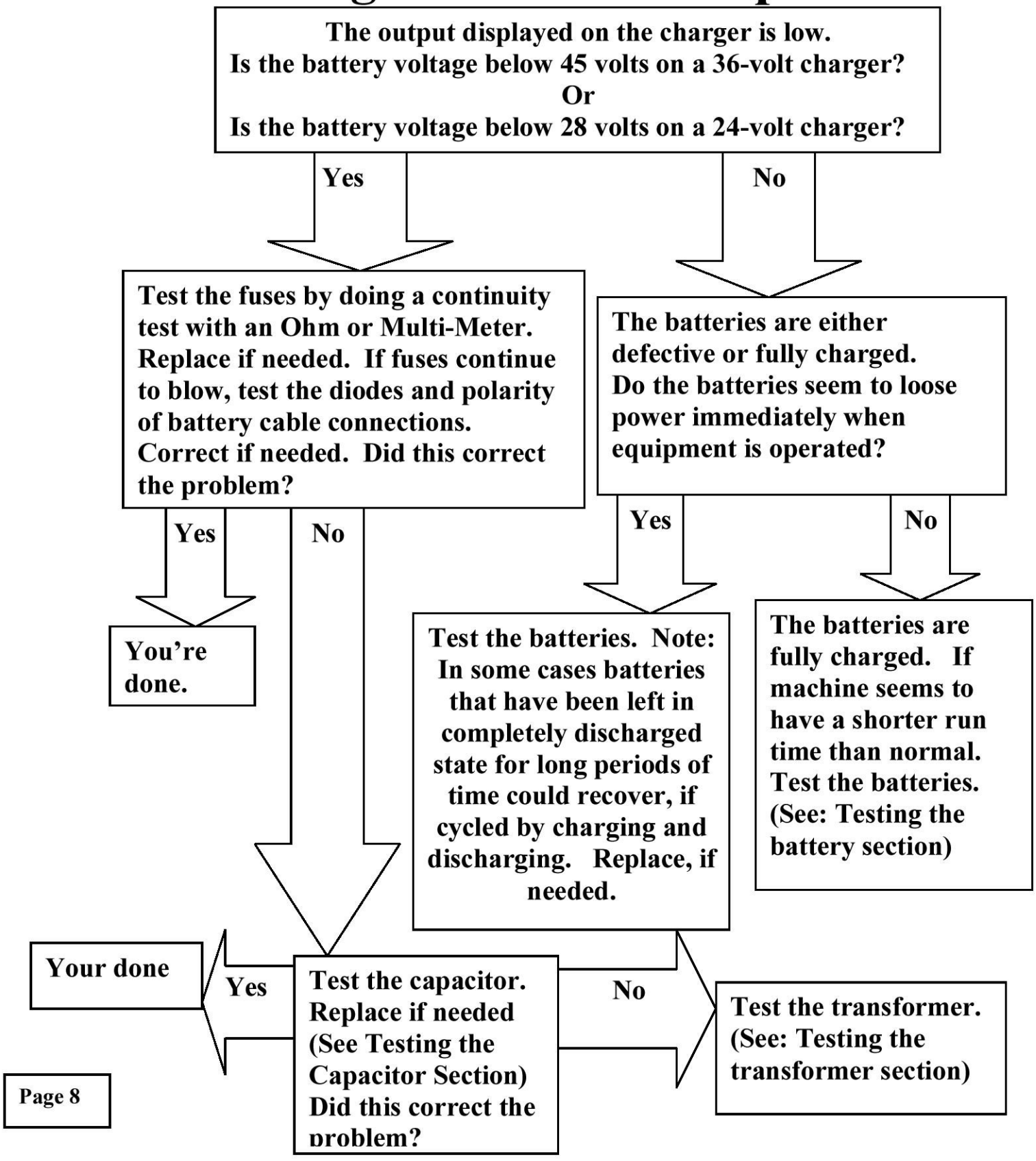
Symptoms:
Relay doesn't click, Voltage at batteries OK
(For both 24 and 36 volt chargers)



Charger Does Not Turn Off



Charger Has Low Output



Testing the Capacitor

1. **Unplug the charger from the AC outlet and battery pack.**
2. **Remove the charger cover.**
3. **The capacitor is mounted in rear of the charger.**
4. **Carefully discharge the capacitor before testing by shorting across the two terminals with screwdriver.**
5. **Carefully disconnect the two terminals. Note: These wires will not tolerate a lot of bending, because they are a single strand of wire.**
6. **A good analog ohmmeter with variable ohm ranges will be needed for this test. *(Note: Digital and inexpensive meters aren't recommended.)* Select an ohm range that will show you a good deflection of the meter in both directions.**
7. **Touch probes to each terminal and repeat by reversing the two probes repeatedly. If this is done correctly the needle on the meter should deflect in both directions each time the probes are reversed. Note: A good capacitor should show a smooth deflection. Any sporadic or intermittent action would indicate a faulty capacitor. Failure to deflect or to deflect only in one direction would also indicate a faulty capacitor.**

Testing the Relay

The relay is mounted inside the charger, on the right backside of the front case. It is black and consists of four terminals. The two large terminals are for the contacts, which turns the power on to the transformer. One lead is from the black lead from the AC cord and the other is one cloth covered brown lead from the transformer. The two smaller terminals are for the coil, which receive power form the control (circuit board) 24 volts for the 24-volt chargers and 36 volts for the 36-volt chargers. ***Note: If the coil of the relay does not receive power, It will not turn on the charger or activate the relay.***

The large contact terminal should close when the appropriate voltage is applied to the coil of the relay.

