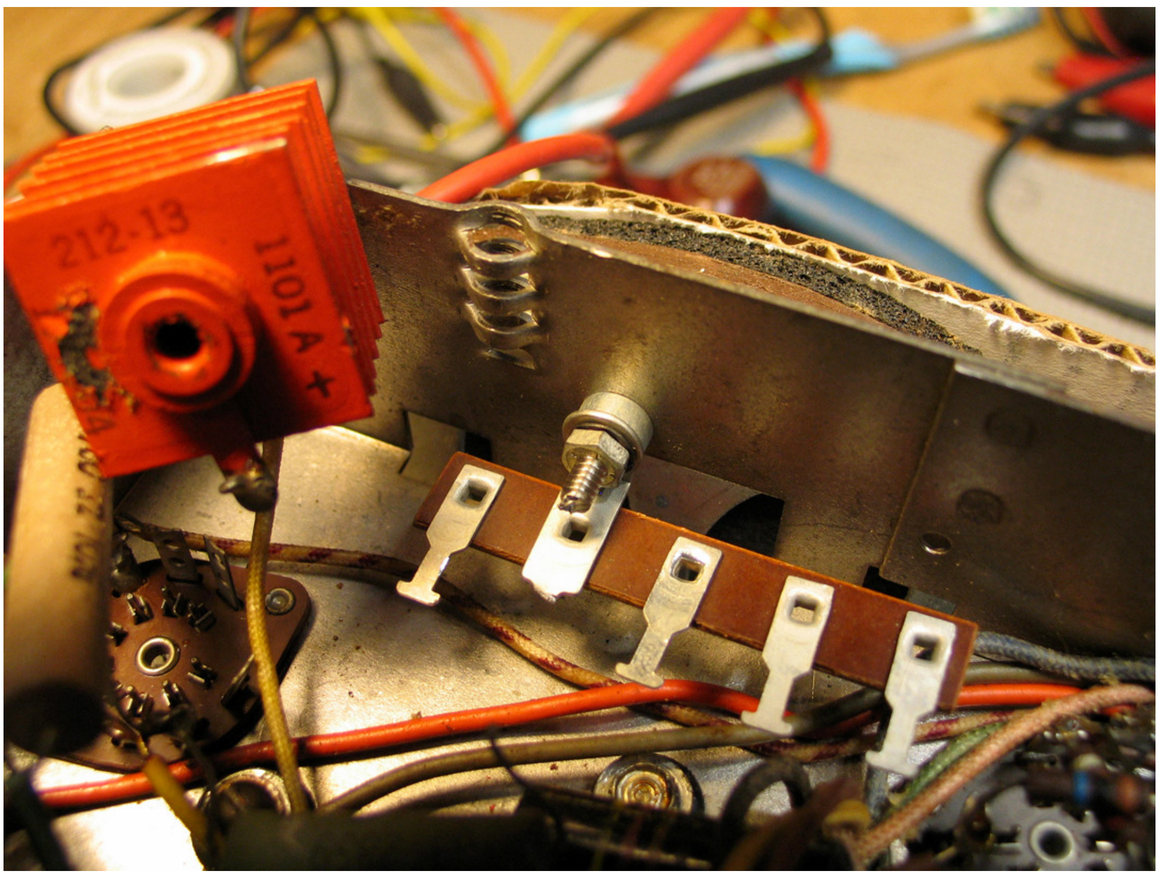
Replacing the Selenium Rectifier in the Zenith Trans-Oceanic Radio

G500, H500, and all 600 Models

Theory and Practice



by
Ed Morris

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Introduction

Zenith Trans-Oceanic radios are designed to operate on battery power. However, they come equipped to operate on household current as well. The pre-WWII 7G605 and post-war 8G005 Trans-Oceanics used a rectifier tube to convert household AC current to DC current.

With the introduction of the G500 Zenith Trans-Oceanic in 1949, Zenith updated the Trans-Oceanic electronics with miniature tubes, and a solid state selenium rectifier in place of the vacuum tube rectifier used on the two earlier models.

