SERVICING HORIZONTAL SWEEP CIRCUITS

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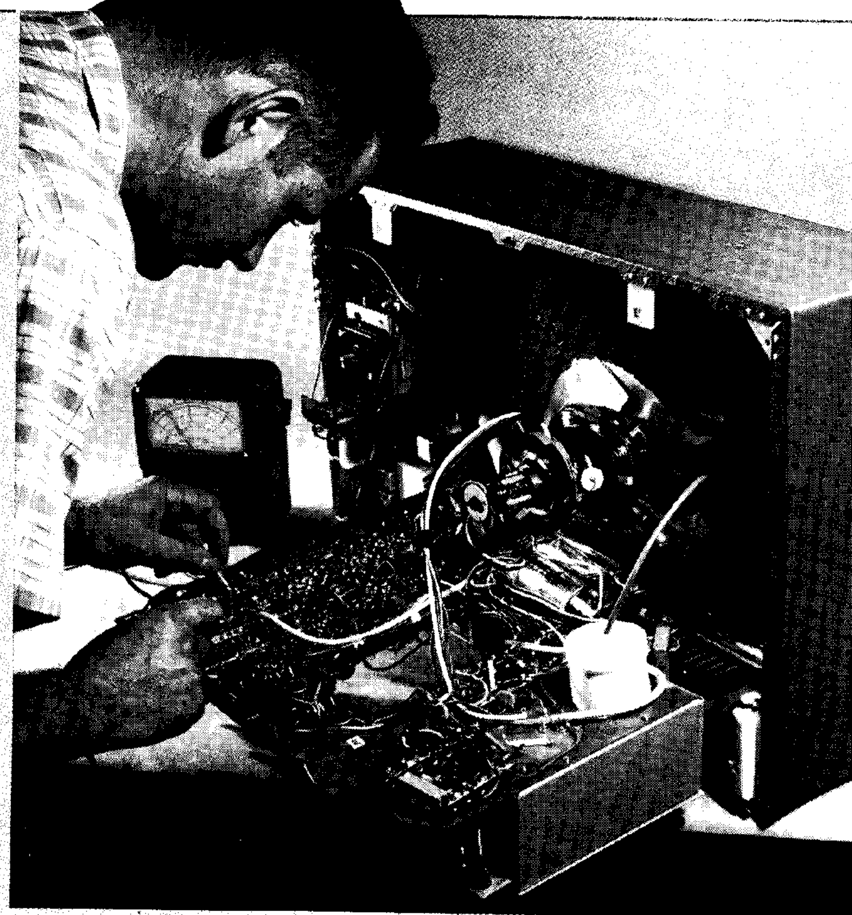
Here are some hints and tricks that may help you out the next time you run across that tough one.



TV SETS ARE GETTING TOUGHER TO FIX every day. Nowhere is that truer than in the horizontal-sweep circuit sections. Gone forever are the days when a simple multivibrator fed an output tube that drove a flyback transformer, which in turn energized the deflection yoke and the high-voltage rectifier. That was the basic sequence, with only slight variations, which was followed by just about all the manufacturers.

There were, to be sure, peripheral circuits that varied from system to system, and those could and did cause problems, but those problems were minor compared to what we face now. For openers, there's the switch from tube to solid-state stages. Even with a severely overloaded circuit, and the output tube glowing red, you could usually pull the plug in time to prevent any great damage. In modern, solid-state sets, however, it takes no time at all to lose a couple of expensive transistors to a sudden short.

Early solid-state sets tended to follow the design pattern of the tube models. The advent of modular sets made things even more simple, with many manufacturers putting the oscillator on one tiny plug-in board and keeping the output uncomplicated. A classic design was the Zenith EC/FC chassis of a decade ago. That set was so easy to service that few ever required shop repair.

