DECEMBER, 1958 35 CENTS

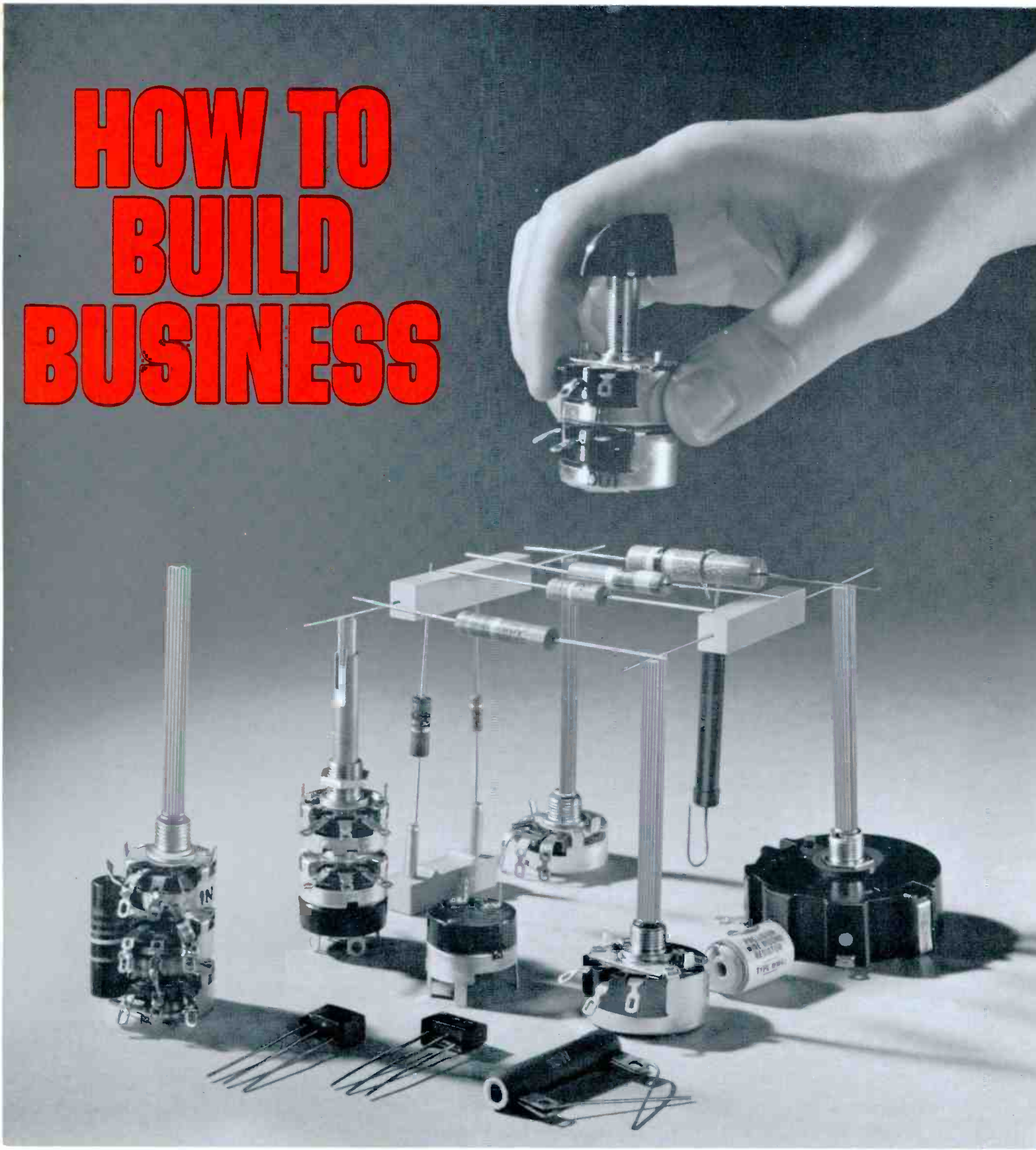
Howard W. Sams

PF PHOTOFACT® REPORTER

including Electronic Servicing

This Month's Highlights

IF Alignment Made Easy
Helpful Hints for PC Servicing
Troubleshooting by Waveform Analysis
Plus December Supplement To Sams Master Index



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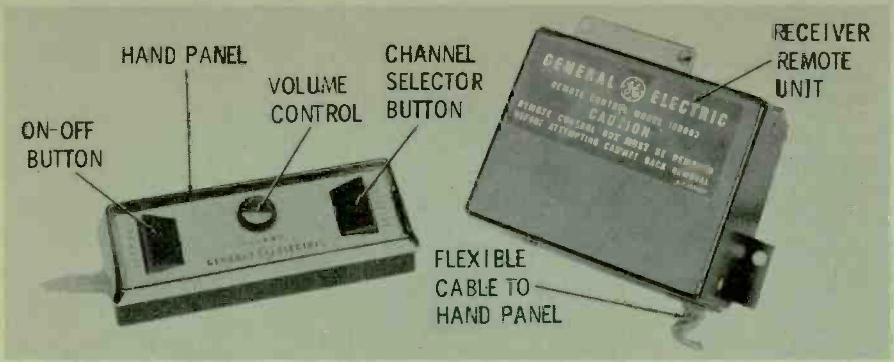
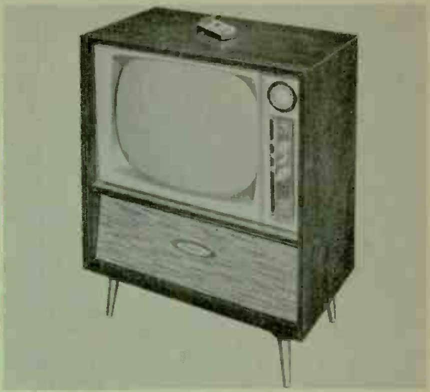
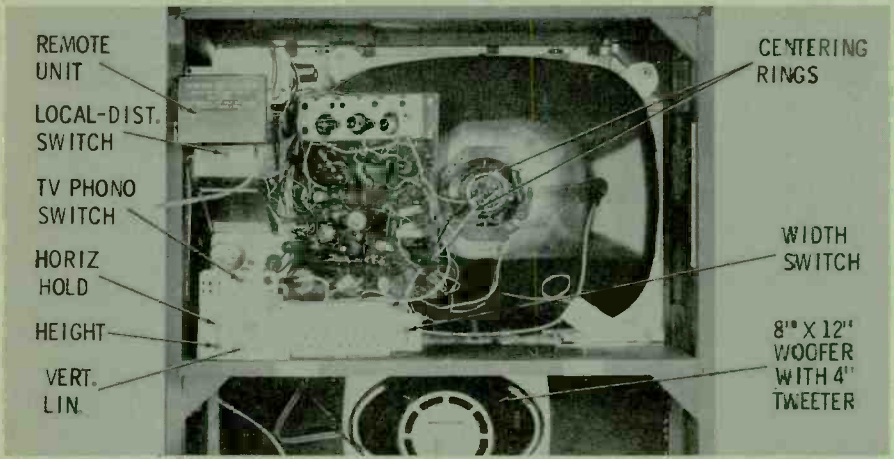
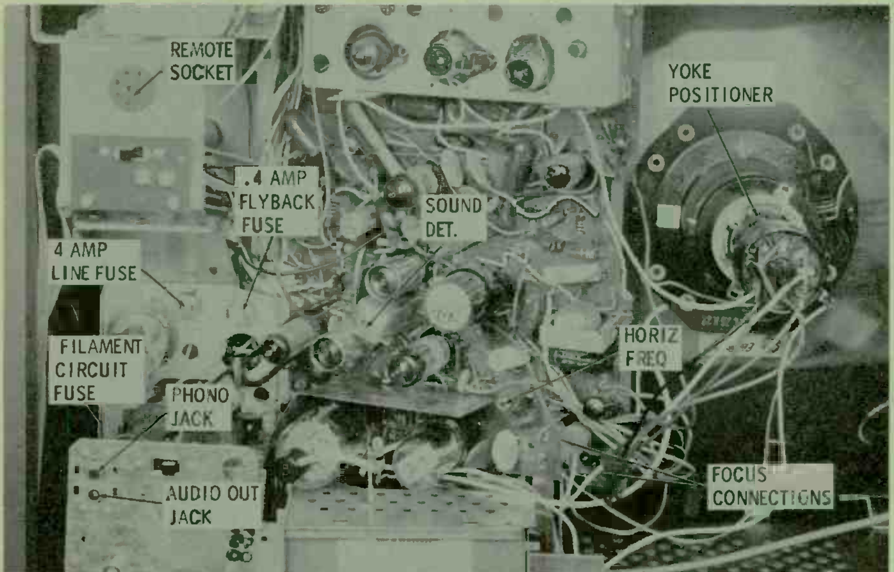








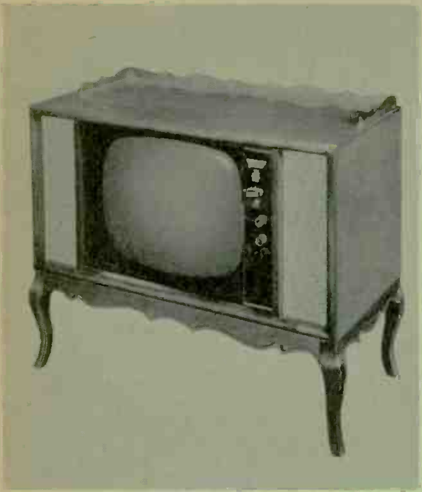
General Electric Model 21C2550 Chassis U3

Major features of this new 21" console include pushbutton tuning for all VHF channels, 3-way remote control, coaxial speaker system, and 110° picture tube. The hand panel of the remote assembly permits the user to turn the set on or off, select channels, and adjust volume continuously. A four-wire flexible cable connects the hand panel to the receiver's remote unit. This unit, containing only a transformer, relay switch, and thermal cutout, plugs into the rear of the set directly behind the tuner.

Removing the back from the set, you'll find all of the somewhat vertically-styled chassis mounted on the left side of the cabinet. The large printed wiring board, serving almost all circuits except the power supply and tuner, is placed on an angle following the contour of the picture tube. Service adjustments and tubes are all well exposed with the exception of the 1J3 high-voltage rectifier. This tube is housed in the cage below the printed board. Although it may not appear so, the picture tube and chassis can be removed from the cabinet as one complete assembly. The tube can then be separated from the chassis for easier bench servicing if desired.

Taking a closer look at the transformer-powered chassis, you'll find some newcomers in the tube lineup. In the third video IF stage, for example, the manufacturer has made use of a 6EW6. Others that might be mentioned are the 12DQ7 in the video output stage and the 6DN7 vertical oscillator-output tube. The paralleled filament circuit for all tubes is fused by a short piece of #26 wire located on a terminal board in back of the power transformer. The yoke positioner pointed out in the photograph can be loosened by using long-nose pliers to slip the end of the spring up and over the bend in the ring clamp. Terminal connections for the focusing anode of the picture tube are located in the lower corner of the wiring board.

The small pushbuttons around the channel indicator select VHF channels 2 through 13 and a UHF position for sets incorporating this feature. Fine tuning for each channel is a "one-set-and-forget" operation. Each button screws in and out as a fine tuning adjustment. Once they have been set up, the tuning device is automatically positioned whenever the channel is selected. For automatic channel selection using the remote control system, all buttons for non-operating channels should be screwed out. The motor-driven tuner will then select only the active channels chosen.



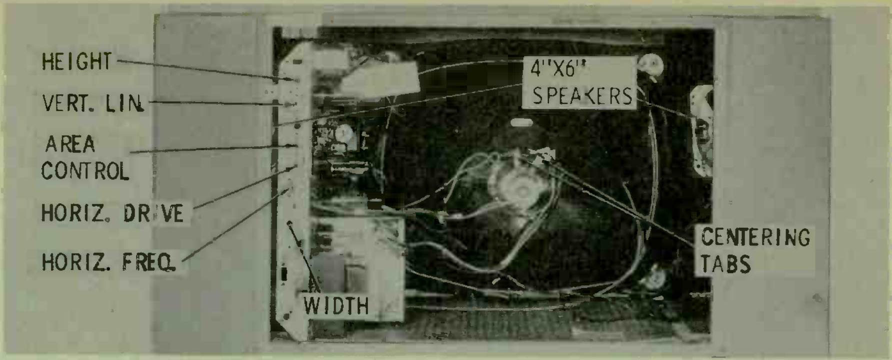
Hoffman Model SP3531 Chassis 341

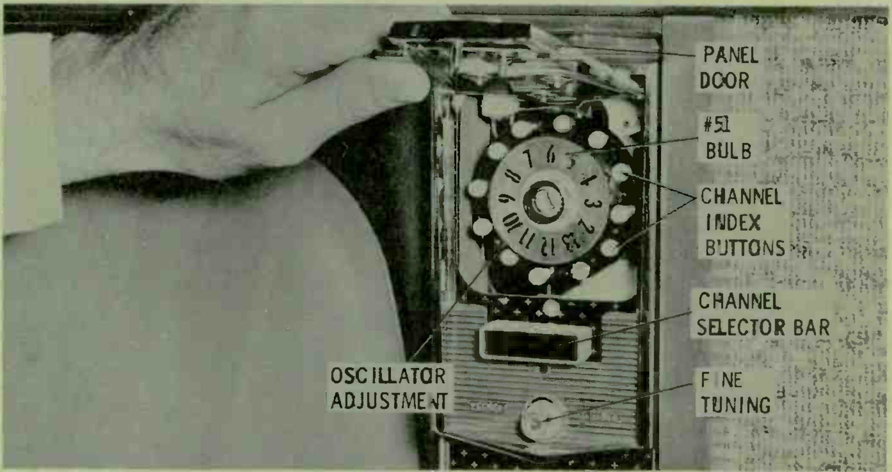
A hardwood cabinet, *Dyna - Touch* automatic tuning, and a 90° picture tube are featured in this 21" model from the *Signature Series* line. Removing the rear cover from this particular set, you'll find the transformer-powered chassis mounted upright along the left side of the cabinet. It has conventional wiring throughout and makes use of a Standard Coil VHF turret tuner. All service adjustments are on the rear apron of the chassis as shown. The AREA CONTROL is an AGC potentiometer electrically positioned in the plate circuit of the triode keyer.

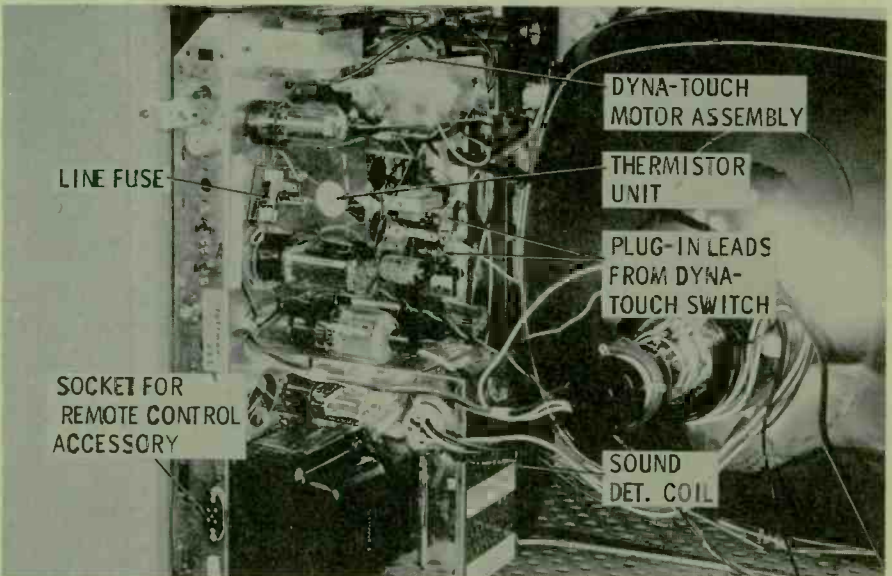
You'll find no manual channel selector with sets having the *Dyna-Touch* feature. The motor-driven tuner automatically selects channels by a touch of the bar knob on the front panel. To preset or index the automatic tuner, remove the push-on type selector bar and lift the small panel door upward. The index buttons are pressed in for desired channels and pulled out for all others. VHF oscillator adjustments are accessible through the front of the cabinet and may be set one at a time as the tuner turret is rotated.

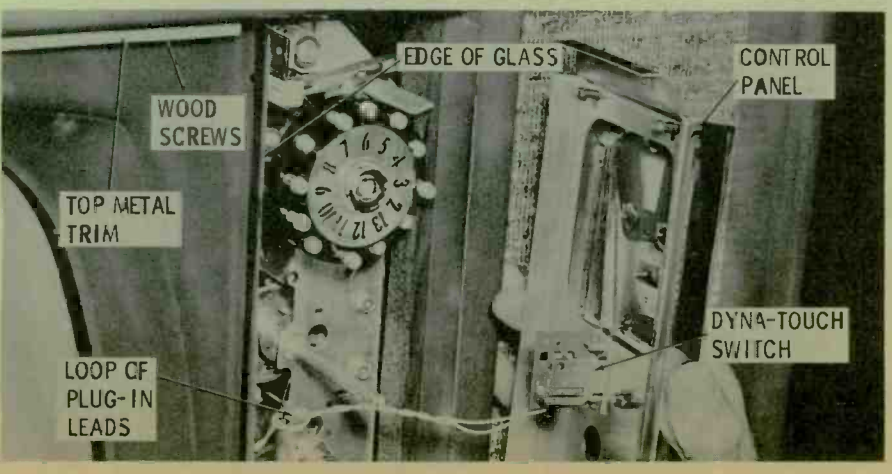
A 3-amp slow-blow fuse is physically located on top of the chassis near the rear, and is electrically in series with the AC input line. Directly in front of the fuse is a thermistor which acts as a surge-limiting resistor to control warm-up. This component should normally measure about 79 ohms when cold. A special push-pull switch labeled SYNC LOK is operated by the shaft of the brightness control. Another somewhat hidden feature of this chassis is the automatic spot-extinguisher switch found as part of the on-off switch on the volume control.

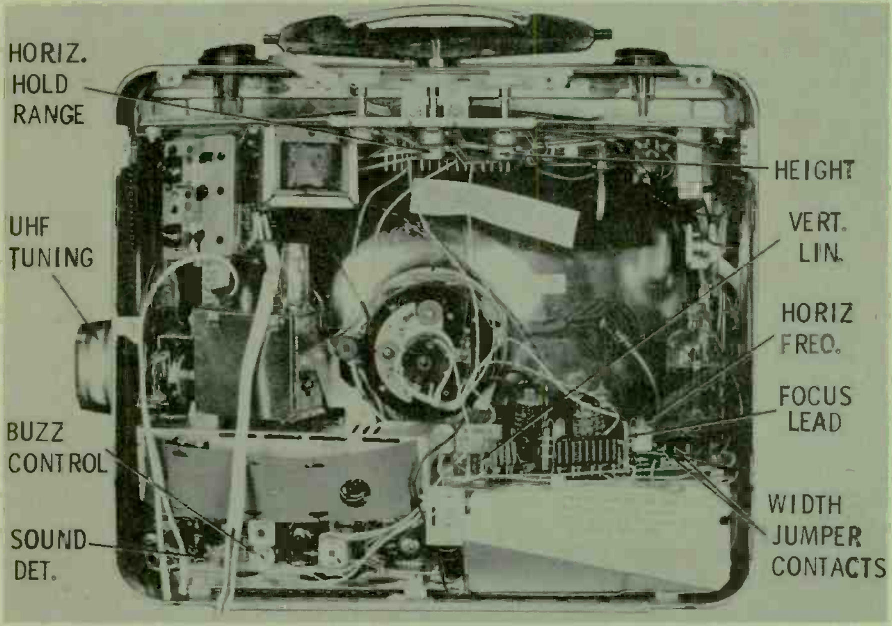
Since it takes a little doing to remove the safety glass on this model, you might heed the following. First, remove the rear cover from the set and disconnect the two *Dyna-Touch* switch leads from the terminal board on top of the chassis. While you're at it, also free the loop pointed out in the photograph. After removing the push-on control knobs, lift the front panel up and out of its bottom trim strip. To prevent damaging the cabinet, the control panel should be completely removed, not merely tilted to one side, when taking out the glass. Next, remove the four Phillips-head screws holding the top metal trim and remove the strip. Tilt the glass outward at the top; then pull it up and out of the lower trim piece.

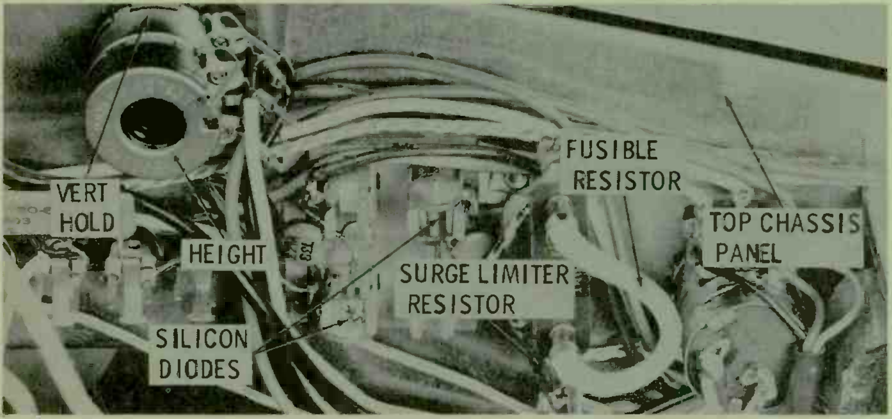


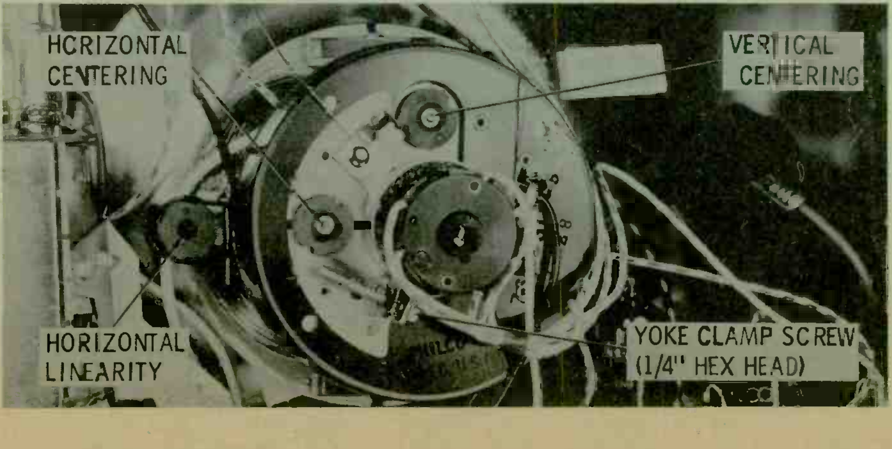


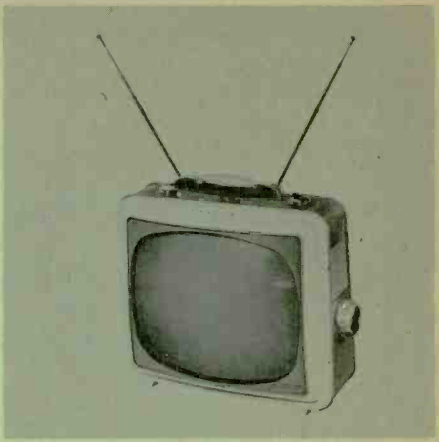












Philco Model UG3050GL Chassis 9H25U

The first time you are called on to service this receiver, you may not be in the customer's home. Instead, he may come strolling into the shop with it in one hand like a brief case. This particular *Slender Seventeener* incorporates the new short-neck 110° picture tube and both VHF and UHF tuners.

The *Scan-Tenna* assembly is a combination carrying handle and rotatable antenna. The antenna elements telescope into the handle and can be tilted up or down.

With the back removed, you'll find that the chassis forms a frame around the 17DAP4/SF17 picture tube. Three separate printed wiring boards are employed — one for the IF stages, one for the video and sound sections, and one for the sweep circuits. Horizontal hold range and height adjustments are positioned as rear sections of the two conventional hold controls. Each may be adjusted with the use of a thin screwdriver through the shaft of the front control section. Picture width may be increased by placing a jumper across the two outside terminals on the sweep board.

The "hot" chassis features two silicon rectifiers in a voltage doubler B+ supply. Both are tucked under the top chassis panel, where you'll also find the B+ and series filament resistors. The plug-in fusible unit has a value of 5.6 ohms, while the surge limiter should measure about 200 ohms cold and 3.5 ohms hot. In sets featuring only a VHF tuner, however, the resistor used will have a value of 400 ohms cold and 10 ohms hot.

Picture centering is accomplished by rotating two magnets, which are imbedded in the yoke assembly as shown. Horizontal linearity correction is also a magnet adjustment located just to the left of the yoke. Although they appear to require special alignment tools, these magnets can usually be turned with your fingertips.

You might keep in mind that the 1G3 high-voltage rectifier has a short bulb and should be replaced only with the same type. A taller 1B3 will come too close to the flyback transformer and usually cause arcing. All other tubes in the set are of the special 450-ma series-string variety. Since you may not have these tubes in your caddy yet, here's the entire lineup:

3 CY5-RF amp.	4CS6-sound det.
6BR8A-conv.	12ED5-audio out
3AF4A-UHF osc.	13DE7-vert. osc/out
4DE6-1st IF	2EN5-hor. phase det.
4 DE6-2nd IF	9AU7-hor. osc.
6AM8A-IF/vid. det.	17DQ6A-hor. out
8AW8A-vid. out/noise inv.	17D4-damper
12AZ7A-sound IF/sync	1G3-HV rect.

