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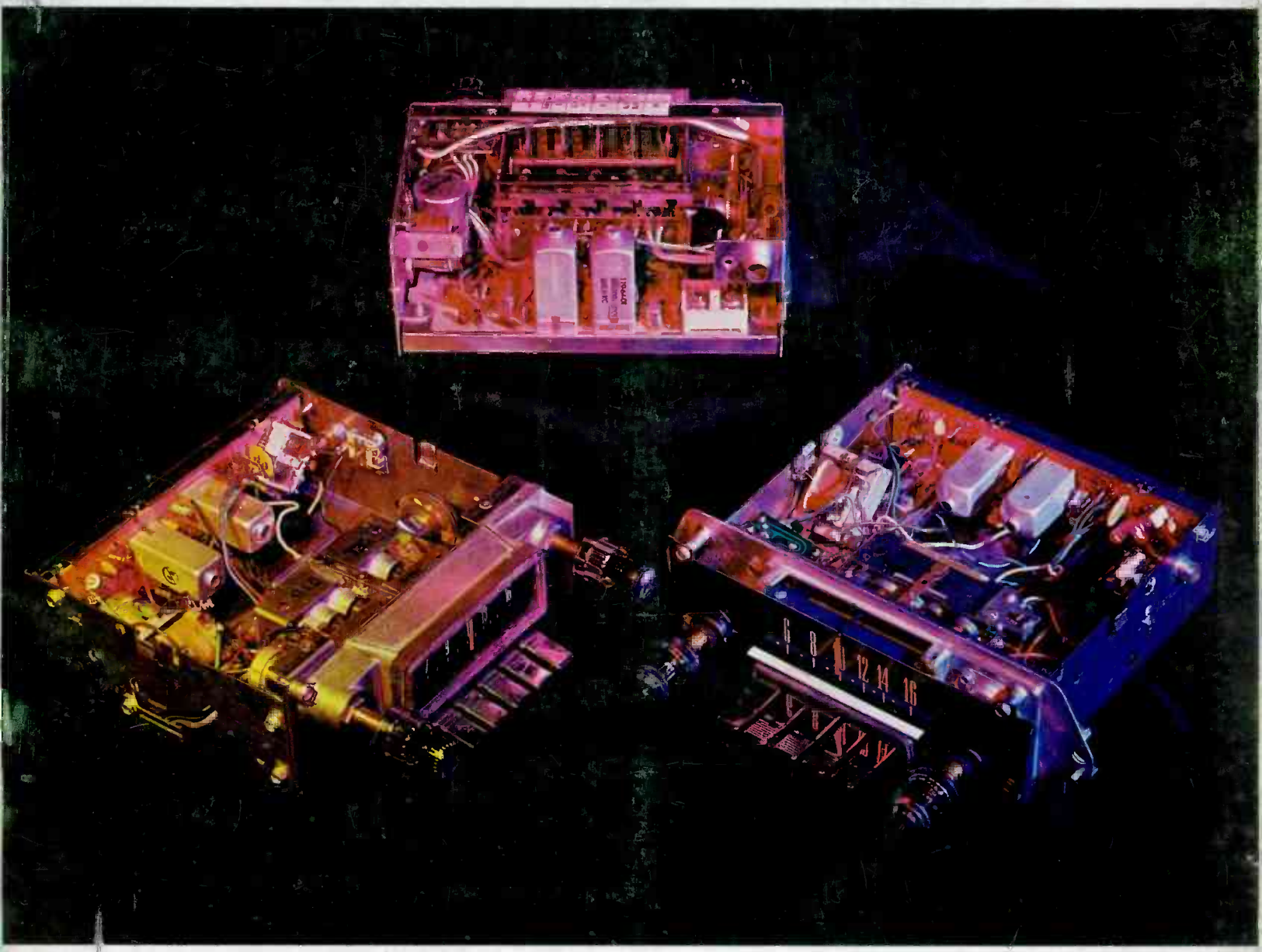

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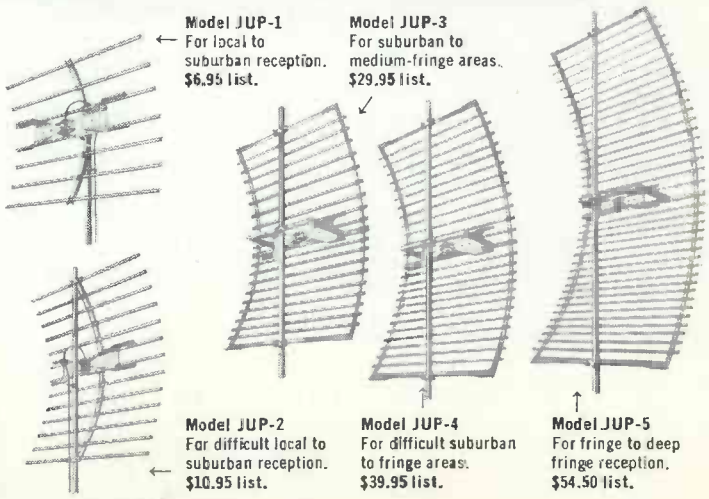

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Horizontal Troubleshooting from A TO Z

by Thomas A. Lesh and Norman D. Tanner

The hard-driven components of the horizontal sweep system must work at peak efficiency to maintain satisfactory performance; thus, it's understandable that the horizontal section gives rise to more service problems than any other TV circuit. It also deserves its reputation of being tough to service, because its mode of operation is complex, and because testing procedures are hampered by the presence of extremely high voltages.

To help keep up with the continual demand for more service information about horizontal sweep, this article is aimed at up-dating and consolidating the reader's knowledge in this important area of servicing. It will furnish an increased overall understanding of how the horizontal circuit works, and will call attention to some specific problems that cause particular difficulty.

Two Main Divisions

In this study, just as in actual troubleshooting, we will find it convenient to split the horizontal system into two parts—taking the grid of the horizontal output tube as a dividing point. Most troubles are relatively easy to isolate either to the section ahead of this point (the oscillator-AFC circuit) or to the following section (the output and high-voltage system).

In many cases, analysis of visible symptoms will give clues that point toward one section or the other; for instance, most frequency-stability problems originate in the oscillator or AFC, and a large proportion of width problems develop somewhere in the flyback circuit. However, initial inspection of the symptoms may give misleading information, as in the many cases where so-called "flyback trouble" actually turns out to be the result of a weak oscillator. Thus, it is often helpful to check the drive to the output tube quite early in the process of servicing—say, immediately after all pertinent tubes have been checked and the accessible sweep components inspected for obvious faults.

Even a rough check for the presence of the drive voltage, using an AC VTVM or a portable scope, can be useful on home calls as an aid in estimating the extent of trouble. Routine use of such a test is becoming more and more practical, since many newer-model sets are constructed so the grid of the horizontal output tube is accessible without removing the chassis from the cabinet.

In the more difficult cases of poor horizontal-sweep operation, the question is not merely whether the drive waveform exists, but whether it measures up to specifications. This question can be rapidly answered by inspecting the drive amplitude and waveshape with a calibrated scope, or by injecting a substitute signal from a flyback-circuit test instrument to see if the output section can regain normal functioning if properly driven.

Next comes the much more burdensome job of pinpointing the exact defect within one of the two major areas. We will begin tackling this problem by analyzing the output section, which causes service technicians the most grief.

Flyback and Yoke Circuit

The basic configuration of the horizontal sweep output circuitry has been fairly well standardized throughout the past ten years; nearly all models of receivers have included an autoformer-type circuit generally similar to that shown in Fig. 1. This layout is notably simpler than those used in many sets of the early 1950's; simplicity has been achieved, in the face of increasing power requirements, by making the individual components more rugged and by tightening up on their specifications. The great electrical stress applied to each component means that deterioration of any one part, or unwise choice of a replacement, can easily degrade the performance of the flyback-yoke circuit enough to result in a loss of raster. Even the most minor faults may show up as weak high voltage, a width problem (either too little or too much), or nonlinearity of sweep. By and large, modern circuits—unlike their predecessors—allow for only a minimum of finicky adjustments to width, drive, and linearity. These characteristics stay reasonably normal as long as the sweep circuits are in good condition; discrepancies great enough to annoy the viewer usually indicate a need for repairs, not adjustment.

It is very difficult to relate specific troubles to specific components in the horizontal flyback circuit, because of the extensive interaction among components. Before any attempt is made to discuss cures for particular problems, it would be well to review the operating cycle of the flyback system, and see how each component fits into the total picture.

This description will start at the beginning of horizontal scan—assuming the CRT electron beam has just retraced to the left side of the screen. At this time, the flyback transformer possesses stored energy, in the form of a collapsing magnetic field.

Scanning left half of screen: The damper tube conducts, dissipating the energy stored in the flyback. Its conduction causes the boost capacitor (C3 in Fig. 1) to be charged so that the plate connected to the fly-

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back transformer becomes more positive than B+. The current path from the boost capacitor to the damper is via the portion of the flyback between terminals 1 and 4, partially shunted by the horizontal windings of the yoke. Current flows from the boost side to the "hot" side of the yoke (terminal 7 to 2). The amount of current decreases linearly as damper conduction tapers off; this reduces the strength of the deflection field developed by the yoke, and allows the electron beam to move from the left edge to the center of the screen. During this portion of the sweep scan, the horizontal output tube is held in cutoff by the negative-going swing of the drive signal at its grid.

Scanning right half of screen: The grid voltage of the horizontal output tube rises above cutoff as the damper current approaches zero. Using the charged boost capacitor as a plate-voltage source, the output tube conducts more and more as the grid voltage continues to rise. The plate-current path is downward from flyback terminal 5 to 1. In parallel with the portion between terminals 3 and 1 are the horizontal yoke windings; thus, current now passes from yoke terminal 2 to 7 (note the reversal from the preceding half cycle). As the current rises, it induces an increasingly strong deflection field that forces the electron beam toward the right edge of the screen.

Retrace: At the end of each scan, the horizontal output tube is suddenly driven into cutoff by a sharp drop in grid voltage. This interruption in current induces a pulse of high voltage in the flyback transformer, and stores energy in the transformer as mentioned at the beginning of this discussion. Yoke current rapidly reverses, and the electron beam is swept quickly back to the left edge of the CRT. The flyback pulse, stepped up in amplitude by a high-voltage winding on the autotransformer, is rectified to obtain a CRT anode voltage that exceeds 20 kv in many recent models.

The flyback system comprises a high-Q circuit that tends to oscillate when pulsed; it is tuned so that a half-cycle at the resonant frequency will correspond to the desired length of time for retrace. Only this one half-cycle of oscillation is permitted to occur at full strength; thereafter, the damper diode is driven into conduction on alternate half cycles, thus loading the flyback and reducing the oscillations to an insignificant level.

When you can visualize the horizontal flyback system as a functional unit, the mystery disappears from many servicing problems that have been costing servicemen an unnecessarily great amount of time and money.

"No Raster" Problems

A long list of possible defects can account for a blank CRT screen with high voltage weak or absent. It is convenient to divide these into four major categories:

1. Simple failure of a tube; or an easily located fault in a capacitor or some other component that is characteristically a weak link in the horizontal circuit.
2. Loss of adequate drive to the output tube.
3. Loss of efficiency in flyback-circuit operation, as a result of defective or incorrect parts.
4. Overloading of the flyback system, with or without component damage.

Category 1 presents no extraordinary service problems. Most of the troubles in category 2, which will be discussed in further detail in the second half of this article, are also relatively easy to handle. It is in dealing with the remaining two categories that the serviceman often finds himself in deep water.

In category 3, "loss of efficiency" implies that the flyback circuit is operating, but is unable to generate sufficient high voltage to produce a visible raster. Many of these conditions are "cool-running" troubles in which the horizontal-output tube and damper currents are below normal. Here are some of the more prevalent troubles:

(a) A defect in the high-voltage circuit itself—for example, insufficient filament voltage on the HV rectifier tube, or a faulty high-voltage winding on the flyback transformer. In such cases, voltages and currents in the horizontal output and boost circuitry are normal.