Some Trans-Oceanic collectors routinely replace the selenium rectfifier found in the 500 and 600 series Trans-Oceanics as part of the electrical restoration process. This is purely a matter of choice. As long as the selenium rectifier's output is within specifications, there is no need to replace it from a performance point-of-view.

Over time, however, the selenium rectifier output will diminish to the point performance of the radio is degraded. Reception on the higher shortwave bands will go first as the voltage to the tube filaments drops as the selenium rectifier ages. Audio quality may be affected as well, characterized by distortion or low volume.

Replacing a defective or dying selenium rectifier is not a complicated process. If you can replace a capacitor, you can replace a selenium rectifier.

Preparation

Before attempting to replace the selenium rectifier, the radio should be restored to good electrical condition. This means replacing the electrolytic capacitors, the paper/wax capacitors, and out-of-tolerance resistors. A vacuum tube that tests weak or questionable should be replaced as well.

If you are new to restoration of vintage radios, the Zenith Trans-Oceanic is basically not any more complicated than any All-American AA5 radio. The 500 and 600 series Trans-Oceanics are five tube radios with a solid state rectifier.

This guide is for the 500 and 600 series Trans-Oceanics. All the models are quite similar. The 7G605 and 8G005 radios are very different, and this guide does not apply to them.

If you are replacing the selenium rectifier in a radio you have previously restored or that has been playing satisfactorily in the past, you may proceed directly to replacing the selenium rectifier. At a minimum, however, I recommend replacing the electrolytic capacitors if they have not been replaced. You can find a guide to replacing the electrolytic capacitors on the Resource Page at edsantiqueradios.com, or at this link:

http://elmphotography.com/radios/CapCanRS.pdf

If your Trans-Oceanic is a new find in unknown condition, it is best to first test the radio to see if it is working at all, and how well. I recommend testing an unknown radio on battery power first. You can purchase a reproduction battery or make your own. Information is available at edsantiqueradios.com.

A simple working battery can be made with ten 9-volt cells and six D-cells. Check the Resource Page for plans. If the radio plays on battery power, the next step is to test it on AC power. A Variac should be used for the AC power test, but if you don't have one, a dim bulb tester is a good alternative. You can find plans online to make your own. As a last resort, cross your fingers and plug the radio into a 120 volt AC outlet. The rectifier tube should glow. If the set does not start playing within a minute or so, unplug it. There is an issue in the AC power supply.

At this point, a complete restoration may be in order. If you are new to Trans-Oceanic restoration, download this guide:

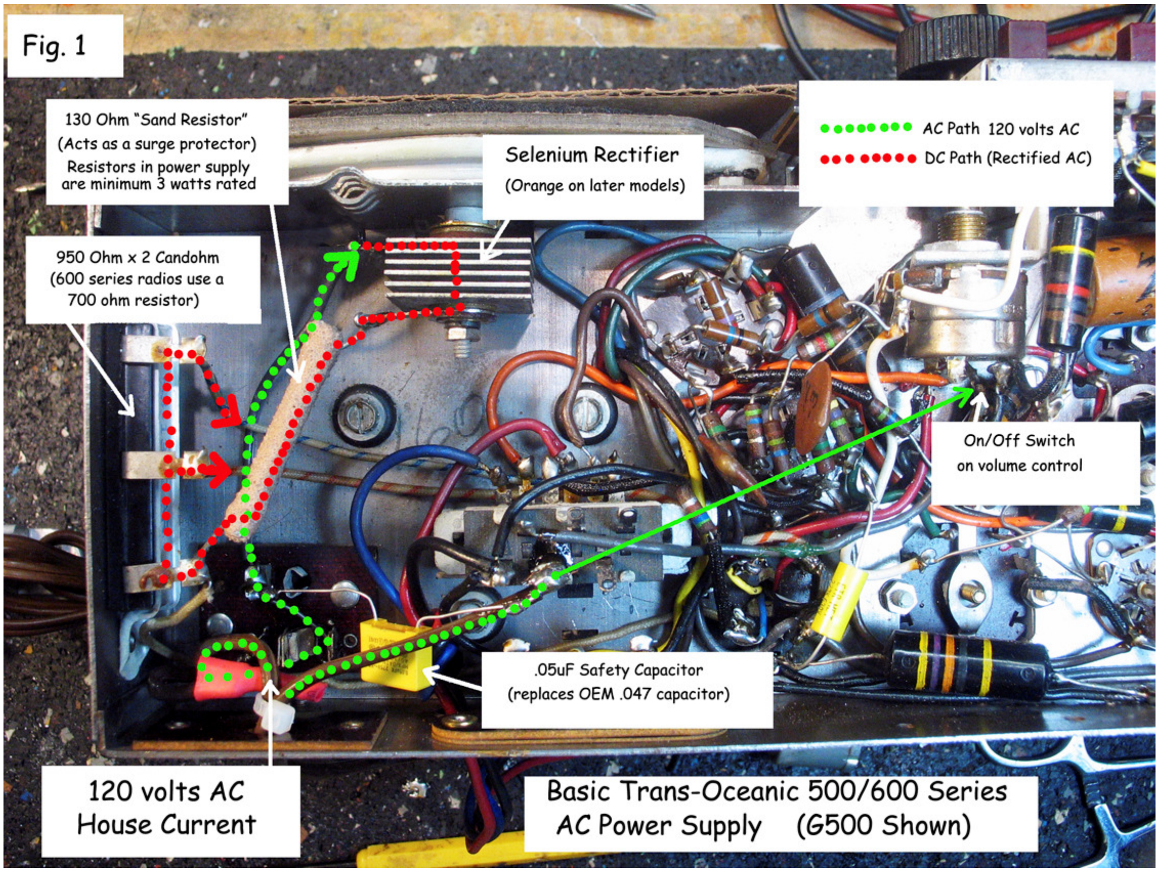
http://elmphotography.com/pdf/H500%20Restoration%20Guide.pdf