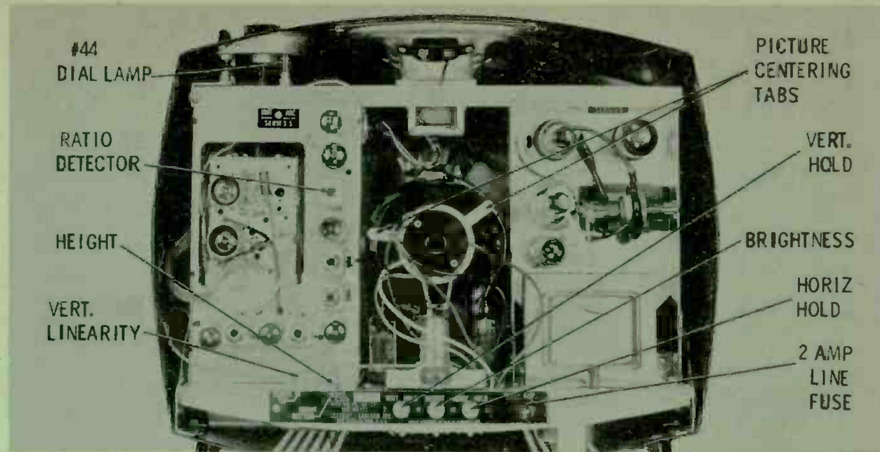
Setchell-Carlson Model P65 Chassis C105

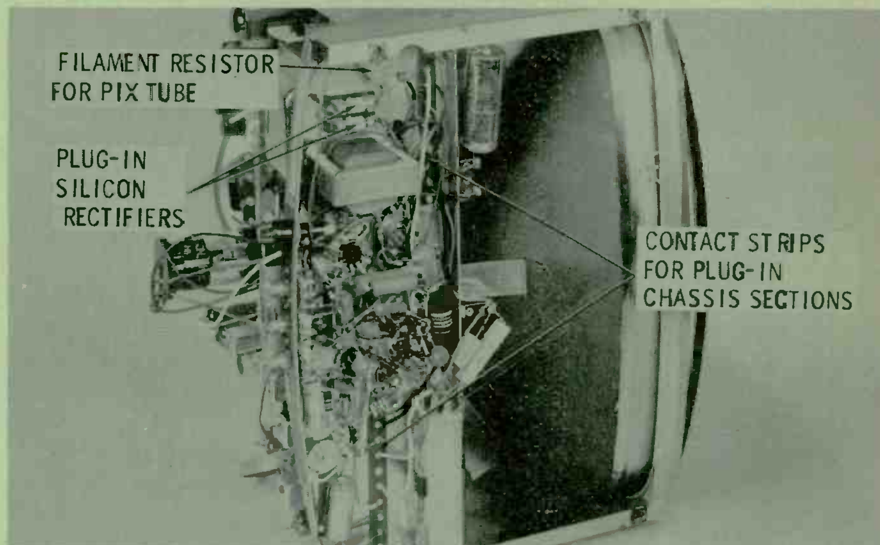
This new portable with top tuning features a combination horizontal and vertical chassis built around the neck of the picture tube. All tubes are easily reached with the cabinet back removed. This includes the 6DQ6 horizontal output tube, the 6AX4 damper, and the 1G3 high-voltage rectifier which are out in the open and not housed in a separate compartment. All service adjustments are shown in the rear cabinet view. Don't bother to look for horizontal frequency, drive, linearity, or width, because they are not used.

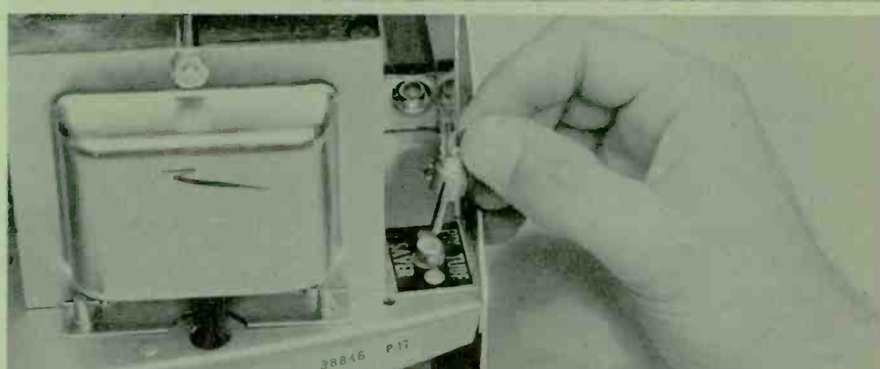
Taking the chassis out of the cabinet by removing four screws from the bottom and resting the entire assembly on its side, we can examine the conventional-type wiring of the lower chassis section. Although the set contains two silicon rectifiers, it also employs a power transformer with secondaries isolated from the line. Filaments of all tubes except the picture tube are connected in a conventional parallel arrangement. 1N60 crystal diodes are employed in the video detector and horizontal phase detector stages, thus reducing the number of receiving tubes to only 15, not counting the high-voltage rectifier and picture tube.

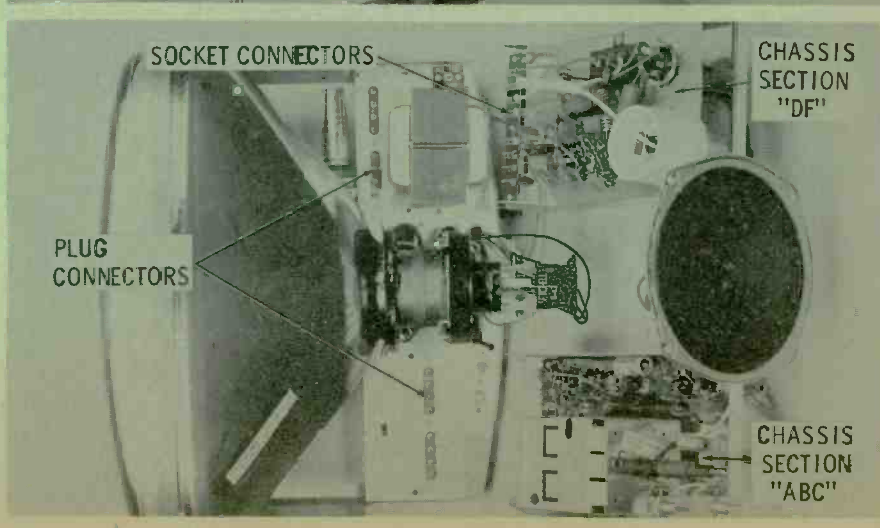
One unusual feature of this receiver is its special PIX TUBE SAVER jack located on the rear corner of the bottom chassis near the power transformer. When the picture tube ages and is slow in warming up or lacks enough brightness, the user or serviceman merely inserts the "saver" plug into the chassis jack as shown. This acts as a built-in booster which increases cathode emission by stepping up the heater voltage. Voltage for the filament circuit of the CRT is supplied from a special 7- to 8-volt tap on one winding of the power transformer. This voltage is reduced, however, by a 3-ohm resistor connected in series with the heater and in parallel with the *saver* jack. The *saver* plug shorts out the dropping resistor, thus permitting all of the supply voltage to be applied across the heater.

The vertically mounted sections of the chassis consist of two plug-in units that can be entirely removed from the bottom horizontal section. To free either plug-in unit, remove the two hex nuts under the lower chassis, and unplug the contact strip by lifting up on the whole assembly.









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NEXT MONTH

Servicing Sync Circuits
Descriptions and photos of trouble symptoms as they relate to specific component faults.

Mobile Radio Installation
A picture story showing techniques used to install various radio communication units.

Low-Voltage Power Supplies
The heart of every electronic unit is the B+ source. Do you know all you should about it?

CONTENTS

ABOUT THE COVER

This month's theme is rather obvious, "The joy is in the giving." When the picture-taking was all over, a 5-year old lass, who had been curiously eyeing the proceedings, slowly approached our costumed serviceman. With her head quizzically cocked to one side, mouth slightly agape, and eyes wide with wonder, she managed to squeak in a small, half-sure voice, "Hi, Santa." The resulting size of the lump in ol' Santa's throat we'll leave to your imagination.

MERRY CHRISTMAS!

USE HANDY CARD AT BACK TO ENTER YOUR SUBSCRIPTION

Letters to the EDITOR

Dear Editor:

Is it possible to get back issues of *Video Speed Servicing* — that is, those which were published before the feature appeared in PF REPORTER?

H. L. PAYTON
Seattle, Wash.

Yes, these have been compiled into two volumes. Limited quantities of Vol. 1, in loose-leaf binders, may be purchased at $4.95 each. Bound editions of Vol. 2 are $2.95.—Ed.

Dear Editor:

Here is a servicing tip that overcomes the annoying problem of keeping the deflection yoke up tight against the bell of a test picture tube such as the 8XP4. For a long time, I have been using an old dual ion trap with the magnets removed. Its springs grip the neck of the tube tightly enough to keep the yoke where it belongs — much simpler than using jigs, brackets, clamps, etc., as described in many published items.

DAVID GREENE
Philadelphia, Pa.

A simple clamp is a highly effective holding device, as we can testify from long experience in our own labs. A suitable type of clamp was described and pictured on page 59 of our June, 1956 issue.

The only drawback is that the tube must depend on the yoke for support, a tough situation in newer TV sets where the yoke is neither attached to the chassis nor equipped with long enough leads so that the check tube will rest on the bench. Even though jigs and brackets are somewhat complex, they have the advantage of keeping a firm grip on the entire check-tube assembly.

"Floating" yokes are generally fastened to the picture tube by pinch clamps equipped with rubber pads. These devices are ideal for keeping yokes anchored on the neck of any picture tube, including a check tube.—Ed.

Dear Editor:

Why do the ads in PF REPORTER so often portray TV servicemen wearing bellhop uniforms? I wonder if other servicemen resent this as I do. In these parts, our servicemen are rather well-dressed.

Name withheld by request

We go along with the comments set forth in "Dollar & Sense Servicing" last August under the heading, "Right Dress." Briefly, this point of view maintains that either uniforms or "dress-up" clothes are appropriate; which you use depends on the impression you wish to create.—Ed.

Dear Editor:

The October issue is very good, especially the article by Stan Prentiss about the old Philco set. This treatment of a volume-produced TV receiver is the best yet, and it should be repeated on other highly popular brands such as Zenith and RCA. Don't bother with sets that haven't reached the market in large volume.

As for marking a chassis with the correct PHOTOFACT Set number, we have been doing this on every set we have repaired since the first issue of PHOTOFACT came out. We mark both the chassis and the rear cover of the cabinet with red crayon.

JOSEPH G. ARTZNER
Malvern, Ohio

This just proves what we've always thought — old TV sets never die. Stan Prentiss will continue his series on popular old sets — see the RCA KCS47 coverage in this issue.—Ed.

Dear Editor:

I liked the *TV Hospital* idea in the October *Dollar & Sense Servicing* column. Lately, I've been using the enclosed card in my own business. It has caused a lot of talk, and I now have almost twice as much work as I used to have.

CHARLES H. BOND
South Braintree, Mass.

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'Nuff said?—Ed.

Dear Editor:

I would like to contribute a few suggestions for names that might be given to service shops specializing in hi-fi or commercial sound: High, Wide and Fi; Sound Sound; Dr. Sound; or Guy-Fi Sound.

ROBERT D. LAYTON
Hemet, Calif.

Like we've always said, our readers are highly imaginative.—Ed.

Dear Editor:

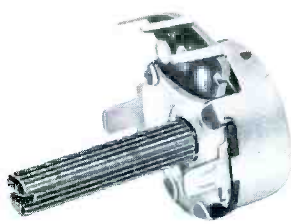
I found your article on *Pocket-Sized Portables* (July, 1958) so interesting that I decided to look up the circuit of the General Electric Model 766A radio. However, this receiver was not listed in the *Master Index* to PHOTOFACT *Folders*.—Why?

RICHARD RUFER
Hayward, Calif.

Very simple: It's a brand new receiver! The PHOTOFACT *Folder was being prepared at the time our article was written, and was recently issued as Set 417, Folder 5.—Ed.*

> As announced in the September issue, PF REPORTER subscription rates increase to $4.00 per year effective Jan. 1, 1959. By acting before this date, you can extend your current subscription at the present, lower rates. A handy order card is bound in at the back of this issue for your convenience.

ready, willing and able



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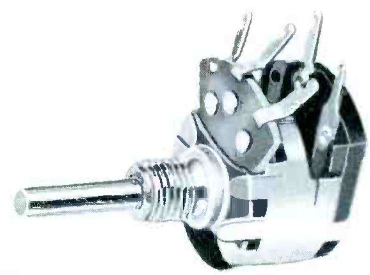

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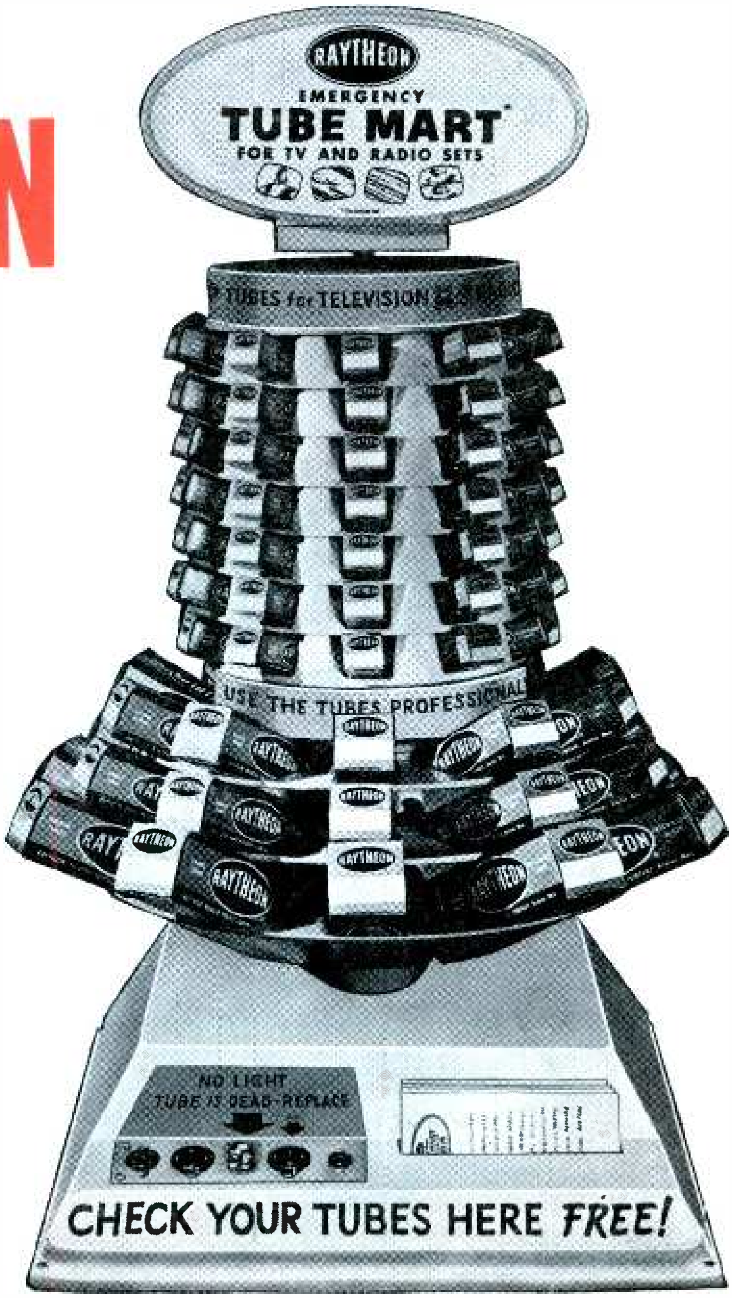
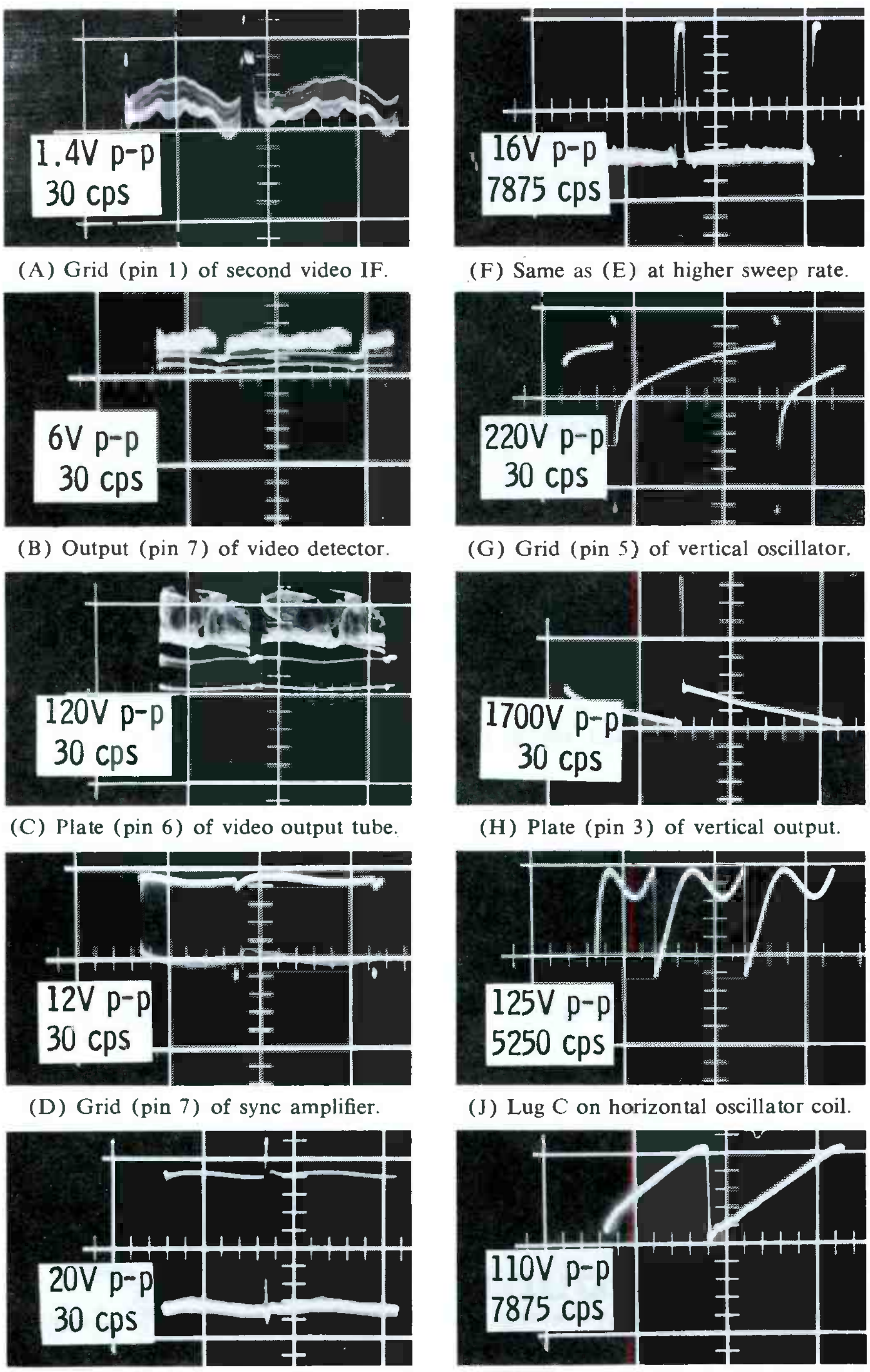


across the BENCH

by Stan Prentiss



(A) Grid (pin 1) of second video IF.

(F) Same as (E) at higher sweep rate.

(B) Output (pin 7) of video detector.

(G) Grid (pin 5) of vertical oscillator.

(C) Plate (pin 6) of video output tube.

(H) Plate (pin 3) of vertical output.

(D) Grid (pin 7) of sync amplifier.

(J) Lug C on horizontal oscillator coil.

(E) Plate (pin 6) of sync amplifier.

(K) Grid (pin 5) of horizontal output.

Fig. 1. Waveforms observed in RCA Chassis KCS47A during normal operation.

RCA Chassis KCS47

Although these fine old receivers are going into their ninth year of operation, we still find them on the bench from time to time. There must have been a fabulous number of these sets made. After I finish repairing one of them, hardly any time passes before I'm back at work on another. There are several versions of this excellent old chassis, designated by different suffix letters. For a complete cross-reference guide to various models and chassis in the KCS47 production run, refer to Table I.

Tunable buzz in the audio and tendancy toward loss of horizontal sync have both been common complaints in these receivers, especially since they have reached a ripe old age. Unfortunately, there are no quick cures; about the only remedy I've discovered is a good, long session of checking voltages and waveforms to find defective parts.

Since the PHOTOFACT Folders for this chassis series didn't include waveform pictures, I have assembled a series of normal waveforms taken from the "A" version. All of these patterns, presented in Fig. 1, were taken in a medium-to-high signal area with an oscilloscope having a flat vertical frequency response from DC to 4.5 mc. A low-capacitance probe was used wherever necessary. The peak-to-peak voltage amplitudes listed for each waveform may be used for reference if your local signal conditions and your test equipment's capabilities are taken into consideration.

I recently serviced two KCS47's that had the characteristic troubles I mentioned. The first one was guilty of picture flickering, tearing, and occasionally a complete loss of video. The sound had a buzz that varied with the setting of the fine tuning control and was always loudest when there was a considerable quantity of black in the picture. The second receiver also buzzed in the same manner, and it invariably lost horizontal sync when the televised scene changed from the program to a commercial. Both receivers lost sync when the contrast control setting was reduced. Let me show you what procedure I followed in correcting these faults.

TABLE 1—VERSIONS OF RCA CHASSIS KCS47	
Chassis Suffix	**Models Where Used**
None; T	6T53, 6T54
A; AT	6T64, 6T65, 6T71, 6T74, 6T75, 6T76
B	7T103, 7T104
C	7T112, 7T122, 7T123, 7T124
D	7T132
E	16T152
F	7T103B, 7T104B
G	7T112B, 7T122B, 7T123B, 7T125B
GF2	7T111B

Begin with Power Supplies

In any electronic troubleshooting procedure, it's a good rule to check power-supply voltages as the next step after testing tubes. Circuits can't function right unless they have proper DC operating potentials. In the KCS47 chassis, there are three B+ voltages (none negative) with plenty of electrolytics for ripple filtering. Two of these voltages, the 370- and 115-volt supplies, are relatively constant regardless of signal conditions. However, the intermediate 200-volt supply is subject to considerable change when signal is applied. This shift in voltage is due to a changed conduction level in the RF amplifier, all four IFs, and the first video amplifier, all of which are connected to the 200-volt supply.

With the antenna disconnected, the intermediate B+ supply is just about 200 volts. A fairly strong input can cause this potential to rise to at least 250 volts. This normal variation can cause quite a bit of confusion when troubleshooting this branch of the B+ circuit. Fortunately, though, it is usually rather easy to spot the culprits responsible for defects here.

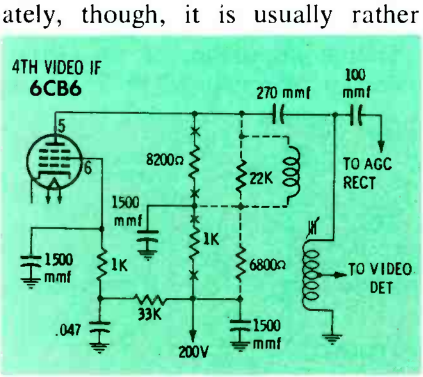


Fig. 2. Modifications to fourth video IF circuit of RCA Chassis KCS47.

First, determine if the voltages at the other two power-supply taps are normal. If not, pull the 5U4G rectifier tube and make sure that the RMS readings on plate pins 4 and 6 of the socket are at least 350 volts (measured from each pin to ground). A correct reading at this point is a clue that the power transformer is operating properly, at least when not under load.

Further investigation should begin at the filter capacitors and proceed, if necessary, to other principal points in the B+ circuit. Uniformly low readings mean leakage or a partial short from the power supply to ground, while abnormally high readings indicate an open condition in a load circuit which normally draws heavy current.

Under usual conditions, the 370- and 115-volt supplies measure well within a 5% tolerance. If they are okay, but the 200-volt supply seems suspiciously low or high, you can immediately turn your attention to the plate and screen circuits of tubes supplied from the latter. Before you permit the power supply to pass inspection, check the ripple waveforms on the various B+ lines to make dead certain that the various filter capacitors are doing a good job of removing hum and pulse interference.

Check the IF's

When you are satisfied that the power supply is working normally, connect an antenna to the set and measure the DC voltages at the grids of the first three video IF amplifiers. VTVM readings ranging from —3 to —5 volts indicate that these stages are operating and that there is no DC leakage through their coupling capacitors. At this point, if you wish, you can apply a demodulator probe to the plates of the video IFs and see if the waveform shapes and amplitudes are anything like those shown in Fig. 1A. If they aren't, better recheck the IFs to find out why. By the way, don't be in a hurry to

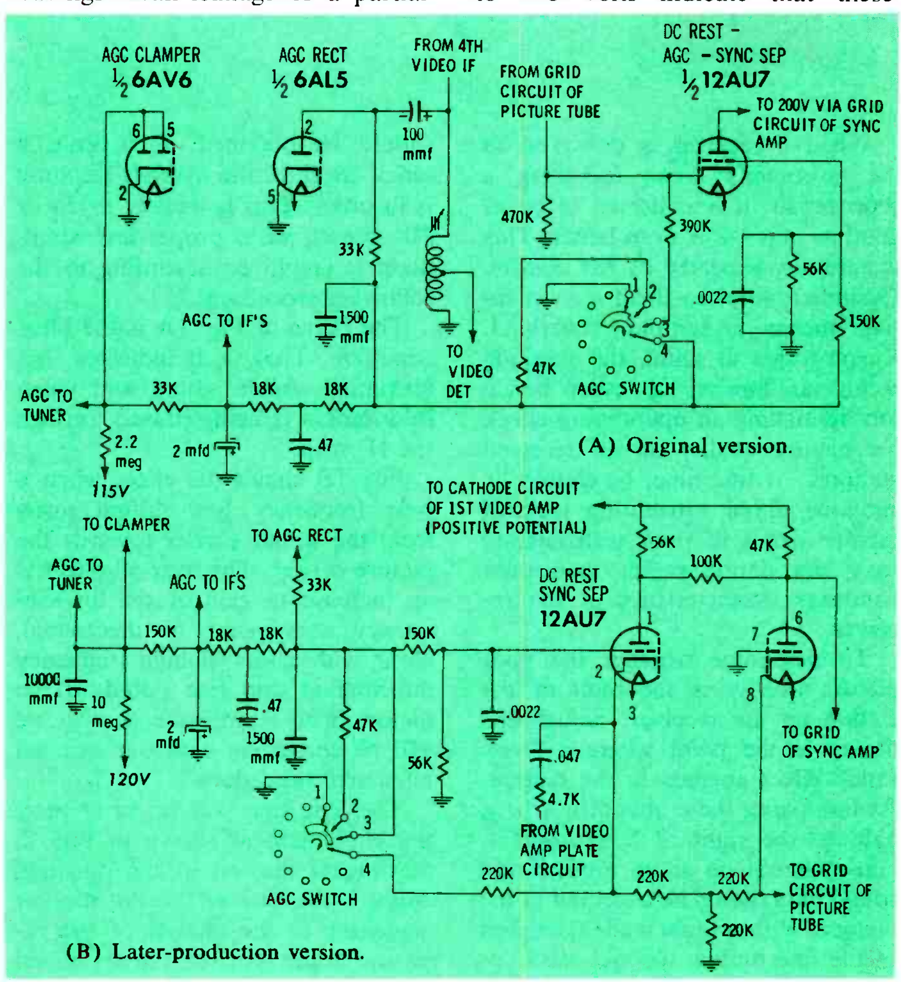


Fig. 3. AGC circuit of RCA's KCS47.