That kind of a set just isn't made anymore. With most manufacturers abandoning modular construction, and with each one trying to outdo the others in sophistication, it's the home repair that has become the rarity. Oscillators and drivers now can consist of more than five transistors, and the failure of any of those, or their surrounding circuitry, could disable the system. In addition, we have overload protectors, shut downs, fail safes, and what-have you's that are supposed to disable the system should the high voltage go beyond specified limits. Needless to say, those suffer breakdowns of their own, compounding the problems they were designed to prevent.

In repairing modern sets, there's no room, or time, for error. It takes a fraction of a second to blow a $12 transistor, and only a fraction of a second more to blow another.

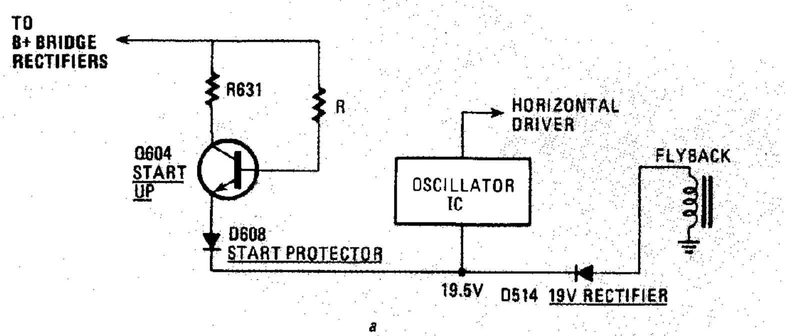
Essential equipment

Two pieces of equipment are essential in the repair of a modern set—an oscilloscope and a Variac. The scope is used to tell you if and how well things are working, and the Variac lets you work at relatively low voltage, giving you the time required to make some measurements before blowing things out. A variable DC supply is also nice to have, but a few six-volt dry-cell lantern batteries will do the job just as well; those are needed to check out the start circuits.

Start circuits

Oh yes, the start circuit, one of the nastiest things ever found in a TV set. Of course, we all know that transistors are incredible things; when one compares them with the slow-warming, hot-running, energy-wasting vacuum tubes that they replaced, one can really get to love them. One of the nice features of transistors is that give them 20, 10, or even just a few volts on which to run and they go into operation instantly. Using that feature, however, someone originated the start circuit, and like most bad habits, it proliferated.

Figure 1 shows two such start circuits. The one in Fig. 1-a was used by Sony some years ago, and the one in Fig. 1-b is used by RCA in some of their more recent sets. The principle behind both is the same. They generate a pulse of voltage at the moment of turn on; that pulse is fed to the horizontal oscillator and excites it into operation. The start circuit, having served its purpose, is then disabled. The voltage needed to keep things running—called, naturally enough, the run voltage—is taken from the flyback, recti-



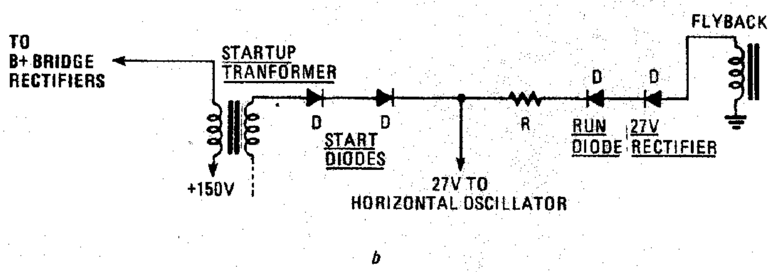


FIG. 1—TWO START-UP CIRCUITS. The one shown in *b* is used by RCA in many of their more recent sets.

fied, and fed to the oscillator at the same point in the circuit as the start pulse.