You can find it on the Resource Page at edsantiqueradios.co.

The Basic AC Power Supply in Trans-Oceanic Radios

The selenium rectifier is easy to find. It is an orange square composed of six plates on a axis. See the photo on the cover page. The OEM selenium rectifier is usually orange in all models except the G500, which used a silver selenium rectifier. Sometimes a blue selenium rectifier may be found.

Figure 1 shows the basic AC power supply found in the Zenith Trans-Oceanic.



120 volt AC current enters the radio through the power cord. One leg goes to the on/off switch located on the volume control. The other leg goes to the anode terminal on the selenium rectifier. The selenium rectifier removes, or blocks, one half of the AC sine wave, converting AC to DC current, although not a perfect DC current. The electrolytic capacitors filter this rippling DC current to even it out.

The selenium rectifier has a lot of resistance, so there is also a drop in voltage when the current exits the selenium rectifier. Next it passes through a 130 ohm surge resistor. This resistor looks like it is covered with sand, and is often called a "sand resistor." Its purpose is to prevent voltage spikes from damaging the tubes. If the surge resistor does not test within +/- 130 ohms, it should be replaced with a new resistor rated at 5 watts.

From the surge resistor, the current passes through a candohm, which is a two part wire-wound resistor in a single housing. Each section of the candohm is rated at 950 ohms. The total resistance from one end to the other is 1900 ohms. It should also be tested and replaced if not within specifications. The candohm can be replaced with two 1000 ohm ceramic resistors rated at 5 watts.

The candohm is tapped in the center and at each end. Rectified DC current is fed from these taps to the filament string of the vacuum tubes and the various circuits of the radio.

The tubes, except for the 3V4, are designed to operate at a filament voltage of 1.4 volts. Unlike AC powered radios, these do not glow, at least at a level detectable in normal light. You cannot diagnose a bad tube by looking for a glowing tube. The typical tube lineup is a 3V4 audio power tube, a 1U5, two 1U4's, and a 1L6.

The 1L6 is the converter/mixer tube, and if the filament voltage is too high, its life will be shortened. These tubes are in short supply and very expensive. Solid state replacements are available online. If the voltage is too low, the tube will not oscillate, and the radio will perform poorly, if at all. Shortwave reception on the higher bands is the first to go; the BC band may continue to receive at low voltages.

