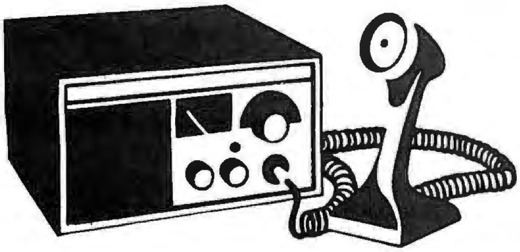

CB Scene

By Len Buckwalter, K10DH

HARMONIC TV INTERFERENCE

In a previous column, we dealt with a type of television interference called "fundamental blocking." This time, let's look at another source of TVI—"harmonic interference."

All efficient transmitters produce harmonics, which are signals at integral multiples of the desired or "fundamental" frequency. Thus CB rigs, which have a fundamental of 27 MHz, also produce energy at 54 MHz, 81 MHz, 108 MHz, etc. — the second, third and fourth harmonics.

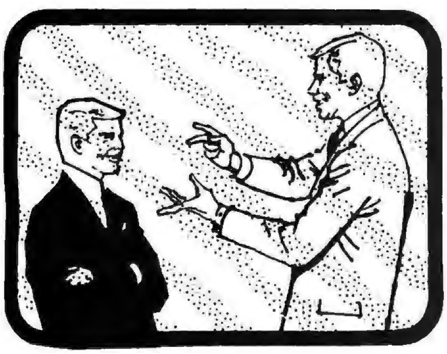

Fig. 1. Cross-hatch interference.

Harmonics are a problem because they become interfering signals on frequencies which are used by other services. For example, CB's second harmonic (54 MHz) could affect the picture carrier of television's channel 2 whose video information starts at 54 MHz. The third harmonic (81 MHz) could zonk the upper end of channel 5, which occupies the frequencies between 76 and 82 MHz.

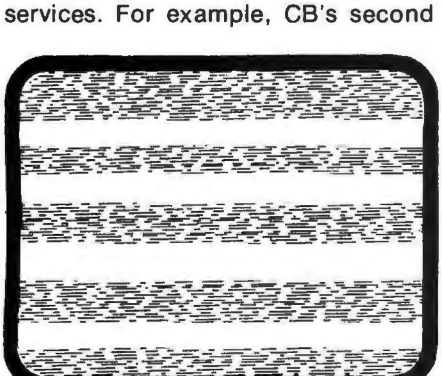

Fig. 2. Sound-bar interference.

TV isn't the only service susceptible to harmonic interference from CB transmissions. The fourth harmonic on 108 MHz elbows into the top of the FM broadcast band. Although CB signals use amplitude modulation (to which FM receivers are immune), it's still possible for your voice to be heard on the FM sound systems of both TV and radio receivers through "incidental rectification."

CB's fifth and sixth harmonics fall on 135 and 162 MHz, which are not allocated to TV stations. However, these frequencies are assigned to commercial and government two-way radio services, which should not be interfered with. Further, the seventh and eighth CB harmonics—on 189 MHz and 216 MHz—are potential causes of TVI because they fall within channels 9 and 13.

The biggest source of TV interference, however, is the second harmonic, followed by the third. This is so because the power of a harmonic falls rapidly as its frequency grows higher, and the effects of higher-order harmonics are negligible unless a receiver is extremely close to the CB set.

There are several clues to look for if you suspect TVI is caused by harmonics. They are easy to examine, thanks to the greatest test instrument since the oscilloscope—the TV screen—which, after all, is an oscilloscope of sorts. The most effective

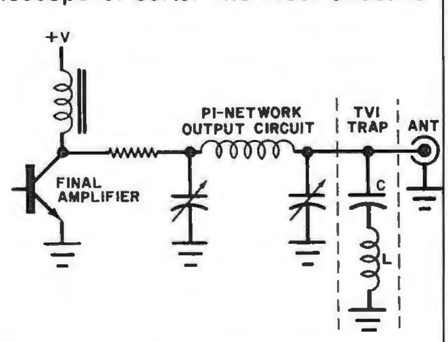

Fig. 3. An LC series wavetrap.

way of identifying harmonic interference is to note which channels are affected. Only those channels which have a harmonic relationship to the Citizens Band could present problems. If ALL the channels, or one not harmonically related to 27 MHz, show symptoms of TVI, the problem lies elsewhere (most likely in the TV receiver itself). Because the second harmonic falls on 54 MHz, and is the most powerful multiple, TV channel 2 is the one most commonly affected.

Another important sign is the visual pattern of the interference. If the harmonic is potent and the TV receiver and the transmitter are very close, complete picture "blackout" may occur. Weaker harmonics might cause the picture to be broken up, leaving a jumble of light and dark lines, or cause a "negative" (light and dark areas reversed) to appear. More often though, "cross-hatching"—diagonal bars or lines in the picture—is experienced (Fig. 1). This pattern is caused by heterodyning between the harmonic frequency and the carrier picture frequency. They are wide and few in number if the frequency difference is small, and very fine and plentiful if the harmonic and video carrier are farther apart.