Now, that's all very nice, but it certainly has complicated life. If there is anything wrong on the output side of the circuit, loading it down, the run voltage will be affected, cutting off the oscillator. That can be quite a problem all around, but especially in those Sony receivers that used an SCR in the output. Sony called that SCR a GCS (*G*ate *C*ontrolled *S*witch). The nature of that particular device is that if it fails to receive its input signal, it self-destructs—instantly; it has no patience with a lazy oscillator. We have a "Catch 22" here. If the start circuit fails and/or the oscillator does not take off, the GCS shorts out. If the oscillator does in fact start up but is unable to keep running, due to some malfunction in the output side, the GCS shorts out. Either way, you lose.

When you come across a Sony with a shorted GCS (along with an open four-amp fuse and a shorted regulator transistor), the first step to take is to check out the oscillator. Using the start-up circuit for the Sony KV1920, shown in Fig. 1-a, we can see that the 19.5-volt bus supplies the power to the oscillator. The oscillator, however, can run on far less power than that, a fact that works to our advantage when troubleshooting the chassis.

We start by examining the collector of the driver transistor with the oscilloscope. Without plugging the set in, feed six volts DC to the circuit (positive to the 19.5-volt bus, negative to chassis); use either the variable DC supply or the batteries we talked about earlier. You should get a rock-solid signal at the horizontal frequency. It will be less than the 70 volts called for in the schematic, and it will be distorted, but this is not an operational set; all we are interested in now is whether or not the signal is there. If the signal is missing, find out why by working backwards. If it is there, tap the PC board in and around the oscillator. If you see any movement in the waveform when you do that, look for a poor solder joint, or other mechanical problem, somewhere. Even a slight flutter could be what caused the GCS to blow in the first place, so the importance in making sure that the signal you see is rock steady can not be overemphasized.

If you are satisfied with things to this point, it's time to get up your courage and install a new GCS. Once that's done, apply power to the circuit slowly, using the Variac. Start with 50 volts, and keep the oscillator running with the DC supply (or battery). As you increase the voltage, you should hear a rush of noise through the speaker at 75 volts, and at 80 volts a small raster should begin to appear.

If you do not hear that sound, stop! It means that the sound section is not getting its scan-derived voltage because the sweep system is not working. Increasing the applied voltage any farther is tempting fate.

The place to look for trouble now is on the output side of the GCS. Keeping the voltage at 75 volts will minimize the danger of destroying the GCS while using conventional troubleshooting techniques to track down the culprit: defective tripler, shorted scan rectifier, etc.

On the other hand, if sound and picture appear, back the voltage down to 75 and remove the battery; leave the scope attached, however. Check to see if the oscillator starts when the set is turned on. If it doesn't, the start circuit is probably bad. Check Q604, D608, and R631; that resistor will frequently be burned open. The cause of that can often be traced to a shorted 200-volt scan rectifier, or anything else that might knock out the run voltage forcing the start circuit to do more than was intended.

It's much easier to service a set in which the output is separated from the oscillator. A Philco 5CY81 that we recently came across is a perfect example (see Fig. 2).

The circuit breaker in that set was tripping. When the screws holding down the output transistor were removed, however, the breaker held. When the output of the oscillator module was scoped it turned out to be normal. Reinstalling the screws, the Variac was used to slowly apply power. When the voltage got to about 70, the breaker tripped. Troubleshooting was done by simply lifting each component in turn and reinstalling it until the culprit was found. In this case, when the pincushion transformer was unsoldered the breaker held. It turned out that the transformer had shorted turns.

That troubleshooting process was simple and straightforward in that instance because the oscillator module depended solely on the regular power supply for its operating voltage. By keeping the Variac at 75 volts, we were able to protect the transistor. Otherwise, at full AC voltage, each turn-on might have been its last.

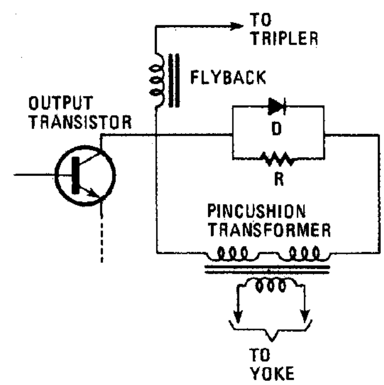


FIG. 2—A SIMPLE REPAIR. A shorted pincushion transformer was the cause of the excessive current drain in this Philco circuit.