The goal when replacing the selenium rectifier with a silicon diode rectifier is to find the proper value of dropping resistor, combined with the silicon diode, that will provide 1.36 to 1.4 volts to the tube filaments of each tube. Slightly less than 1.4 volts will prolong tube life with good performance. To measure the voltage at the 1L6, connect the leads of a DMM to pins 1 and 7. You can also measure the voltage in the same manner at any of the other tubes except the 3V4, which has three filament pins, at requires about 2.8 volts at the filament pins 1 and 7, or 1.4 volts between pins 1 and 5 or 5 and 7.

The silicon diode rectifier has very little resistance compared to the selenium rectifier, so a dropping resistor is needed to prevent excess voltage from reaching the tube filaments. Where the selenium rectifier dropped voltage by 5 to 10 volts, a silicon diode rectifier only drops voltage by about 1 volt.

Replacing the Selenium Rectifier

The selenium rectifier is usually replaced with a 1N4007 silicon diode. These are inexpensive, and can be purchased online from various electronic suppliers such as Mouser, Allied, and Digi-Key. You will also need an assortment of 5 watt ceramic resistors. You will also need a multimeter (DMM) and a Variac is recommended as well.

First, make sure the radio has been recapped, including the electrolytic capacitors. Replace the candohm if it is not within specifications. Then follow the steps below to replace the selenium rectifier.

Step 1. Remove the chassis from the cabinet. Disconnect the lead from the AC power line to the selenium rectifier's anode terminal.

Step 2. Disconnect the 130 ohm sand resistor from the cathode terminal (+) of the selenium rectifier.

Step 3. The selenium rectifier is attached to the chassis by a long bolt through its center. Remove the nut and washer with a 1/4" wrench. Slide the selenium rectifier off the bolt.

NOTE: Some restorers leave the disconnected selenium rectifier in place, and use the cathode terminal where the 130 ohm sand resistor was attached as a tie point for the silicon diode.

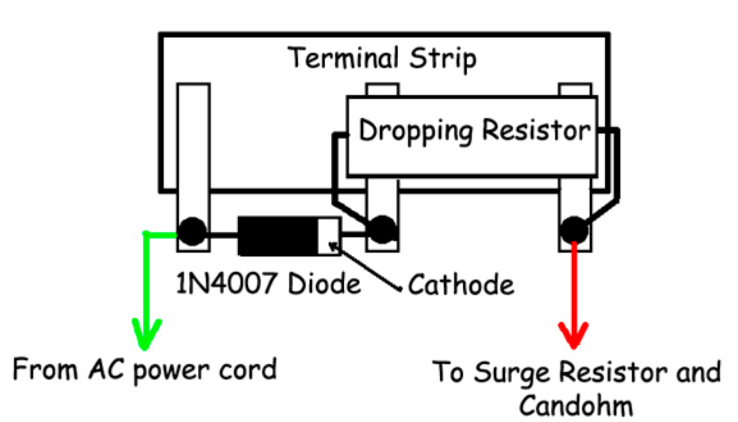
Step 4. Loosen the three screws holding the speaker in place with a 1/4" driver or screw driver enough to remove the long bolt that held the selenium rectifier.

Step 5. Prepare a terminal strip by mounting a 1N4007 silicon diode between two of the terminals (Fig 2). You will also be mounting a dropping resistor on this terminal strip once you determine the correct value.

WARNING: Do not connect any components to a terminal connected to the terminal strip's mounting stud and radio chassis.