• *Please turn to page 63*

how to check and improve the performance of TV sets

by Mike Martynec

IF alignment made easy

When a receiver is delivered to the customer's home following a shop repair, it is expected to be as good as new — or even better. This is naturally expected by Mr. & Mrs. Customer, since to them a shop repair means a complete overhaul. Keeping this in mind, the thinking technician finishes up every bench job by making an operational check for picture quality on all received stations. At this time, he should be cautious about attributing lack of picture detail to poor transmission from the station rather than poor bandpass characteristics of the receiver.

To determine whether the poor picture quality is the fault of the station or the receiver, adjust fine tuning to the point where a "wet-sand" effect appears in the picture. At this point, there should not be a halo to the right of large objects, audio should be at its loudest and sound bars should be observed in the picture. With a slight readadjustment of the fine tuning, the wet-sand appearance and sound bars should disappear and a sharp, crisp picture should be obtained. If it isn't, a quick check of the over-all response is in order. This is usually a 15- or 20- minute job if proper test equipment is employed according to the following procedure.

The curve of Fig. 1A is the ideal condition. That is, it indicates that maximum usable sound and video information is being passed through the IF strip.

Fig. 1B shows the effect when a pole frequency has shifted away from the sound carrier towards the picture carrier. The over-all effect is an increase in gain of the low-frequency component of the signal, along with a loss of high frequency information and fine detail in the picture. This is, in essence, what we will be correcting with our over-all alignment procedure.

The first step will be to connect the equipment as shown in Fig. 2. Starting at the left of the drawing, connect the ground of the marker generator to the chassis of the receiver. If the receiver chassis is tied to one side of the AC line, use an isolation transformer to protect the receiver and test equipment. The marker output is clipped to the receiver chassis near the mixer plate output or near the grid of the first video IF stage. This connection may be moved slightly, depending on how much marker injection is realized.

Fixed bias is connected to the AGC line to prevent overloading and to insure normal operation for the gain-controlled stages in the tuner and video IF strip. In older receivers, where AGC is developed at the video detector, 2 to 3 volts of bias is ample. However, keyed AGC circuits may require more bias for proper operation. (See service literature for correct bias levels.)

The scope ground is tied to chassis ground, and the scope input connected to the video detector load resistor. This point is frequently called the "looker point." Horizontal sweep for the scope will be supplied from the sweep generator. This automatically synchronizes the scope's horizontal trace with the sweep frequency of the generator signal.

Output impedance of the sweep generator, normally 52 or 75 ohms

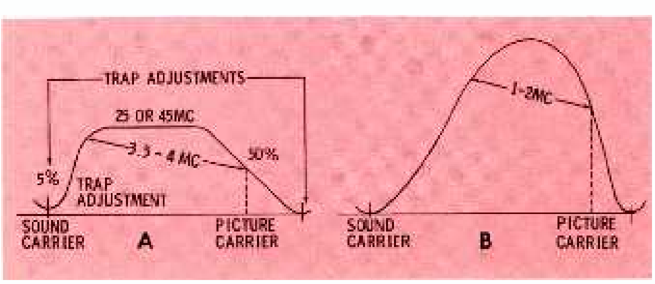


Fig. 1. Over-all IF response curves.
(A) Ideal curve—broad, flat top. (B) Excessive low-frequency gain.

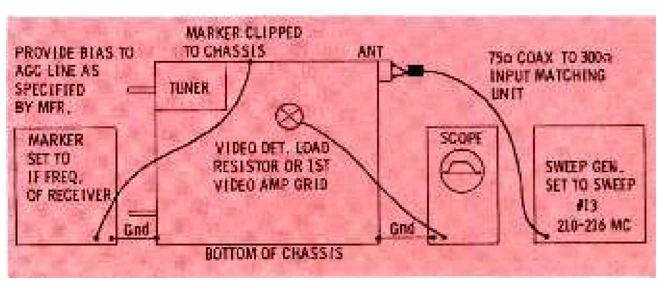
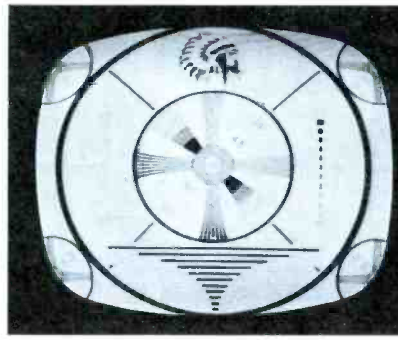


Fig. 2. How to connect test equipment to receiver for an IF alignment job.

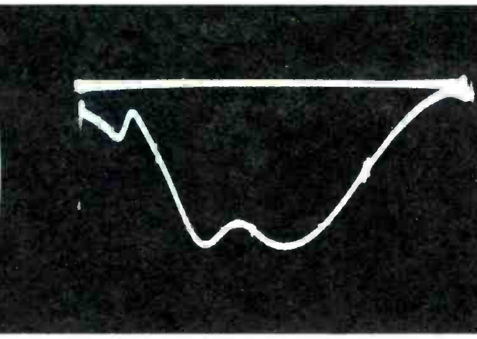
unbalanced, is matched to the 300-ohm balanced antenna input of the receiver through a simple resistive network (see Fig. 3). The sweep is adjusted for a center frequency of 213 mc so that it will cover Channel 13. Sweep width will be at least 6 to 8 mc to insure viewing the total response curve.

All necessary test equipment is now properly connected. With the receiver tuned to Channel 13, adjust the sweep generator center-frequency dial until a response curve appears on the scope screeen. During this operation, you may experience several similar curves. Choose the one nearest the Channel-13 calibration point. Now, converge the retrace curve, using the phase control on the sweep generator. Decrease marker and sweep outputs to a value that will still allow the response curve to be seen at maximum usable scope gain. Adjust bias to the level specified in the service literature. By increasing the output of the sweep generator, it will usually be possible to flatten out the top of the response. This is misleading and shows that overloading is occurring. Ease up on sweep generator output until the response curve does not change shape when the gain is reduced or increased slightly. Now inject just enough marker to see the pip, and you are ready to make adjustments. For those who have not set up for alignment before, the foregoing may appear awkward at first; but, after 2 to 3 setups, it will take less than 5 minutes to do.

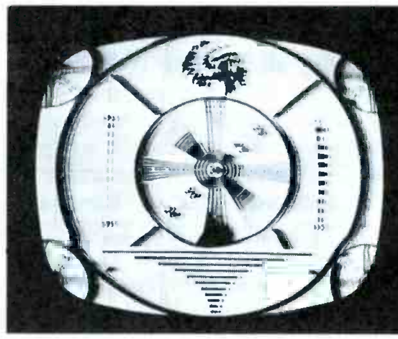
From the service data, obtain sound and picture IF frequencies along with any trap-alignment procedures. Assuming the curve of Fig. 1B is realized, adjust the mixer-plate and video IF points slightly to determine which one controls the high-frequency end of the bandpass curve. A slight adjustment should cause the response to approach that shown in Fig. 1A. A touch-up of the other adjustments should then produce a normal curve. Be sure to set the traps as specified by the technical data. Uncouple the test equipment and air-check the receiver. Set the fine tuning control to the center of its range and retune the local oscillator on each channel to obtain best sound and picture. You will be pleased with the results! After 2 to 3 over-all alignments you will very likely become "alignment happy," but this will soon wear off. ▲



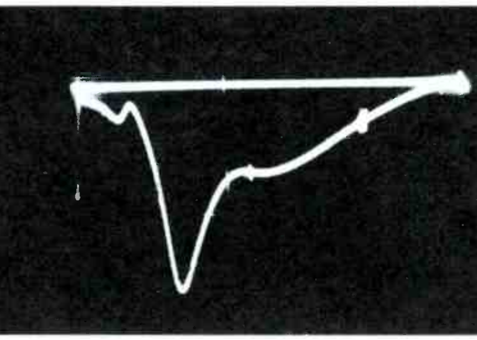
Clarity of detail, absence of ringing, and a lack of smear in large areas indicate that test pattern is normal.



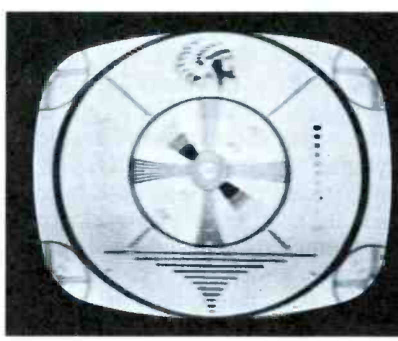
In a normal IF response pattern, the video carrier is at 50% of peak amplitude and sound carrier is at 10%.



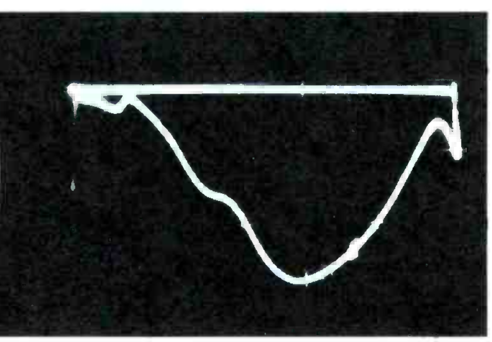
When picture detail is fuzzy but the scanning lines are sharp, a loss of high-frequency response is indicated.



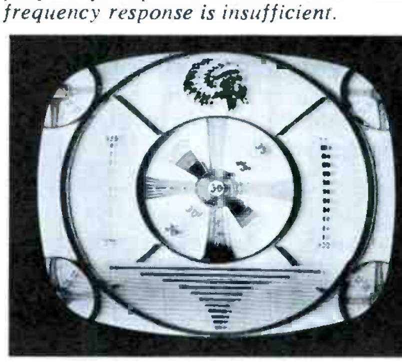
Attenuation of high video frequencies will occur if the IF response curve shows poor gain near sound carrier.



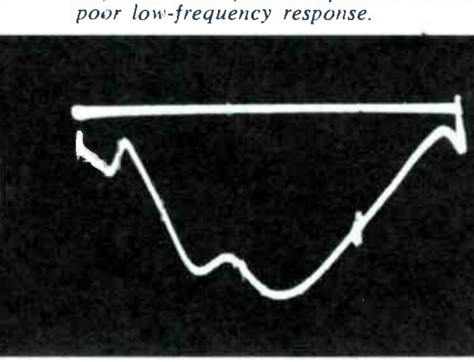
Ringing and smear result when high-frequency response is excessive and low-frequency response is insufficient.



Peak indicates excessive high-frequency response, while flattened portion indicates poor low-frequency response.



If low- and high-frequency response are both excessive, a combination of smear and ringing will be produced.



The video-carrier marker falls too high on the curve, which is peaked more on the low side than on the high side.

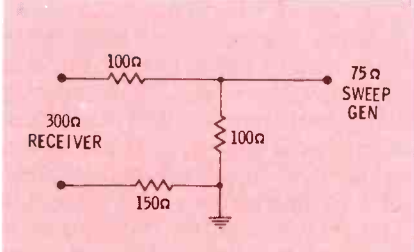


Fig. 3. This resistive network matches generator output to receiver input.

A Lot of Talk. Commercial and industrial two-way radio systems are operating all around you, often in places you may not realize. Congestion in the frequency bands used by these services has become so severe that "split-channel" operation has been adopted; that is, bandwidths have been cut in half to accommodate double the number of stations. The industry is now busy changing over from the wide-band to the narrow-band system.

Typical of the uses recently found for two-way radio is the system used on city transit buses in Rochester, N. Y. Mobile units in all buses allow the drivers to keep in touch with dispatchers at the bus company's offices. Since all emergencies, breakdowns, and traffic delays are reported promptly, the dispatcher can readily reroute buses to close up gaps in service and prevent the "bunching up" of buses caused by traffic jams.

Are you interested in servicing mobile radio? Before you are allowed to touch the inside of a transmitter, you need to obtain at least a second-class radiotelephone license from the FCC. In case you have wondered, this license *does not* require that you learn Morse code, as would be necessary for a radiotele*graph* license.

$ & ¢

Man At the Front. After finishishing a series of house calls, have you ever felt as if you've been up in the front lines fighting a battle? In a sense, that's what you've been doing, for the serviceman is spearheading the electronic industry's drive to make its products more useful to the public.

Among all highly-trained technical people, the serviceman stands alone as one who must be able to deal effectively with human beings as well as mechanical devices. In connection with their recent All-American Awards program, Mr. Irvine D. Daniels of General Electric Co. put it this way: "The serviceman must not merely solve highly intricate electronics problems—but must tailor the solutions to the personalities, needs, and desires of individuals." The most brilliantly designed equipment is a flop without someone to keep it functioning well enough for the owner to get his money's worth.

Difficulties are bound to arise when complicated electronic devices are put into the hands of the non-technically-minded public; but, with the serviceman doing his part to supply practical answers for these problems, further electronic developments even more revolutionary than TV will be able to take their place in American life.

$ & ¢

Lemon. Pity the customer whose new TV set has several failures during the first few months. About the time of the third or fourth breakdown, he may unhappily conclude that the set is hopelessly defective and that he's been stung.

If he's following this train of thought, admit that he has had an unusual run of bad luck; but point out that there's no reason why the set should be doomed to a lifetime of trouble. Explain that all the trouble may have been "smoked out" (but don't talk *too* optimistically, since another defect or two may be lurking under that chassis).

When you encounter a set whose sorry history has earned it the label of "lemon," give it a more thorough going over than usual. Take time to determine if any circuits are unusually critical in adjustment or otherwise border on defective operation. You may lose a few dollars on the job, but the money will be well spent if you make a friend out of the customer.

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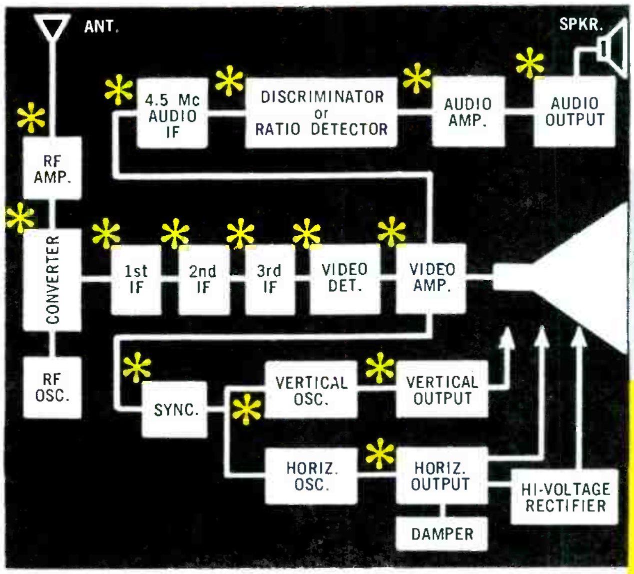

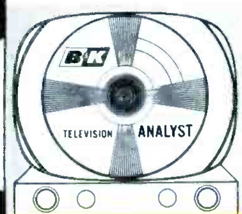

and watch the ← result on the TV set itself

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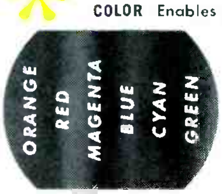

Generates white dot and crosshatch patterns on the TV screen for color TV convergence adjustments.

Generates full color rainbow pattern of orange, red, magenta, blue, cyan, green to test color sync circuits, check range of hue control, align color demodulators, etc.

SET ADJUSTMENT Enables you to check and adjust the vertical and horizontal linearity, size and aspect ratio of television receivers.

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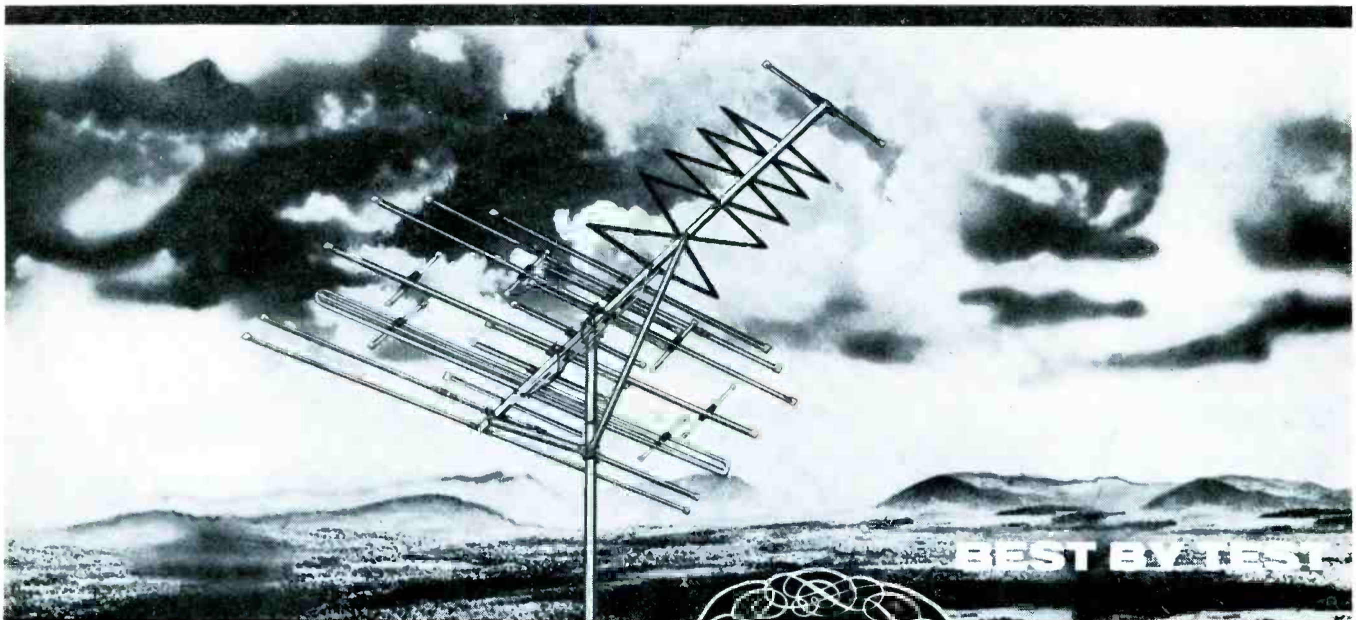

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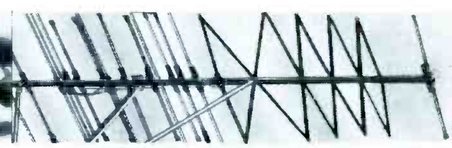

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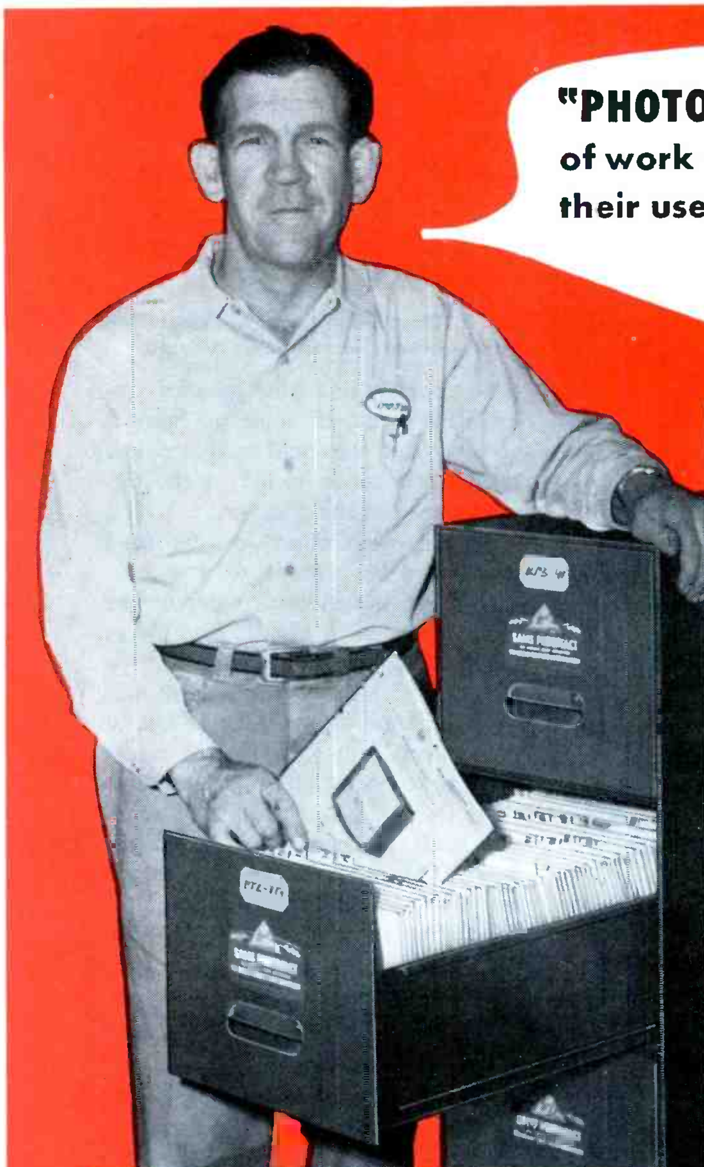

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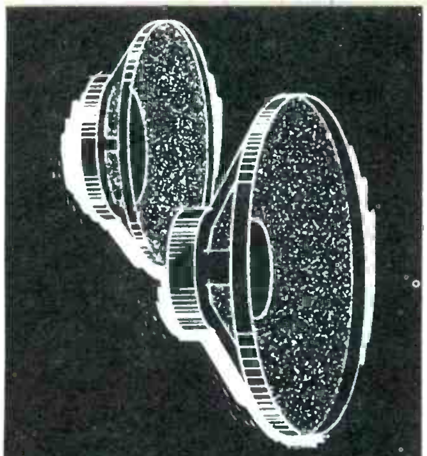

AUDIO FACTS

servicing HI-FI equipment

part 2

by Alan Andrews

Hi-Fi systems are usually made up of a number of individual units which are interconnected through cables and switches and operate together to reproduce full-range sound. All hi-fi rigs contain a speaker system, a power amplifier, a preamplifier, and either a phonograph or an AM-FM tuner. Deluxe outfits may have both a phonograph and an AM-FM tuner as well as a tape recorder. Trouble occurring in one unit can interfere with the operation of other units; thus, before a trouble can be corrected, it must be localized to a specific unit. Once this has been accomplished, only the faulty unit need be considered. Troubles encountered in a hi-fi system fall into four main groups: no output, distortion, hum, and noise. This article will present methods for recognizing and isolating troubles in these categories.

No Signal Output

When the customer's complaint is no signal output, the first thing to determine is whether or not the condition exists for all signal inputs. If, for example, records can be played normally but no radio programs can be received, then the tuner is probably at fault. However, if there is no output when any signal source is being used, the trouble must be in some unit common to all signal inputs.

If the speakers are completely dead (no output at all, not even hum), the fault is in either the

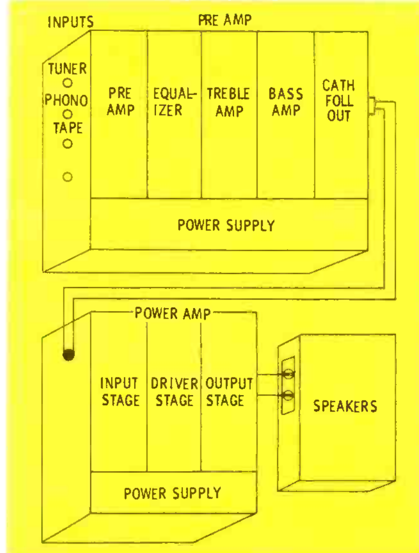

Fig. 1. Block diagram of hi-fi system is handy guide for localizing trouble.

power supply or in the speaker system. However, if noise or hum is coming from the speaker, the fault is most likely to be found in the circuits ahead of the speaker.

