TROUBLESHOOTING RECEIVERS

The four methods of troubleshooting are:

1. Circuit Disturbance
2. Signal Substitution
3. Signal Tracing
4. Measurement of Circuit Parameters

Definition of Terms:

Circuit Disturbance - Any operation or procedures that disturb a circuit from its normal condition.

Signal Substitution - Injecting signals in various circuits to determine if they are operating properly.

Signal Tracing - Tracing a signal stage by stage through the receiver. NOTE: This method requires that a signal be present, although sometimes random noise will support signal tracing.

Measurement of Circuit Parameters - Voltage and resistance measurements around a suspected stage.

Use of one or more of these methods will enable isolation of the defect to one stage or small area.

Circuit Disturbance is by far the quickest in most instances since very little test equipment is required. Measurement of Circuit Parameters is like looking for a needle in a haystack unless the problem is loss of supply voltages or unless the problem has been isolated to a single stage.

Each method described has merit and should be used wherever practical and expedient; however, one must be able to isolate the problem quickly in order to fulfill the requirements of his profession. Quick troubleshooting and repair makes profits for everyone concerned, since it saves time to both the technician or GESS and the customer.

These methods have not changed since the early beginnings of radio even though many changes have taken place in this field. From crystal detector to grid leak detector to TRF to superheterodyne and now transistor receivers, these methods remain as the basis of troubleshooting receivers.

Now, how are these methods applied?

The first requirement is a symptom. If the customer does not have one to relate, one must be found by testing the unit's performance. The symptom should automatically lead to the method of troubleshooting. For instance, if a set is dead, you should start by checking power input to the set. An easy way of checking this is to measure the 2nd limiter or discriminator voltage. If voltage is present at either of these jacks, the unit has both filaments and B+. If no reading is found in these jacks, the B+ and filament voltages should be checked. Of course, if the unit has a vibrator or transistor power supply, these will make a sound indicating that battery voltage is present.

If the unit does not have power input, of course, fuses are the best possibility. If voltages are present indicating 2nd limiter and discriminator, but no sound comes from the speaker, the audio or squelch circuits may be at fault. Measurement of the AC voltage on the plates of the audio stages will narrow the field. If AC voltage is present on the plate of the final, then the speaker or voice coil circuit is defective.

Of course, for these tests, the squelch should be open. If no AC voltage is present, the unit may be squelch blocked or the audio may be shorted to chassis. Check the volume control leads for short to chassis. When starting this problem, the 2nd limiter voltage was assumed to be normal. One quick way of determining if the squelch is blocked is to short the 22K resistor in the cathode of the first audio amplifier to chassis {Progress Line}. If the speaker makes noise, the unit was squelch blocked.

Squelch blocking in GE Progress Line may occur for either of two primary reasons: too much noise from the noise amplifier or very low 2nd limiter voltage. Again assuming that any tubes with open filaments have been replaced. Thus the problem narrows down to a small area. Generally speaking, all of the tests mentioned on this one unit would require very few minutes and only a common VOM.

Circuit disturbance could also have been used as well as signal tracing; however, in this instance the measurement of circuit parameters is faster unless quick examination shows the filaments out, or the vibrator dead, which would indicate fuse trouble. The final audio tube could be removed and reinserted to check filament and B+ voltage, as well as audio output section; however, most final audio stages are too hot to handle.

In sets which are alive but weak, the signal substitution method seems best unless past experience shows weak spots that can be easily checked.

Signal tracing is rarely used on communications equipment; however, it has definite merit. A sensitive high impedance headphone will permit testing from the first limiter through the voice coil including the squelch circuits in part.

Circuit disturbance is by far the quickest, generally simplest, and usually least used efficiently. Circuit disturbance, remember, is anything that is done to a circuit to disturb it from normal operation. This would include shorting points to chassis, substitution of components in part, removal of tubes, transistors, crystals, or other elements that can be readily removed.

It would also include clipping on a jumper or touching a screwdriver to a grid to act as a noise antenna, etc.. Circuit disturbance is of no value if the receiver is almost OK, but has great merit when a receiver is very poor. If the receiver is almost OK, signal substitution and tracing will be much more profitable.

In order to troubleshoot a receiver, the design methods must be recalled; that is, what is each stage designed to do? Remember that the IF stages supply the gain. The mixer stages generally unity or very low gain, and the RF stage some gain, but mostly the RF stage has to establish a signal to noise ratio.

Some problems will put this simple thought to shame, but generally speaking, with the receiver aligned properly, if the receiver has very poor sensitivity, that is, 1000 microvolts or more (assuming alignment OK) the problem lies in a mixer or IF stage. If the receiver has medium poor sensitivity, that is, 20-100 microvolts, the problem is in the IF and if the set is fair, that is, 1 to 5 microvolts, the problem is in the RF. This is a rough rule, but is borne out very often.