(b) B+ supply voltage below

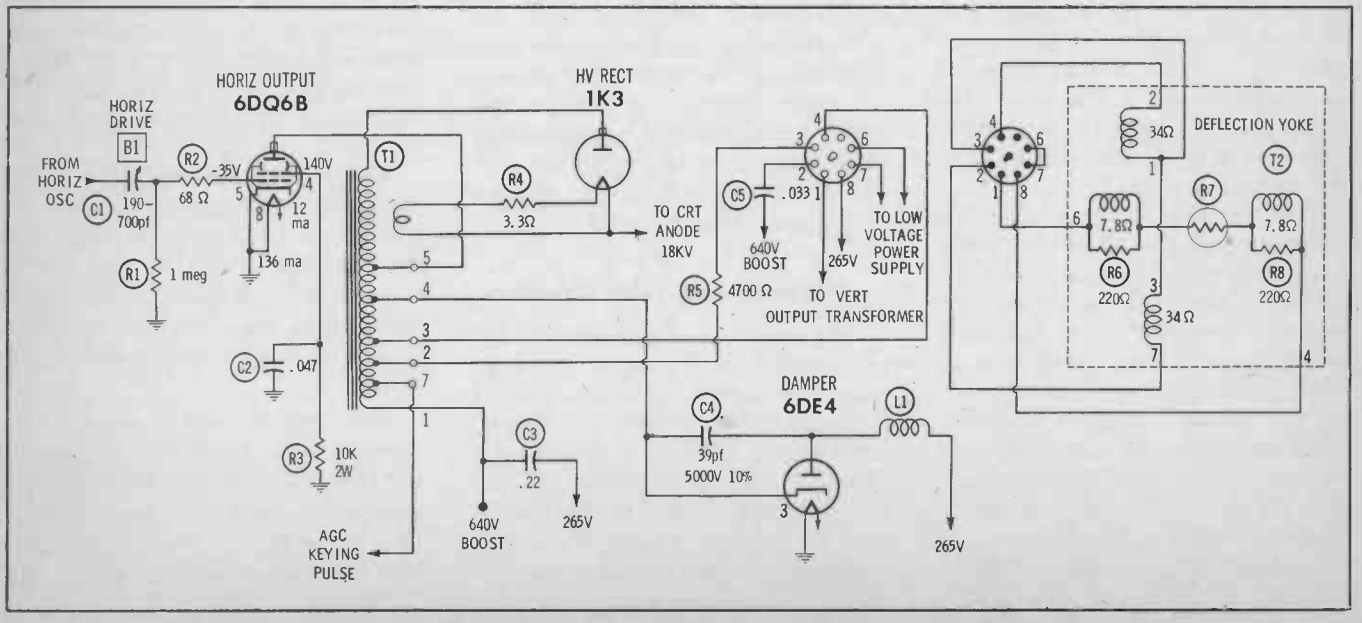


Fig. 1. Typical horizontal output circuit—from grid of output tube to anode of picture tube.

normal, due to a defect in the B+ circuit or an overload on some B+ line outside the horizontal section. In such cases, the loss of raster and reduction in high voltage may be the primary symptom.

(c) Low plate current in the horizontal output stage, even though the tube is good and the drive signal is normal. An increase in value of a screen dropping resistor can produce this effect by decreasing both the screen voltage and the screen current. (Note that a screen-voltage measurement alone is not sufficient to identify this trouble; either the screen current or the resistance must also be checked.) A leaky screen-bypass capacitor (C2 in Fig. 1) can produce similar symptoms, but in this case the current through the screen dropping resistor (R3 in Fig. 1) will be greater than the current actually passing through the tube. (Moral: check the bypass capacitor before attempting to measure current.) If the output stage includes a cathode resistor, a loss of raster might be traced to this component being burned open or greatly increased in value.

(d) A defect in the boost capacitor (C3 in Fig. 1) which prevents the boost voltage from rising very far above the B+ level. This fault could be either leakage, an open connection, or a significant decrease in capacitance.

(e) Shorted turns in the flyback or yoke. Even a single shorted turn can lower the Q of the flyback circuit enough to drop the high voltage to a submarginal level. An ordinary ohmmeter check may fail to find the short for one of two reasons: The change in resistance from the normal value is insignificant, or the short appears only when high-voltage pulses are applied. It is sometimes feasible to check a yoke for this type of internal short by disconnecting it and noting whether the remainder of the flyback circuit is then able to develop normal high voltage. However, operation of the circuit without the yoke does not give results that are consistent in receivers. It is preferable to make a substitute test with a similar component (if one is available) or with a flyback-circuit tester. Along a different line, an interesting and useful method of testing yokes and flybacks is the "ringing check"," fully described in "Ringing Checks for Sweep Coils" PF REPORTER, March 1963.

(f) Incorrect type flyback or yoke. A close match to the inductance of the original unit is necessary to preserve the proper Q and resonant frequency of the whole circuit.

Category 4 includes the most frustrating troubles of all — those which blow the sweep fuse, or cause the flyback transformer to overheat. These components seldom fail of their own accord; some other defect in the circuit is usually responsible for the excessive current. Such a defect can take a long time to find, if set operation must be restricted to short periods in order to protect it from further damage due to current overload. Some of the more common output-circuit defects that can cause these "hot-running" trouble areas follow:

(a) Flyback or yoke winding shorted to core or ground; or short between horizontal and vertical windings of yoke. These faults sometimes give themselves away by arcing; in certain cases, they can be detected by disconnecting the suspected winding and checking with an ohmmeter.

(b) Abnormally high current drain on boost line, as a result of a short in some load circuit. Boost filter capacitors, especially electrolytics, are likely offenders. Loads can readily be disconnected from the boost source to see if the burden on the flyback system is relieved.

(c) Excessive power drawn by screen circuit of output tube, with resulting increase in power that must be dissipated by the plate. Note that screen-voltage readings may not reveal any abnormality; if value of screen dropping resistor has become too low, voltage will check "normal" even though screen current is excessive. (If you doubt this, try using Ohm's law to check it.)

(d) Loss of cathode bias on output tube, in circuits where cathode is above ground potential. A shorted cathode-bypass capacitor is the probable culprit.

(e) Failure of accessory components such as those in the damping network of the yoke. (To find all of these components, be sure to check inside the yoke cover, as well as in the HV cage.) This type of fault often causes a drastic increase in local RF currents within the yoke circuit — enough to burn out a resistor such as R5 in Fig. 1—although no significant increase may be noted in the output-tube or damper current.

(f) The fact bears repeating that loss of grid drive to the output tube can cause severe overheating of this tube and of the flyback transformer.

Minor Aches and Pains

When a sweep-circuit defect is not severe enough to destroy the raster completely, the screen presentation may contain definite clues to the location of the fault. This is fortunate indeed, since the malfunction might be small enough to escape notice if the whole sweep section had to be examined.

Width problems may indicate nothing more than an incorrect setting of the width control. (This is one service adjustment that has been retained in a fair proportion of recent-model sets.) If the control is set to the limit of its range, or if no control is provided, here are a few factors that may be involved in width defects:

(a) Overall output of sweep circuit. Note the function of width coils is to *reduce* the power delivered to the yoke;

that is, they absorb power from the flyback transformer. Certain troubles in the output circuit have a similar effect, causing an unwanted shrinkage of the raster horizontally. A weak output stage or poorly functioning flyback are among the major suspects. Some receivers use a width sleeve to increase or decrease the width on the screen. The sleeve does not reduce power delivered to the yoke, but rather shields—and thereby decreases—the effects of the deflection-yoke currents on the CRT beam. Maximum width is attained when the sleeve is completely removed from the yoke. Inserting the sleeve into the yoke reduces the effect of the magnetic field and thus decreases width.

(b) High voltage. If a defect that reduces sweep power also reduces CRT anode voltage, this tends to compensate for the loss of width, since the beam becomes easier to deflect; poor focus sometimes becomes the most noticeable symptom in these cases. On the other hand, if a malfunction lowers yoke drive without much effect on high voltage, a narrow picture is one of the first symptoms noted. A likely cause is a mismatch between yoke and flyback transformer.

(c) Screen circuit of horizontal output stage. Note that some sets use a pot in this circuit as a width control. The screen resistance must be set up to provide optimum screen power—enough that the output tube will adequately drive the flyback circuit, but not enough to exceed the screen and plate wattage-dissipation ratings of the tube. Screen current and voltage are both given in service data, as a means of gauging screen power.

Linearity faults can be divided into three categories, according to the portion of the screen most severely affected.

(a) If only the right side of the raster is compressed, this means yoke current is reaching maximum before the scanning cycle is completed. The usual cause is that the horizontal output tube is being driven prematurely to saturation — either because the drive signal is poor or because of a defect in the output circuit itself. Look for troubles that decrease the bias on this tube.

(b) If the left side is compressed or has a rippled appearance, the most probable site of trouble is the damper circuit or the damping (anti-ringing) networks associated with the yoke.

(c) A wrinkle, fold, stretch, or compression running vertically down the middle of the screen is related to the "drive line" that was a familiar sight in early TV models. This symptom merely indicates a lack of smooth transition between damper conduction and output-tube conduction in mid-cycle; the ordinary remedy is to correct a biasing error that has developed in the output stage (by adjusting a drive control, if provided; otherwise, by troubleshooting).

The "drive line" should not be confused with a filmy or milky trace that sometimes appears in a similar position when the CRT becomes unblanked during a portion of the horizontal retrace interval. Remedies for that condition (often called "phasing ghost") include: AFC phase adjustment; installing horizontal retrace blanking; or correcting an excessively long horizontal retrace time due to incorrect component values in the flyback circuit.

A small percentage of sets include a horizontal linearity coil in the plate circuit of the damper. To promote long life of the sweep system, this coil should be set for a *dip* (minimum) in horizontal-output cathode current or sweep-fuse current (just as in color sets). This setting should coincide with acceptable linearity; if not, repairs are advisable. Note that the coil and its associated capacitors may not be at fault in such cases; the trouble could be in various other areas of the horizontal section, as indicated above.

A *dim raster* may be a clue to horizontal sweep trouble, although the possibilities of a weak CRT or a defective video circuit also need to be considered. This symptom is rather vague, and is of only limited help in troubleshooting. It generally means that the high voltage is below normal; however, this condition may be due to improper horizontal drive, inefficient operation of the output stage, or overloading of the flyback system, as well as to HV rectifier troubles.

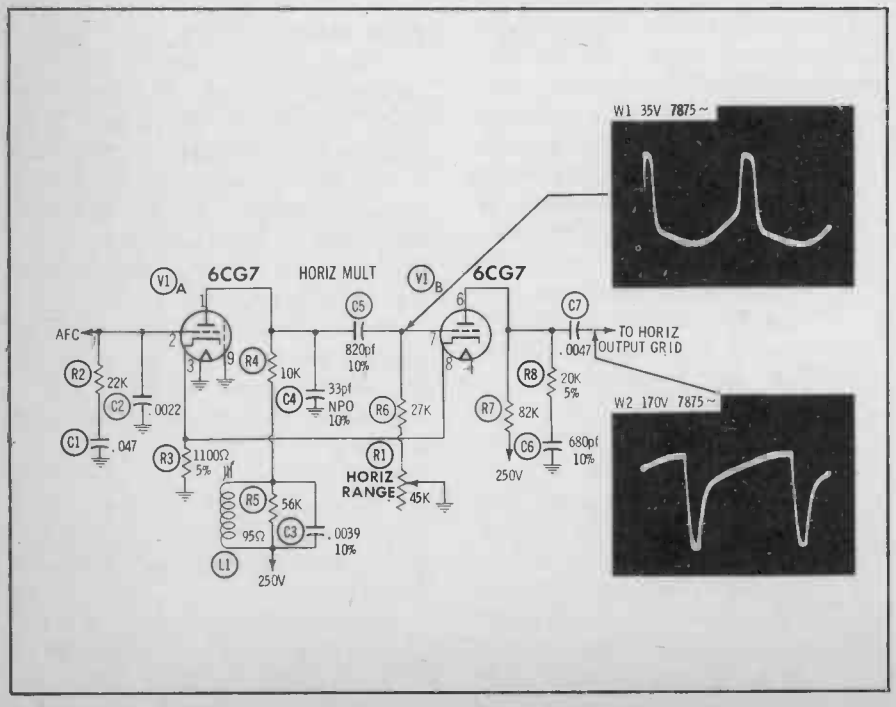


Fig. 2. Multivibrator has ringing coil in plate circuit of first section.