Signal substitution can be used to localize the trouble to a specific section of the system. Consult the block diagram in Fig. 1. Starting at the output, the test signal can be connected to the speaker terminals to make sure the speaker is not at fault. Then it may be applied at the input and output of each successive stage (working back from the speaker) until the signal is no longer heard. This procedure will isolate the trouble to a single stage, thus simplifying the process of locating the

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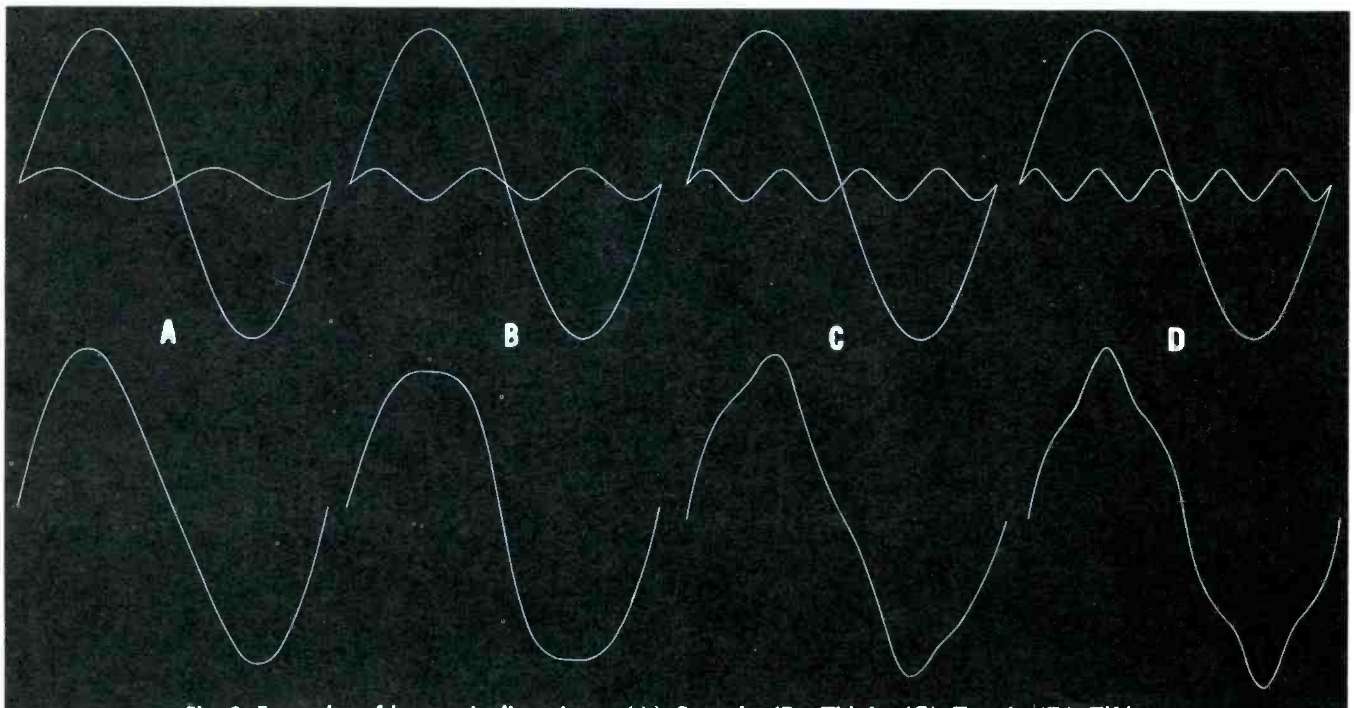

Fig. 2. Examples of harmonic distortion. (A) Second (B) Third (C) Fourth (D) Fifth

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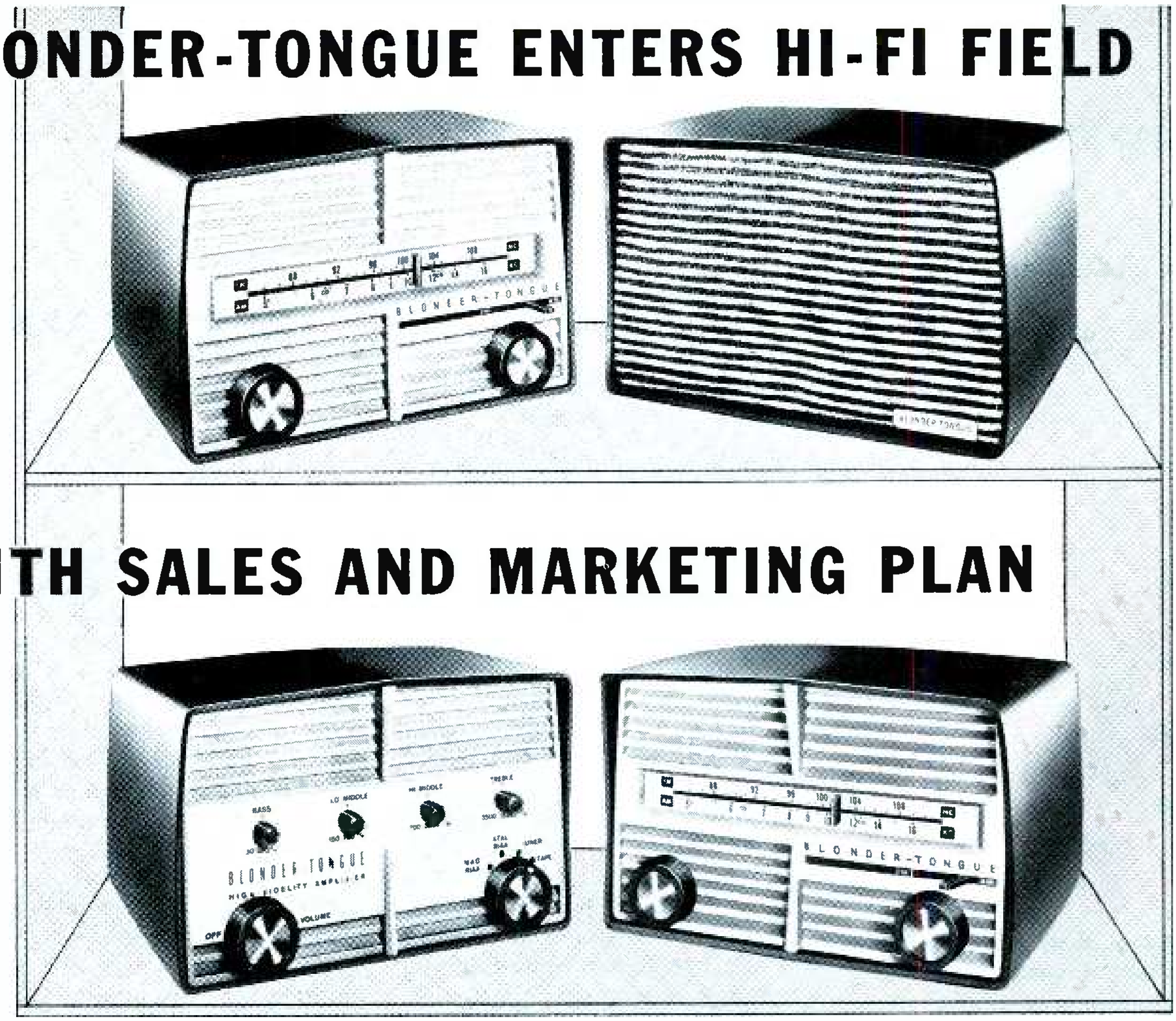

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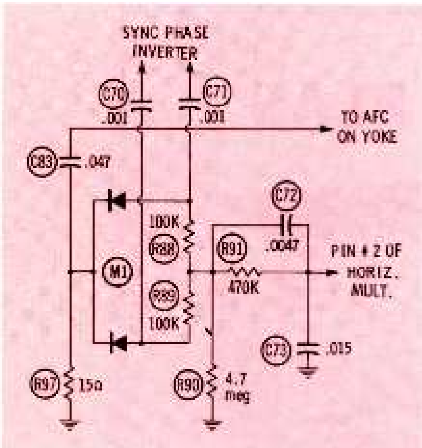


Fig. 1. Selenium-diode horizontal AFC circuit in Admiral Chassis 19YP4PRS.

Printed circuits are here to stay, so it's up to us to find efficient ways of servicing them. Essential test instruments for printed-circuit work include not only a reliable scope and VTVM, but also a good capacitance-resistance checker—one that measures power factor, capacitance, insulation resistance and leakage. If you are still checking the latter two characteristics with an ohmmeter, you are making it hard for yourself. The scope and VTVM are needed to get you as close to the defective part or parts as possible; then you can start checking individual parts. To do this on a PC board, don't start clipping parts and soldering new ones in their place. This practice is not only time-consuming, but can result in other troubles of your own making.

Watch me while I perform some typical PC service jobs. I won't go into any detailed discussions of trouble symptoms and their causes, but I'd like to show you how defective parts are located and new ones are installed.

For our first job, let's examine an Admiral Chassis 19YP4PRS. According to the customer, the picture is a "scrambled up mess," while the sound is okay. After making several checks with the scope, I know that the trouble is located in the horizontal AFC section. I even have a hunch that the dual selenium diode (M1 in Fig. 1) is the culprit. After unsoldering one of the end terminals, I test this diode section for both forward and reverse resistance with an ohmmeter. The first diode seems to be OK, so I'll unsolder the other end lead of M1 and test the other diode section. Sure enough, this one is defective. When I clip in a new dual selenium unit, the trouble disappears.

Now we have the problem of permanently installing the new component. First, I pick out a drill bit just the same size as the diode lead wire. Inserting it in the old "egg beater," I drill a hole in each of the solder-filled eyelets from which I have removed a lead. Insertion of parts is now a very simple matter. I poke the leads of the new component through the drilled out holes, bend over about ⅛" of lead wire, and solder.

While I think of it, I would like to mention a word or two about soldering. I use a 100-watt gun or iron and employ the tap method. That is, I get my iron hot—then, holding the solder next to the wire lead, I tap the wire lead without touching the foil. If a one-second tap or touch is not sufficient, I try one more. Never hold your iron on the lead or terminal while it is heating up. *First* make sure it will melt solder; then apply it to the terminal.

If I had been in more of a rush to complete this job, I might have figured that the dual diode was probably bad—so I might as well go ahead and clip it out before testing, rather than going to the trouble of unsoldering the leads. Of course, I would be taking the risk of ending up with a perfectly good diode having leads too short for reinsertion into the circuit, but this situation

• *Please turn to page 56*

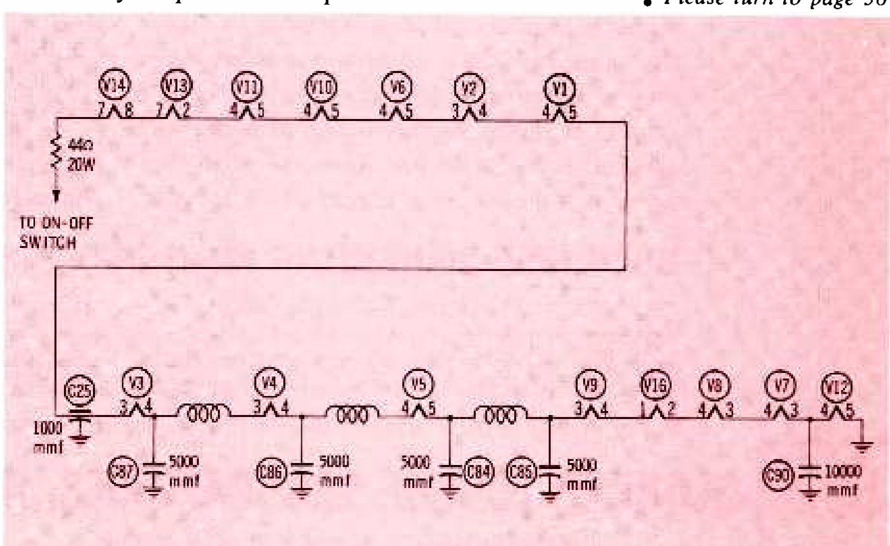


Fig. 2. Heater-cathode leakage in V5 caused V9, V16, V8, V7 and V12 to go out.

Sylvania comparisons point out—

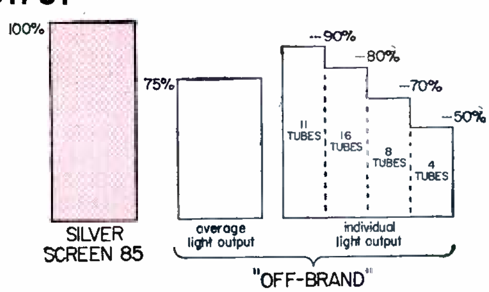
The big difference in Picture Tubes!

Here's the inside story on why local "off-brands" don't measure up to Silver Screen 85® standards

If you're like most dealers, you know off-brand tubes don't have the same quality standards as first-line tubes. To help you see how big the difference is, Sylvania purchased a nationwide sample of sixty 21YP4A's made by 19 different local tube makers. These tubes were put through the same production tests that all Sylvania tubes must pass.

Not a single local off-brand passed all 54 mechanical and electrical tests! Many of these were minor defects making little or no difference in whether or not the tube "lit up." But look how loose manufacturing controls can affect the important features of light output, focus, and life!

LIGHT OUTPUT



So far, 39 off-brand tubes have been compared with the *minimum* light output of Silver Screen 85. Five additional tubes couldn't even be tested. Eleven tubes were less than 90% as bright as the minimum for Silver Screen 85; 16 were less than 80%; 8 were less than 70%; and 4 were *less than 50%* as bright. Since most Silver Screen 85 tubes average as much as 125% of minimum standards, the difference becomes even greater. Small wonder that Silver Screen 85 is the easy way to more satisfied customers.

FOCUS

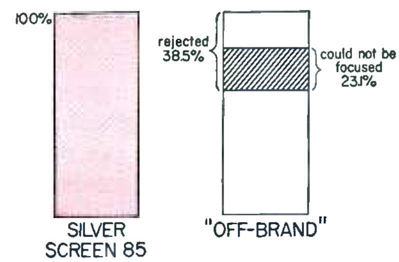
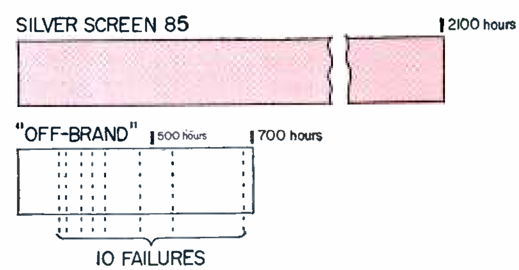


Chart 2 shows how these same 39 tubes stacked up to registered limits on focus voltage. 38.5% were rejected under these limits. Over half of all those rejected could not be focused in a TV receiver. Small wonder then that "Silver Screen 85" pictures are sharper, brighter, clearer.

LIFE TEST



Nineteen off-brand tubes were placed on Sylvania's standard 2000-hour life test. Chart 3 tells you how fast these tubes developed slow-heating cathodes. Over half, or ten units, failed to go beyond the 700-hour mark. Small wonder then that Silver Screen 85 gives you less troublesome callbacks.

Of all the off-brand tubes tested, Sylvania engineers estimate that 43% probably would not have operated properly in a TV set. Why gamble your reputation, customer satisfaction, and success. It's just *good business* to sell up to "first line" picture tubes; Silver Screen 85 picture tubes.

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QUICKER SERVICING

By Calvin C. Young, Jr.

This business of home service calls is getting more complicated with the passage of time. I can remember when a service kit needed only 6 or 7 tools, a cheater cord, ¼- and 5-amp fuses and 12 to 15 tubes.

As things stand now, you need a complete set of standard tools, another set of very short ones, and a third set of very long ones, in addition to well over 100 different tube types, 14 to 15 different fuse types, and 6 or 8 values of fuse resistors for B+ circuits in sets using metallic rectifiers. If your service kit is large enough and if you get your "Wheaties" regularly, you can manage to carry most of the things necessary to complete most normal service calls.

Try and visualize if you can, a technician on a recent home service call, loaded down with a kit of 300 tubes; a fuse caddy with 15 styles of fuses; a complete assortment of fusible resistors (4.7 through 9 ohm); sets of pigtail, plug-, and clip-in rectifiers; a filament tester; a complete set of standard, long, and short nutdrivers; a normal compliment of screwdrivers, Phillips drivers, diagonal and long-nose pliers; a soldering gun; and finally, a set of alignment tools and a drop cloth. With this assortment, how can he fail to fix that little portable?

Fail he did, though — even after he had located the trouble (a shorted rectifier which he replaced), the repair couldn't be completed. Why? The fusible resistor was open and all the markings on it were in Greek (no, not really, but they might just as well have been). The number

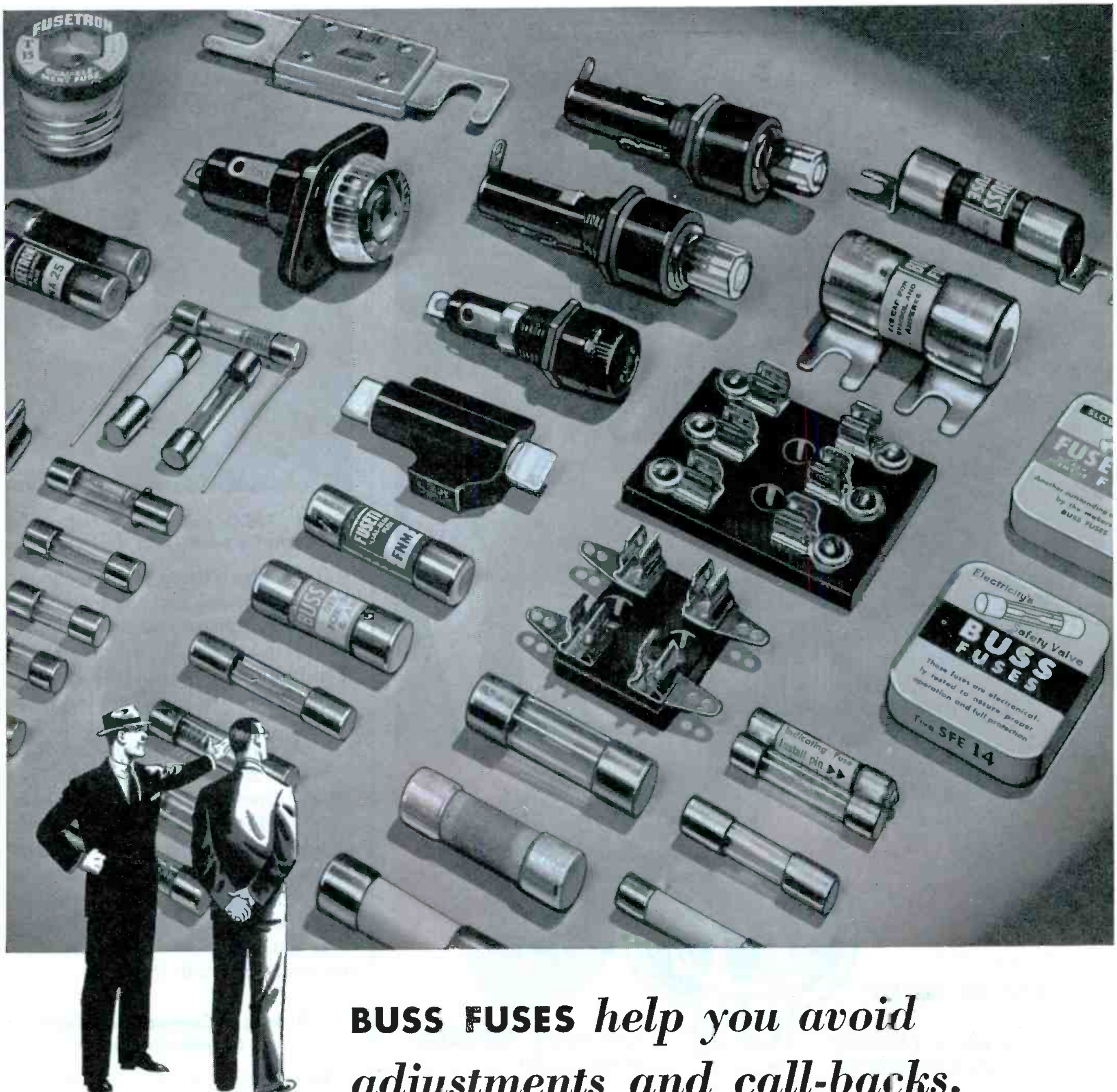
TABLE I—CROSS REFERENCE GUIDE ON FUSIBLE RESISTORS

Manufacturer	Part No.	Value Ohms	Watts
Admiral	61A19	7.5	5
	61A28-3	5	5
	61A19-2	7.5	5
Airline	259V002H01	7.5	*
	43X380	7.5	5
	R-1409	5.5	5
	259V004M01	4.7	5
	20E1042	7.5	5
	B154089-1-6	7.5	5
	46M-23018	9	5
	46M-22301	9.1	5
	46M-20681	5.6	5
Ambassador	24-1073	5	5
Artone	24-1073	5	5
	24B1116	4.7	5
Bendix	268021-1	5.6	5
Capehart	453924B-1	7.5	5
CBS	31000472	7.5	6
Coronado	TRP-28	4.7	5
	46M-25577	4.7	5
	46M-23018	9	5
	24B1116	4.7	5
	024-201116	4.7	3
Crosley	154089	7.5	5
Dumont	02310001	7.5	5
Emerson	394158	5	5
	397118	6	*
Firestone	24B1116	4.7	5
	46M-23018	9	5
	43X380	7.5	5
Hallicrafters	024-201116	4.7	3
	24-1116	4.7	5
	24B1116	4.7	5
	24-1073	5	5
	24B1011	7.2	5
	25B1004	7.5	5

Manufacturer	Part No.	Value Ohms	Watts
Hoffman	4762	7.5	*
Hyde Park	25B1011	7.2	5
Magnavox	240074-1	5	*
	240601-1	7.5	5
	24077-1	5	5
Majestic	B-6,326-1	7.5	5
Meteor	S431007	7.5	5
	24-1073	5	5
Motorola	17K738862	7.5	5
	17K742136	5	5
	17A711500	7.5	5
	17A711027	7.5	5
	1K711574	5	5
	1K711027	7.5	5
	1K1027	7.5	5
	17A791166	7.5	5
	17A791696	5	5
	17A700149	5	5
	17A791166	7.5	3
Muntz	RW-005-13	5	5
Olympic	RE 3823	7.5	5
	R-1409	5.5	5
Philco	33-1366-3	5.6	5
	33-1366-2	5.6	5
	33-1366	4.7	*
RCA	100117	5.6	5
	103824	4.7	5
	100117	5.6	4
Raytheon	46M-23018	9	5
	46M-22301	5.6	5
Sentinel	240074-1	5	*
	240601-1	7.5	5
	20E1042	7.5	5
	B154089-1-6	7.5	5
Silvertone	24-1116	4.7	5
	43-1011	5	*

Manufacturer	Part No.	Value Ohms	Watts
	43-1009	5	5
	24-1073	5	5
	431007	7.5	5
	431008	7.5	5
	25B1011	7.2	5
	S431007	7.5	5
	T43-1007	7.5	5
Sonora	R1409	5.5	5
Spartan	240074-1	5	5
Sparton	PA4227	7.5	5
Sylvania	187-0053	4.7	5
	187-0028	7.5	5
	189-0046	4.7	5
Trav-Ler	F6-1	5.6	5
	F6	5	*
	F8	7.5	5
	TV-F-6	5	5
Truetone	024-201116	4.7	3
	43X380	7.5	5
	224-200002	10	10
	24B1116	4.7	5
	46M-23018	9	5
	46M-25577	4.7	5
	46M-20681	5.6	5
Wells Gardner	43X380	7.5	5
Westinghouse	V-16023-1	7.5	5
	259V002M01	7.5	5
	259V004M01	4.7	5
	259V002H01	7.5	5
Zenith (1)	63-3287	6	5
	63-3269	7.5	5
	63-3644	6	5

* Wattage Not Given by Mfr.
(1) Original Not Declared as Fusible by Mfr.



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That's why BUSS fuses provide maximum protection against damage due to electrical faults. Users are safeguarded against unnecessary repair bills, — and your reputation for quality and service is protected.

Equally important, BUSS fuses eliminate needless blows that irritate users and require adjustments or call-backs on the part of sales and service organizations.

Protect yourself against faulty fuses causing trouble by relying on BUSS fuses. To meet service needs, there is a complete line of BUSS fuses available.

For more information on the complete line of BUSS and FUSETRON Small Dimension Fuses and Fuseholders . . . Write for bulletin SFB. Bussmann Mfg. Division McGraw-Edison Co. University at Jefferson, St. Louis 7, Mo.

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Fig. 1. TACO comparison test setup demonstrates need for a new antenna.

100117 doesn't say a thing about ohms and watts, and the technician knew that replacement with too high a resistance value would only cause it to fail in an hour or two. He also realized too low a value would not provide the proper protection. So, the job wasn't completed.

When similar reports were received from some of our readers along with a request for a chart on fusible resistors, the author began a set by set survey and used it to prepare the Cross Reference Guide given below. With this data to help you, you'll have no trouble completing more repairs in the home.

Antenna Comparison Test Speeds Sales

Have you ever wished that you could visually demonstrate to your customer the improved results he would get with a new antenna system. If you have, but are stymied by the sure knowledge that such a project would require a prohibitive amount of time — rejoice! Such a demonstration is now possible and will take less than 10 minutes of your time. The TACO *Comparator* test setup illustrated in Fig. 1 permits the new antenna to be raised to a height of about 20′, where it can be oriented for optimum reception by merely twisting the lower mast section. If you will examine the installation layout in Fig. 2 and follow along with me, I'll show you how one man can make the installation in the least possible time.

First of all, join two 10′ mast sections with the guy ring positioned above the bulge on the bottom end of the upper section of mast. The guy ropes are already secured to the ring and require no attention at this point. Now, attach the antenna (to which a 50′ coil of lead-in wire has been connected) to the upper end of the top mast section. With the bottom end of the 20′ mast centered in the triangle formed by the three guy anchors, attach the two spread guys to their respective anchors. Dig the bottom of the mast into its assigned spot and walk the 20′ assembly up. Now, holding onto the remaining guy tightly, walk to the third guy anchor and secure the rope. Back off and sight the mast to see if it is as nearly vertical as possible.

For the final step, take the other end of the lead-in, which has the *Comparator* switch assembly attached to it, into the customer's home and attach his existing antenna wire to the open terminals of the switch box. Now, attach the short wire from the switch to the antenna input terminals of the receiver and you are all set for the sales-clinching demonstration. By simply sliding the switch back and forth, you can show the customer the improvement a new, correctly-installed antenna can make in the operation of his receiver.

Chain Reaction in RCA Color Set

Multiple component failures that result from the effects of a former trouble are not uncommon. However, when it involves three dual-concentric controls, all of which affect the convergence of a color set, that's another matter.

An example of this concerns an RCA color receiver (CTC5A chassis) which had no vertical sweep. When tube replacement and control adjustment failed to cure the problem, the chassis was taken into the shop for further analysis and repair. The picture tube setup (21AXP22, convergence assembly, deflection yoke, purity magnet and blue-lateral corrector) was not disturbed because a suitable yoke was on hand in the shop for bench operation.

It took only a few minutes to locate the reason for no vertical deflection. Voltage and resistance

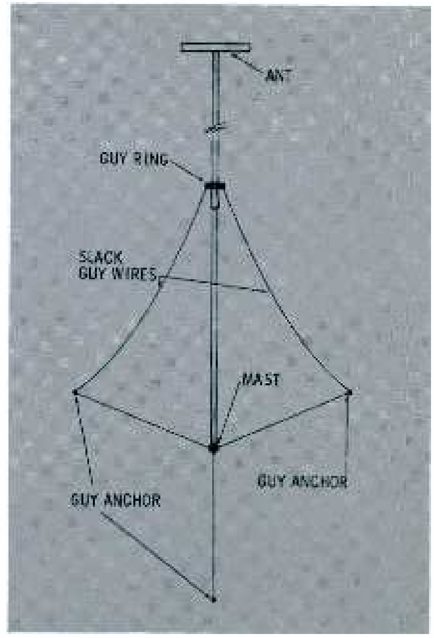

Fig. 2. Comparison tester can be erected on any plot of ground 10′ by 30′.

measurements revealed an open cathode circuit in the vertical output stage. A study of the schematic (Fig. 3) resulted in a rather rude awakening. For the circuit to be completely open, three controls connected in parallel all had to be open.

The DC controls in the horizontal output stage were good, as evidenced by the presence of the bright horizontal line on the screen of the 21AXP22. (Note the fuse in the horizontal output cathode circuit, providing protection for the DC controls as well as the flyback and other horizontal output components.)

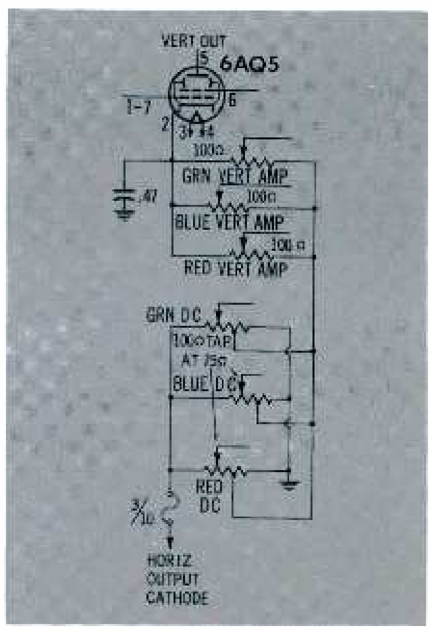

Fig. 3. Vertical amplitude controls are cathode load for vertical output stage.