Regulator outputs

In addition to run-start circuits, the newest RCA sets, such as the CTC97 (see Figs. 3 and 4), have another wrinkle to worry about: a regulator output. That is an SCR that supplies a regulated 114 volts to the output transistor.

Here's how to troubleshoot problems

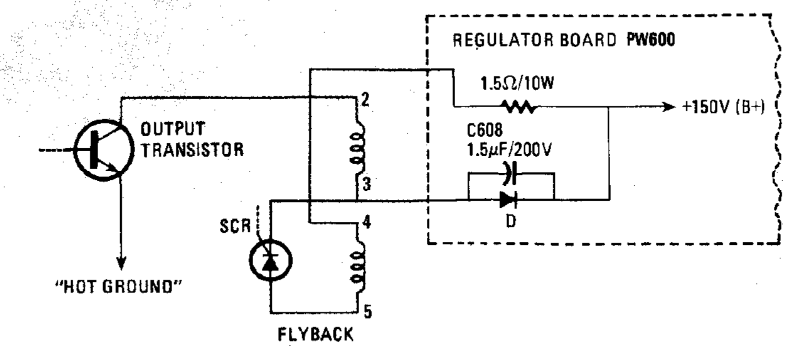


FIG. 3—THE SCR IN THIS CIRCUIT supplies a regulated 114 volts to the output transistor. The circuit is from an RCA CTC97.

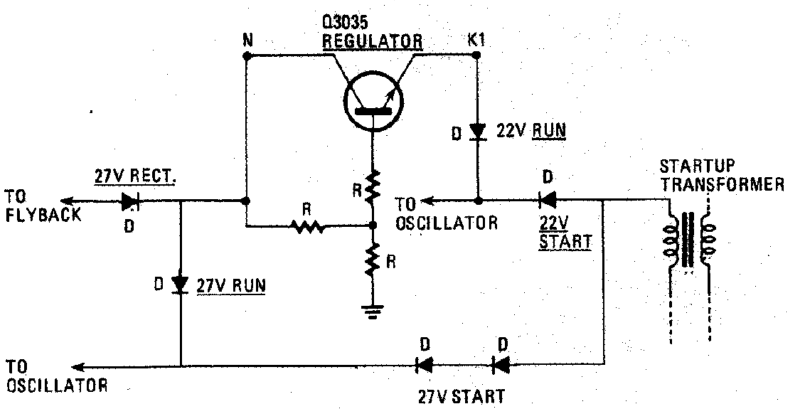


FIG. 4—ONLY THE 27-VOLT run voltage, applied to terminal N, need be supplied for testing. The22-volt run voltage is taken from the regulator transistor, Q3035.

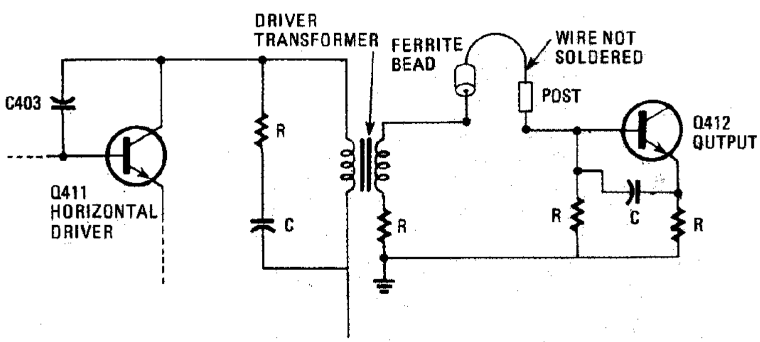


FIG. 5—AN UNSOLDERED WIRE and a leaky capacitor caused two unusual and hard-to-diagnose problems in the CTC108

involving that circuit. If a dead set has no output collector voltage (reading to a hot ground, not the chassis), and the B+ is OK, remove the SCR as a precaution and install a jumper between the anode and cathode connections in the circuit. Again using the Variac, bring the voltage to 90. Using the scope, keep an eye on the output transistor's collector voltage and make sure that it does not exceed 114. If the set comes on, that means that there is trouble somewhere in the regulator circuit that is preventing the SCR from being gated on. Check all components on PW600, the regulator board.

