SERVICE CLINIC

More about capacitors

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NOT LONG AGO WE DISCUSSED FILTER capacitors—the troubles they can cause, how to identify those problems, and so on. This month, let's take a look at some of the other types.

Bypass capacitors

In all, there are four classes of capacitors used in radio and TV circuits: filter, bypass, coupling, and tuning. *Bypass* capacitors do just what their name implies—they bypass unwanted signals straight to ground or common, to make the bypassed point a perfect ground for RF or any other AC signal. They can cause some easy-to-fix problems and some tough ones. The easy ones are when they're shorted. An unmistakable clue is the complete loss of the normal DC-voltage at the bypassed point, while the supply voltages are OK. A shorted bypass capacitor may also be responsible for dropping resistors heating up, so watch out for that symptom, too.

When bypass capacitors open up, we see something completely different. The former ground point now becomes hot, and all kinds of odd things can happen. Just as with filter capacitors, the most obvious symptom is feedback; we find signals where there should be none and those get into the power-supply circuits and into other stages. That can cause odd oscillations, beats in the picture, color problems, squeals in the sound, distortion, and other difficulties. We'll show you some horrible examples.

An open bypass capacitor in the wrong place can reduce the gain of an RF/IF amplifier stage. How? Look at Fig. 1-a. It shows an IF (or RF) stage with a tuned transformer. The signal voltage is developed between the top of the primary winding and ground. Let's say that the value of resistor R is 1000 ohms, and the impedance of the primary the same. We'll supply a one-volt signal to the primary. (Notice how I always use easy figures?) In normal operation, all of the signal voltage is developed across the primary, for the bottom end of the winding is ground for the signal.

If the bypass capacitor opens, though—as shown in Fig. 1-b—its lower end is no longer at ground potential and the total impedance is now 2000 ohms. We'll get only 0.5-volt of signal across each half of the primary circuit, and the gain of the stage will have been halved, with obvious results.

Fortunately, there's an instrument that will catch open bypass-capacitors in a hurry. You knew what I was going to say, didn't you? Yes—an oscilloscope. For a fast and accurate test of any bypass capacitor, just touch the probe to the bypassed point, with the scope's vertical gain turned as high as possible. You must see no signals at all; if you see *anything*, the bypass isn't working. In tube circuits, you can bridge a new capacitor across the circuit while the power's on. In solid-state sets, *don't!* Instead, turn the power off, tack in the substitute capacitor, and then turn the set back on. If the unwanted signal is gone and the symptom disappears, you've found the problem.

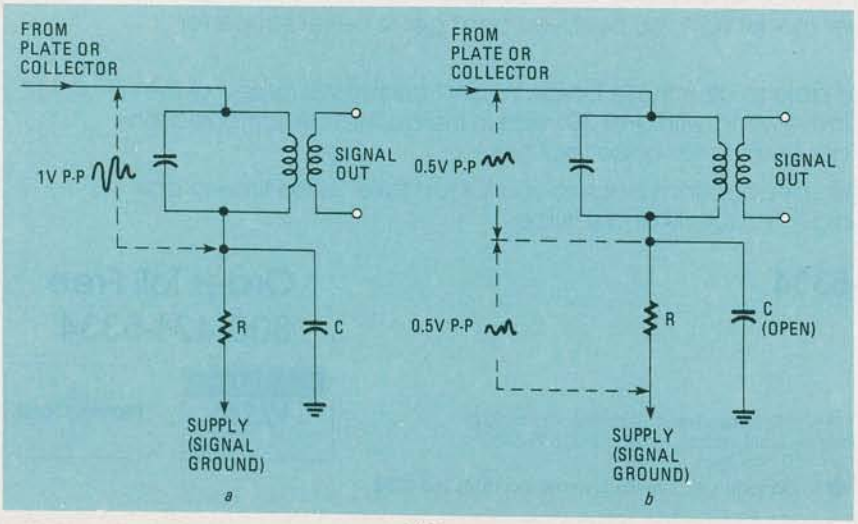

FIG. 1

There's one thing you must remember: the capacitor makes the bypassed point "ground." However, if the ground-end of the capacitor isn't *perfectly* grounded, you'll get the same results as you would from an open capacitor! That is especially applicable to PC-board sets, where the board is mounted on a "mother board" or a heavy metal-frame chassis. The metal frame is often the common ground for the whole set. All of the ground points on the PC board must make perfect contact with the common ground, or you'll have the mother and father of all feedback loops! That would have the same effect as opening up every bypass capacitor on the whole board!

Horrible example number one: My own ancient (ca. 1963) CTC-15 had more different trouble symptoms than you could shake a stick at. They were all intermittent, of course, and seemed to point to first one circuit, and then another, as the cause. I hunted and hunted and got nowhere, until one day it hit me. I got out my heavy-duty soldering gun and resoldered all of the seven ground points on the signal PC-board. Bingo! The symptoms went away and haven't come back yet.

The same thing has shown up in many of the newer sets; one Quasar (horrible example number 2) had similar problems. The cure was to run an extra ground-lead from the common of a very large filter capacitor on the back of the PC board over to the metal frame. Always suspect solder joints; to eliminate poor ones, re-do each joint and make sure the solder melts well and sticks cleanly. That takes only a little time and can solve some odd problems.

Horrible example number 3: A tube-type Philco color set had good color, but an odd background. The left half of the screen (vertically) was blue, the right half was gold. For once I got into the correct circuit early on—the bandpass amplifiers. The screen grid in the first bandpass-stage showed signals that shouldn't have been there. Shunting a new capacitor across the old got rid of the signals, and the problem.

I took the original out, and checked it

on my capacitance bridge just for fun. It looked perfect—the right value, no leakage, etc. When I put it back in, though, the problem came back. Then I noticed that the ground lead of that capacitor went all the way around the tube socket to a ground point on the other side, where other ground leads were tied. Hmm. I shunted the ground end of the capacitor to the chassis right at the body of capacitor with a test prod and the symptoms disappeared. I then soldered the ground end of the capacitor to the nearest ground lug I could find, and there were no more problems. The original ground lead was long enough to have enough inductance at the very high frequencies involved at that stage to cause feedback!

Coupling capacitors

Let's take a quick look at coupling capacitors. They're the easiest to check. The signal going in should be the same as the one coming out. If it isn't, the capacitor is open. That's all there is to it.

If the a coupling capacitor is leaky, the DC voltages in both input and output circuits will be upset and you will probably get distortion and low gain in audio stages. Little low-voltage electrolytics are very common in transistor circuitry; those cause a lot of the problems by opening up.

My guess is that a very common problem with dry electrolytics is an intermittent ground lead on the outside foil of the capacitor. When you find one that is definitely open, don't bother to take it out and check it! The heat of unsoldering the original will probably cure it but the relief will only be temporary. Don't mess around—replace the capacitor.

Here's one more common bypass-capacitor problem. If the emitter bypass-capacitor in common-emitter audio stages opens up, you'll have a horrendous feedback from emitter to base, severe distortion, and loss of gain. A clue to this is the presence of the same amount of signal on both the emitter and base; there should be no signal on the emitter.

I haven't covered all the things that defective capacitors can do to you, but I hope I've given you a few new ideas on the subject. Now, armed with your new knowledge, go out and get 'em! **R-E**