Circuit disturbance will locate problems where the sensitivity is 20 to several thousand microvolts, but sensitivities around 5 microvolts or better will usually require signal substitution, unless tube substitution corrects it.

The difference between AM and FM receivers must also be recognized. An FM receiver is actually two receivers in one, that is, an audio receiver and an RF receiver. Since the audio out of the discriminator is fixed for signals that saturate the limiters, the audio gain in an FM receiver has very little effect on receiver sensitivity. In an AM receiver, the gain of every circuit counts, since audio level out is a direct function of RF input.

In an FM receiver, therefore, sensitivity problems will usually be in the RF section of the receiver. The second limiter voltage is an indication of the gain of the IF section. The first limiter is an indication of noise or signal intensity on the RF grid, therefore on the antenna if one is connected.

In troubleshooting by circuit disturbance, the second limiter voltage is monitored while various circuits are disabled by removing the tube or grounding a grid or similar section. A change in second limiter generally means that stage was functioning. Beginning at the discriminator and working toward the RF section, the first stage disturbed that does not change the second limiter is the defective one. Of course, the amplifying unit should be replaced first and if this does not solve the problem, circuit parameters should be measured and evaluated against a normal reading.

Now we will see how these methods apply to transistorized receivers.

TPL TROUBLESHOOTING

The TPL does not have a second limiter metering jack; however, the audio at the speaker indicates the condition of the IF section of the receiver. By taking a metal screwdriver and touching various points in the receiver IF, with the squelch open, the unit will respond to random signals. If no response is found, the receiver's IF is weak or defective. With proper care the transistors may be substituted with the exception of Q308, which drives the speakers. If Q308 is removed with the unit operative, the speaker will draw excessive current and may be damaged. Q306 is the 1st DC amplifier. Removal of Q305 will open the squelch in a normal receiver.

If the unit fails to have a snappy squelch, Q306, 7 or 8 may be at fault; however, if the unit fails to quiet when squelched but merely decreases in volume, Q308 is the most likely suspect. By unplugging the speaker and measuring at Pin 3 of the speaker jack, a voltage will be found that changes with squelch open or closed.

Squelch open should give 0 volts. Squelch closed should give 5 or 6 volts negative with respect to receiver common, the red jack on the audio board.

The circuit disturbance method works very well on transistorized units since high voltages are not present and one does not need to worry about being shocked. Various points in any receiver may be found which may be touched by any device that will act as an antenna, and thereby pick up random noise, broadcast stations, and such. This will aid in easily isolating the defective stage. In TPL for instance, random noise may be picked up in the 2nd mixer by touching one particular resistor with a finger. This resistor is next to the 8410 KC crystal in the 2nd mixer. One end of resistor R-1 in the 290 KC gain stage is sensitive to noise. R-1 is on one end of the IF chassis all alone. Touching the sensitive end will increase the audio noise at the speaker if the set is normal.

The limiter stages on the audio board are also sensitive to random noise, by holding a screwdriver by the metal shaft and touching the 2N450 limiter transistors on their metal cover. It may be necessary to make a bare spot to touch, or touch one of the transistor bases.

In troubleshooting the RF and 1st mixer section, you will find signal substitution works most easily. A signal can easily be inserted by touching the tuning capacitors in various stages with a metal screwdriver and touching the screwdriver shaft with the generator cable. This will permit isolation of a defective transistor. The one exception is if the receiver *should* be 6/10 microvolt, but it is just under microvolt, in which instance, substitution of the transistors is indicated, and do not forget to then retune that stage. Of course, once the defective stage is found, the amplifying unit should be changed, and followed through with measurement of circuit parameters if that fails to correct the difficulty.

If a receiver will not tune to frequency as measured at the discriminator, it becomes necessary to isolate which frequency determining element is at fault. In most two-way receivers, three such elements will be found. The discriminator and first and second oscillator crystals all work together to determine the final operating frequency.

Frequency standards for the IF frequencies then become necessary. Nearly any kind will do if it is fairly accurate. Such units as the BC-221 and LM-20 are suitable. Many homemade units are in use, as well as presently available commercial units. Each shop should have some IF frequency standard, preferably one which can quickly and easily be used.

Familiarity with the test equipment and the unit to be repaired are undoubtedly very valuable; however, familiarity with the proper troubleshooting methods is just as valuable and should not be neglected.

Quite often you can save time and increase profits by properly utilizing the methods described. We realize that this is brief. However, it is not intended as a training sheet for beginners, but rather as a reminder to those who know these methods, but have neglected to use them fully.

We would like your written reaction to this short write-up and any other thoughts you feel should be written up in a similar manner.

Please address your comments to the undersigned.

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