Oscillator-AFC

At this point, let's return to the question of why the horizontal drive waveform might fail to have the proper amplitude, shape, or frequency. Several distinct types of horizontal oscillator - AFC circuits are in common use; we will now have a look at each major type, tracing its normal operation and keeping our eyes open for possible trouble spots. In discussing frequency errors, we'll assume that a normal sync signal is supplied.

Cathode-Coupled Multivibrator

This popular circuit uses both sections of a dual triode, with the second section (V1B in Fig. 2) operated as a switching device. V1B conducts only long enough on each cycle to trigger horizontal retrace. When it is nonconducting, C6 changes from B+ through R7 and R8, and the gradually rising voltage across R8-C6 forms the linear slope of the drive waveform (W2 in Fig. 2). The next pulse of conduction in V1B discharges C6, and the cycle starts again.

Most troubles that affect the amplitude or shape of the drive waveform are located in this immediate area. For example, weak drive can be leakage or low value of C6, increased value of R7, or insufficient DC voltage available at the B+ end of R7. Incorrect drive waveshape as well as incorrect amplitude can result from wrong values of these and associated components. One common type of distortion in drive waveforms — an excessively flattened positive peak—is related to insufficient grid bias on the output stage. Compression at the right edge of the raster is a common visual symptom of this condition. A small flat spot in the drive signal is normal (as shown in Fig. 3A), since the output-tube grid is driven to saturation at the end of each scan cycle; however, an exaggerated flat spot (as shown in Fig. 3B) should be cause for suspicion if the sweep circuit is turning in poor performance.

The remainder of the multivibrator circuit is concerned mostly with sustaining oscillation at the correct frequency of 15,750 cps. When the second section of the multivibrator (V1B) conducts, its cathode current rises, thus increasing the voltage drop across the common

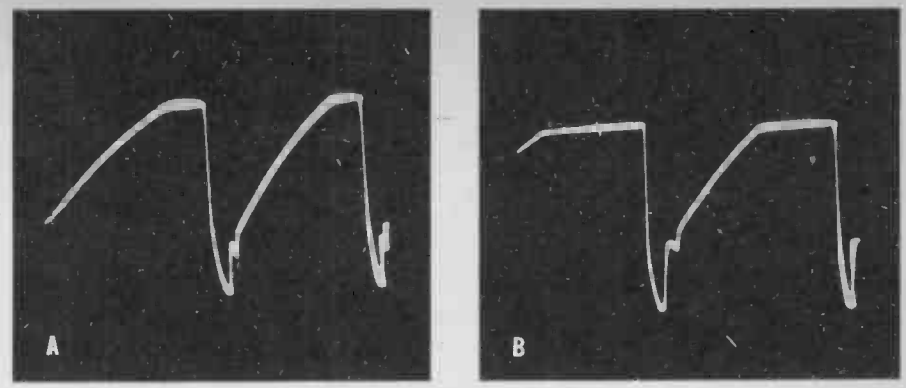


Fig. 3. Duration of flat top is important in horiz output grid waveform.

cathode resistor R3. As a result of the rise in cathode voltage, the first section of the tube is forced into cutoff. When V1A is driven into cutoff, the plate voltage (pin 1) rises toward the applied B+ voltage. This change in plate voltage (a positive-going signal) is coupled through C5 and tends to drive the grid of V1B positive, increasing its conduction. As the second section reaches saturation, the increasing voltage drop across cathode resistor R3 ceases; thus, the plate voltage of V1A is no longer changing. The grid of the second stage begins to draw current which charges C5 (grid side negative) and cuts off the second section of the tube. With V1B in cutoff, a lesser voltage drop is developed across R3 allowing V1A to begin conduction. (This first section is normally designed so that it comes out of cutoff as soon as conduction stops in the second section.) As the first section begins to conduct, the plate voltage at pin 1 goes in a negative direction (less positive). This negative swing in plate voltage appears at the grid of V1B as a negative signal, further assuring cutoff of this section.

The first section (V1A) soon reaches a steady state of conduction, and the second section (V1B) cannot conduct again until the charge on C5 leaks off through R1 and R6. Notice in Fig. 2 the RC discharge time is adjustable by the horizontal range control (R1) — thus it controls the length of the cycle. This control acts as a coarse adjustment of the horizontal hold, with finer adjustment being accomplished by ringing coil L1. Some receivers may omit the range control and use only the ringing coil as a means of adjusting oscillator frequency.

This ringing coil is comparable to the waveform coil found in a blocking - oscillator circuit. Multivibrator operation shock-excites the ringing-coil into sine wave oscillations, which are superimposed on the grid waveform of the second section of the multivibrator. With the ringing coil adjusted properly, the sine wave increases the slope of the waveform during the period when the second half of the tube is just about ready to come out of cutoff. This means that slight fluctuations in cutoff-voltage have little effect on the timing from cycle to cycle. Misadjustment of the ringing coil has just the opposite effect. In other words, it slightly changes the starting time of conduction in the second half of the tube.

Oscillator troubles generally fall into one of two major categories:

(a) Amplitude or distortion faults in the drive waveform applied to the grid of the horizontal output tube. Almost always, this is caused by a fault in C6, C7, R7, or R8.

(b) Frequency faults in the multivibrator section. These faults may be due to a number of things: a value change in C5, a leaky C4, or trouble in the ringing circuit itself. The wide range of adjustment in the ringing coil may cover up many troubles in the multivibrator or AFC section unless they are intermittent. A good way to determine definitely if the multivibrator section is operating at the wrong frequency is to connect the scope to a known scource of 15,750 cps (another receiver for instance); set the scope operating controls for two horizontal pulses. Move the scope to the suspected horizontal output grid, and

check to see if there is exactly the same number of pulses at this point. If the frequency is different, trouble exists in either the horizontal AFC or oscillator stage.

Common-Cathode AFC

The horizontal multivibrator section shown in Fig. 2 is usually controlled by an AFC circuit like that in Fig. 4. The purpose of the AFC circuit is to supply the necessary DC voltage to the grid of the first half of the multivibrator so it will cut off and resume conduction at just the right instant to maintain correct timing of each cycle.

A "too-fast" error in frequency will advance the phase of the feedback sawtooth waveform (W1 at the anode of M2) and result in a less-negative output from the AFC network. At the grid of the first multivibrator section, this less-negative voltage will make this section harder to cut off at the beginning of retrace, and will tend to slow up the start of the next cycle.

When the oscillator is running too slow, just the opposite effect is accomplished in the AFC diodes. A more negative DC voltage is developed and the grid of the multivibrator is easier to cut off; thus the frequency of the oscillator is increased.

When the oscillator is operating at the correct frequency (15,750 cps) the output of the AFC circuit may not be an exact zero reading. The correct DC voltage *reference* is the important factor; any voltage change above or below this reference will shift the operating frequency of the oscillator in the appropriate direction. Also, conduction of the two AFC diodes may not be exactly equal; however, as long as the relative conduction of the two remain constant, trouble will not be encountered.

Troubleshooting the common-cathode AFC circuit isn't really difficult, once the trouble has been determined to exist in this network. Isolating the trouble can normally be accomplished by grounding the grid of the first section of the multivibrator and adjusting the ringing coil until the picture is in sync or tends to drift slowly back and forth across the screen. If this condition can be reached, the trouble is in the AFC section; if it can't, the multivibrator section is probably at fault.

AFC faults can be placed into two main categories:

(a) *No raster:* This can be caused by an AFC defect only if the grid voltage on the first half of the multivibrator stage changes enough that the tube can no longer conduct or that the tube is never cut off. This could be caused by an open AFC diode or open C4, or possibly a very leaky or shorted C2.

(b) *Loss of horizontal sync:* It is impossible to tie down any one or two components and say they are the usual cause when sync is lost. Questions that also have to be considered are: how great is the frequency error, can the picture be made to sync at any setting of the ringing coil, and is the loss intermittent or is it more noticeable on strong or weak stations? Normally the trouble can be pinpointed to one or two components by carefully analyzing the waveforms obtained at the same points as those shown in Fig. 4. For example, a shorted C3 or open R4 or R5 would result in no signal at the anode of M2. A leaky C2 or C4 would greatly change the

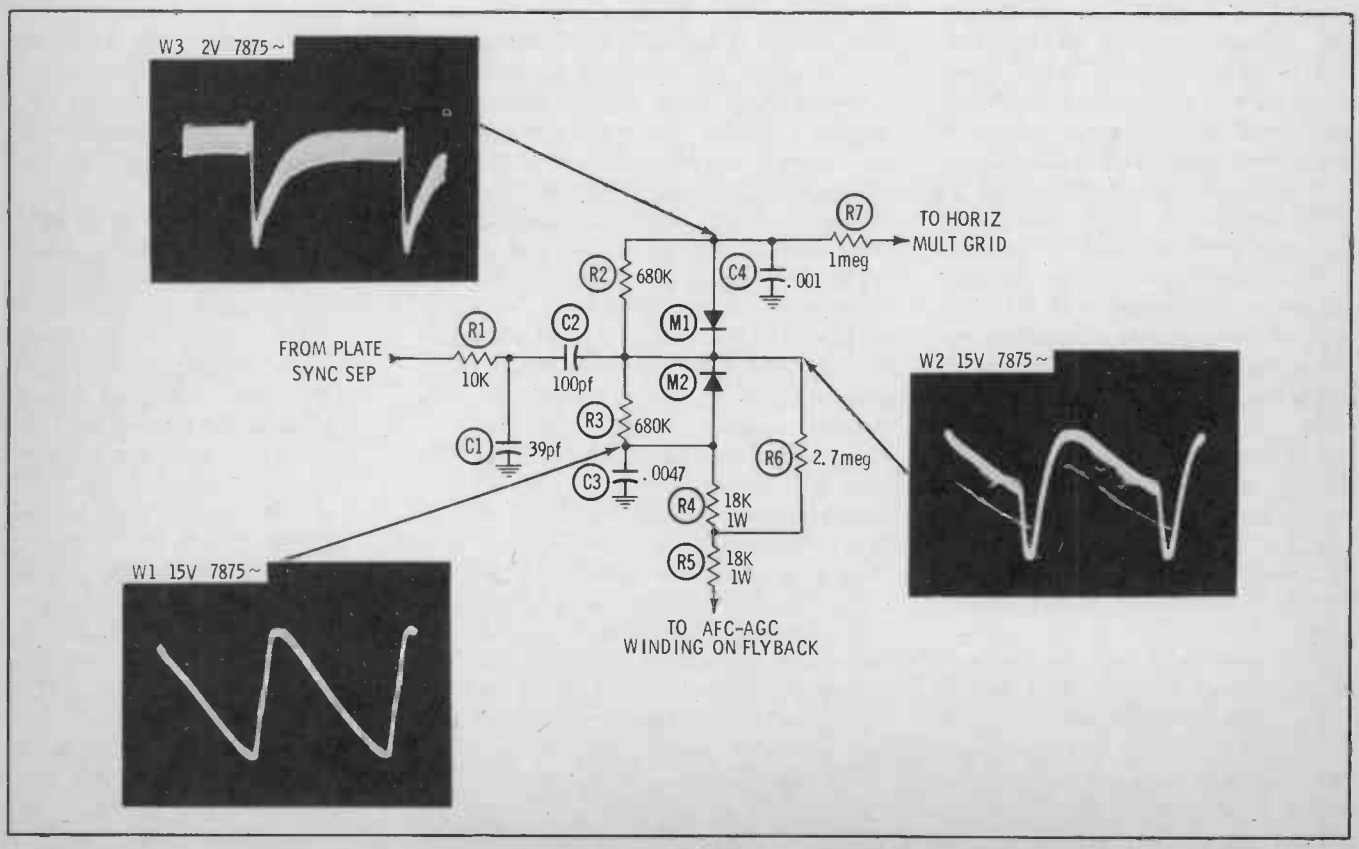


Fig. 4. Common-cathode AFC establishes bias on first half of multivibrator.