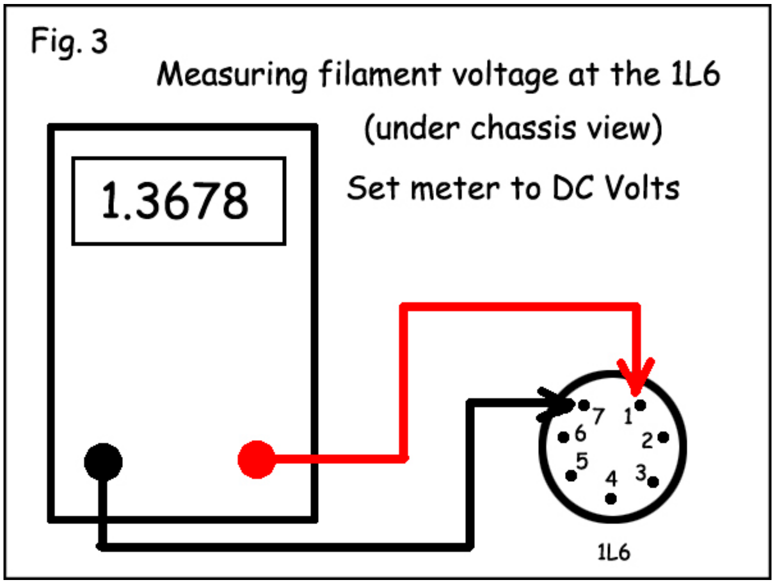
Experience has shown that most often a 5 watt, 50 ohm dropping resistor will be close to the correct value, providing the 130 ohm surge resistor and the candohm are within specification. If you know these values are correct, you can mount a 50 ohm, 5 watt resistor on the terminal board.

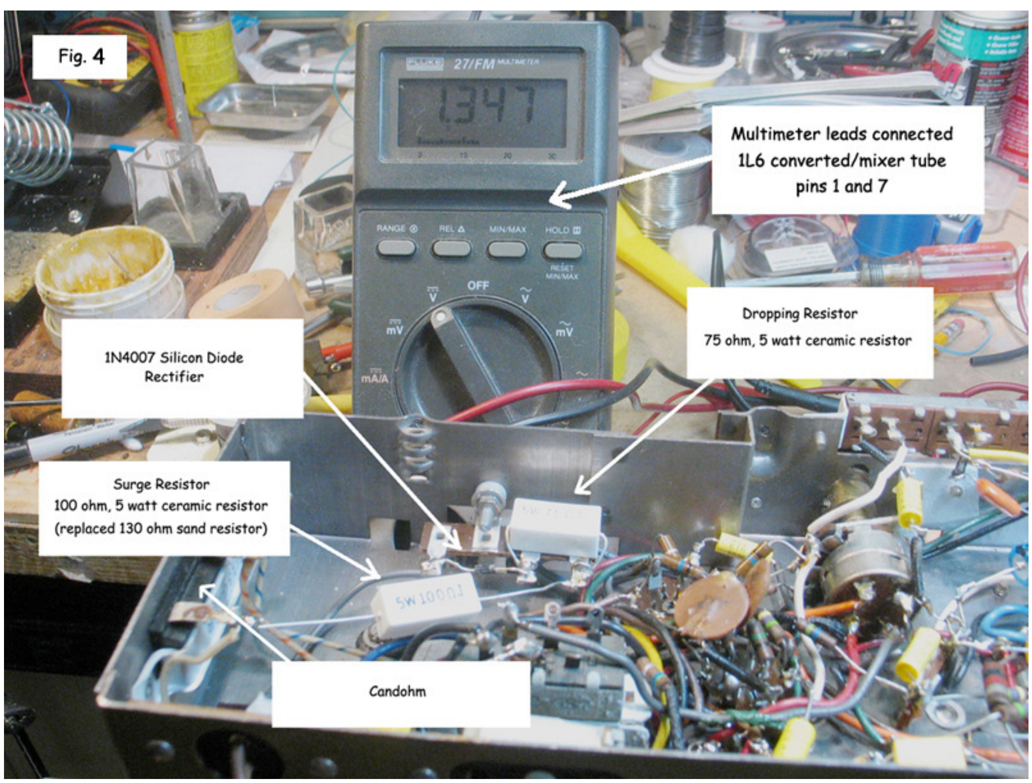
Fig.2



Step 6. Determine the value of the dropping resistor. If you are leaving the 130 ohm sand resistor in place, use gator wires to connect a 50 ohm, 5 watt resistor to the cathode end of the silicon diode and the other to the 130 ohm resistor. Connect your multimeter to pins 1 and 7 of the 1L6 tube (Fig. 5) and read the DC voltage as you bring the voltage up to 120 VAC on a Variac. Don't let the filament voltage go over 1.4 volts DC.

