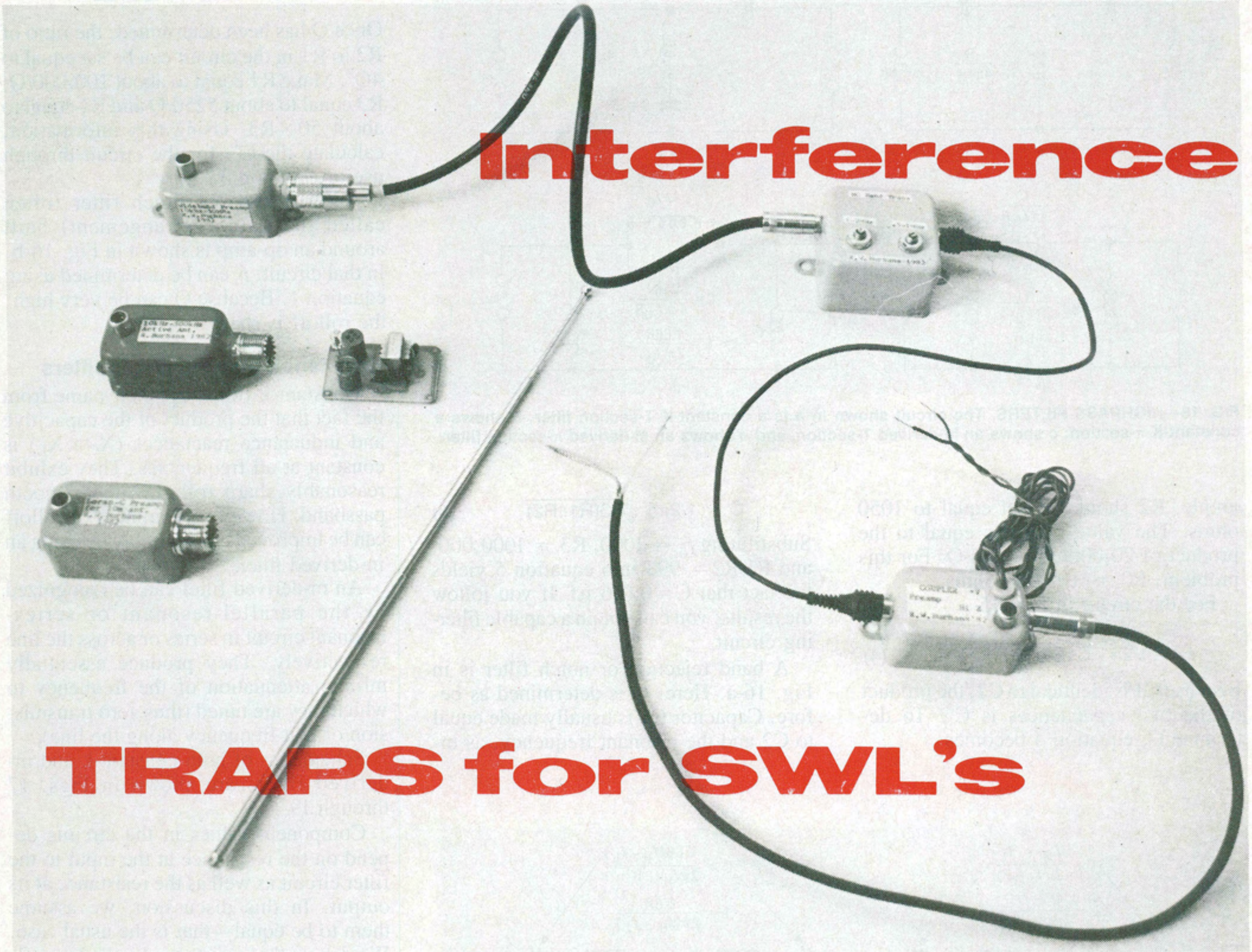
Interference TRAPS for SWL's



Interference from AM (broadcast-band signals can often be a source of irritation for shortwave listeners and longwave enthusiasts. Here's one way to eliminate the offending signals.

