Telephony 101 – Network Circuits and Varistors March 11, 2013

Hello All,

As always, please send any questions about the reading assignment directly to me at oldtimetelephones@goeaston.net. I will bundle questions if necessary, repeat the questions, and give answers in an e-mail to the TCI List Server before moving on to the next reading assignment. This way everyone will benefit from these questions and answers. By sending questions directly to me, we will avoid unnecessary clutter on the List Server. Previous reading assignments, notes, questions, and answers are available in the TCI Library at http://www.telephonecollectors.info/index.php/telephony101 (this is a new URL, but the old one will eventually get you there).

Please read pages 162 through most of 170 in Chapter 19 and the section titled Varistor, which starts on page 220 in the Appendix. This will give us the basic principles of the network circuits.

Network circuits are not hard to understand, so don't be intimidated by them. In fact they are quite simple. Remember the old booster circuit in which some of the transmitter's ac voice current went through a secondary winding in a loop around the transmitter to "boost" the line voltage? Then, in the original WE anti-sidetone circuit, a tertiary winding was added so that some of this ac voice current could bypass the receiver thus lowering the sidetone. Well it's the same in the network circuit, only the bypass part around the receiver has been changed a little, as you can see in Fig. 19-1. So the network circuit is still a booster circuit with some bypass around the receiver to reduce sidetone. Pretty simple. The things that look complicated are mostly bells and whistles, so to speak, and you can just ignore them when considering how the circuit works.

The post-war T1 transmitter and U1 receiver were both more efficient than earlier ones, and this was great for service on long lines. But on short lines, the volume was now too loud, so an "equalizer" was designed to spoil some of this volume. The equalizer worked automatically by utilizing dc current on the line (low current on long lines, and high current on short lines). The original equalizer was rather clunky and actually employed a resistance element that heated up. Details are given in the book, but you don't have to follow them closely.

Bell Labs did a lot of research on solid-state electronic devices, and they developed a kind of resistor whose resistance depended on the applied voltage. These so-called "varistors" have a very high resistance (thousands of ohms) when the voltage across them is quite low, but when the applied voltage increases the resistance drops. These varistors are engineered to change from high resistance to low resistance at convenient voltages, and graphs for the varistors used in telephones are shown in Figs. A-4 and A-5 on pages 221 and 222.

The first application of a varistor in telephones was to shunt noise pulses around the receiver. Remember that ac voltages across the receiver are in the neighborhood of 30 millivolts. You can see from Fig. A-5 that these varistors will eliminate (short out) any sounds that have voltages above about 400 millivolts (0.4 volts). So any voltage that is ten times the normal value (e.g., from switch operation) will find a low resistance path around the receiver.

The next use of varistors was to replace the clunky equalizer. This was accomplished by putting one varistor around the receiver to bypass more ac current when the dc battery current was high. A second varistor was put across the line to let some dc line (battery) current bypass the transmitter when this line current was high. This turned down both the receiver volume and the transmitter volume on short lines without degrading their performance on long lines.

You can see how all of these varistors were used in standard WE 500-type phones and rotary dial Princess phones in Figs. 19-9 and 19-10. The resistor and condenser at the top of the figure near terminal F is just the old radio-frequency filter to avoid transmitting dial pulses to your radio.

For those who are not particularly interested in a lot of details, I would say please don't give up now. Just look at the wiring diagram of a 500-type phone (Fig. 19-9) and recognize the general flow. Direct current from the line flows through the transmitter, and some of the ac voice current goes through a little receiver loop. You've seen this all before. Forget about the details if they bother you.

The next reading assignment is on touchtone dials. They are complicated, so you can skip this section if you like and you shouldn't feel bad. However, to the more curious I would say that this is probably the only comprehensible description in existence of the working principles of these dials. I don't think you will find a good description anywhere else.

If there are any questions about the current reading assignment, we will deal with the questions before moving on to the next reading assignment.

Ralph