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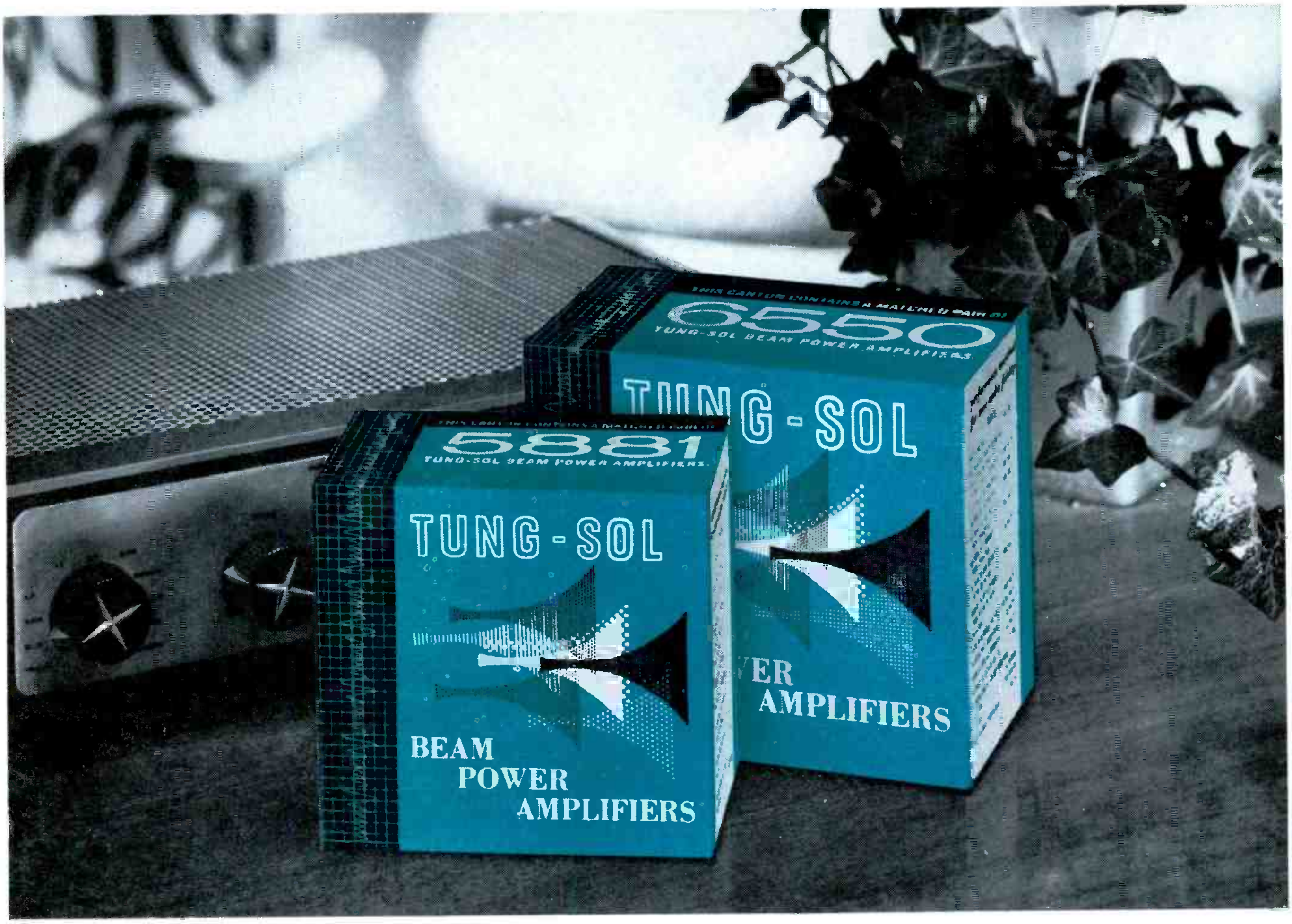

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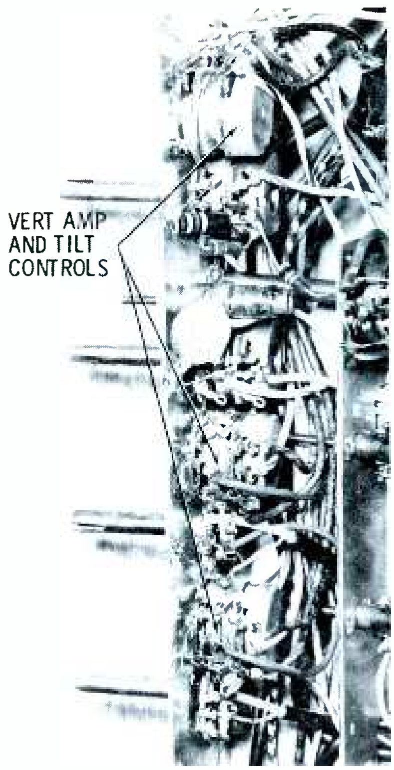


Fig. 4. Vertical amplitude controls consist of three dual concentric controls.

Pursuing the vertical trouble further, a thorough visual check of the printed board was made. The conductor to the cathode (pin 2) of the 6AQ5 had been patched at some previous time. At this point, the 6AQ5 was placed in a laboratory-type tube tester and thoroughly checked for shorts, leakage, gas, emission, and GM. No defects were found. With this knowledge, it was a simple matter to reconstruct the events leading up to the failure. First of all, a 6AQ5 (most likely the original) shorted and blew out a section

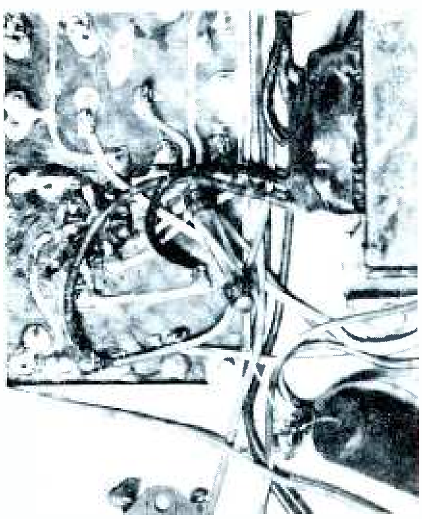


Fig. 5. Pigtail-type ⅛-amp fuse is easily installed in 6AQ5 cathode circuit.

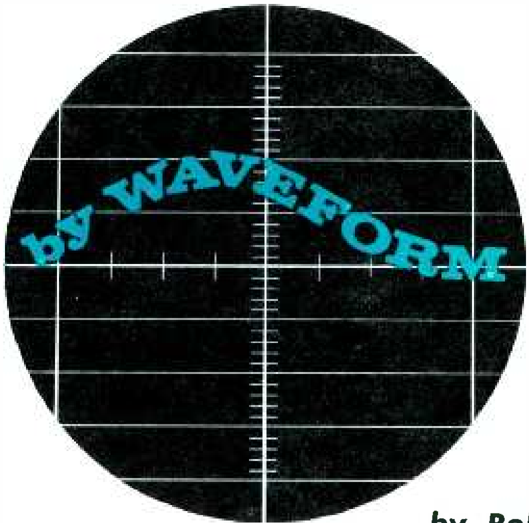
of foil. Naturally, this happened only after a considerable amount of current had passed through the three cathode controls. A new tube was installed, the foil was patched and the set worked okay. The cathode controls had not failed yet; they had only been scorched by the current that opened the foil. The set was placed in operation and functioned normally for awhile; however, the scorched controls were constantly being tortured by the normal cathode current. Finally they failed and caused loss of vertical sweep. The three dual controls (Fig. 4) were not only time consuming to replace, they were hard to obtain. Actual replacement time, (6 electrical connections to each control) was a little over an hour. Total shop time on this job was about 2 hours, considering actual replacement and analysis time.

Because these controls affect dynamic convergence to a large degree (they are the entire vertical convergence panel), the set had to be completely reconverged. Naturally, this all added up to a sizeable repair bill, making it necessary to explain the entire sequence of events to the customer.

The technician had foreseen the customer's concern that the trouble might recur and had taken positive action to prevent it. He had noticed the 3/10-amp fuse in the cathode circuit of the horizontal output tube and got the idea to install one in the vertical stage. Because the idea was to protect the controls, a little math was employed to figure just what rating the fuse should have. Using the formula $P = I^2R$, the maximum safe current through the three controls was calculated to be approximately 200 ma. A check of the tube manual revealed that the 6AQ5 could pass as much as 49 ma in vertical output service, so a ⅛-amp fuse was installed (see Fig. 5). This would provide adequate protection for the controls and also insurance against fuse failure every time the tube developed a little leakage or gas content.

The next time you have a CTC5 series chassis in the shop for any type of repair, install a ⅛-amp fuse in the vertical output cathode circuit and protect your customer against a similar experience. ▲

troubleshooting by WAVEFORM analysis



Using a generator and scope to test video circuits

by Robert G. Middleton

To make practical use of a scope in troubleshooting, you have to know how to read the messages conveyed by the waveforms. Once you learn to recognize various types of distortion and their causes, you can often put your finger directly upon a faulty circuit or component.

To illustrate what can be accomplished by proper waveform analysis, let's apply a test signal of known characteristics to the input of a typical video amplifier and use a scope to examine the output. We can demonstrate that certain defects in the amplifier will produce frequency distortion of the test waveform. Such distortion is a clue that the circuit faults will also distort the video signal and produce a poor TV picture.

Test Setup

The video detector circuit must be included in our analysis, since its peaking coils and load resistor are also an important part of the video-amplifier input circuit. Accordingly, we will apply the test signal at the input of the detector as shown in Fig. 1. A signal generator with a built-in modulator is being used in this illustration. If your generator does not include a modulator, you can use an external one; connect it as in Fig. 2.

The signal generator is tuned approximately to the IF frequency of the receiver, and its output is modulated by the signal from the square-wave generator as illustrated in Fig. 3. We can regard the square-wave generator as a switch that abruptly keys the IF signal off and on.

A low-capacitance probe is used with the scope in Fig. 1, and the picture-tube socket is unplugged in order to eliminate its input capacitance from the video-amplifier output circuit. For all practical purposes, the input capacitance of the probe substitutes for the input capacitance of the picture tube during the tests. If the receiver has a series heater string, a dummy tube such as a 6SN7 with all but the heater pins cut off can be substituted for the picture tube.

The frequency response of the scope must be at least as good as that of the video amplifier; this means that it should be flat up to about 4 mc. A narrow-band scope is useless in this type of test work.

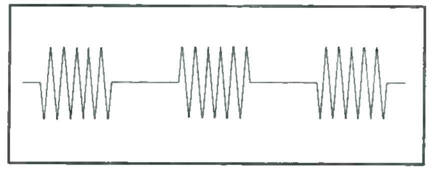


Fig. 3. Appearance of carrier modulated by audio-frequency square wave.

High-Frequency Test

Start the test by modulating the IF carrier with a 100-kc square wave. Fig. 4 shows several ways in which the test signal may become distorted in passing through a video amplifier. We are primarily concerned with studying the distortions in these waveforms and seeing how they can help us to localize faults to specific circuit components. Look at Fig. 4B and note that the square wave has rounded corners with sawteeth. This dual distortion is caused by the following circuit actions:

1. Insufficient high-frequency response in one of the peaking-coil circuits, which rounds off

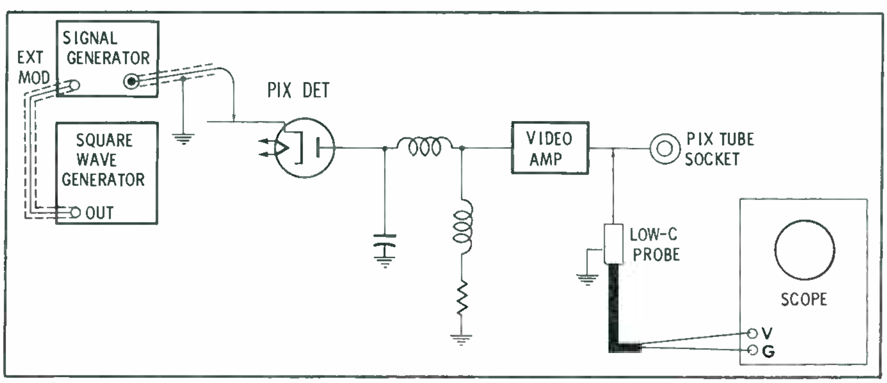


Fig. 1. Setup for testing video amplifier with square wave generator and scope.

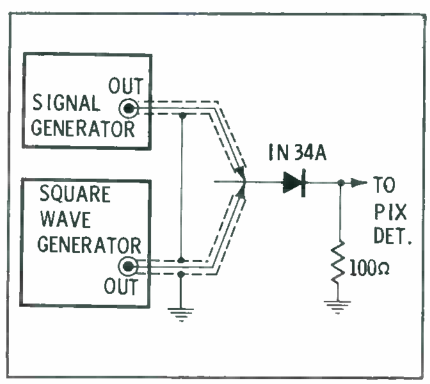


Fig. 2. External square-wave modulator.

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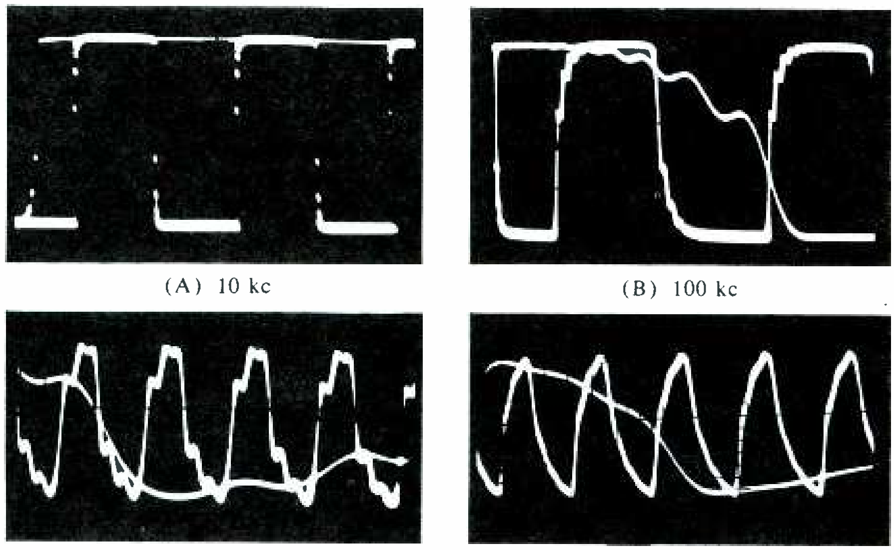

(A) 10 kc (B) 100 kc

(C) 500 kc (D) 500 kc

Fig. 4. Output of video amplifier with over-peaked and under-peaked stage.

corners (Fig. 5).

2. Excessive high-frequency response in another of the peaking-coil circuits, which causes ringing and produces a jagged trace (Fig. 6).

When a circuit with fault No. 1 is followed or preceded by a circuit with fault No. 2, their combined action causes the output square wave to have rounded edges with superimposed sawteeth as in Fig. 4B.

The simplest way to locate the source of ringing in a video amplifier is to touch the peaking coils one by one. This adds a certain amount of stray capacitance and thus reduces high-frequency response. In other words, we can deliberately distort the over-all square-wave reproduction. If the ringing disappears, we can conclude that the part of the circuit being touched has excessive gain at high frequencies. Making the "touch test" on a circuit with normal or deficient high-frequency response would result in only slight attenuation of the ringing, but it would tend to produce more severe rounding of the waveform edges.

In cases where ringing is not traceable to peaking-coil trouble, we can sometimes remedy the condition by increasing the value of the plate-load resistor (R in Fig. 6). The ringing can usually be minimized but not completely eliminated. Increasing the load-resistor value past a certain point will have little effect on ringing, but it will have an objectionable effect on corner-rounding. Hence, choosing the right value must be somewhat of a compromise.

We can sometimes compensate for excessive rounding of waveform corners by decreasing the value of the plate-load resistor R (again assuming that there is no peaking-coil trouble). This is also a compromise procedure. Decreasing the load-resistor value past some point will result in little improvement of corner-rounding, but may cause a rapid increase in ringing.

Remember, the picture-detector load resistor and peaking coils are just as important as the plate loads of the video amplifiers in determining over-all frequency response. Best picture quality will be obtained when

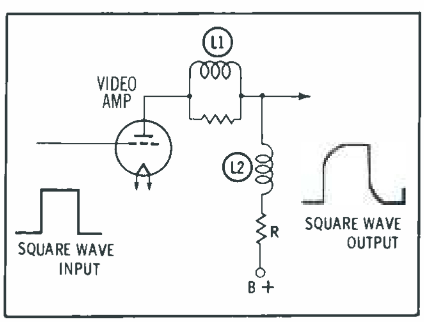

Fig. 5. Poor high-frequency response causes round corners on the wave.

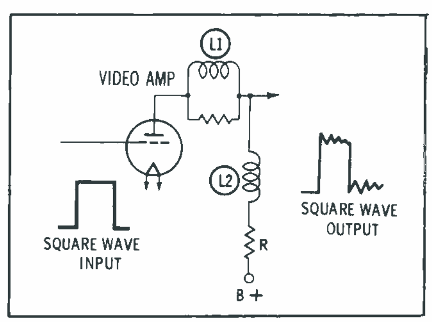

Fig. 6. Excessive high-frequency response causes distortion known as ringing.

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the 100-kc square wave is reproduced with as little distortion as possible.

Ringing will cause ghostlike images following sharp edges of objects in the picture. For example, a black edge will be followed by a white line or negative ghost, and vice versa. Severe ringing generally results in multiple ghosts. (Note the symptom pictured in Fig. 7A.)

Corner-rounding causes blurred, poorly-defined edges in the picture. Excessive rounding often results in smear at the edges of objects in the picture, as shown in Fig. 7B.

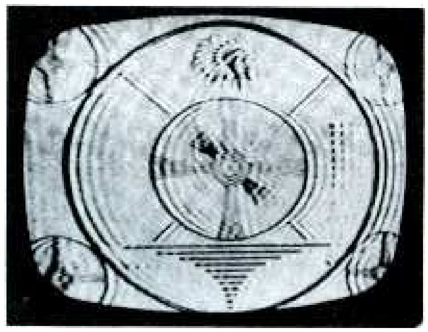
Low-Frequency Test

To check the low-frequency response of the video section and to show up any faults in the coupling and decoupling circuits, adjust the square-wave generator to modulate the IF carrier at a 60-cps rate. The test setup will be the same as before, except that we are now driving the picture detector with a 60-cps square wave instead of the 100-kc signal.

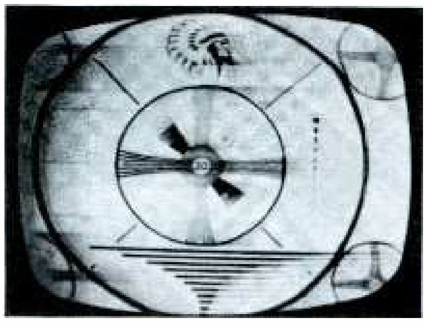
The kind of distortion most commonly found in this test is a downhill tilt of the reproduced 60-cps square wave. This is caused by too short a time constant in the grid-coupling, plate-decoupling, screen-bypass, or cathode-bypass circuits. Basic low-frequency square-wave distortions are shown in Figs. 8 and 9. This type of fault may be localized by bridging a 0.1 mfd capacitor across each of the grid-coupling capacitors while watching the pattern. If the tilt disappears or is reduced, more coupling capacitance is needed.

You can localize bypassing and decoupling faults in the same manner. Sometimes, the capacitance may be too low in two or even three circuit branches. If you observe uphill tilt in the square wave, as shown in Fig. 8, check the condition of the low-frequency boosting circuit found in some video amplifiers. This is the only circuit in which an incorrect time constant will cause an uphill tilt.

Output waveforms with convex or concave tops, like those in Fig. 9, are caused by low-frequency peaks or dips. This fault is less common than a simple tilt, but it is sometimes observed when low-frequency decoupling is insufficient. Combinations of tilted and curved tops are



(A) Excessive gain at high frequencies.



(B) Deficient gain at high frequencies.

Fig. 7. Trouble symptoms resulting from frequency distortion in video amplifier.

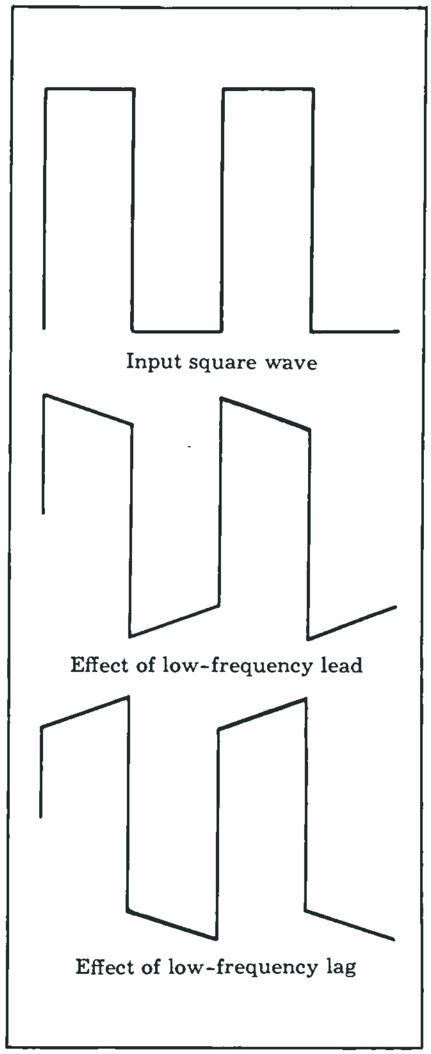


Fig. 8. Results of phase distortion produced by poor low-frequency response.

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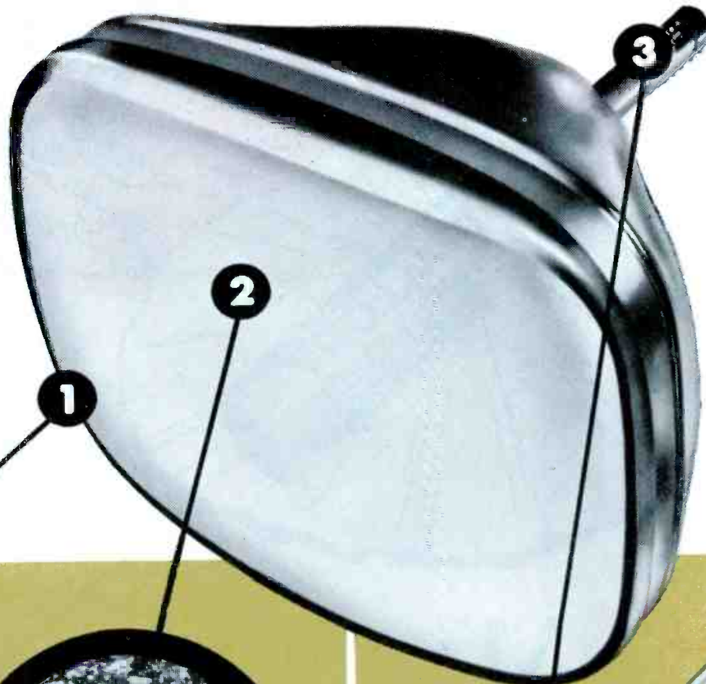

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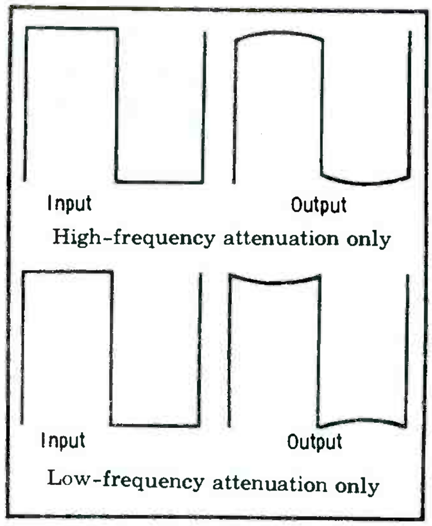

Fig. 9. Curved tops on square waves caused by unevenness in response.

occasionally caused by faulty coupling and decoupling circuits.

Appreciable tilt in a 60-cps square-wave pattern corresponds to nonlinearity of the gray scale in various parts of the picture. Consider a large wall or background scene with an over-all medium-gray tone. If tilt is occurring, the shade of the background will not be uniform but will vary from light to dark (or vice-versa) between the top and bottom of the screen.

This introduction to practical waveform analysis shows the great value of this method of troubleshooting. The technique can be applied to many other receiver circuits such as the sync, sweep, and sound systems—but that's another story. ▲

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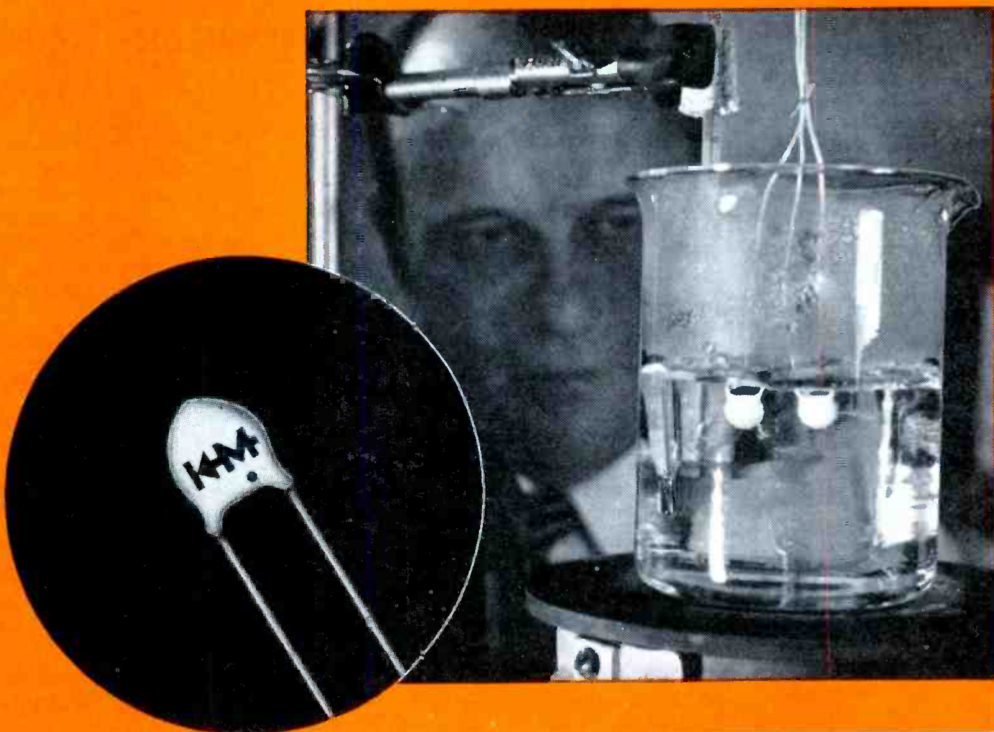

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THE TROUBLESHOOTER

ANSWERS YOUR SERVICE PROBLEMS

Down in the Valley

I have a cabin along the bank of a river at the bottom of a thousand-foot canyon. Can I run a thousand feet of line from an antenna at the canyon rim and get a signal at the cabin? I hope it's possible.