R.W. BURHANS

SHORTWAVE AND LONGWAVE RADIO listeners are often plagued with interference from strong, local, broadcast-band (BCB) stations. The interference often results in intermodulation distortion in the receiver. Antenna tuners or RF preselectors are often used to reduce the problem. Sometimes, traps made up of parallel-tuned L-C circuits are simply connected in series with the receiver's antenna-input cable. However, a more effective trap—one that we will discuss—is the T-notch circuit. The T-notch trap also consists of a parallel L-C circuit—but the capacitor has a center tap that is fed to ground through an adjustable resistor. Figure 1 shows a dual T-notch circuit that is used to attenuate interference from two local broadcast-band stations. (In our case, each station is located about one mile from the test sight.) Of course, a single T-notch trap can be used if you have a single-station interference problem.

The T-notch trap operates as a delay-and-add network. The tunable, parallel L-C circuit provides a 180° phase shift from input to output. The delayed signal is then added to the original (with a multiplying constant). The variable resistor—by letting you adjust the phase and how much of the original signal will be added to the delayed signal—provides a way to adjust the circuit for a sharp null.

Circuit design

Let's consider a single T-notch trap. For a 50-ohm antenna system, the trap's inductor, L, is chosen such that its reactance (X_L) is in the range of 30 to 100 ohms. At the band of frequencies we're interested in (600–1600 kHz), that requires an inductance in the range of 7 μH to 12 μH with a fairly large parallel capacitance. (Two capacitors, connected

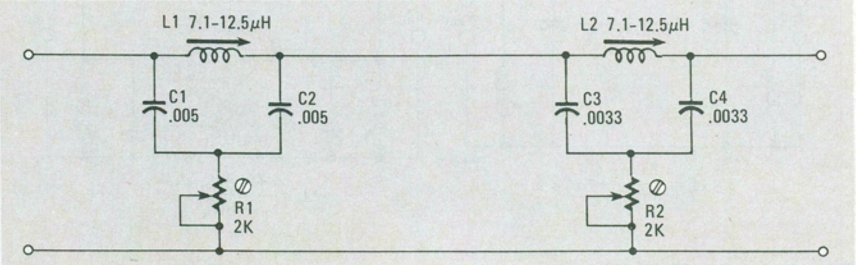


FIG. 1—T-NOTCH TRAP. Our trap was set to reduce interference at 970 kHz and 1340 kHz. Coils L1 and L2 were set to 10.5 and 8.5 μH respectively.

TABLE 1—Capacitor Selection

Capacitor value	Trap frequency for L = 12.5 μH	Trap frequency for L = 7.1 μH	Midband X_L
.01μF	625 kHz	810 kHz	40 Ω
.0068 μF	770 kHz	1000 kHz	50 Ω
.005 μF	860 kHz	1200 kHz	65 Ω
.0033 μF	1100 kHz	1480 kHz	72 Ω
.0022 μF	1360 kHz	1800 kHz	100 Ω

PARTS LIST

R1, R2—2000 ohms, trimmer potentiometer
C1-C4—polystyrene capacitors (values depend on the interfering frequencies—see text and Table 1)
L1, L2—7.1–12.5μH slug-tuned coil (Mouser 542-23A105RPC or equivalent)

in series, are required for each trap. Don't forget that the value of each will be double that required for an equivalent single-capacitor parallel L-C resonant circuit.) Table 1 shows a selection of capacitors designed to cover the AM band. (The capacitance values shown are for each capacitor—not the equivalent of the two capacitors in series.) The inductor is a 7.1-to-12.5 μH slug-tuned, adjustable RF coil with a Q greater than fifty. We mentioned one possible source for that coil in the parts list. In addition, we have also used many surplus adjustable inductors on older-style ceramic forms with considerable success.

Trap performance

While the trap will work best when driven from a 50-ohm source and terminated in a 50-ohm receiver load, it can also be used with 500-ohm receiver input-terminals. However, its null will not be as deep. Figure 2 is a graph that shows the typical response of a T-notch trap circuit when it is connected in series with a 50-ohm active antenna system that covers the range of 10 kHz to 30MHz. (Such active antenna systems were discussed in the February through April 1983 issues of **Radio-Electronics**.) We should note that this trap circuit does not present any problems when it is used in series with active antenna systems where DC power flows in the connecting cable between an antenna preamplifier and receiver coupler. The reason that that is the case is because there is a direct, low-resistance DC path from input to output and no DC ground.