DC output voltage of the AFC network, thus causing the multivibrator section to operate at an incorrect frequency. In this case, W1 would change shape considerably and shift frequency somewhat from the normal 15,750 cps.

Synchroguide

The *Synchroguide* oscillator and triode AFC circuits, depicted in Fig. 5, have been used in television receivers for several years. This type of AFC-oscillator circuit has proven to be rather stable. However, component defects can certainly cause the oscillator to operate at the wrong frequency, resulting in symptoms ranging from horizontal bars in the picture to a very narrow raster or no raster at all. Understanding the basic operation of this circuit can lead to great savings in troubleshooting time.

The oscillator is held in cutoff during most of each cycle by the charge on C7. As this capacitor discharges through R4 and R5 the negative voltage on the oscillator grid is lowered to the point where the tube is allowed to conduct. When the oscillator tube conducts, a large negative pulse develops at the plate; the suddenly increased plate current discharges C9 and forms the flyback or fast portion of the drive sawtooth. When the oscillator goes into cutoff (immediately after the brief retrace or flyback pulse), C9 charges again through R10 and forms the scan portion of the drive sawtooth waveform, which is then coupled to the horizontal output grid.

The waveform coil (L2) "rings" and modifies the normal sawtooth shape of the oscillator plate waveform, adding a sine shape to it. This altered waveform causes a more rapid voltage rise near the point where the oscillator tube begins conducting. The oscillator frequency is controlled mainly by the grid voltage on the tube, the bias causing the tube to go into or come out of cutoff more quickly or more slowly. An increase in negative grid voltage lowers frequency; a less-negative bias results in the oscillator operating at a higher frequency.

When the AFC tube conducts, increased cathode current flows up through R4 and lowers grid voltage on the oscillator—thus speeding up the cycle. Remember: The AFC tube conducts harder when the sync pulse tip is positioned higher on the feedback waveform (a modified sawtooth), this condition occurs when the oscillator is operating too slow. When the oscillator frequency is higher than normal, the top then rides lower on the waveform, thus

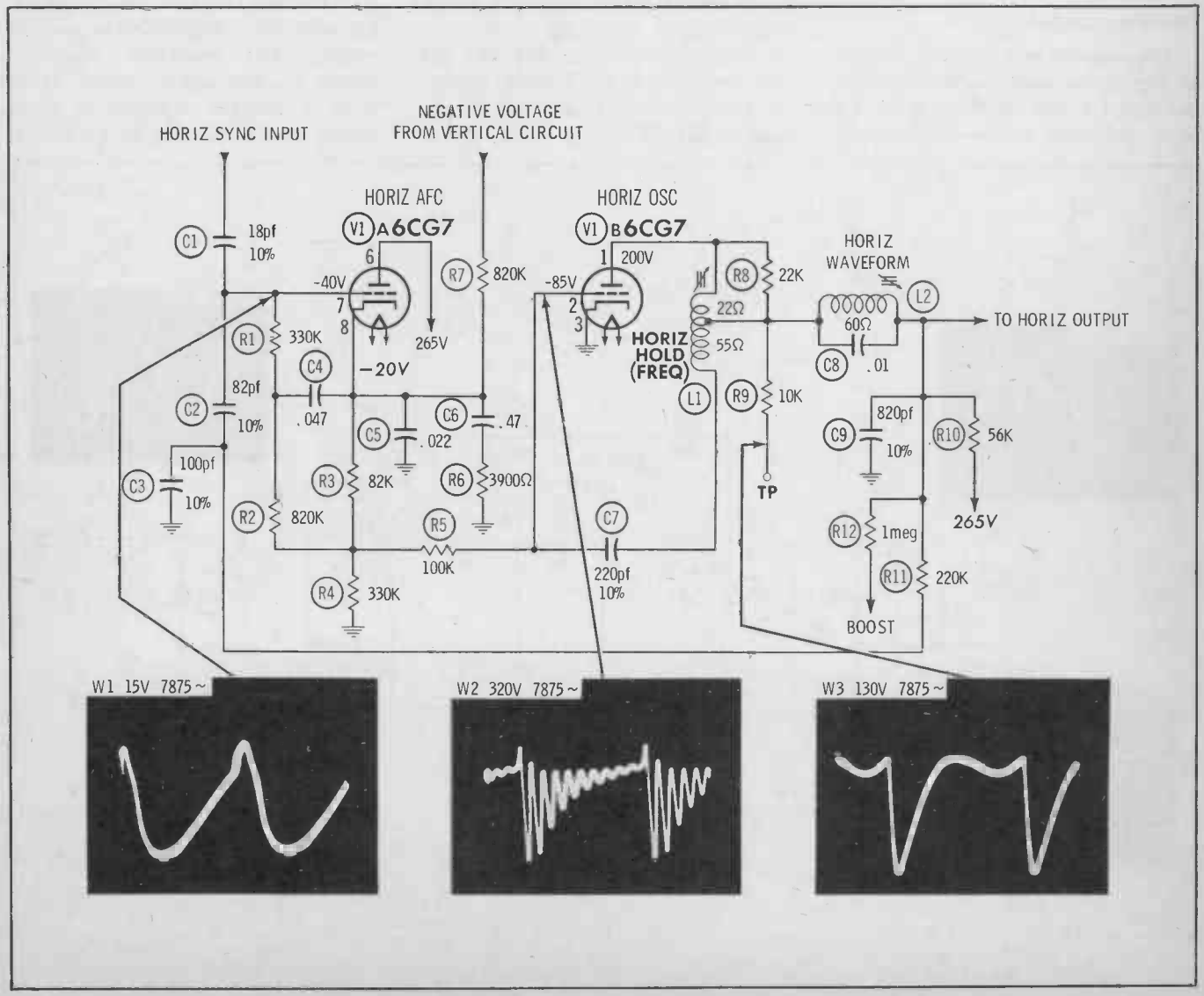


Fig. 5. Horizontal frequency coil is used as hold control in synchroguide circuit.

decreasing AFC tube conduction and increasing oscillator grid bias; the result is a slowdown in operating frequency of the oscillator.

DC voltages on the AFC stage may vary widely from one circuit to another. The service data for the particular receiver should be referred to for normal voltage reading. Also, slight changes in component values in either the AFC or oscillator section may be compensated for by a wide latitude of adjustment in the horizontal frequency and waveform coils.

Remember, though, even slight leakage in the sync coupling capacitor (C1) or AFC feedback capacitor (C2) can greatly upset the AFC operating voltages and pull the oscillator far from normal frequency. Leakage in the oscillator feedback capacitor (C7) will change the oscillator grid voltage, and may also shift the frequency considerably.

Sine-Wave Oscillator

The sine-wave oscillator (shown in Fig. 6) is aptly named because the signal at the oscillator grid is a nice, clean sine wave—the result of "flywheel effect" in a tuned tank circuit. Oscillation is sustained by feedback from cathode to grid; the feedback network includes a grid-leak bias network (R6-C7), which sets up class-C operation (this oscillator tube conducts during only about ⅕ of the positive-going waveform cycle).

This mode of operation produces a characteristic wide negative pulse as drive capacitor C11 is discharged. The great width of the drive pulse doesn't affect horizontal retrace time, because the leading edge of the pulse triggers the retrace and the beam is well on its way before the trailing edge of the pulse occurs. Besides, the output tube remains in cutoff during the first half of the drive waveform, and so the pulse width has no adverse effect on operation of that stage, either.

The horizontal AFC tube (sometimes called reactance tube) keeps the oscillator operating at the correct frequency. Diodes M1 and M2 are connected in the familiar phase-detector arrangement, and change bias on the AFC stage as and if frequency errors occur.

AFC grid voltage, and consequently plate current and oscillator grid voltage, vary with conduction of diodes M1 and M2. A voltage divider network, consisting of R10 and R11, feeds a small portion of the oscillator grid voltage to the AFC grid. The high resistance of R10 minimizes any loading effect on the oscillator and reduces the voltage to a correct proportion. Because this voltage divider network is used to derive bias for the AFC stage, an AFC-tube cathode resistor is not required.

Conclusion

An understanding of the operation of AFC, oscillator, and output circuits, along with a knowledge of the waveforms that should appear at various points throughout these circuits, can lead to valuable time saved when repairs are required. Concentrating scope checks and/or voltage and resistance measurements on the section which is at fault is the real solution to horizontal troubleshooting problems. ▲

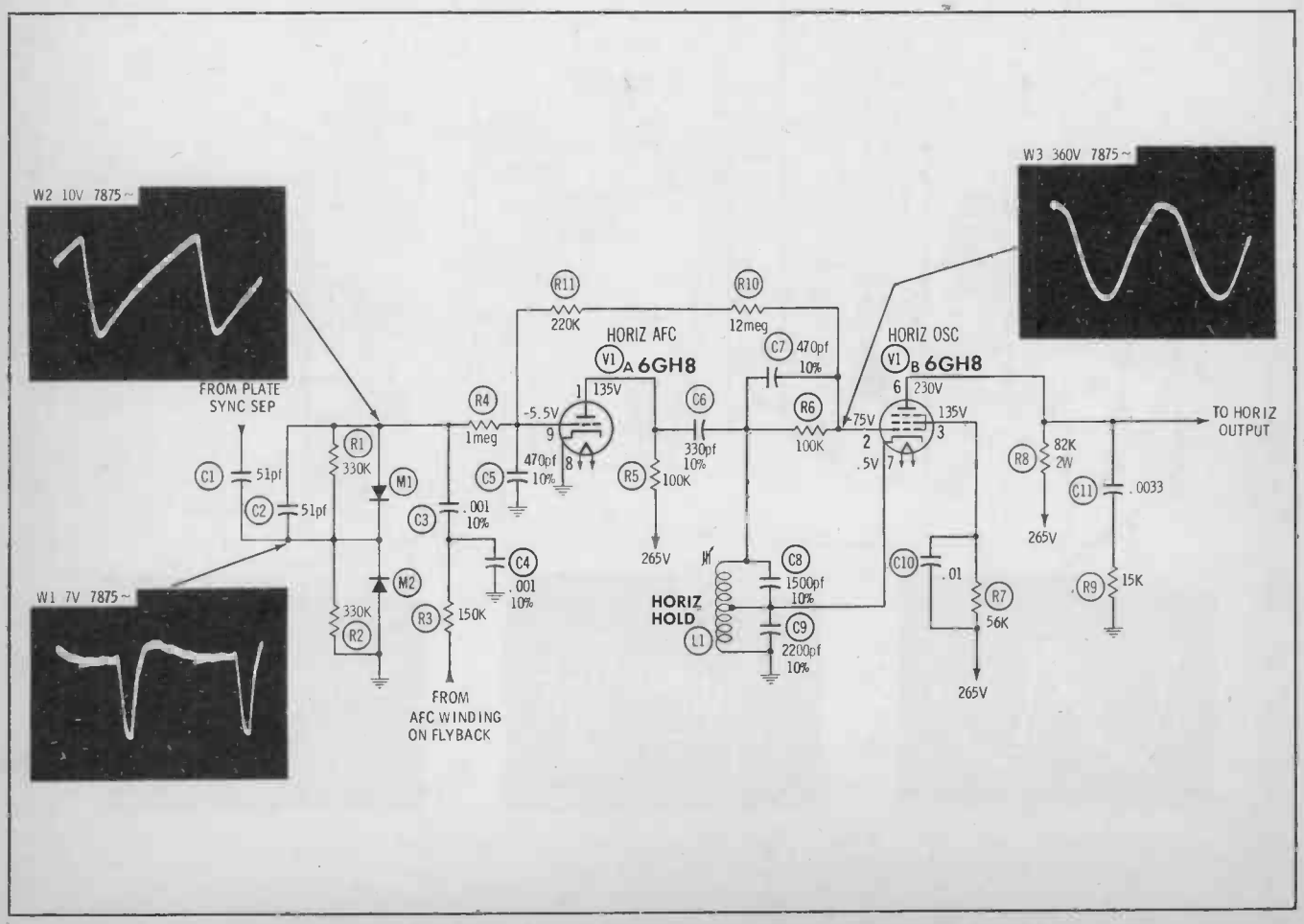


Fig. 6. Sine-wave oscillator is controlled by triode AFC and diode phase detector.