CHESTER WISNIEWSKI

Rio Vista, Calif.

Unless you move the cabin to the canyon rim, you'll probably have to install a broad-band VHF amplifier at the antenna site and feed its output into your transmission line. (Several weatherproof amplifier units are available for the purpose.) This will require AC power, but you should have little trouble in running a power line up to any site that can be reached by the TV transmission line. Unless you are using coaxial cable for the signal, avoid running the two lines close together.

If the signal at the antenna site is good and strong, you might be able to obtain a usable signal at the cabin without an amplifier. The loss in 1000' of line is bound to be tremendous, but you can minimize it by using a type of lead-in with a very low attenuation factor. Open-wire line would be your best choice.

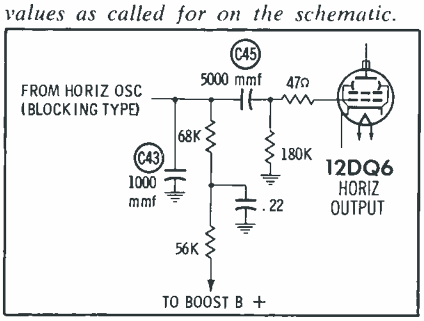
No Raster

A Trav-Ler Model 1710 had sound but no high voltage. After long efforts to repair the trouble, I finally took a substitution box and tried different values of capacitance in place of C43. When I reduced the value to 500 mmf, I got a raster. The grid voltage of the horizontal output tube, which had been only —5 volts, went to the correct value of —33 volts. Restoring C43 to the original value of 1000 mmf caused the raster to go out again. Would you explain why this small change in value made so much difference in operation?

FRANK MASSI

Oak Park, Ill.

C43 is a load for the oscillator as far as AC signal voltages are concerned; in other words, the output sawtooth signal is developed across this capacitor. For C43 to do its job properly, the capacitance ratio between it and the coupling capacitor C45 must be correct according to the design of the set. Since you had to lower the value of C43 to restore operation, I suspect that C45 may have decreased in capacitance. Try replacing both units with new ones having the same values as called for on the schematic.



Tuner Adjustments

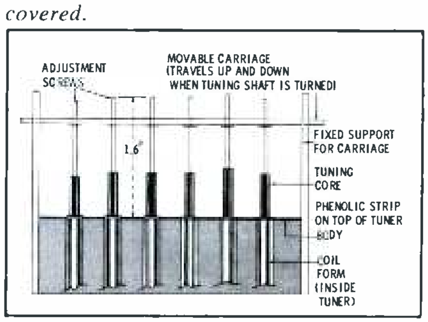
I am unable to align the continuous tuner on a Raytheon Model M1611 so that it will receive all available channels. When it is adjusted to receive both sound and picture on Channel 2, I lose Channel 6. The same thing happens with Channels 7 and 13 on the high band.

Could there be some error in the alignment instructions given in PHOTOFACT Set 147, Folder 9 for this set? The directions read, "Turn the tuning control until *the tuning core carrage is at the top of its* stroke. Preset the tuning cores 1.6" above the coil-mounting strip." When this is done, the cores are completely clear of the coil forms. They do not re-enter until the carriage has traveled part of the way down.

JOHN L. WOOD

Long Beach, Calif.

As shown in the drawing, the measurement of 1.6" should be taken from the tips of the core adjustment screws to the coil-mounting strip, which is a phenolic board imbedded in the top cover of the tuner. If the cores themselves are positioned 1.6" above the mounting strip, they will be too high — as you have discovered.



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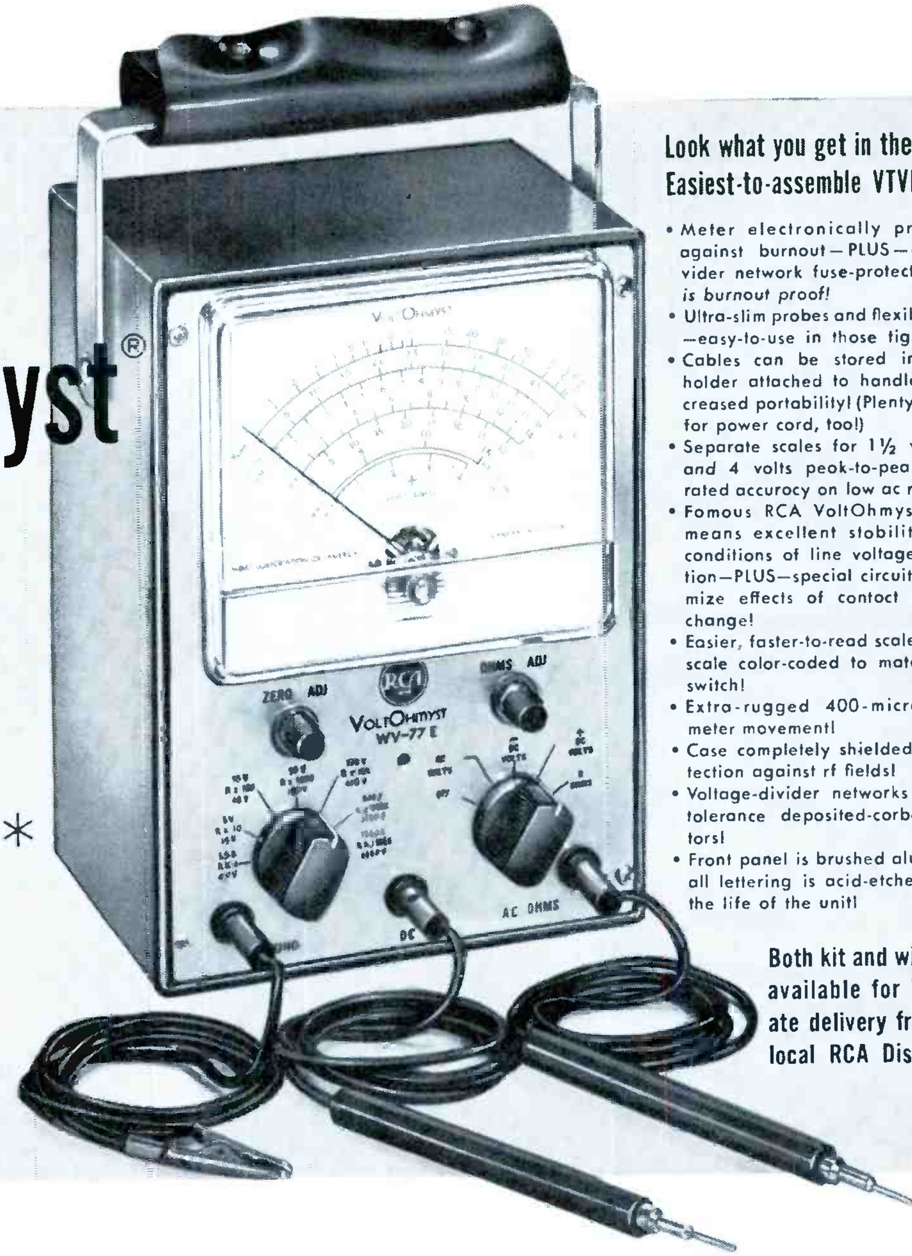

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- Extra-rugged 400-microampere meter movement!
- Case completely shielded for protection against rf fields!
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SPECIFICATIONS

Ranges:

DC and rms—1½ volts to 1500 volts full scale in 7 overlapping ranges

Peak-to-peak—4 volts to 4000 volts full scale in 7 overlapping ranges

Resistance—from 0.2 ohm to 1000 megohms in 7 overlapping ranges. Zero-center indicator for discriminator alignment

Accuracy—±3% of full scale on dc ranges; ±5% of full scale on ac ranges

Frequency Response—flat within ±½ db, from 20 cycles to 500 Kc on all ranges up to and including 400 volts peak-to-peak

Input Resistance—11 megohms with probe and cable

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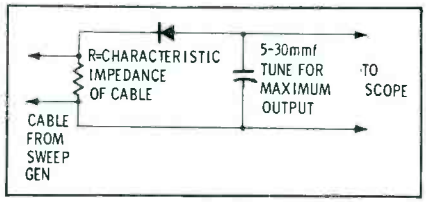

Checking Alignment Setups

I would like to have a circuit to check my sweep and marker generators, as well as my scope, just before aligning a set. I've heard of a circuit which allows the technician to put an IF curve on the scope and move a marker over it. This is a quick way to find out if the alignment equipment is working as it should.

Hugh O. Butts

Des Moines, Iowa

The simplest solution would be to keep a spare TV set around the shop and use its IF strip as a standard. Once you have "calibrated" its alignment curve using a generator and scope of known good quality, you could use this set to recheck your test equipment from time to time with a minimum of trouble.

To see whether or not the output of the sweep generator is flat over the entire IF band, you might apply its output to the scope through a detector circuit having a flat response across this frequency range. (The schematic shows a detector which should be suitable.) Connect and operate the test equipment just as though you were performing a regular alignment. Instead of obtaining a typical IF response, however, you should expect a rectangular-shaped pattern formed by a lower base line and a trace above it representing the output of the generator. Any curvature or slope in the top trace is an indication of uneven output from the generator or distortion in the scope amplifier.

Buzz

Severe 60-cps buzz in an RCA Chassis KCS88BX can be stopped only by pulling the vertical multivibrator or output tube. Tube substitution does not help, nor does replacement of the vertical output transformer.

Richard Barnum

Oakfield, N. Y.

The interference is most probably being carried from the vertical section to the audio section by way of the 210-volt B+ line. Check to see if any of the filter capacitors on this line (especially those in the cathode circuit of the audio output tube) have decreased in value or become open. If you have a scope, first check the waveform on the 210-volt line for any evidence of 60-cps pulse voltage.

If you don't find B+ filter trouble, search the chassis to see if any vertical circuit components are physically close to audio components. Leakage or electromagnetic coupling between these two sections of the receiver could account for the buzzing.

NOTES on test equipment

informative reports from the lab

by Les Deane

What's Your TV Strength?

By TV strength, I don't mean the size of set you can pick up and carry—I'm referring to the strength of the received signal. To do the best job when orienting antennas, checking boosters and lead-in, locating maximum signal areas, and comparing antenna systems, the TV serviceman needs an instrument which will enable him to measure signal intensities. Recently introduced by Simpson Electric Co., the field strength meter pictured in Fig. 1 is designed for power-line or battery operation on both VHF and UHF bands.

Specifications and features are:

1. Power Requirements — 117 volts 60 cps, self-contained rechargeable 6-volt battery (optional accessory), or 6-volt auto battery; power consumption approx. 18 watts; separate AC and DC fuses provided.
2. Signal Frequencies — tunable range for all television channels 2 through 83; meter indicates video carrier strength; input impedance 300 ohms.
3. Sensitivity — minimum signal less than 10 uv to 50,000 uv; accuracy better than ± 6 db on VHF and ± 8 db on UHF.
4. Signal Output — special jacks on rear panel provide monitoring of 40-mc IF signals and audio modulation.
5. Size and Weight — $11\frac{3}{8}''$ x $7\frac{3}{8}''$ x $9\frac{1}{2}''$; $14\frac{3}{4}$ lbs. less battery.

To help familiarize you with the instrument, I chose the front-panel photo in Fig. 2. Functions of the various controls can best be outlined by a description of the operation for one particular application. Suppose, for example, you wanted to measure the signal strength of several different VHF channels at one point in an antenna distribution system. (I actually performed this operation in our lab.)

First, I connected the AC cord to an outlet on the bench and applied power to the meter by placing the power selector switch in the AC position. Using a short piece of 300-ohm twin lead, I made a connection between the antenna outlet and the VHF input terminals on the front panel of the Model 498-A. I next set the frequency calibration switch and the VHF channel selector to the first channel number that I intended to receive and measure.

After the unit had warmed up, I slowly reduced the signal attenuator or level control until I obtained deflection on the meter. When the VHF fine tuning knob was adjusted for maximum signal indication, the meter needle went off scale. I quickly increased the input attenuation to lower sensitivity and bring the needle back on the scale. Rocking the fine tuning again, I watched the meter until maximum deflection was obtained. Attenuation was then reduced until the needle read full scale, and the signal strength from markings around the attenuator knob was noted. This control (see Fig. 2) is calibrated for full-scale indications of 100 to 50,000-microvolts. For input signals of less than 100 microvolts, the attenuator is set to its maximum counterclockwise rotation and the signal strength read directly on the zero to 100 scale of the meter.

Checking other features of the Model 498-A, I found both an audio and an IF output jack located on the rear panel of the instrument (see Fig. 3). The audio output connector is a regular two-conductor phone jack. Using a pair of high-impedance headphones, this point can be used to monitor either TV sound modulation or the 60-cycle buzz produced by vertical sync. Although TV sound for channels 4, 6 and 13 cannot be picked up in this type of monitoring, sync buzz can be heard

Fig. 1. Simpson's new 498-A field strength meter can be substituted for the tuner used in any television receiver.

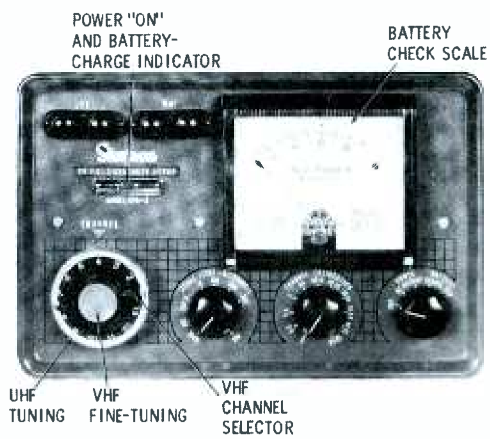

Fig. 2. Front panel of the Model 498-A features VHF-UHF tuning and a large $4\frac{1}{2}''$ meter with 50-microamp movement.

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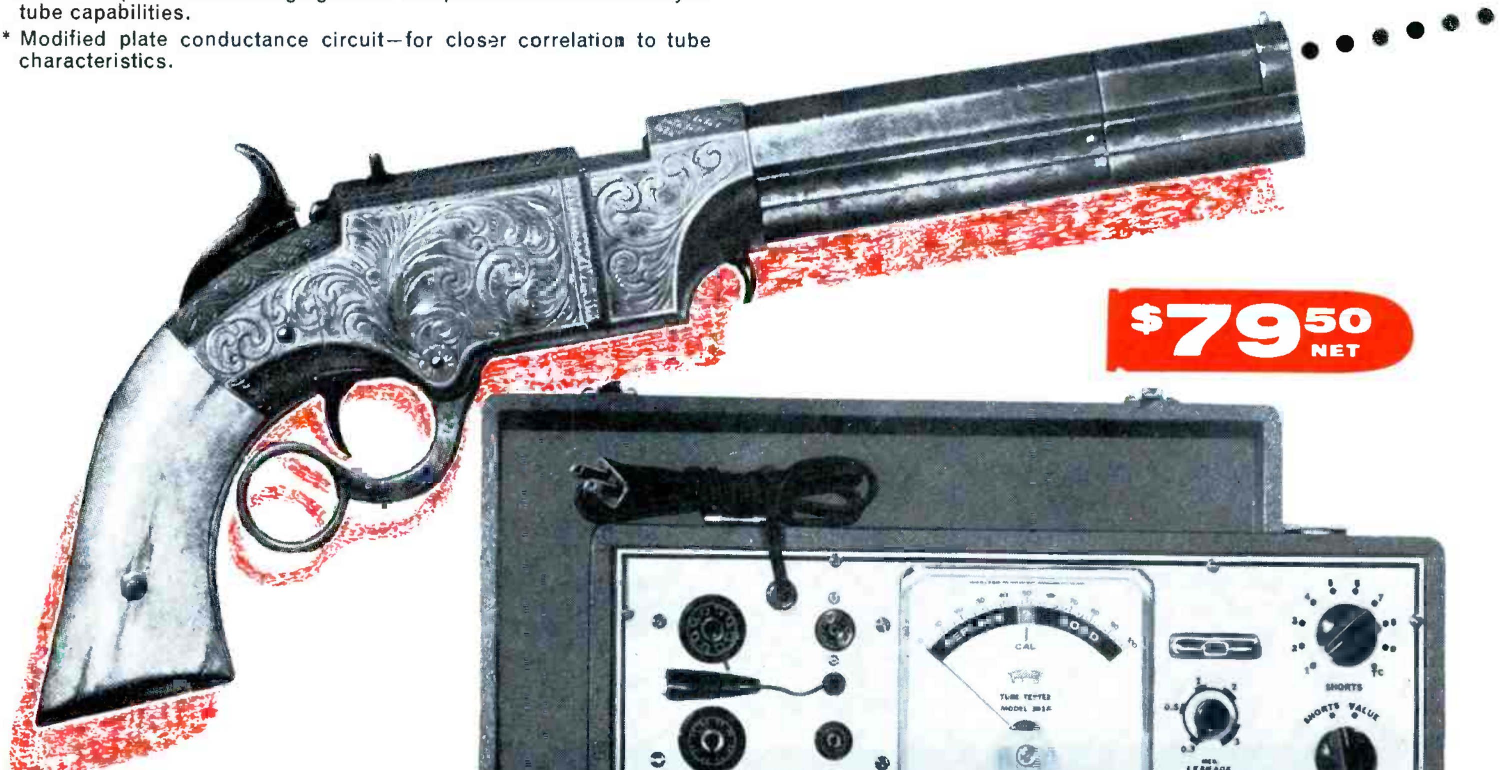

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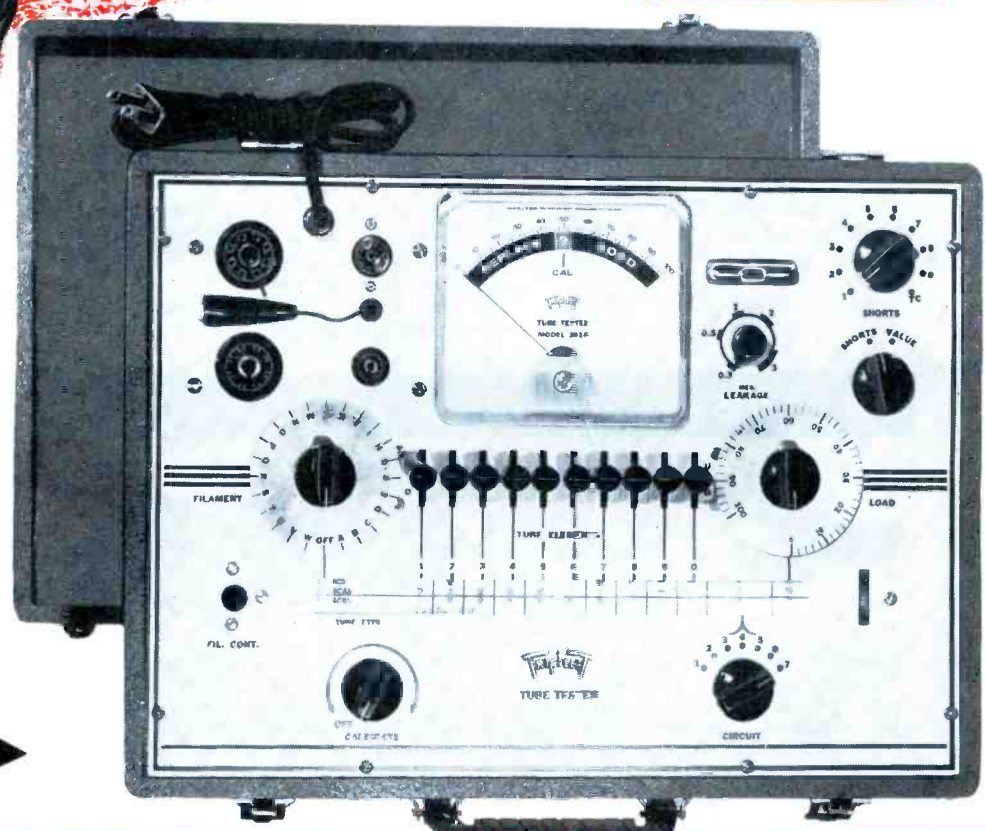

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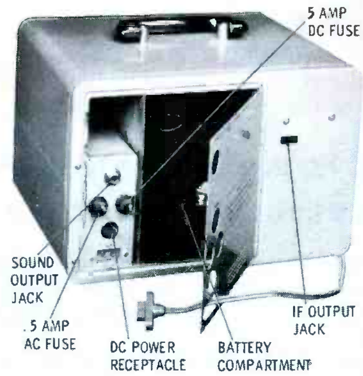


Fig. 3. Rear panel features of the meter include audio and IF output jacks.

on all channels, which is especially useful when you want to distinguish between transmitted signals and interference.

To test the operation of the instrument's tuner, or to substitute for a conventional TV tuner, a separate IF signal is available from the IF output jack shown in Fig. 3. This signal is a modulated 40-mc IF carrier which may be used to drive the first video IF amplifier of any receiver operating in the 40-mc range. Since testing the output of a TV tuner using a substitution method would be of great assistance to the serviceman, I thought you might like to see how simple it really is.

Using a special plug supplied with the instrument, and a short piece of coaxial cable, I coupled the IF signal from the rear of the meter to the first IF stage of a receiver. In the receiver, I unsoldered the tuner lead at the grid of the first IF tube and connected the test cable in its place.

With the set and meter both operating, I was able to tune in all available channels and reproduce picture and sound without a bit of help from the receiver's tuner. The arrangement for this substitution trick is pictured in Fig. 1.

Troubleshooting with "Junior"

The vacuum-tube voltmeter shown in Fig. 4 is manufactured by RCA Components Div., Camden, N. J. Designed for radio and TV, as well as industrial service work, the Model WV-77C *Junior VoltOhmyst* comes complete with AC-DC-ohms probe and cable, attached ground lead, and operator's manual.

Specifications and features are:

1. Power Requirements — 105 to 125

Fig. 4. RCA's new Junior VoltOhmyst incorporates meter burn-out protection.

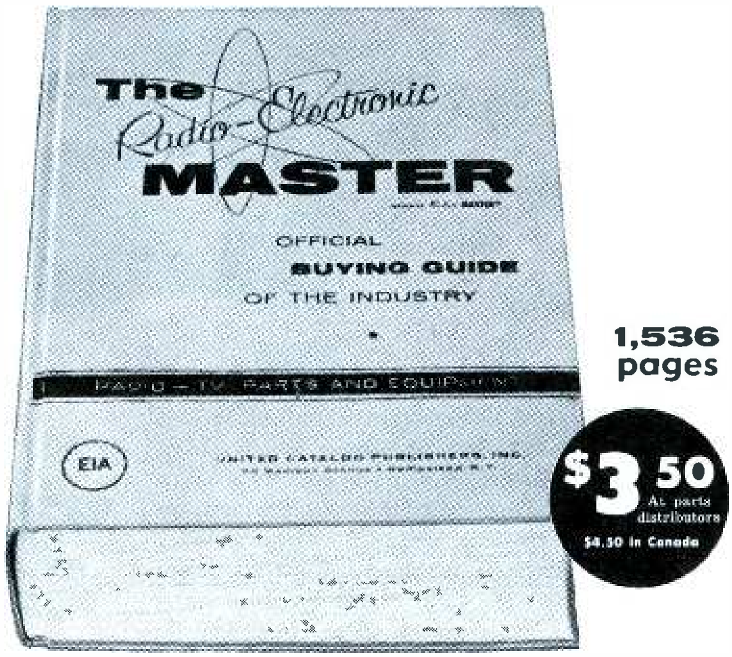
volts, 50 to 1000 cps; power consumption 5 watts; one self-contained 1.5-volt battery.

2. AC Voltmeter — rms ranges 0 to 3, 12, 60, 300, and 1200 volts with separate scale for 0 to 3 volts; frequency response 30 cps to 750 kc ±1 db for 1000-ohm source, and to 3 mc ±1 db for 100-ohm source; accuracy ±5% of full scale deflection; input impedance up to 60-volt range .2 megohm, for 300-volt range 1 megohm, and for 1200-volt range 2 megohms; maximum combined AC-DC input 1800 volts.
3. DC Voltmeter — ranges 0 to 3, 12, 60, 300, 1200 volts; accuracy ±3% of full scale on + volts and ±5% on — volts; input resistance 11 megohms.
4. Ohmmeter—ranges R x 1, 100, 1000, 100K, and 1 meg, center scale 10; zero- and ohms-adjust controls on front panel.
5. Size and Weight — 8" x 5⅜" x 4½"; 4 lbs.
6. Accessories — RF probe for extending frequency response to 250 mc; high-voltage probe increases DC range to 50,000 volts.

Before twisting any knobs on this *Junior VoltOhmyst,* I wanted to examine its inner construction. In so doing, I found that the entire chassis, which is attached to the front panel, comes out of the metal case after removing four small Phillips-head screws from the front panel and one large screw from the rear of the case.

The instrument utilizes two dual-section tubes—a 12AL5 and a 12AU7. One diode section of the 12AL5 is used as an input detector for AC voltages, while the other serves as a rectifier in the B+ circuit. The two triode sections of the 12AU7 are employed as DC amplifiers in a push-pull bridge circuit.

In the course of examining this particular meter from a design standpoint, and actually using it to



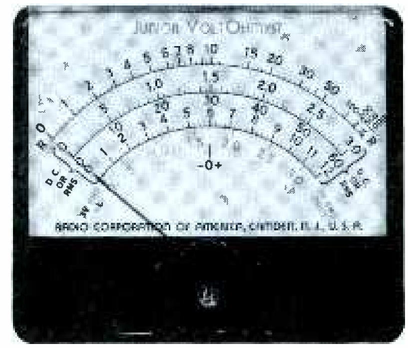


Fig. 5. Meter face of Model WV-77C indicates its versatility as a tester.

troubleshoot a few chassis, I made a number of AC and DC voltage measurements on all scales and found the accuracy of each to be well within the limits stated in the specifications. The small divisional markings for each scale (Fig. 5) and the zero-center calibration point are features which make the Model WV-77C very useful in discriminator alignment work and for bias measurements.