If the relay *clicks* three seconds after connecting charger to the appropriate battery pack, but fails to turn the charger on. Either of three tests could be made:

1. **Disconnect the black wire and the transformer lead from relay (with the AC and DC cords disconnected) and carefully connect them together. Plug it into the batteries and AC outlet to test. If the charger activates, replace the relay.**
2. **Connect the charger into the AC outlet and battery pack. Test for AC voltage across the two large terminals on the relay (The black and the transformer lead). If about 115 volts is present the contacts are open, which indicates the relay is defective.**
3. **Disconnect the AC and DC cords from batteries and outlet. Disconnect the black lead and transformer lead from the relay. Plug the charger into the battery pack. Using an ohm meter test for continuity across the two large terminals of the relay that you removed the wires from.**

4. **Note: If there is 24 volts on 24 volt chargers or 36 volts on 36 volt chargers is present across the coil of the relay and the contacts don't close. The relay is defective. If there is not appropriate voltage at the coil, see "Trouble Shooting Chargers Continued" section.**

Why Diodes Fail

The most common cause of diodes failing is from disconnecting the charge plug from the batteries while the battery charger is still charging. This causes a surge to the diodes. The higher the output the charger is putting out, the greater the risk of causing a failure.

The second most likely cause is from an incorrect polarity of the charger plugs. When the positive and negative wires are reversed, an excessive amount of current will pass through the diodes from the batteries.

The third most common reason is from over heating. The diodes need to be properly heat sunk with thermo or heat sink compound.

Why Fuses Blow

The most common reason is from shorted diodes
The fuses can blow from an incorrect polarity of the charger plug.
The fuses must be a 30 amp. Busse slow blow type. Using a under rated fuse could failure prematurely.

Testing the Diodes in the Charger

1. **Disconnect the charger plugs from the AC outlet and battery pack.**
2. **Remove the eight screws holding the top cover and remove.**
3. **Locate the diodes (located in the rear right corner of the charger).**
4. **Remove the white and red wires mounted on the center terminal.**
5. **Use an ohmmeter (muti-meter) to test continuity of diodes. Place one probe on the top terminal of diode and the other on the metal part of the assembly next to case. Reverse the probes on the same two terminals. A good diode should have continuity in one direction only. Replace, if open in both directions or of if shorted in both directions.**
6. **Repeat step 5 on the bottom terminal.**
7. **If replacing see the "Replacing the diode section".**

Replacing the Diodes

Disconnect the wires on the diodes. Note which terminals they where connected to on the relay. Remove the two screws, washers and nuts the secure the diode. Remove the old diode and clear insulator. Apply a liberal amount of thermo or heat sink compound on the back surface of the metal plate of diode and on the back surface of the new clear insulator closest to the case. Replace screws, washers and nuts and tighten.
Connect the wires to terminals and tighten.
Replace cover and eight screws. Tighten. Test the charger.

Load Testing and Jump Starting the Charger

Note: This is an optional test for testing the output circuit without batteries and jump starting the charger. The timing circuit and relay are not tested with this test.

1. **Disconnect the AC power cord and DC cord from the batteries.**
2. **Remove the case cover by removing the eight screws.**
3. **Locate the relay mounted inside the charger. It is on the top right backside of the front panel, if you are facing the front of the charger. The relay is black in color with four wires attached to it.**
4. **Remove the following two wires from the relay. One black wire going to the relay from the AC power supply and the large brown cloth covered wire coming from the transformer.**
5. **Connect the two wires together using a jumper wire or connector.**
6. **If jump starting low batteries go to step 8. If load testing with out the batteries go to step 7.**
7. **To load test the charger without batteries. Jump across the two contacts on the charger's battery plug. *Note: This is the plug on the end of the charger's cord <u>Not</u> at the battery pack.* Plug the charger's AC cord into the outlet. A good charger should display about 65 to75% (13.2 to 15 amps on a 20 amp charger) of the DC output rating on the meter, that is printed on the front of the charger. If the meter on the charger displays 30 amps. or pegs the meter, test for a blown fuse or an open diode.**