TUNER REPAIRS

$9.50

FOR COMPLETE OVERHAUL

Includes ALL parts (except tubes)
ALL labor on ALL makes

24-HOUR SERVICE with FULL YEAR WARRANTY

Sarkes Tarzian, Inc., largest manufacturer of TV and FM tuners, maintains two completely-equipped Service Centers to serve YOU. Both centers are staffed by well-trained technicians in this specialized field and are assisted by engineering personnel to assure you of FAST, DEPENDABLE service.

Tarzian-made tuners—identified by this stamping—received one day will be repaired and shipped out the next. A little more time may be required on other makes. Every channel is checked and re-aligned per manufacturer's specifications, not just the channels which might exist in any given area.

You get a 12-month guarantee against defective workmanship and parts failure due to normal usuage. Cost to you is only $9.50 and $15 for UV combinations, including all labor and parts except tubes. No additional costs. No hidden charges. All tuners repaired on approved, open accounts. You pay shipping. Replacements on tuners beyond practical repair are available at low cost.

When inquiring about service on other than Tarzian-made tuners, always send TV make, chassis and Model number. Check with your local distributor for Sarkes Tarzian replacement tuners, parts, or repair service. Or, use the address nearest you for fast factory repair service.

SARKES TARZIAN, INC.
TUNER SERVICE DIVISION

See your distributor, or use the address nearest you

537 South Walnut St.,
Bloomington, Indiana
Tel: 332-6055

10654 Magnolia Blvd.,
North Hollywood, Calif.
Tel: 769-2720

Manufacturers of Tuners . . . Semiconductors . . . Air Trimmers . . . FM Radios . . . AM-FM Radios . . . Audio Tape . . . Broadcast Equipment

Circle 2 on literature card

Have you tried new QUIG® connectors?

Not just another wire spring connector!

The 3-in-1 QUIG is brand new and different . . . Copperweld wire inner core, a layer of flux, and an outer jacket of solder . . . all you need is heat!

Makes one-handed soldering possible!

Ten times actual size

Once again, Sprague helps the TV-radio service industry by solving two increasingly serious problems . . . parts replacement in those "inaccessible" chassis nooks, such as crowded tube sockets, as well as soldering onto the delicate circuitry of printed wiring boards.

Mechanically sturdy and electrically reliable, the revolutionary QUIG provides fast, expertly-soldered connections as easy as A-B-C!

A Snip Lead

B Slip on QUIG

C Heat QUIG, Connection Made!

NOBODY ELSE HAS QUIG CONNECTORS... YOU GET 'EM ONLY FROM SPRAGUE PRODUCTS!

QUIGS are now being packed with Sprague Atom® Capacitors *at no extra cost to you!* Whenever you need tubular electrolytics, insist on pre-packaged Sprague Atoms from your parts distributor and you'll automatically get your QUIG component connectors . . . the biggest boon to the service technician since the soldering gun!

SPRAGUE®
THE MARK OF RELIABILITY

WORLD'S LARGEST MANUFACTURER OF CAPACITORS

65-410

Circle 3 on literature card

A HOWARD W. SAMS PUBLICATION

PF Reporter™

PHOTOFACT

the magazine of electronic servicing

VOLUME 15, No. 1 JANUARY, 1965

CONTENTS

ABOUT THE COVER

It is being said that radio programs are more colorful than ever. We think the color most satisfying to an auto-radio service technician is green—in the cash register. Many millions of auto radios offer a broad source of income for the service industry, so be sure of your share through speedy and efficient repair techniques like those starting on page 58.

Subscription Prices: 1 year—$5.00, 2 years—$8.00, 3 years—$10.00, in the U. S A., its possessions and Canada. All other foreign countries: 1 year—$6.00, 2 years—$10.00, 3 years—$13.00. Single copy 50¢; back copies 65¢.

Indexed in Lectrodex.
Printed by the Waldemar Press Div.
of Howard W. Sams & Co., Inc.

Letters to the Editor

Dear Editor:

Many thanks for the item "Futile Filtering" in your August 1964 issue. I just happened to have two sets in the shop with exactly that trouble, causing intermittent loss of horizontal drive. Your reference to the "May *Troubleshooter*" had me puzzled for awhile, but after careful searching, I tried the May 1963 edition and what do you suppose I found? I'll bet you can guess my suggestion, too: Indicate the *year* when you make reference to previous issues.

ROBERT C. PARKER

Seaside, Calif.

Thanks, a lot and congratulations, Bob, on your imaginative solution. From now on, you'll see the year appended to past-article references. As for these, here are the correct references: Peter Gernat's question (and the answer) appeared in the January 1963 issue on page 69. The reference to page 87 of the April 1963 issue is correct; it tells of trouble caused by inadequate horizontal shielding. As Bob points out, the "Off Again,—On Again, item appeared in the May 1963 issue, on page 79.—Ed.

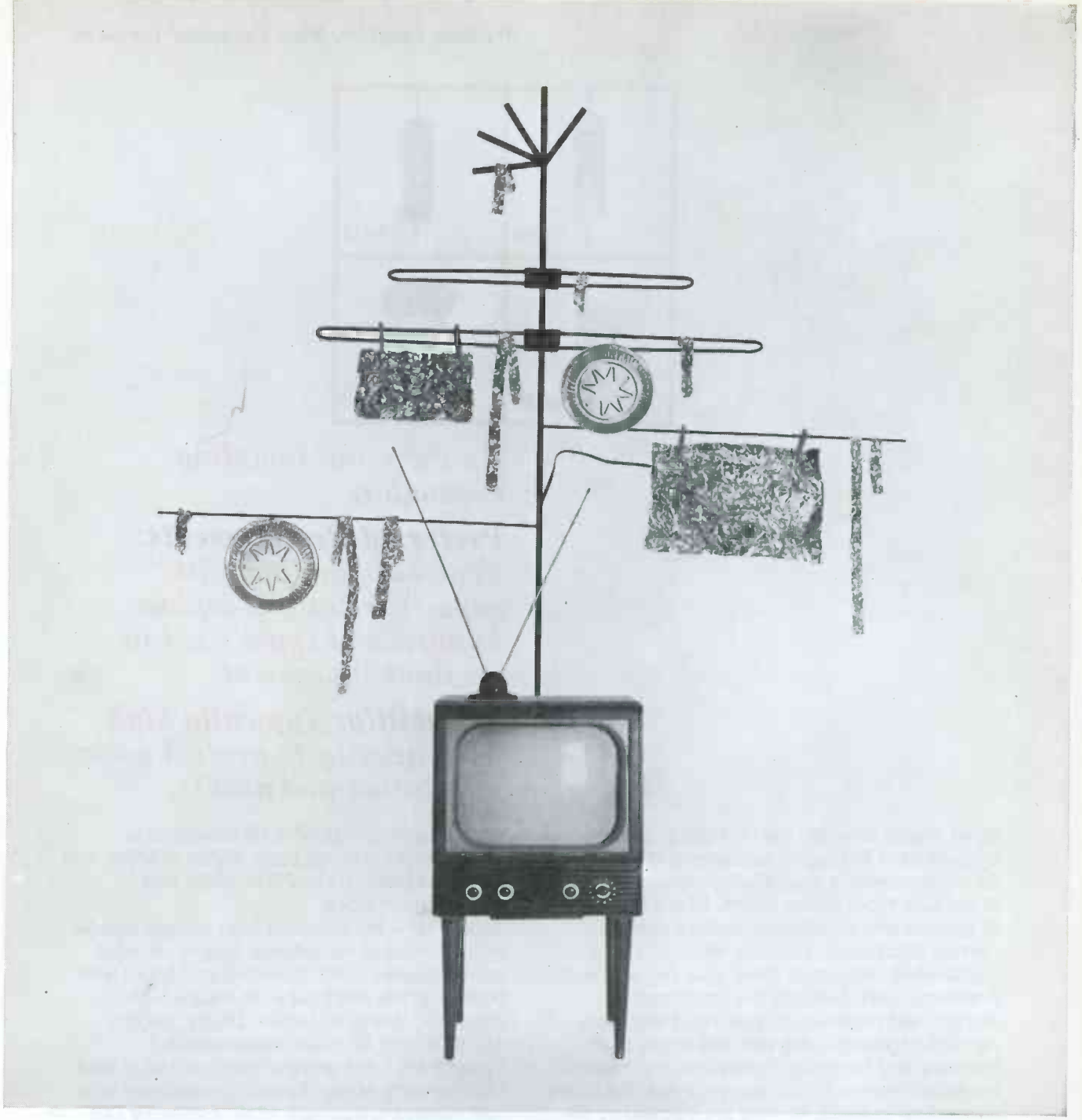
Dear Editor:

I enjoy reading PF REPORTER very much and notice that you help readers from time to time with information we don't get elsewhere. I wonder if you can help me with the following problem: Several of my friends own radios made in Germany. Recently, two FM stations went on the air here, at frequencies above 100 mc. We find, however, that our receivers tune only to 100 mc. What would be the simplest approach to this problem?

J. ULLMAN

Sault Ste. Marie, Canada

First of all, I'm surprised that a modern set imported from Germany would tune only from 88 to 100 mc. Are you sure the receivers in question are actually built for FM? It is possible they are AM receivers for VHF bands. Secondly, assuming they are actually FM sets that tune only to 100 mc, I would suggest that you can raise the frequency of each tank coil in the RF, mixer, and oscillator stages by spreading the turns farther apart. At 100 mc, chances are these coils are made of heavy, stiff wire. You can raise the tank-circuit resonant frequency further by reducing the shunt capacitance—trimmer or fixed. You may find a bit of tracking error when you do this. Thirdly, keep in mind that when you raise the upper frequency limit, you also raise the lower limit. Thus, the lower end will no longer reach 88 mc (in case you have stations in that end of the FM band).—Ed.



aerial view: do-it-yourself style

He's going to need a real antenna. So he'll be looking in the Yellow Pages. The chances are 9 in 10 he'll then take action. Will he see your ad?

When his wife sees his creation, this man will be joining the 21 million people who turn to the radio, television, and high fidelity headings of the Yellow Pages every year. (That's 33% of the entire market!)

When he does look in the Yellow Pages, chances are 9 in 10 he'll either call, write, or visit. (Every 100 references to the radio, television, and high fidelity headings of the Yellow Pages bring 93 calls, letters, or visits!)

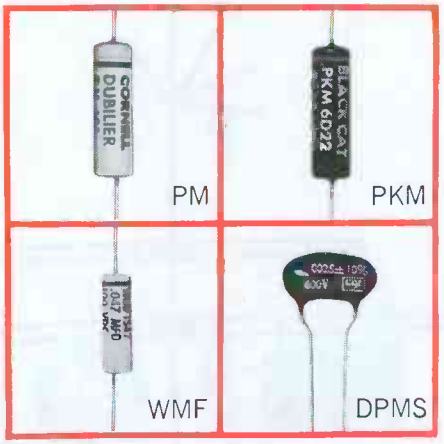
That's action! With Yellow Pages ads you can expect that kind of action . . . a recent extensive national usage study — consisting of over 19,000 interviews—proved it.

Call your Yellow Pages man. He'll show you what the study learned about your business. And he'll be glad to help you plan your own Yellow Pages program. You'll find him in the Yellow Pages under "Advertising — Directory & Guide."