If your voltage between pins 1 and 7 is between 1.36 volts and 1.4 volts at 120 volts, you are good to go. If the voltage is too high, increase the value of the dropping resistor. If the voltage is too low, lower the value of the dropping resistor. The total value of the resistance between the cathode of the silicon diode and the candohm should be around 180 ohms, but may vary depending on the overall condition of the radio and your AC line voltage.



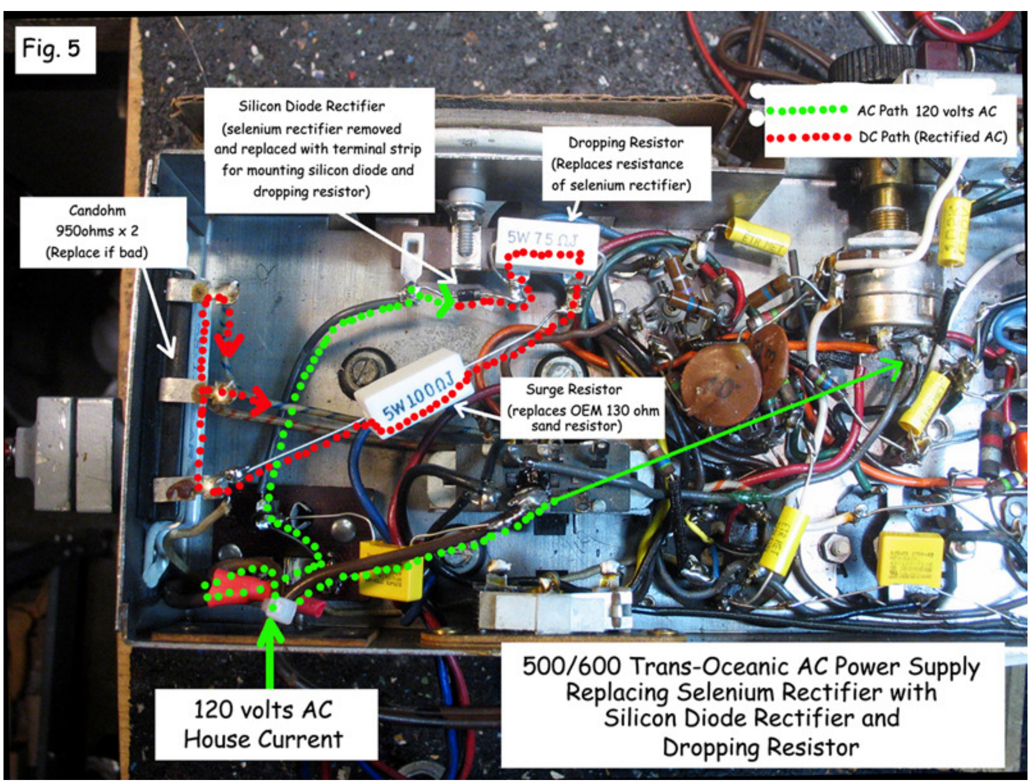


If you are replacing the 130 ohm sand resistor with a resistor of a different value, then you may need to experiment with various combinations of dropping and surge resistor values.

In the example shown in Fig. 4, the 130 ohm sand (surge) resistor was replaced with a 100 ohm, 5 watt resistor. So a 75 ohm, 5 watt dropping resistor was placed between it and the silicon diode, for a total of 175 ohms. The voltage between pins 1 and 7 of the 1L6 tube is 1.34 volts, a little on the low side, but still useable.

Step 7. Once you have determined the correct value of the dropping resistor or combination of dropping and surge resistor, solder the dropping resistor in place on the terminal strip and reconnect any other components. Remove the DMM leads from pin 1 and 7 of the 1L6. Check for performance on the highest bands to make sure the 1L6 is oscillating well. If your radio's band spread includes 15 mHz, see if you can pick up the WWV time signal from Fort Collins, Colorado.

Step 8. Re-install the chassis in your cabinet and enjoy! The figure below shows the circuit path for the silicon diode rectifier, dropping resistor and surge resistor.



The values shown above are for the specific G500 Trans-Oceanic used as an example. Your values will vary, depending on the condition of your radio and whether you are just replacing the selenium rectifier, or other components in the power supply as well.