8. **Note: With this test, an open diode or a blown fuse would have the opposite symptoms, as opposed to plugging into batteries. An open diode and blown fuse would display a low output, if charger were connected to a good set of batteries. If meter on charger appears to be vibrating, check for a shorted diode.**
9. **Plug battery plug from charger into the battery pack. Connect the AC cord to an outlet. Note: This will by-pass the automatic shut off feature of the charger. The batteries should not be left unattended.**
10. **Every 15 to 30 minutes, shut off the charger and test the battery voltage. When battery voltage reaches minimum voltage, reconnect the two wires previously removed from the relay of charger.**
11. **Replace the charger's case and tighten screws.**
12. **Connect the AC cord to the outlet.**
13. **Connect the DC cord to the batteries. The charger should turn on by it self when connected to the batteries.**

Testing the Timing Circuit

1. **The circuit board should be tested installed in the charger and ran through a complete charge cycle.**

2. **The circuit board should supply either 24 or 36 volts DC to coil terminals of the relay (depending the voltage of charger being tested). The minimal voltage must be present inside the charger (across the amp meter of the charger and the center terminal of the diode assembly), depending on the voltage of the charger being tested, when DC plug is connected to a good set of batteries. A 24-volt charger requires about 16.8 volts. A 36-volt charger requires about 25.2 volts to activate charger.**

3. **The circuit should never allow the charger to stay on for over 16 hours, except if a minimum voltage of 40.5 volts isn't reached during charging on a 36-volt charger or 27 volts reached on 24-volt charger. (2.25 volts per cell)**

4. **The circuit board should shut the power off to the relay coil, if the voltage of the battery pack doesn't rise every 25 to 30 minutes. Note: This voltage measurement must be accurate. As little as 1 Mili-volt of a rise could keep the charger on.**

Testing the Transformer

The voltage output across the leads going from the transformer to the two diodes should be 48 to 60 volts AC on 24-volt chargers and 72 to 96 volts AC on 36-volt chargers. This voltage can be easily measured the top and bottom of the diode assembly while charger is on with load. Voltage across the capacitor should be between 400 to 600 volts.
Noisy Transformers: Noisy transformers can not be repaired in the field. In these cases, the charger should be replaced.

Maintaining Deep Cycle Batteries

1. **Always keep the water levels above the plates.**
2. **Fill cells with distilled water only. Tap water can cause an excessive build up of minerals and reduce the chemical reaction of the batteries. Thus shortening the life and performance of the batteries.**
3. **Use appropriated filling devices when filling the batteries. Do not use a garden hose. Flooding the batteries can flush the electrolyte out of the battery and shorten its life.**
4. **Fill cells 3/8 to 1/2 of an inch above the plates. Do not fill above the fill marker in batteries. Over filling can cause the electrolyte to percolate out onto the case while charging.**
5. **Check water level daily and fill if needed, prior to charging.**
6. **Keep all battery cable connections tight.**
7. **Keep all battery posts and cables clean.**
8. **Clean the battery cases with a mixture of baking soda and Water solution or commercial spray that neutralizes the acid. Spray the cases with a water displacement chemical or a silicone. This will help break the flow of current across the case. Note: The electrolyte on the surface of the case can cause:**

   ***A*. The batteries to discharge faster even while sitting and a shorter run time.**

   ***B*. The battery charger to stay on for extended periods. Thus causing an over charge condition and shortening the life of the battery.**

Testing Deep Cycle Batteries

Load Testing

Load test battery with an automotive type load tester. This test puts an ampere load on the batteries and measures the voltage at the same time. If voltage drops to low on the meter would indicate that the batteries are weak or discharged. Load testing can identify dead cells, broken or disconnected plates, and cells or charge status. This is good test, however it can only detect certain failures.

Hydrometer Testing

Hydrometer testing can measure specific gravity of deep cycle batteries. This allows you to detect weak cells, which are causing loss of running time. This also a good test. It like wise can only detect certain problems. The hydrometer should have specific gravity markings such as 1.265, 1.250, 1.225, and so on. Hydrometers with the four balls are not accurate enough for this test.

Fully charged batteries should read 1.265 and will decrease as batteries are discharged until they reach 1.120. This test should be done when batteries are charged and cooled. Allow one hour or more to cool. It can also be done after batteries are partially discharged, if they are allowed to cool. However you will not be able to detect the full capacity of the battery.

To do an accurate test, the battery water level must be high enough to extract enough electrolyte to fill hydrometer enough so that the float floats. Water should be added prior to charging in order to let the electrolyte to mix. The greater the variation between cells, the greater the loss of run time. For example, if the readings are 1.265, 1.265 and 1.225 in one 6 volt battery. The low cell would be considered weak and greatly reduce the performance of the battery or shorter run time. This battery would have a 40 point variation. Batteries that have weakened cells in most cases it can still be used as long they continue provide adequate run time. A battery with a 40-point variation or more should be determined defective.

Minuteman batteries are rated for 500 charge cycles. Every time the batteries are charged it uses one cycle. To insure getting the expected life, unnecessary charging should be avoided.

100 % charge = 1.265 Specific Gravity
75 % charge = 1.225 Specific Gravity
50 % charge = 1.190 Specific Gravity
25 % charge = 1.120 Specific Gravity