Advertise for action... **Yellow Pages**

Circle 6 on literature card

"The responsibility of leadership is to innovate, produce and deliver a reliable product."
William Dubilier, Mica Cacapitor Inventor



By-Pass and Coupling Capacitors

Preferred Replacements: Four outstanding CDE capacitor designs replace hundreds of types used in original equipment.

Reliability: Typically high CDE quality to protect your reputation and profits.

What do you do when the off-beat or special by-pass used in original equipment fails, and no replacement is available? Simple . . . use one of the CDE types shown above. Of the hundreds of by-pass and coupling capacitors used in current equipment, CDE has selected these outstanding designs to solve your replacement problems. Each features the most modern designs and materials to give you a wax-free, non-inductive capacitor with extremely high moisture and humidity resistance, and highest insulation resistance in a compact size. Each can be used up to 125C. All four are stocked by the vast network of CDE Authorized General Line Distributors—the proper replacement—when and where you need it.

Type PM—the general purpose axial lead tubular replacement that offers the advantages of the most expensive materials without added cost. The molded housing and ALL-MYLAR* dielectric are impervious to moisture. 200v, 400v and 600v units in stock.

Type WMF—about half the size of the PM, this undisputed leader in miniature, film wrap Mylar* tubulars is the answer when small size is a requirement. ALL-MYLAR dielectric is protected by a tough outer Mylar wrapper and solid end seals. 100v, 200v, 400v, and 600v units in stock.

Type PKM—the compact high-voltage tubular replacement of exceptional quality. Molded casing houses Mylar dielectric combined with highest grade kraft paper to insure high-dielectric strength. 1000v, 1600v, 6000v, 10,000v, and 12,500v units in stock.

Type DPMS—the general purpose radial lead replacement. Mylar dielectric combined with high dielectric strength kraft. Exclusive CDE multiple epoxy-phenolic dipping process forms a rock-hard, moisture-impervious casing. Printed circuit radial leads can be used for point-to-point wiring, if desired. 200v, 400v, 600v and 1600v units in stock.

Order your supply of these preferred replacement by-pass and coupling capacitors from your CDE Distributor. For more information, ask him for Section 204 of the CDE REPLACEMENT COMPONENT SELECTOR, or write: Cornell-Dubilier Electronics, Division of Federal Pacific Electric Co., 50 Paris Street, Newark, New Jersey, 07101.

*Du Pont T.M.

CDE CORNELL-DUBILIER
INNOVATION WITH RELIABILITY

Circle 7 on literature card

"Reliability without innovation is just a fancy word for improving an old breed!"

William Dubilier, Mica Capacitor Inventor

D. C. Tubular Aluminum Electrolytic Capacitors

Preferred Replacements: Three selected types, immediately available, cover all replacement needs.

Reliability: Typically high Cornell-Dubilier quality to protect your reputation and profits.

The right replacement . . . when and where you want it. Immediately available from the CDE network of Authorized General Line Distributors, and especially selected to solve any under-chassis and sub-panel tubular electrolytic replacement problem. Each of the three D.C. aluminum electrolytics use highest quality materials, utilizing the latest, exclusive CDE processes—the result of CDE's 53 years of knowledge and experience in capacitors.

Type ECSP—for printed circuit and low voltage, transistorized equipment. The industry's only rectangular cased, miniature electrolytic. Pre-molded case, exclusive moisture resistant encapsulation, and guaranteed lead center dimensions. Available 3 to 75 volts DC working, 3 to 250 microfarads, operating temperature range—20 to 65C.

Type NLW—for transistorized and portable equipment, or other miniaturized applications. Ultra-miniature axial lead electrolytics, hermetically sealed in aluminum cases, and provided with plastic insulating sleeves. Available 3 to 150 volts D.C. working, 1 to 450 microfarads, operating temperature range—40 to 85C.

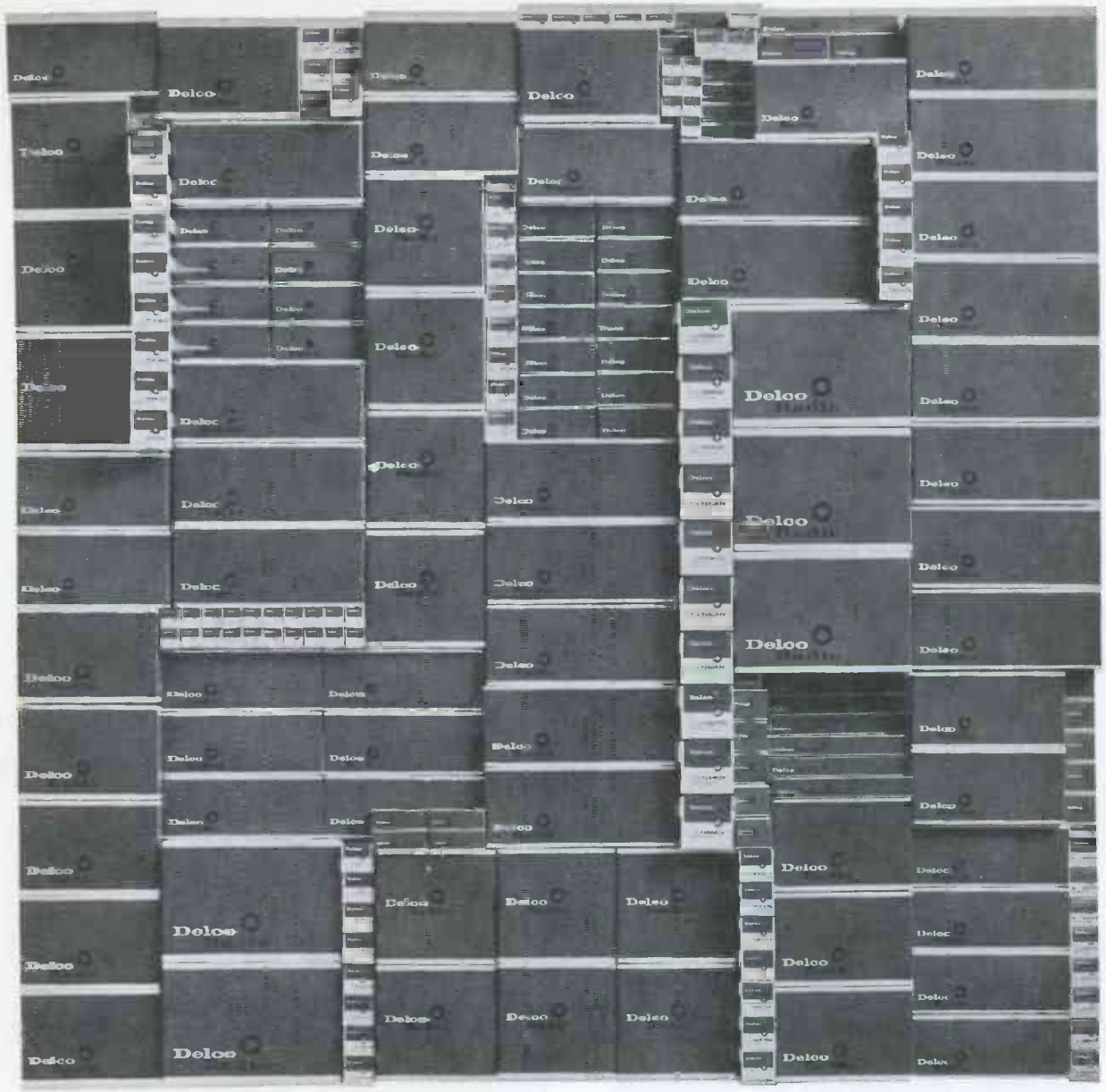
Type BR/BBR—the famous CDE "Blue Beaver"®, most popular and widely used of any tubular electrolytic. Hermetically sealed in compact aluminum cases and provided with cardboard insulating sleeves. Available 3 to 700 volts D.C. working, 1 to 5000 microfarads, operating temperature range—20 up to 85C. Also available BBRD (dual), BBRT (triple), and BBRQ (four section).

Order a supply of these preferred replacements from your CDE Distributor. For more information, ask him for Section 201 of the CDE REPLACEMENT COMPONENT SELECTOR, or write: Cornell-Dubilier Electronics, Division of Federal Pacific Electric Co., 50 Paris Street, Newark 1, New Jersey.

CDE CORNELL-DUBILIER

INNOVATION WITH RELIABILITY

Circle 7 on literature card



If the part you need isn't here, we've probably got it on the next shelf.

How can we be so sure we've got the auto radio parts you need? There are two reasons. One, nearly *half* the cars on the road have Delco radios. And we make Delco radio parts. Two, you can service *most* other kinds of radios with Delco parts.

We think this makes things easier on you. Because you can get just about all your parts from one reliable source, your United Delco supplier.

And what you get are good parts. You don't have to say a prayer every time you use them. They're well-built, well-tested parts that won't let you or your reputation down.

Your United Delco supplier will gladly send you our big detailed catalog. (To find the supplier nearest you, phone your area number below and ask for the Zone Service Manager.)

United Delco

DELCO RADIO • Division of General Motors

Atlanta.....Cedar 7-1501	Detroit.....584-1025	New Orleans.....523-4281
Boston.....Wells 3-3100	El Paso.....Keystone 3-1651	New York.....Judson 2-3824
Buffalo.....TF 2-5362	Houston.....Jackson 6-4338	Omaha.....558-0225
Charlotte.....Edison 4-8671	Indianapolis.....Melrose 6-4351	Philadelphia.....Garfield 3-8200
Chicago.....437-5300	Jacksonville.....Exbrook 8-5755	Pittsburgh.....Court 1-6551
Cincinnati.....Cherry 1-2310	Kansas City.....Fairfax 1-3900	San Francisco..Landscape 6-8221
Cleveland.....671-6460	Los Angeles.....Dunkirk 5-6487	Seattle.....Parkway 2-4477
Dallas.....Fleetwood 2-8471	Memphis.....Jackson 5-6471	St. Louis.....Jefferson 3-4230
Denver.....Keystone 4-0273	Minneapolis.....331-4811	Washington, D.C..Juniper 8-7494
	Newark.....297-3300	

Circle 8 on literature card

The Electronic Scanner

news of the servicing industry

Name Change

In an $800,000 expansion and reorganization program, **Hy-Gain Antenna Products,** Lincoln, Nebr. has adopted the new name of **Hy-Gain Electronics Corp.** The plant facilities are being enlarged to almost twice original size, providing more than 70,000 square feet of office, manufacturing, and engineering space. Equipped with the latest production machinery, the new building will provide additional space for laboratories and test sites. According to the company, the expanded engineering facilities will permit additional research and development projects in design, development, and testing. Products to be included are: commercial, industrial, and military antennas; antenna systems and related components; antenna systems for business/industrial, Citizens Radio, and Amateur Radio services.

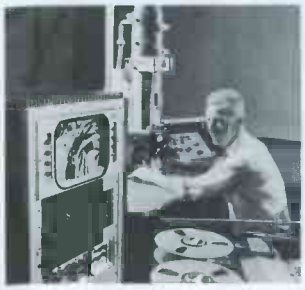
On-Job Education

An Office of Job Training has been opened in Washington, D.C. by **NATESA.** Mr. Vincent Lutz, past president of NATESA, is in charge. His services will be available without charge to any electronic service group wishing to develop an on-the-job training program under provision of the Manpower Development and Training Act of 1962.

New Name

All **Eastman Kodak Co.** magnetic sound tapes marketed through electronic supply houses, audio departments, and similar outlets will hereafter be sold under the name Kodak Sound Recording Tape. The tapes will be identical to those previously sold under the Eastman brand name, except for new type designations and increased information printed on the back of the tape.