When used at frequencies above 3 MHz or below 500 kHz, this T-notch trap is very effective at removing interference from broadcast-band stations—as seen in Fig. 2, the trap's −3-dB skirts start at 500 kHz and extend to 3 MHz. In our test setting, we achieved nulls of at least −40 dB at the two selected local-interference frequencies. You should find it possible to tune the trap for an even deeper null of −60 dB—but that requires very careful adjustment of the inductor and adding-resistor. At the deepest null point there will be a pronounced 2nd-harmonic effect, but at a very low level. That effect (where you see a signal of twice the frequency of the interfering signal) is a result of the addition of the delayed and original signal.

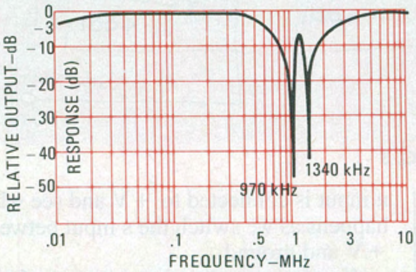


FIG. 2—THE RESPONSE of the trap in Fig. 1 is shown here. The local offending stations are WATH (970 kHz) and WOUB (1340 kHz). While the power of neither station is above 1 KW, they produced considerable interference.

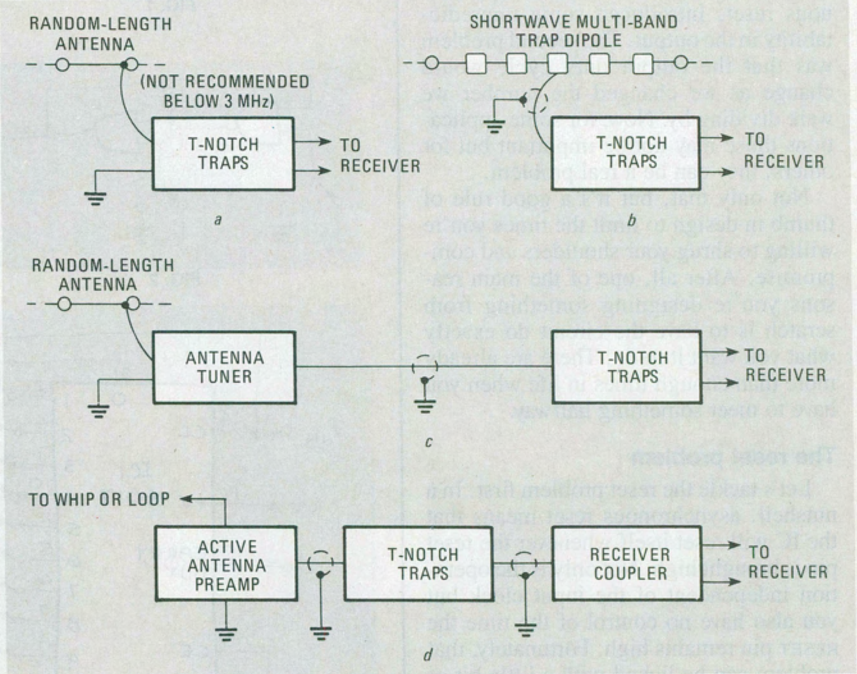


FIG. 3—THE T-NOTCH TRAPS can be used with various antennas.

Tuning the trap

To be of use, the trap has to be tuned to the particular offending stations in your area. The method of adjusting the traps is rather simple: First, tune your receiver to the interfering station. Next, adjust the inductor to reduce the signal and then adjust the resistor for a sharper null. We mentioned previously that the resistor is used to trim the circuit and obtain a sharp null point. That null is deepest when $R = QX_L/4$ (where Q is the unloaded Q of the inductor). It is usually necessary to go back and forth over those adjustments—that's particularly true when two traps are used (because of the interaction between the circuits.)

Appications

The T-notch trap is not limited to reducing broadcast-band interference. We have used similar traps for Loran-C receiver input circuits to remove 88-kHz and 115-kHz signals that were causing interference in the desired 90–110 kHz Loran-C range. If you are designing a trap circuit that uses use similar inductor values for traps for two different frequencies, it is often best to place the lower-frequency trap first (toward the antenna) with the higher-frequency trap toward the receiver.

Figure 3 shows ways of using T-notch traps with various receiving antennas. If a short random wire is directly connected to the trap input at frequencies below about 3 MHz, the trap shunt capacitance will effectively short the antenna or act like a large attenuator. Thus, this low-impedance trap is most useful at a 50–500-ohm impedance level when inserted between a receiver and a tuned antenna, antenna tuner, or active-antenna system. **R-E**