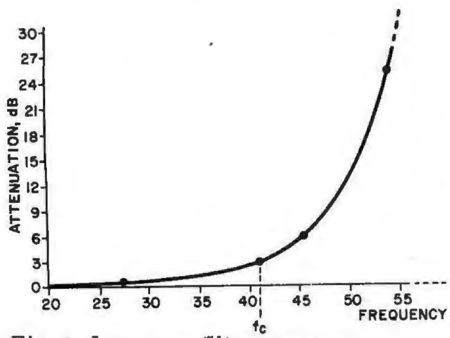

Fig. 4. Low-pass filter response.

Harmonics can also cause "modulation bars" or "sound bars," a series of dark and light horizontal bands across the screen that step with the syllabic rate of the CB'er's voice. (Fig.2). It's possible that sound bars may appear when the carrier is modulated even if no cross-hatching is produced by a "dead" carrier.

While it is sometimes possible to treat an individual receiver to eliminate the harmonic-caused interference, this is *not* the course to take. You are merely treating an isolated symptom, and not the source of the disease—the *transmitter*. The FCC clearly specifies that a transmitter output should be as "clean" of harmonics as possible. The minimum figure to shoot for is 50 dB below power output. In this case, the 4-watt output from a CB transceiver should contain no more than 40 microwatts of harmonic energy.

Harmonic Suppression. There are several ways to obtain a high degree of harmonic suppression.

First, manufacturers usually provide an internal trap tuned to 54 MHz to cope with the second harmonic. As shown in Figure 3, it's an LC series trap across the r-f output. The trap offers very low impedance to any 54-MHz output and, in effect, short-circuits them to ground. The fundamental on 27 MHz is virtually unaffected.

If you're causing TVI on channel 2, the trap could be misadjusted or defective. Check your owner's manual—some manufacturers give a standard procedure for tuning the trap. One technique is to watch the interference on a TV set tuned to channel 2 close to the CB rig. As you tune through an access hole on the chassis, adjust the trap for minimum interference to the picture. Some traps use a coil slug which should be adjusted with a plastic tuning tool. Others have a trimmer capacitor that should be tuned with an insulated screwdriver.

The FCC, incidentally, refers to this procedure in its regulations. They state that brief transmissions can be made (with the antenna connected), "when necessary for the detection, measurement, and suppression of harmonics. . . Test transmissions using a radiating antenna shall not exceed a total of 1 minute during any 5-minute period . . ." That's time enough to tweak a tuning trap.

A series-tuned trap can only handle one harmonic, the one to which it is tuned. There's another, more flexible approach — an outboard low-pass filter.

Low pass filters as the name implies, are designed to allow all energy below the "cut-off" frequency to flow unimpeded, while frequencies above that frequency are not allowed to pass. Low-pass filters for CB should have a cut-off frequency of about 43 MHz, leaving the CB signal virtually unaffected. The insertion loss, or the amount of desired signal lost in the filter, is often below 0.5 dB (which is negligible).

As we move farther above cut-off, higher frequency signals have an even more difficult route through the filter. A typical low-pass filter has a frequency response shown in Figure 4. Note that the cut-off frequency (f_c), at which the amplitude is reduced by 3 dB (one-half), is 41 MHz. A signal on 54 MHz, on the other hand, is attenuated by a whopping 25 dB to 3/1000 of its original strength). Add that to the harmonic suppression provided internally by the CB manufacturer and almost all interference will vanish.

Making Filters. Low-pass filters can either be made at home or bought assembled. There are a large number of commercially available models. They are rather simple, though, and the schematic of a good one is shown in Figure 5. All capacitors (use 100 and 70 pF in parallel to get 170 pF) should be 500-V silver mica components. Given in the schematic are the number of turns for each coil. Wind them with 12 or 14 gauge wire on half-inch (1.3-cm) ID forms, at 8 turns per inch. The dashed lines are metal shields. The entire assembly can be mounted in a 6" × 4" × 2" (15.2 × 10.2 ×5. l cm) enclosure.

The low-pass filter that you install (whether home-made or a commercial unit) should be inserted in the line close to the transceiver output via a short coaxial jumper. Then connect the antenna feedline to the ANT jack on the filter. Bond the chassis to a good earth ground.

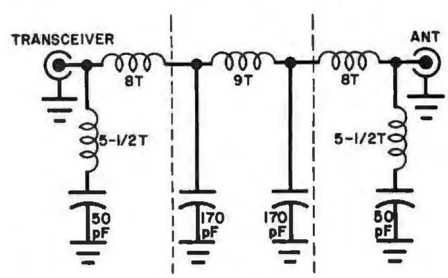

Fig. 5. Typical low-pass filter.

Another solution to the harmonic problem is to use an antenna matchbox. These devices, while designed to provide the correct output impedance for the transceiver, also add a degree of selectivity and harmonic suppression. In fact, a well-designed antenna-matching network can attenuate the harmonics by as much as 40 or 50 dB—all by itself! In many cases, they will clear up the interference, with the added bonus of allowing the final to work into a purely resistive load—the preferred order of things. ◈