More Magnification



A system to apply television techniques to the electron microscope can boost the instrument's visible magnification power ten-fold to 2,000,000 times. C. H. Colledge, vice president and general manager of the Broadcast and Communications Products Div., **RCA,** described the system as "the most important single advance in microscope design since the perfection of the microscope itself." Images heretofore have been too dim to observe at high magnifications, or the specimens themselves were destroyed or altered when exposed to the microscope's strong electron beam. The TV system intensifies the images formed when specimens are examined in the microscope and displays them on standard TV monitors. The conventional electron microscope is capable of direct magnification of 200,000 times, enabling scientists to observe objects 1,000,000 times thinner than the human hair. The addition of television increases the instrument's direct magnifying potential ten-fold, so much that the average 1" paper clip would appear 32 miles long and a man's foot some 400 miles long. However, most observations in electron microscopy are made at magnifications well below these theoretical limits.

VHF television tuners employing 600 workers. At present, Oak Electro/netics Corp. (Hong Kong) Ltd., has a 5000-square-foot plant and employs about 80 in subassembly operations. The company has leased an additional 42,000 square feet in a new plant where tuners will be assembled from parts fabricated in the United States. Initial shipments are scheduled to begin in the last quarter of 1964 and full production by mid-1965.

UL Listing Program

The UL listing program, started in April 1964 to cover all of **Matsushita Electric's** 30 factories, divisions, and departments with specialized "UL listing" lines of communication, is now in full operation. This comprehensive program, named "Operation UL," has the basic objective of securing UL listing for every Matsushita electronic and home-appliance product. All products now coming off production lines have been or will be submitted to one of the UL Testing Laboratories in Santa Barbara (Calif.), Northbrook (Illinois), New York or Chicago. Among the already approved products now being marketed in the United States is the Panasonic Model 763 (the first imported FM-AM line-connected, tube-chassis radio to be so listed.)

Color-TV Advertising

Is it possible to sell the "beauty and advantages" of color television via radio? **Packard Bell** thinks so! The company has been running an extensive radio advertising campaign via 60 stations in 25 major Western markets. The results are well worth watching. Radio has been used to sell color television

BUSS: 1914-1964, Fifty years of Pioneering....

New Plant

Construction of a complete new **Antennacraft** manufacturing plant was started in November. Located on their four-acre site just west of Burlington, Iowa, the new installation will enclose complete office facilities, with machines and equipment for plastics molding, aluminum-tube rolling and one additional production line. Operation in the new structure is expected to begin on or about January 1, 1965.

Year's Service Free

Effective immediately, all 1965 **Admiral** color television receivers sold in the Chicago area will carry a one-year parts and labor warranty at no additional cost. Victor Croft, general manager, announced that each sale includes setup and delivery in the customer's home, hookup to an existing antenna, and complete service for 12 months—including replacement or repair of defective parts and tubes. The unconditional *service* and *parts* guarantee is believed to be the only one of its kind in the industry.

License Law Pending

In their September convention at Roswell, N.M., **Television Electronic Service Assn. of New Mexico** elected new officers and discussed problems of the TV industry. They decided, among other things, that in January of 1965 they would try to get a television technician license law passed. The annual convention for 1965 was set to be held in Albuquerque next June.

Tuner Expansion

A major expansion program of **Oak Electro/netics Corp.** will convert their Hong Kong subsidiary to a manufacturer of

switch adding broadband radio reception to the existing two-way, shortwave system in the two mile-long tunnels. "So far as we know, there is not another tunnel anywhere with AM radio reception," Morris said. The 17.5-mile long bridge-tunnel, longest in the world, opened for traffic last April. It spans the mouth of Chesapeake Bay between Virginia Beach and Virginia's Eastern Shore. Its two tunnels dip as much as 90' under the bay surface beneath channels used by ships plying the ports of Hampton Roads and Baltimore. The technique that makes the system possible, developed by **General Electric,** is referred to as "Guided Radiation." The system consists of AM antennas mounted at each end of the tunnels and connected to amplifiers. The amplifiers boost the signals received by the antennas and feed them to antenna cables running the length of the tunnel ceilings. The cables were built into the tunnels originally to provide two-way short-wave communication for the bridge-tunnel's patrol cars, maintenance, and emergency vehicles. Only the outside antennas and amplifiers had to be added to make the system serve car radios.

Export Possibilities

Harold Harris, vice president in charge of sales and engineering of **Channel Master Corp.,** is in Yugoslavia as a member of a special U.S. trade mission to Yugoslavia. The trade mission, sent by the Department of Commerce, left October 2 on a one-month trip, to explore the Yugoslav market for American goods. The seven-man team took with them more than 360 specific proposals from U.S. firms interested in doing business in Yugoslavia, to discuss them with foreign trade representatives in the five major Yugoslav cities. ▲

....New Developments in Electrical Protection

before on a limited scale by individual dealers, but this marks the first time it has been used across the board by a major manufacturer. Their success could stimulate a new approach to television-set advertising.

Communications Seminar

The Newark-Herrlinger Corporation of Cincinnati, in cooperation with **Texas Instruments,** was recently host to more than 125 engineers and engineering buyers from the Cincinnati-Dayton area at a seminar on communications. A series of technical papers on semi-conductor applications for communication equipment in the megacycle and gigacycle range was offered at the meeting, with a question - and - answer period following the presentation of each paper.

The program is part of the service given to industrial customers by the Newark Corp., one of the larger radio parts distributors specializing in industrial sales.

Shown examining one of the portfolios of papers presented to each engineer attending the seminar are (L to R) Chuck Poncher, manager of Newark-Herrlinger; Harry Cooke, TI research engineer; Bob Spoeneman, TI local sales representative; Clancy Cordes, N-H industrial salesman; and Grady Giles. TI research engineer.

Underground Reception

In November, the Chesapeake Bay Bridge-Tunnel became the first travel facility in the world where motorists can listen to their car radios while driving through a tunnel. J. Clyde Morris, Executive Director of the Bridge-Tunnel, flipped a

Circle 10 on literature card

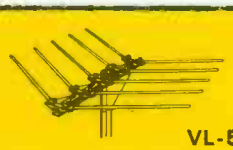
The VHF-FM antenna that challenges all competition

VL-10 (Illustrated)
9 driven elements
1 parasitic element
List price $34.95

NEW FINCO® Swept Element "COLOR-VE-LOG" VHF-FM ANTENNA

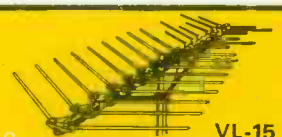
Finco's Color Ve-Log challenges all competition on color or black and white reception and stands behind this challenge with a "Guarantee of Supremacy". The swept element design assures the finest in brilliant color and sharply defined black and white television reception – as well as superb FM monaural and stereo quality. FINCO precision-engineered features make these advanced-design antennas indispensable to good home sight-and-sound systems. And, of course, they carry the famous unconditional guarantee from the leading manufacturer in the field – FINCO. Promote the Color Ve-Log Antennas with pride, sell them with confidence, and profit handsomely.

Featuring Finco's Exclusive Gold Corodizing

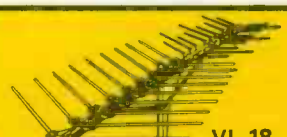


VL-5
5 element VHF-FM
5 driven elements
List price $16.95

VL-7
7 element VHF-FM
7 driven elements
List price $23.95



VL-15
15 element VHF-FM
9 driven elements
6 parasitic elements
List price $46.95



VL-18
18 element VHF-FM
9 driven elements
9 parasitic elements
List price $54.50

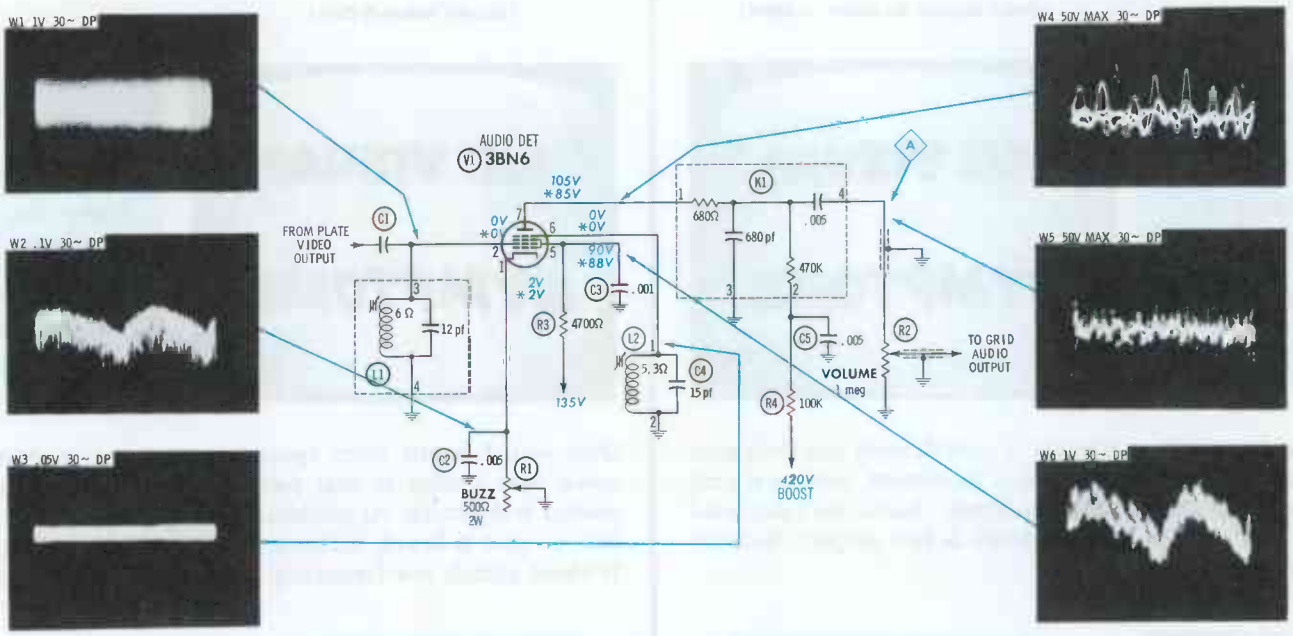
The FINNEY Company • 34 W. Interstate Street • Bedford, Ohio

Write for color brochure #20-307, Dept. 310

Circle 11 on literature card

'BN6 Sound Detector

Boost-Fed Plate



DC VOLTAGES taken with VTVM, on inactive channel; antenna terminals shorted. *Indicates voltages taken with signal present—see "Operating Variations."

WAVEFORMS taken with wideband scope; TV controls set to produce normal picture and sound. Direct probe (DP) usable at all points throughout the circuit.

Normal Operation

Gated-beam FM detector circuit depicted above, uses 3BN6 (specially constructed tube) as audio detector and limiter. Sound IF stage isn't needed with this circuit; signal from plate of video output tube is applied directly to C1. Sound takeoff coil L1 is tuned to pass frequencies 25 kc above or below 4.5 mc, thus allowing only frequency-modulated 4.5-mc signal to appear at first control grid (second grid—pin 2) of tube. Resonant tank circuit—L2 and C4—develops and sustains oscillation when signal is present at pin 2. Signal at pin 6 (second control grid) is also 4.5 mc, but is 90° out of phase (in quadrature) with signal at pin 2. Tube conducts only when signal excursions on both control grids are positive, therefore frequency modulation of carrier (signal shifting above or below 4.5 mc) causes plate current to vary at audio rate—larger shift gives greater plate-current change, and louder audio. Sync pulses and other noise will not be heard unless amplitude of incoming sound signal becomes so low that tube is not driven into saturation on each positive peak. Buzz control (R1) adjusts gain of V1 and eliminates amplication of low-level sync pulses which may not have been filtered by input-grid network. Alignment of L1, L2, and R1 can be accomplished by reducing signal strength at antenna terminals until hiss is heard and adjusting for maximum undistorted sound, with minimum buzz. In this set, plate voltage is supplied from boost; defects lowering boost voltage will also reduce sound output. Volume control (R2) may be adjusted to tap off any desired signal level.

Operating Variations

PIN 1 Cathode voltage varies from 0 to 4.5 volts, with or without signal, depending on setting of buzz control. Normal is 2 volts.

PIN 2, 6 No valid information can be gained by measuring voltage on either of these control grids. With or without signal, VTVM loads circuits and results in zero reading.