Since I also measured resistances but found no mention of the ohmmeter accuracy in the manufacturer's manual, I decided to check this feature myself. For standards, I selected five precision-type resistors with values equal to center scale readings for each range (10 ohms, 1000 ohms, 10,000 ohms, 1 meg, and 10 meg).

I found the ohms indications very satisfactory on all ranges; in fact, with the zero and ohms adjustments set properly, accuracy of the 200-microamp movement was better than 1% on all ranges.

The test probe supplied with the Model WV-77C is shown in Fig. 6. This unit is designed to minimize capacitance loading and features a built-in switch to permit quick adaptation for either DC voltage or AC-ohms measurements. If you desire to attach the probe to any point, an

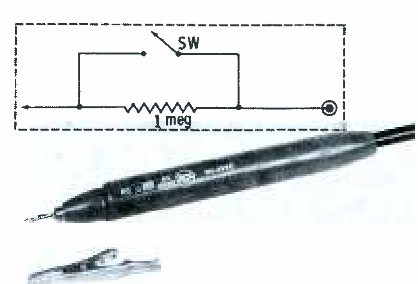


Fig. 6. Schematic and photo of the test probe supplied with the VoltOhmyst.

alligator clip which slips over the tip is also provided.

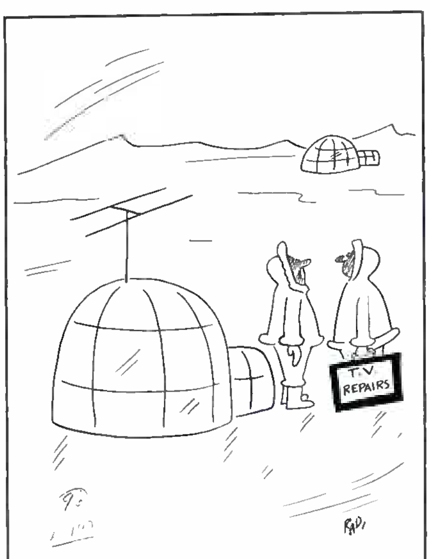
Picture Tube Bad?—Shoot It!

By using the handy portable instrument pictured in Fig. 7, you may save both your time and your customer's money. Known as the Model 200 CRT tester-reactivator produced by Vis-U-All Products Co. of Grand Rapids, Mich., it is used to test and rejuvenate all types of television picture tubes including the newer 110° types.

Specifications and test features are:

1. Power Requirements — 105 to 125 volts, 50/60 cps; power consumption under test approx. 12 watts; panel lamp serves as fuse; safety interlock cord supplied.
2. Emission Test — measures beam current to phosphor screen; emission indicated on 4½" meter; plug-in test cable and 110° socket adapter provided.
3. Bias Test — fixed negative voltage applied between grid and cathode to check cutoff point and condition of grid aperature.
4. Life Test — relative meter indication of active cathode coating remaining.
5. Shorts Test — filament-to-cathode and grid-to-cathode shorts indicated by neon panel lamps; grid-to-cathode shorts may be burned off.
6. Rejuvenation — voltage applied to cathode reactivates coating; "magic eye" on front panel indicates response to treatment.
7. Size and Weight — 10" x 6" x 5", 6½ lbs. complete.

Using four defective TV picture tubes, each of which produced the familiar trouble symptom of dim raster and washed-out picture, I made several experiments with the Model 200 to evaluate its capabil-



"All we get is snow on our screen!"

Fig. 7. Vis-U-All 200 performs four tests and reactivates picture tubes.

ities. When I advanced the contrast and brightness controls during two preliminary tests, the white portions of the picture would turn a silvery gray. This is sometimes known as the "Zombie effect" and occurs quite often in tubes having low emission or gas.

Without going into details about operating procedures, which incidentally are printed inside the detachable lid, the results of my lab findings are as follows: The original emission test reading on the meter was less than .1 for all four tubes—an indication of very low emission. Indications were that one of the tubes had internal shorts. I was able to successfully reactivate three of the four "guinea pigs" and restore their emission to a reading of between .2 and .4 in the good area of the meter scale.

In the case of the shorted tube, I

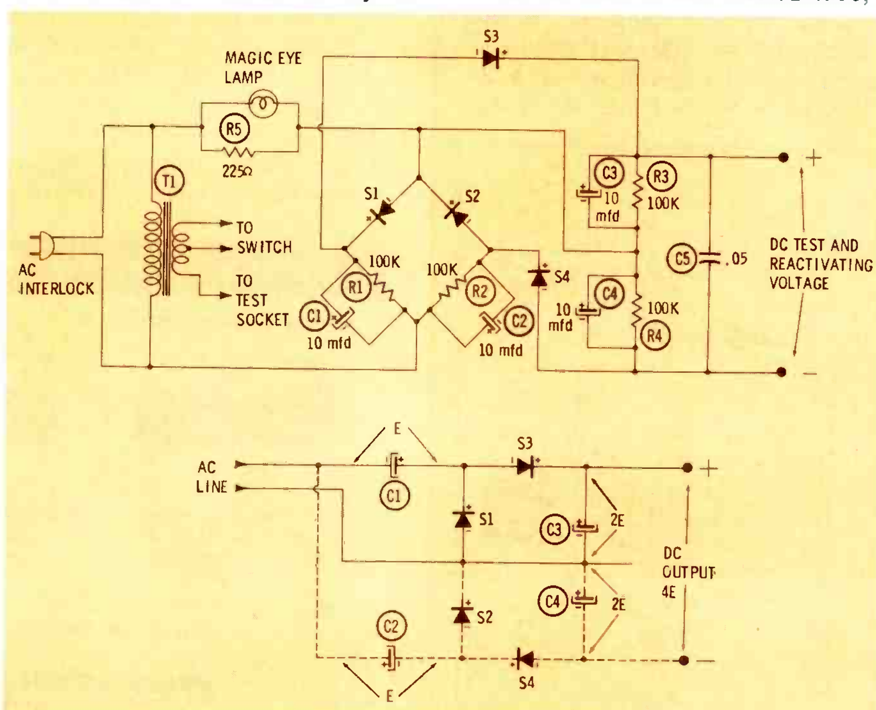


Fig. 8. Power supply for Model 200 (A) Complete Circuit. (B) Simplified diagram.

Fig. 9. This Vis-U-All adapter plugs into test cable and fits new 110° tubes.

placed the function selector in the REACTIVATE position and was able to burn off the short between grid and cathode, but the one between filament and cathode remained. This tube was not ready for the cash can, however, for by merely isolating the filament circuit from ground with a small 6.3-volt transformer, the tube could be operated satisfactorily.

The thing that impressed me most about the design of the Model 200 was its power supply circuit, which obtained approximately 560 volts DC from the AC line. Since I didn't happen to have a schematic of the instrument, I removed the case and drew the power circuit schematic shown in Fig. 8A.

I found that the instrument employed four silicon rectifiers and four electrolytic capacitors in two voltage doubler circuits, one from each side of the power line. Since it was somewhat difficult to recognize a familiar circuit design from Fig. 8A, I simplified the arrangement into the style of Fig. 8B. That portion in solid lines represents a simple doubler network such as might be found in any television receiver. With one side of the AC line as reference, the instrument also makes use of a second doubler, shown by the broken lines in Fig. 8B. Thus, we have two rectifier circuits—one positive and one negative with respect to the common side of the AC line. By adding these two outputs in series, a potential of 560 volts, or about 4 times the peak AC input voltage, is available for use in the tester and reactivator circuits.

Other interesting features of the Model 200 are the "Magic Eye" indicator on the front panel, which tells the operator when the tube has had enough reactivating voltage, and the convenient adaptor socket (Fig. 9) for testing 110° tubes.

PC Servicing

(Continued from page 26)

wouldn't discourage me. Here's a good method you can use to mend a clipped lead: Take a piece of #22 tinned wire about 3″ or 4″ long, and get a small drill bit like I was using awhile ago. Wrap the wire around the bit as close as you can, until you have a little spiral about ¼″ long. Take this little sleeve, slip one end over the remaining part of the component lead, and attach the other end to the stub of lead wire that projects from the PC board. Press the coil against the wire stubs with long-nose pliers. Now solder the connection by applying an iron to the middle of the sleeve.

There are times when it becomes downright exasperating to locate a part on a PC board. You know what I mean if you've ever used the Braille system (with the aid of a strong light) to find your way around in a circuit. I have even been misled into unsoldering the wrong part, but I now have a technique for avoiding needless unsoldering. Try the following idea: Take a piece of insulated #14 or #12 solid wire 10″ long, and bend it double. Now you have a pair of calipers. Working on the component side of your PC board, choose a reference point. You may be able to locate a certain part that is conspicuous on both sides of the board, or perhaps you can find an unused hole and insert a small piece of spaghetti through it. Spread open your calipers so that one end touches the lead you want to unsolder and the other end is at the reference point. Repeating this procedure on the reverse side will enable you to locate the exact spot. Use a sharp instrument to make a small X on the board at the reference point; then, when you go back to work after a break, you will know exactly where to start in. By cutting off ¼″ of insulation and sharpening each end of your calipers, you can use them as a jumper to check for cracks, etc., in the printed wiring.

Our next set, by coincidence, is another Admiral — a Chassis 17Z3DB this time. The complaint is no sound and no raster. Removing the back cover, we see that most of the tubes light up, but that 5 of them don't. At first glance, this looks like a simple deal — one of these 5 tubes must be open. However, actual tests show them all to be good. Well, now, what have we here? All the tubes in this set are in one series string (see Fig. 2). Since only 5 are unlit, we can suspect that they are not receiving heater voltage because of a short to ground at some intermediate point in the string. Studying the schematic, I find that the unlit tubes are V12, V7, V8, V16, and V9. The rest of the tubes glow with about normal brilliance. The fusible resistor in this particular set is soldered in place, so I clip it and pull V12, the last tube in the string. Now I bring my C-R tester into play. When I connect it to pin 7 of V14 and ground and set it for an insulation-resistance check, it shows a short. At this point, I begin to think that one of the 9 capacitors in that string might be giving trouble. However, I decide to wait until later to check these, and I start pulling tubes one at a time. When I remove V5 (a 5AM8), the short disappears, indicating that either V5, C84 or C85 is defective. Further tests with the

C-R checker reveal that, even though V5 checks OK on my tube tester, there is a high-resistance leakage from heater to cathode in the diode section. This cathode (pin 7) goes directly to ground through the secondary of the last IF transformer, which has a very low resistance. My C-R tester (which can detect leakage resistances as high as 2.5K megohms) clearly shows the triode section to have heater-to-cathode leakage. By unplugging tubes, we are able to check the nine heater - to - ground capacitors for shorts without disconnecting a single one. We do this, just in case one is bad; however, they all pass the test.

Notice that we manage to solve the last case without ever having to touch the PC board with a soldering iron. This serves to illustrate that, when you are troubleshooting a printed circuit (or anything else for that matter), it pays to use your scope and VTVM to get you as close to the trouble as possible, and then to study your schematic for a while. Believe it or not, you will often find that you are able to check a dozen or more parts by unsoldering only two or three connections at the most.

Speaking of soldering, you remember that old 100- to 200-watt soldering iron you put away? Yes, the one with a big chunk of copper on one end! Dig it out—you may be able to use it for unsoldering controls and electrolytics. Get a copper disc about the size of a half dollar. If you want, cut it into a horseshoe shape. Now mount this on the end of your old iron by tapping threads into the tip and then fastening the disk onto it with brass screws. Tin the whole thing, letting solder flow over both sides of the disc and the tip of the iron. Of course, if you're not an avid do-it-yourselfer, you can avail yourself of one of several good printed-circuit soldering kits now on the market.

All in all, PC servicing isn't any more difficult than other types of servicing; it just takes other techniques. You will be seeing more and more sets with PC boards, so if you plan to continue to offer fast, efficient service, you'd better spend a little time to develop a good trouble analysis and repair technique. On to better and faster servicing—with thorough, rather than rash action! ▲

Audio Facts

(Continued from page 24)

faulty part by visual observation or by voltage and resistance checks.

Headphones with alligator clip leads are handy for signal tracing. Also, high-impedance crystal phones with good high-frequency response can be used most effectively. A capacitor connected in series with one lead will protect the phones and the technician during plate-circuit tests. When phones are used as an indicator, a slightly different signal-tracing method is used. The signal is applied to the input of the pre-amp during the entire test, and the phones are moved from stage to stage.

The first test point is across the speaker terminals. If there is output from the phones, the speaker is at fault; but, if there is no output, the serviceman should work back through the system with the phones until a signal can be heard. It can then be assumed that the trouble is in the circuit immediately following the point where a signal is first picked up.

Any number of specific troubles could cause lack of signal output. Some examples are bad tubes, broken wires, poor solder joints, poor switch or connector contacts, burnt or wrong-value resistors, open coils, open or shorted capacitors, and shorts between the conductors and shields of connecting cables. Each is a separate condition that must be found and fixed independently. In this respect, hi-fi servicing is no different from radio and TV repair.

When a faulty component is found, it should be replaced with a duplicate of the original whenever possible. Good hi-fi is a result of precise design; therefore, exact values should be used (even for filter components) so as not to disturb the balance or stability of the unit being repaired. If the system is a new one, the technician should look for improper lead connections and misadjusted switches and controls before using the signal-tracing tests.

Distortion

Several different types of distortion can occur in audio systems, the most prevalent of which are:

1. Harmonic Distortion—Nonlinear operation of an amplifier results in the generation of harmonics which are not part of the input signal. The harmonics are whole-number multiples of the frequencies from which they are produced and therefore do not sound discordant.

2. Intermodulation Distortion — In a nonlinear amplifier, the various frequencies making up the audio signal also beat together to produce sum and difference frequencies that are not present in the input signal. These additional frequencies have no harmonic relationship to the signal and are more annoying than those which produce harmonic distortion.

3. Frequency Distortion — A perfect audio amplifier would give equal amplification to every audio frequency; however, practical amplifiers have response curves which drop off at both the high and low ends of the audio range. This unequal amplification is called frequency distortion; when such a condition exists, we say that the frequency response is poor.

Listening to a system may often give the serviceman some idea of the type of distortion for which he should look. Harmonic distortion may not be too objectionable to many listeners because it causes only minor changes in the sound. For instance, it might cause a violin to sound differently but still not displeasing. Intermodulation distortion most often sounds discordant because new frequencies are produced. Frequency distortion shows up as insufficient bass or treble, but does not otherwise alter the tone quality.

Next, the serviceman should determine whether the distortion exists on all program sources or just on one. How about the program material — is it distorted? If so, there is no need to look any further than the signal source, whether it be phono, tape, tuner, or microphone. When distortion exists for all volume levels, it can be assumed that it originates ahead of the volume control; but, if the distortion varies with different volume settings, then it is being introduced in a stage following the control.

To check for harmonic distortion, the system should be adjusted to produce its maximum rated output. An audio oscillator, set at about 1,000 cps, can be used to supply a steady input signal. Such a strong signal from the speaker would be extremely annoying, so a dummy load should replace the speaker for these tests. For such purposes, the audio technician should have available resistors of 4, 8, and 16 ohms with power ratings of at least 50 watts.

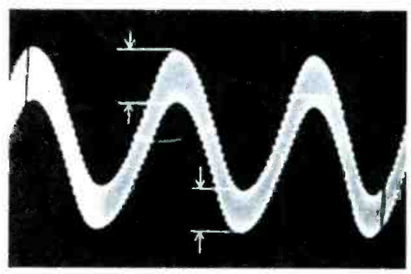
An audio VTVM or wattmeter connected across the resistor will show the output level being produced. A wattmeter will indicate the power output directly, but this type of meter may not always be readily available. Fortunately, an audio VTVM can be used almost as easily. By using the information in Chart I, one can determine the proper voltage for each of the most popular power ratings. For example, a 20-watt amplifier using an 8-ohm load is producing full power output when the reading across the output load is 12.6 volts. For ratings not shown in the chart, the power formula $P = E^2/R$ can be used. Thus, a 12-watt amplifier with a 16-ohm speaker would require 13.85 volts to develop its rated output.

CHART 1—AUDIO VOLTAGE OUTPUTS AT VARIOUS POWER LEVELS

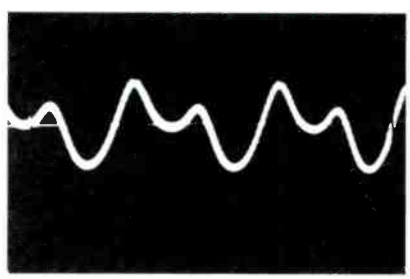
Rated Maximum Output in Watts	Voltage for 4 Ω Load	Voltage for 8 Ω Load	Voltage for 16 Ω Load
5	4.5	6.3	8.9
10	6.3	8.9	12.6
15	7.7	11.0	15.5
20	8.9	12.6	17.9
25	10.0	14.1	20.0
30	11.0	15.5	21.9
50	14.1	20.0	28.3

Checks for harmonic distortion can be made by using an oscilloscope and either a sine- or square-wave audio generator. With the generator connected to the phono or microphone input terminals, turn the volume control to maximum and increase generator output until maximum rated power is reached The waveform at various parts of the circuits can be checked with a scope, starting either at the input or at the speaker. Several examples of harmonic distortion are shown in Fig. 2 for purposes of comparison. The exact degree of harmonic distortion present in an amplifier can be measured with a harmonic distortion analyzer. Basically, this instrument indicates the amplitude of the harmonics being introduced in comparison to the total signal amplitude. It is calibrated in percentage of distortion.

Intermodulation troubles are best checked with an intermodulation distortion analyzer. This instrument functions by applying two sine-wave signals of different frequencies (one high, one low) to the amplifier under test. The amplitude of any additional frequencies produced by interaction is then measured with respect to the two original signals. Examples of intermodulation distortion are shown in Fig. 3. Notice that, in addition to altering the shape of the original signal, the distortion actually creates a discordant signal which falls within the audio spectrum. Both



(A) Mixture of 60- and 3,000-cps signals producing 12% distortion.



(B) Waveform of spurious signal component due to intermodulation.

Fig. 3. Intermodulation distortion.

harmonic and intermodulation distortion analyzers will be described in more detail in a later article.

When the system seems to lack normal frequency response, make sure all controls are properly adjusted. Equalization, tone, loudness, and speaker controls all vary the frequency response, and improper settings will therefore result in uneven response. Incidentally, bear in mind that apparent frequency response is poorest at low signal levels because of the way our ears react to the different levels of sound.

Phono cartridge response can be checked with a test record that provides constant output over a wide range of audio frequencies. Output from the preamplifier at each frequency can be read with an audio VTVM or wattmeter. Be sure the equalizer switch is correctly set and that bass and treble controls are adjusted to the FLAT position. If a linear response is not obtained across the audio band, connect the signal generator to the phono input of the preamplifier and vary its frequency over the same range covered by the test record. (Note! The output of the generator must be flat over the audio spectrum.) If a linear response is produced when the generator signal is applied, the phono cartridge obviously must be defective. However, if the response to the generator signal is also nonlinear, the cause may be in the preamp. The same response test can be used to check the power amplifier and speaker system. Once the distortion has been isolated to a single unit, stage-by-stage tests can be made for further isolation of the defect.

Hum

Normally, hum refers to an audio output at either the AC-line or power-supply ripple frequency (60 or 120 cps). The latter is more objectionable because it is more easily heard. In order to locate the source of the hum, determine first whether or not it exists for all signal inputs. Most cases of hum will originate in the phonograph, so this unit should be checked with extra care.

If the hum is not originating in the phonograph or other signal source, use one of the signal-tracing methods previously described to locate the exact source. One method of isolating hum consists of shorting out or disconnecting signal points in a logical order. To begin with, disconnect the input to the power amplifier. If hum remains, the trouble is in the output amplifier. If the hum stops when the input to the power amplifier is removed, then it is obviously being introduced prior to that point. Individual stages can be checked by shorting grid and plate circuits to ground through a large capacitor. If the hum remains when a given point is shorted, it must be originating after that point. Successive shorting of signal points should disclose where the hum is being introduced.

Don't forget the possibility that hum might come from the power supply and actually be introduced into all stages. Power-supply hum is almost always at 120 cps. Bridging an electrolytic capacitor from B+ to ground should indicate whether or not power-supply filtering is adequate.

Hum can also be caused by other things, some of which are: Transformers or motors positioned too close to a pickup arm, heater-to-cathode short or leakage in tubes, unbalance in push-pull stages, a misadjusted hum-balance control, poor or broken ground connections, defective shields, leakage across tube sockets (especially in low-level circuits), trouble in a feedback loop, and improper lead dress. Faulty components which could cause hum include power supply filter capacitors, resistors or chokes; cathode or screen bypass capacitors; and faulty rectifier tubes. In a few cases, reversing the AC line plug may help to reduce mild forms of noise that sound like hum.

Noise

To track down the source of noise, first check to see if it is being introduced by a signal source. Noise is very often introduced from worn records or styli, or by static interference from a tuner. Second, stop and think! What kind of noise is it? Is it steady or intermittent, is it a form of hiss or other steady noise, or does it crackle and pop irregularly? Quite often, the character of noise helps to pinpoint the actual trouble.

If noise occurs only when a switch or control is varied, look for trouble such as dirty or pitted contacts in that component. Tubes often have noise-producing defects that do not show up on a tube tester. Low-level amplifiers in particular are best checked by replacement with tubes of known good quality. Misadjusted treble controls can result in too much hissing, especially when the treble setting is too high. If the control is already adjusted correctly, decreasing the treble will often lessen the noise; but this is not a suitable remedy because high - frequency audio signals are also reduced in the process.

Motorboating is a type of noise which can be caused by an open screen bypass capacitor or control grid resistor, or else by insufficient decoupling. Although howling and whistling can result from parasitic oscillations in any stage, one of the most common causes for this type of disturbance is a component failure within the feedback loop of the power amplifier. The actual circuit location of the noise introduction can be determined by the same methods used for locating hum. ▲

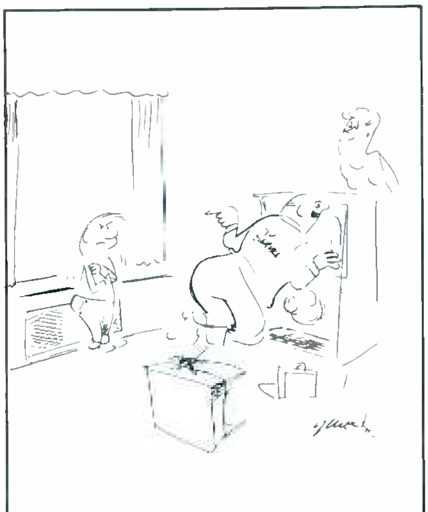
Across the Bench

(Continued from page 17)

try RF or IF realignment. I find that these sets generally don't need it.

Be on guard if the plate voltage of the 4th video IF tube doesn't check exactly as shown on your schematic. You may find that the wiring in the plate-load circuit is not what the diagram says it should be. Earlier models of the KCS47 chassis have an 8200-ohm resistor in series with a 1000-ohm unit, but later models have a combination of a 36-microhenry peaking coil shunted by a 22K-ohm resistor connected in series with a 6800-ohm resistor (see Fig. 2). Since these receivers were built during the early part of the Korean War, when parts were sometimes temporarily in short supply, you may also find slight changes in component values from set to set. (For instance, groups of parallel resistors were even made up to supply the desired values. It works, but it's expensive!)

The aforementioned changes will have some effect on plate voltage — enough to account for a seemingly out-of-tolerance condition, but not enough to explain radical departures from normal values. If something is seriously wrong, remember that someone may have made some ill-advised field changes during the long life of the receiver. Perhaps some misguided individual, noticing the presence of the shunt peaking coil in the fourth IF circuit of most KCS47 chassis, might have decided to install this coil in the occasional receivers that lacked it. If he neglected to change the 1000-ohm series resistor to 6800 ohms at the same time, he would have reduced the total DC plate-load resistance from the original 9200 ohms down to about 1003 ohms. Since there wouldn't be much of an IR drop across the resulting combination, the plate voltage with no signal applied would move up from the customary 125-volt level to the neighborhood of 180 volts.



"S'all right, ma'am — he won't bother me. I got him soldered by his overall rivets to that radiator."

Start Digging In

Before wrestling with some of the more complex circuits, you might do well to make a few "quickie" checks of various large paper capacitors used for coupling and bypass purposes in the IF, video and sync stages. Use a capacitance checker, or test for leakage with a VTVM while the receiver is on. (Remember, this is done by cutting loose or unsoldering the end of the capacitor that is nearer ground potential, and then bridging the meter between this disconnected end and ground. Any DC reading other than zero indicates leakage.) It's especially wise to check the following capacitors: The .047 in the fourth video IF, the .1 between the two video amplifier stages, the .1 in the picture-tube cathode circuit, the .0022 at pin 2 of the 12AU7 DC restorer, the .47 at the cathode of the sync amplifier, and the .01 at the input to the vertical integrator. Some of the other capacitors in the video output stage might also bear checking.

Change any defective capacitors and restore all connections; then make spot-checks of resistors in the video and sync stages and replace any that have either increased or decreased in value. At this point, you are about ready to tackle the really tough circuits in the receiver.

Automatic Gain Control

The AGC system of the KCS47 has some interesting features that can turn into service headaches. Basically, this circuit consists of a network for rectifying and filtering the IF output voltage; however, it also has some accessory items, including a three-position area switch and a tie-in with a combined DC restorer and sync separator. Considered as a unit, this whole circuit is one of the principle roots of the KCS47's troubles.

The original design employed one section of a 12AU7 twin triode for the DC restorer-sync separator function, but this circuit was expanded (in the KCS47T and later chassis) to include both halves of the 12AU7. The early- and late-production versions are shown in Figs. 3A and 3B, respectively. In the former, the leftover half of the 12AU7 is a sync amplifier, and a 6J5 is used as a vertical oscillator. These two functions were taken over by a 6SN7GT in the revised chassis.

In general, the AGC line itself does not change greatly in design from one chassis to the next. The

"It glowed brightly and then went out. Does that mean it's bad?"

sync-pulse tips in the IF output signal cause conduction of the AGC rectifier diode, thus charging the 100-mmf coupling capacitor in the polarity shown in Fig. 3A. Between pulses, this capacitor discharges through the AGC filter network and thereby produces a negative DC voltage which is applied to the RF amplifier and the first three video IFs as bias.