If, on the other hand, there is collector voltage, we have to troubleshoot the oscillator/output system shown in Fig. 4. Looking at that figure, we see that the oscillator depends on two run voltages—27 and 22. But we need only to supply the 27 volts at terminal N; the other voltage is supplied by Q3035. That 27 volts is supplied once again either with the DC supply or four six-volt lantern batteries in series; the negative connection from the supply or batteries is made to the chassis.

Once more we use the Variac and scope to go through the system. One CTC97 we saw required just about every technique mentioned so far to track down what was making the output transistor run so hot. With a jumper across the SCR, and four batteries running the oscillator, one after the other each part had to be patiently lifted until the cause of the problem was found. That may seem like an unprofessional way to go about things, but with complex closed-loop circuits like those, scope measurements become almost useless; as such, lifting components is all that is left. In the set in Fig. 3, when C608 on the regulator board was unsoldered, high voltage crackled. Replacing that leaky capacitor cured everything.

Unsoldered wire

Some problems are harder to track down than others. We remember one CTC108 that gave us a particularly bad time (see Fig. 5). With the battery hooked up, there was a perfect signal coming out of the driver transformer. With no signs of anything being shorted, we decided to temporarily clip a new output transistor into the circuit. Happily, that seemed to cure the problem as the set came on.

Changing that transistor on that particular set was no easy matter as it was soldered in and mounted in a difficult position. You can understand the dismay, then, when the set didn't respond with the new transistor installed. The funny thing was that when the old transistor, the one that was thought to be bad, was clipped into the circuit along with the new one, everything worked once again.

If you've ever been stuck with an oddball situation like this one, you know how time can melt away. You also know that sometimes, after spending hours looking at the underside of the chassis, the answer suddenly becomes obvious.

That was the case here. We knew there was an oscillator signal, but was it reaching the transistor? Being mounted on the rear apron, both the base and the collector were returned to the chassis by wires (the emitter was grounded to the apron). The base wire went to the bottom of a hollow metal post that served as a test point. A loop of bare wire came out of the top of that post, passed through a ferrite bead, and then was soldered to the foil connecting the driver transformer. As it turned out, the looped wire was just sitting inside the metal post—it had never been soldered—so the base was getting no signal. Had the transistor been more accessible, and had the signal been traced through, that would have been just a routine repair. Instead, confusion reigned as it appeared as if two transistors were needed. Of course, that was not the case because the one soldered on the apron was never really in the circuit.

continued on page 78

SERVICING SWEEP CIRCUITS

continued from page 66

Of course, you don't just get one typ of problem in a particular set. Conside another CTC108 with a completely dif ferent set of symptoms. In this instance with the battery in place there was a sig nal, but a poor one that in no way resem bled what was called for. Thus, there wa obviously some sort of problem with th oscillator. But was it the circuit itself o was it some problem in the shutdow circuit that was reacting with the oscil lator?

The first thing to do was to isolate th oscillator from the shutdown circuit. T do that, the shutdown transistor, whic was directly tied to the oscillator, wa lifted. But that had no effect and the sig nal was unchanged. All the oscillato driver transisitors checked out as OK, s the next step was to take some resistanc measurements. An unstable reading be tween the driver collector and groun finally led to the answer—a leaky 27-p capacitor, C403, across the driver.

It's enough to make one wish for th "good old days!" R-