The AGC bias voltage is not fed to the tuner in full strength, but first goes through a delay network consisting of a series resistor (either 33K or 150K) and a connection to the lowest B+ voltage through a 2.2- or 10-megohm resistor. A positive voltage is introduced by this circuit for the purpose of opposing the negative AGC bias voltage. When signal strength is high, the AGC voltage reaching the tuner is still negative — but less so than the IF bias. Whenever the output of the AGC rectifier decreases to a certain level, it is completely neutralized by the positive delay voltage. Then the tuner bias drops to zero and allows the RF amplifier to run "wide open." With further decreases in AGC rectifier output, the tuner AGC line attempts to go positive, but this is prevented by conduction of the clamper diodes. As long as these conduct, the tuner bias is held at a fraction of a volt above ground potential.

Some explanation of the dual-purpose DC restorer-sync separator circuit is in order before we attempt to understand how it affects AGC action. In the circuit of Fig. 3A, a sample of the composite video signal (with negative-going sync pulses) is fed from the grid circuit of the picture tube to the cathode (pin 3) of the 12AU7. Since the grid of this triode section is returned to the AGC line and has no AC signal applied, the stage operates virtually the same as a grounded-grid amplifier. The tube conducts heavily on negative sync-pulse tips, producing negative output pulses in the plate circuit. These are fed to the sync amplifier stage.

The conduction of the 12AU7 during sync pulse time serves to clamp the negative peaks of the picture-tube grid signal at a fixed level. In this respect, the circuit acts the same as a conventional diode-type DC destorer; that is, it clamps the bias on the picture tube in such a way that beam cutoff will occur at the black level (provided brightness and contrast controls are properly adjusted), regardless of shifts in the average background brightness level of the televised scene. AGC voltage is applied to the grid (pin 2) of the 12AU7 to regulate the conduction level of this tube, thus insuring proper sync separator action at practically all signal input levels.

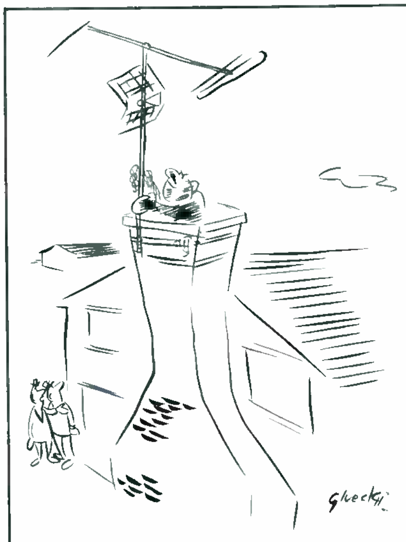
The AGC switch provides additional compensation for differences in signal strength. The maximum counterclockwise position is for use in normal signal areas. If pulse-type noise interference is present, the switch may be turned to the next position in order to shunt a 47K-ohm resistor from the AGC line to ground. This extra resistor shortens the time constant of the AGC filter and thus prevents excessive AGC buildup by the noise pulses. In the third position of the switch, the AGC line is shorted to ground so that the RF, IF and sync circuits can be operated with minimum bias. In this position, overloading and picture distortion can result if signal strength at the tuner input exceeds 200 microvolts.

The circuit in Fig. 3B uses two sections of a 12AU7 in a bridge arrangement for the DC restorer-sync separator function. The first section is similar to its counterpart in Fig. 3A, while the second section is operated as a true grounded-grid stage with approximately the same cathode input and plate output signals as the first section. An important advantage of the two-stage circuit is better control of the bias on the sync amplifier, resulting in improved operation of this stage. AGC switch wiring in Fig. 3B is slightly different from that in Fig. 3A, but the two versions of the circuit have the same basic function.

AGC Repairs

Now that you know a little more about how this circuit works, repairs should be a bit easier. Just one caution: If you come up with some doubtful looking resistance readings in this circuit, look at the resistors in the set and see if they are the same as called for on the schematic. Remember that a number of different values are frequently found in the same application in various KCS47s.

In checking resistors and capacitors in this AGC circuit, are you wasting your time? Not by a long shot, when you're working with an old set, and particularly on a circuit that repeatedly gives trouble. You want action? Get out the capacitance checker and disconnect the 2-mfd electrolytic used as an



"He feels that ladders are dangerous — so he works from the inside."

AGC filter. In the first of those two KCS47s I recently operated on, this fellow had a nasty intermittent short. Its brother in the second set was as open as a severed cable. The other big AGC filter capacitor, a .47-mfd unit, also ought to be checked. When you hook up the capacitance checker and apply 200 volts (the rated voltage), it's often evident that this .47's dielectric has some pretty big holes. While checking AGC capacitors, don't forget the .0022 at the grid of the DC restorer-sync separator. If it changes value or becomes leaky, the AGC voltage will be affected.

Other Circuits

If the audio output of a KCS47 is weak or full of buzz, it's wise to check and repair the AGC circuit before digging into the sound section. Restoring AGC bias to a normal level often clears up the sound. Here's why: This set is a split-sound type with a 21-mc sound IF, and the sound takeoff point is a tap on the secondary of the third IF transformer. An incorrect AGC voltage tends to cause distortion of the IF response curve, and the 21-mc sound IF carrier may ride too high or too low on the slope. An excess of this carrier at the takeoff point causes buzz; if it rides too low on the curve, weak sound will result.

Before giving the sound section a clean bill of health, rotate the fine tuning control through its range on each active channel. Any buzz indi-

PRESS TIME FLASH!

Controlling interest in the Bobbs-Merrill Co., 120-year old book publishers of Indianapolis and New York, has been acquired by Howard W. Sams & Company, Inc.

The Bobbs-Merrill firm will retain its present identity, with Howard W. Sams directing its activities as Chairman of the Board.

Included in the firm's 1250 active book titles are trade, juvenile textbooks, as well as a complete line of legal volumes, digests and statute compilations.

cates that a touch-up of the sound IF or discriminator transformer might still be needed. If no buzz is evident, but the sound is "mushy" except at one extreme of the control's rotation, this is a sign that the local oscillator slugs need readjusting.

I have found that most parts in the sound section of the KCS47 seldom need changing, but occasionally come across leaky coupling capacitors in the audio amplifier stages of these sets. The .0022 across the primary of the output transformer sometimes gets leaky, too.

The horizontal sweep circuits of these receivers need an overhaul now and then. You'll often find that one or more of the DC voltages in the pulse-width, AFC-oscillator circuit read low, particularly in the grid or cathode circuit of the AFC stage. If you suspect horizontal trouble but are not sure where to hunt for it, start by looking at the output tube grid waveform. If it is distorted, the trouble is probably back toward the oscillator stage — or it could be in the cathode or screen circuit of the output tube. Incidentally, be sure that the output tube grid voltage is no less negative than —26 volts, and that the screen voltage reads at least 300 volts.

The capacitor shown as C98 in Fig. 4 will often produce a slow drift in horizontal frequency. Other units which can cause this trouble are C97, C99 and C100. When replacing these units, I prefer mica to paper or ceramic dielectric because the former is somewhat more stable and should last almost indefinitely.

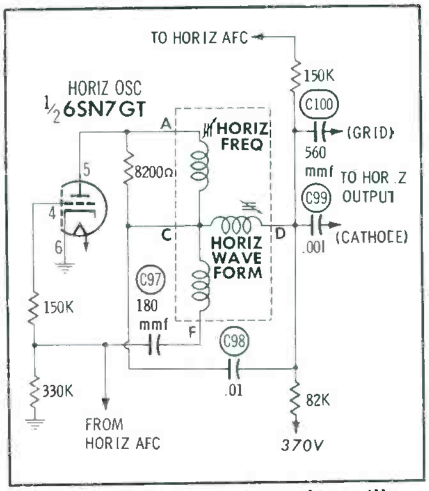


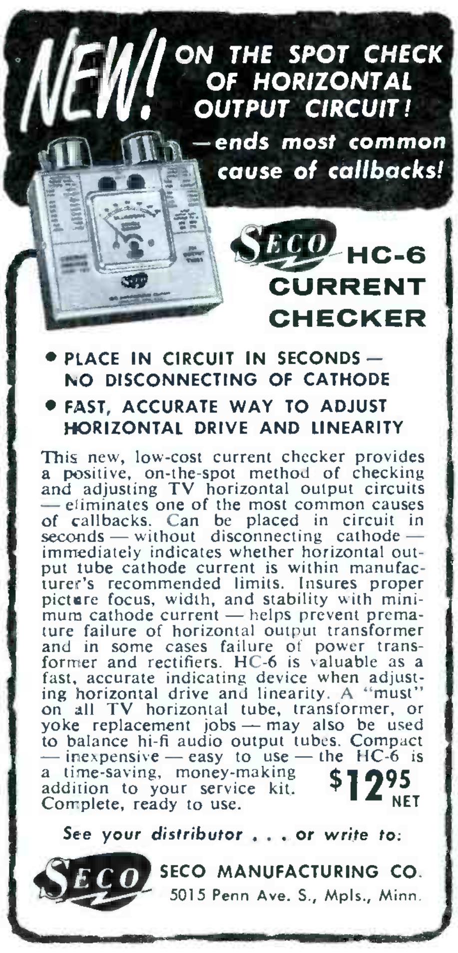
Fig. 4. C98 in horizontal oscillator causes frequency drift if defective.

In the vertical circuit, you will occasionally find a leaky coupling or bypass capacitor. When the coupling capacitor between the integrator and the oscillator goes bad, it can cut off the oscillator or throw it considerably off frequency. Any one of the paper tubular units connected to the vertical output transformer will fail occasionally, causing a variety of symptoms. However, the capacitors in the vertical circuit are not so prone to defects that I would recommend a special effort to test them with a capacitance checker. Waveforms and DC voltages are generally an adequate guide to vertical circuit troubles.

A Last Resort

If an early-production KCS47 (one using the sync circuit shown in Fig. 3A) loses horizontal sync at low settings of the contrast control, you may find that no amount of troubleshooting seems to help the situation. In this particular case, there is one final step you can take: Change the value of resistance between the cathode (pin 3) of the sync separator and ground. You can try substituting a number of different values until you find one that improves synchronization. I always prefer to avoid this sort of thing if I can, but I make an exception in this one case. As I pointed out before, this sync separator circuit has already been subjected to some changes in component values. The PHOTOFACT Folder for the original KCS47 calls for a cathode resistance of 470K ohms, but values up to 680K are found in some individual sets of this model run.

Of course, the object of altering the sync circuit is to insure that the horizontal oscillator will receive usable sync pulses at all settings of the contrast control. Therefore, an oscilloscope should be connected through a low-capacitance probe to the plate of the sync amplifier in order to demonstrate the effect of various resistor changes on the sync output signal. As different resistance values are switched into the circuit, watch for a definite increase in waveform amplitude. You can usually find some value of sync-separator cathode resistance at which the horizontal sync becomes sufficiently stable to allow the set to be returned to its owner. ▲



PRODUCT report

For further information on any of the following items, circle the associated number on the Catalog & Literature Card.

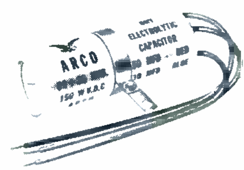
Tube Merchandiser (No. 41Y)

A filament-continuity checker and a "lazy Susan" rack holding 100 tube types are included in the "Tube Mart" counter merchandiser unit being offered to radio-TV service dealers by Raytheon. Designed for placement in drug stores, supermarkets, etc., the display stands 30" high and has a base 15" square. A built-in literature rack is filled with folders that direct the customer to call the sponsoring dealer if tube replacements fail to repair his set.

Phono Cartridge Tool (No. 42Y)

A special tool for installation or removal of phono cartridges, G-C *Mini-Hold*, grips mounting screws as it drives them. Two sizes are available — 2⅞" long (No. 9346; $3.30 list) and 6¾" long (No. 9347; $3.75 list).

Electrolytic Capacitors (No. 43Y)

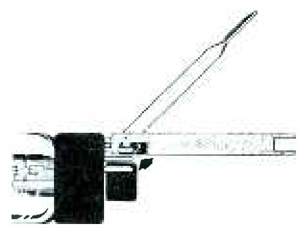


Arco Electronics, Inc. has introduced a new line of electrolytic capacitors including single, double and triple units rated at 150 or 510 WVDC. All types are equipped with pigtail leads except for one 120-mfd, 150V twist-prong capacitor. Each *Arcolytic* is encased in an insulating cardboard sleeve with mounting strap attached.

Stereo Conversion Kits (No. 44Y)

Each of the three Fanon kits for converting phonographs to stereo operation includes an amplifier and two speakers in a single cabinet, a stereo turnover cartridge, and necessary mounting accessories. STK-4, with two 4" speakers, lists for $39.95; STK-5, with 8" woofer and 3" tweeter in fabric-covered cabinet, is $49.95; and STK-10, same as STK-5 but in mahogany cabinet, is $59.95.

Picture Tube Repair Tool (No. 45Y)



Intermittent operation of picture tubes due to defective solder connections at socket pins is easily corrected through use of the *Perfect Pin Crimper* made by Berns Mfg. Co. Actually a 3-in-1 tool which also serves as a channel-selector wrench and screwdriver, it serves to notch pins and element leads to provide solid electrical connections. Price is $1.25.

Communications Radios (No. 46Y)

A single dash-mounted unit contains all controls, speaker, microphone jack, and transistorized power supply for 580 Series *Fleetcom* two-way mobile radios built by Communications Co., Inc. All transmitter and receiver circuits are in another unit designed for underdash mounting. Systems are available for regular or split-channel operation on 25-50 or 144-174 mc. Each mobile unit costs $398.00, and base stations are $430.00.

Audio Tubes in Pairs (No. 47Y)

Matched pairs of Type 6550 and Type 5881 audio power amplifier tubes, tested at the factory for similarity of characteristics, are being marketed by Tung-Sol. Matching is claimed to be effective in minimizing distortion. The 5881's are used in amplifiers rated at less than 50 watts, while 6550's are for amplifiers and commercial sound equipment with outputs up to 100 watts.

Microphones (No. 48Y)

This 2-oz. miniature dynamic lavalier microphone, Electro-Voice Model 649A, is a low-impedance unit with a frequency range of 60 to 12,000 cps. The Model 727 *Slim Ceramic,* another newly-designed microphone, is suitable for public-address or general use. An improved type of inexpensive ceramic microphone for home recording, Model 718, features a case that can be set upright on a flat surface.

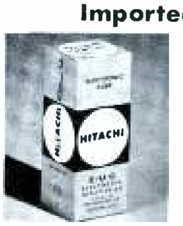
Conversion Offer (No. 49Y)

For $89.95, the owner of any B & K Model 1000 *Dyna-Scan* can have his distributor return it to the factory for conversion into a Model 1075 *Television Analyst.* Horizontal and vertical deflection drive signals, which can be applied to the grids of TV sweep output stages in place of the regular oscillator signals, are among the signals developed for point-to-point signal injection testing techniques. With the converted instrument, troubles in the video, audio, RF, IF, sync, and sweep sections may be quickly isolated.

Short-Wave Receiver (No. 50Y)

The National NC-60 *Special* short-wave communications receiver covers the range from 540 kc to 31 mc in four bands. A bandspread (vernier) knob is usable on all frequencies. Tube complement includes a 12BE6 converter, 12BA6 IF-BFO, 12AV6 detector-AVC-audio, 50C5 audio output, and 35W4 rectifier. The cabinet is finished in black and grey enamel. List price is $59.95.

Imported Tubes (No. 51Y)



Hitachi brand receiving tubes are being distributed in this country by Electronic Utilities Co., Division of The Sampson Co. These tubes, engineered to meet American standards, are available in a wide range of types. All carry a 90-day guarantee.

INDEX TO ADVERTISERS

December, 1958

CATALOG AND LITERATURE SERVICE

ACCESSORIES

1Y. *E-Z HOOK*—Convenient reference sheet titled, "How to Build the Five Most Useful Scope Probes," with schematics, mechanical component layouts, etc. *See ad page 59.*

ANTENNA SYSTEMS

2Y. *BLONDER-TONGUE* — Catalog sheet on 2-set, 4-set, UHF-VHF, and Hi-Lo antenna couplers (Form No. EM-100). *See ad page 25.*

3Y. *CLEAR BEAM*—Literature on full line of FM antennas and do-it-yourself antenna kits. *See ad page 46.*

4Y. *RADIO MERCHANDISE SALES* — Color brochure on 1000 series "Wave-booster" antenna. *See ad page 64.*

5Y. *WESTBURY* — Catalog 89 featuring all-transistorized broadband amplifier Model ABB 9/10 for community TV systems.

ANTENNA TOWERS

6Y. *KTV TOWERS* — 4-page *multicolored* brochure showing tower construction features, plus mounting and installation equipment.

AUDIO & HI-FI

7Y. *ELECTRO-VOICE* — Catalog No. 126 on public-address and general-purpose microphones. *See ad page 9.*

8Y. *ORRADIO INDUSTRIES* — Cross-reference chart on recording tape showing comparable catalog numbers for each type of tape and giving the time for all size tape reels and lengths at all speeds. Also, "IRISH Wire Wobbler," attractive 3-color display card illustrating recording tape, which identifies the store as a recording tape dealer.

9Y. *UTAH RADIO* — New stereo catalog for speakers and enclosures with speaker systems for stereo.

10Y. *WALSCO* — Phono conversion data and wall chart. *See ad page 50.*

CAPACITORS

11Y. *CORNELL-DUBILIER* — Data on service shop storage chests for capacitors. *See ad page 61.*

12Y. *SPRAGUE* — "ABC's of Ceramic Capacitors.," a comprehensive brochure on theory and applications. *See ad page 10.*

13Y. *TOBE DEUTSCHMANN* — Cross-reference chart for twist-prong capacitors, a 24-page booklet providing over 3,525 listings of "Preferred" Tobe twist-prong and tubular electrolytics to replace 5 other major-brand types.

CARTRIDGES & NEEDLES

14Y. *CBS-HYTRON* — "Hints on Using The Columbia CD Stereo Cartridge"

COMMUNICATIONS

15Y. *COMMUNICATIONS CO.* — Information on new 2-way mobile radio system for communication between shops and service trucks. *See ad page 66.*

COMPONENTS

16Y. *CENTRALAB* — "Packaged Electronic Circuit" guide. *See ad page 55.*

CONTROLS

17Y. *CLAROSTAT*—Form #751773 on sound system controls, pads and attenuators. *See ad page 13.*

18Y. *IRC* — Form S-035C, D1r-58 replacement parts catalog. *See ad 2nd cover.*

FUSES

19Y. *BUSSMANN* — Quick reference catalog to all types of fuses used in the electronic industry (Bulletin SFUS). *See ad page 29.*

SERVICE AIDS

20Y. *DE-RO ELECTRONICS* — Illustrated catalog on line of TV and hi-fi aids.

21Y. *GREGG ELECTRIC* — Folder giving complete details on printed circuit repairing. *See ad page 56.*

22Y. *ROGERS* — Literature on the "Tel-A-Turn," new TV chassis rack designed to cut down repair time, eliminate struggling with heavy, hard-to-handle chassis, and permit full rotation and locking in any position.

23Y. *SHELL* — TV Troubleshooter's Guide.

TECHNICAL PUBLICATIONS

24Y. *PF REPORTER* — 1958 Editorial Subject Reference Index.

25Y. *HOWARD W. SAMS* — Descriptive literature on all Howard Sams books covering servicing of TV, radio, hi-fi, etc. Includes data on latest books, "Servicing Transistor Radios, Vol. 2," "Tube Location Guide, Vol. 8," "101 Ways to Use Your Sweep Generator," "Know Your Oscilloscope." *See ads pages 23, 44.*

TEST EQUIPMENT

26Y. *B&K*—Bulletin AP12R gives helpful information on new point-to-point signal-injection techniques with Model 1075 TV "Analyst"; other bulletins describe "Dyna-Quick" Models 500B, 650, and automatic 675 portable dynamic mutual conductance tube and transistor tester, plus Model 400CRT cathode rejuvenator tester. *See ads pages 20, 21.*

27Y. *EICO* — New 20-page catalog shows how to save 50% on professional test instruments, hi-fi, and "ham" equipment in both kit and factory-wired form. *See ad page 67.*

28Y. *HICKOK* — New short-form catalog of 1959 testers. *See ad page 70.*

29Y. *RCA* — Form 3F764 on currently-available instruments. *See ads pages 45, 3rd cover.*

30Y. *SECO* — New 2-color folder showing complete line of test equipment and service aids. *See ad page 69.*

31Y. *SERVICE INSTRUMENTS* — New multicolored catalog includes photographs of each Sencore product in use, contains complete information and schematics. *See ads pages 40, 54, 59, 68, 69.*

32Y. *TRIPLETT* — Special bulletin on new tube tester, Model 3414. *See ad page 49.*

TOOLS

33Y. *KEDMAN* — Catalog sheet describing 4 screwdriver displays and specifications on 14 kinds of screwdrivers in the company's line. *See ad page 54.*

34Y. *VACO* — 12-page, 2-color catalog on special service tool and solderless terminals.

35Y. *XCELITE* — Catalog of hand tools for electronic servicemen. *See ad page 69.*

TRANSFORMERS

36Y. *CHICAGO STANDARD* — 100-page TV Transformer Replacement Guide, cross-referenced for over 7,000 chassis of 98 manufacturers. *See ad page 60.*

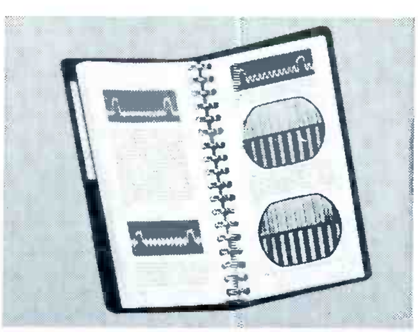
TUBES

37Y. *GENERAL ELECTRIC* — New brochure on G.E. tubes: "Here's Why General Electric Receiving Tubes are Better," and "Receiving Tube Interchangeability." *See ads pages 31, 47.*

38Y. *RAYTHEON* — Revised 14-page Television Picture Tube Characteristics booklet includes data on aluminized black-and-white and color tubes, faceplate deflection angle, bulb dimension, ion-trap requirements and basing diagram. *See ad pages 14-15*

39Y. *SYLVANIA* — European-American Receiving Tube Replacement Guide. *See ad page 27.*

40Y. *Vis-U-All* — Tube Substitution Guide. *See ad page 51.*



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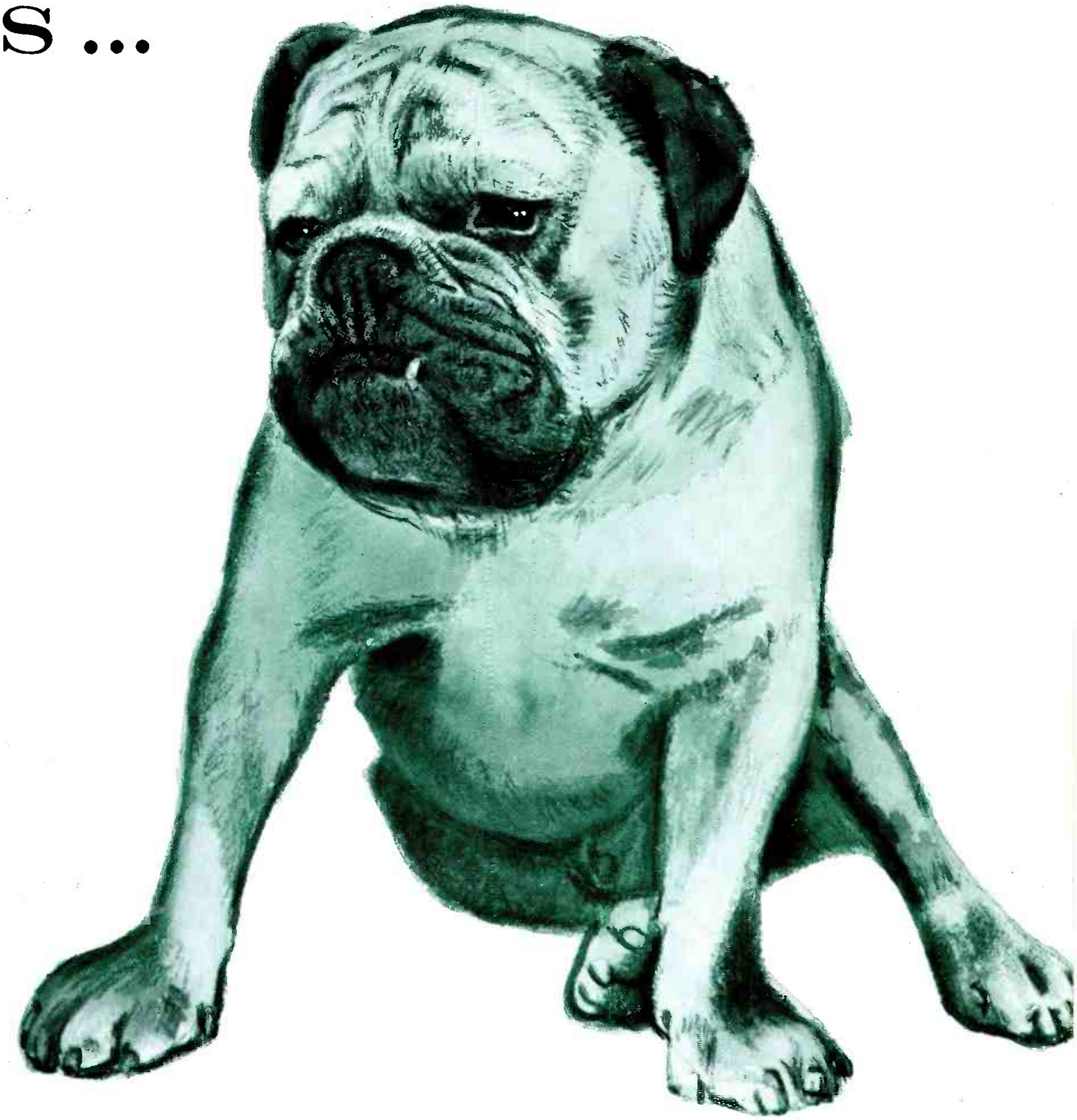

that hold tenaciously to their profit and give bonuses in customer service.

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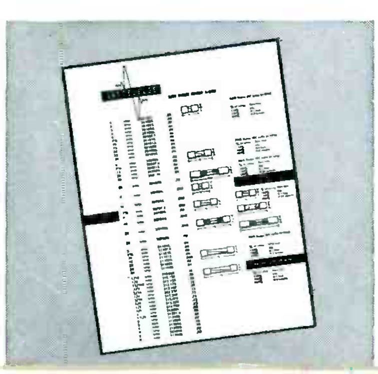

Littelfuse illustrated Price sheet L-358