PIN 5 With or without signal, only slight variation is noted. Buzz control changes voltage only slightly—about 5-volt swing between minimum and maximum setting of control.

PIN 7 Without signal, plate voltage ranges from 55 to 410 volts, depending on setting of buzz control. With signal, plate voltage swings from low of 55 volts to high of 220 volts with rotation of buzz control. Normal is 85 volts.

WAVE-FORMS Grid signal (W1) shows frequency-modulated 4.5-mc signal; amplitude varies with rotation of finc tuning. Scope loads circuit at pin 6 (W3) but presence of 4.5-mc signal can be determined. W4 and W5 both display audio signals which vary in amplitude as audio of station signal fluctuates. Maximum amplitude is 50 volts p-p; decreases to near zero during pauses in transmitted audio signal. W6 contains slight audio signal and normal B+ ripple.

Sound Weak

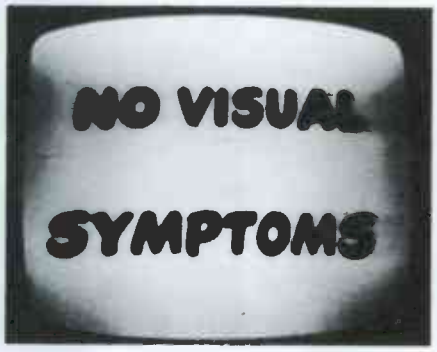
SYMPTOM 1

No Buzz or Hum Present

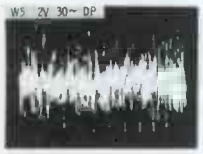
R4 Increased in Value

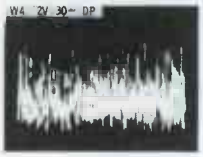
(Plate Supply Resistor — 100K)

Symptom Analysis



Sound heard from speaker is considerably less than adequate. With volume control at maximum, volume is only normal or slightly above normal. Audio isn't distorted by buzz or hum—output stage is first suspect, detector stage second.

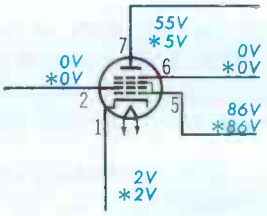




Waveform Analysis

Scope troubleshooting in output stage with station audio is difficult—frequency and amplitude of signal constantly changing. However, input to volume control is only 2 volts p-p on *strongest* signal; proves defect is in preceding stage. Input (W1) to grid of V1 is normal — isolates trouble to defective detector stage. Small, undistorted 2-volt plate signal (W4) isn't conclusive in pinpointing component, but gives hint to trouble in plate circuit.

Voltage and Component Analysis



Best lead to trouble is gained from radical plate-voltage change—55 volts without signal, decreases to mere 5 volts with signal present. Tube isn't overconducting as readings are normal on pin 1 and 5. Boost voltage is normal, therefore trouble must be in plate supply path; cause may be increased value of R4 or 470K resistor located in printed couplate K1. Amount of resistance increase in supply resistor determines exact symptom; slight increase may be barely noticeable, greater increase results in severe loss of volume.

Best Bet: Scope to isolate, then VTVM.

No Audio

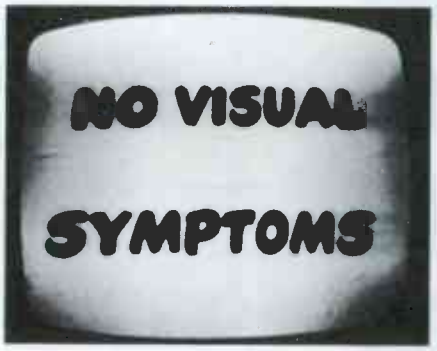
SYMPTOM 2

Loud Noise Present

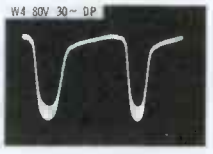
L1 Open, Terminal 3

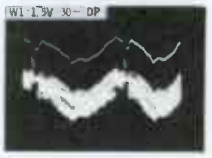
(Sound Takeoff Coil)

Symptom Analysis



Only sound heard from speaker is roar or rumbling noise, very similar to that present when B+ filter capacitor is defective. At minimum setting of volume control, no roar is heard; defect in B+ filtering is unlikely. Without signal, low-frequency roar is less pronounced.

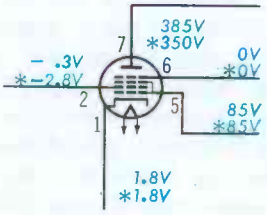




Waveform Analysis

Signal at detector plate (W4) doesn't resemble audio signal; however, this waveform does explain why low-frequency rumbling is present — unexplained pulse is approximately 60 cps in frequency. Pin 2, W1 (compare to normal W1) gives conclusive evidence of trouble in grid circuit—composite video signal is seen here. Defective L1 is likely culprit; this coil should pass only frequency-modulated 4.5 mc signal—not video—to grid of V1.

Voltage and Component Analysis



Pins 1 and 5 have near-normal readings—pretty well rules out defective components associated with these elements of tube. With or without signal, plate and first control-grid voltages are far from normal. Volage on pin 7 has increased to near boost-supply. Pin 2 has negative voltage—should read zero. Plate voltage has risen because of negative grid voltage and increased bias on stage. Open L1 is quickly pinpointed by measuring resistance from pin 2 to ground; meter shows no continuity—normal indication is 6 ohms.

Best Bet: Scope or VTVM will locate this trouble.

Sound Missing

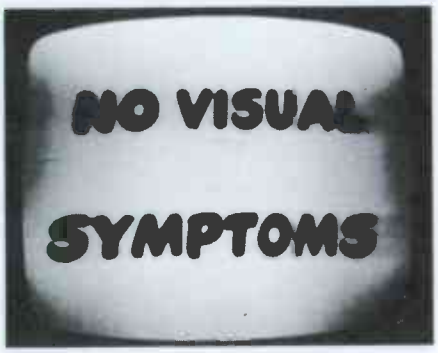
SYMPTOM 3

Buzz in Speaker

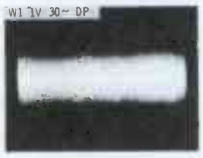
R1 Open

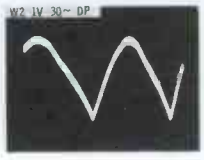
(Buzz Control)

Symptom Analysis



With or without signal, only noise heard from speaker is annoying buzz. Volume control operates normally, changing level of noise in speaker output as it should, but maximum setting doesn't provide even slightest audio—just buzz. Buzz control has no effect.





Waveform Analysis

Plate signal (W4) is reduced in amplitude and isn't audio signal; it resembles 60-cps sine wave. Waveform changes shape as tone of buzz varies. Absence of audio signal at plate suggests trouble is probably before plate circuit. Normal signal at pin 2 (W1) further isolates trouble—control grid circuit components are probably okay. Loss of audio signal at cathode (W2) suggests trouble in cathode circuit is likely; signal here is B+ ripple.

Voltage and Component Analysis

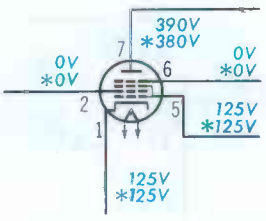


Plate voltage of 380 volts suggests tube is drawing only slight plate current. 125 volts at pin 5 confirms reduced conduction—normal reading is 90 volts. Most significant clue is 125-volt reading on pin 1. With cathode floating (ungrounded), voltage on pin 5 is also present on cathode. Break in printed-circuit board would give same symptom; in either case, resistance measurement from cathode (pin 1) of V1 to ground will reveal open circuit. Shorted tube could damage buzz control. B+ resistors should also be checked.

Best Bet: Scope finds stage, VTVM locates component.

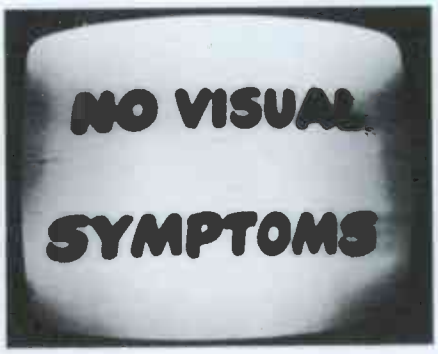
Sound Weak

SYMPTOM 4

Buzz present

R3 Increased in Value

(Screen Supply Resistor — 4700 ohms)

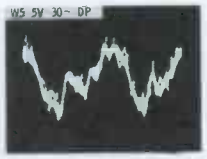


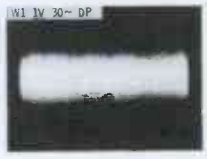
Symptom Analysis

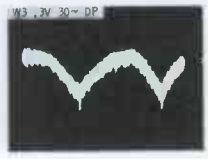
Slight amount of audio can be heard from speaker but is almost over-ridden by annoying buzz. Volume control varies amount of sound heard from speaker; however, even at maximum setting of control, volume is weak. Buzz control has only very slight effect on buzz.

Waveform Analysis

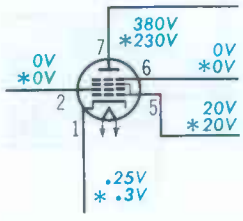
Only slight amount of audio signal (5 volts p-p) is present in W5; also, during pauses, considerable B+ ripple can be seen. W1 is normal—indicates trouble somewhere between grid circuit of V1 and input to volume control. Signal at pin 6 (W3) is predominantly 60-cps ripple; only slight amount of 4.5-mc signal is present. Scope is useful in isolating trouble to sound detector stage, but will not pinpoint defective component.







Voltage and Component Analysis



Tube conduction and plate current of V1 are greatly reduced, proven by decreased voltage on cathode and increased voltage on plate. Screen grid (pin 5) measures only 20 volts (normal is 90), therefore trouble in screen supply path is likely; reduced tube conduction would otherwise cause screen voltage to increase, not decrease. Weak volume is explained by lower amplification of tube—usual with screen-voltage reduction. Decreased cathode voltage changes bias on stage, thus allowing passage of 60-cps signal—reason for buzz.

Best Bet: VTVM will do entire job.

Buzz In Sound

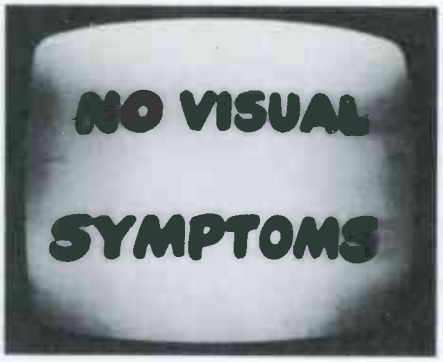
SYMPTOM 5

Volume Greatly Reduced

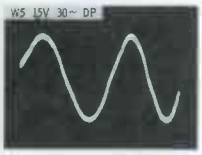
L2 Open, Terminal 1

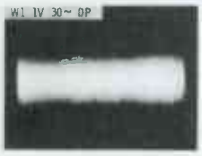
(Quadrature Coil)

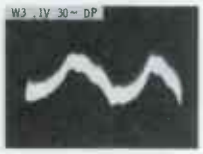
Symptom Analysis



Only very slight amount of audio can be heard, even at maximum setting of volume control. Hum or buzz is quite pronounced. Volume control operates normally—will change output level, and nothing is heard at minimum setting. R1 varies volume but buzz is still present.



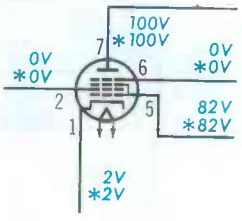




Waveform Analysis

Input to volume control (W5) proves trouble is in preceding stage. Slight amount of audio is present, but majority of signal is 60-cps sine wave; explains why hum is being heard. W1 shows incoming sound signal to be normal; trouble must be in detector stage. W3, on second control grid, gives most conclusive evidence to trouble; 4.5-mc signal isn't present here. Content instead is rather minute audio signal dominated by 60-cps hum.

Voltage and Component Analysis



Practically no helpful information can be gained from voltage measurements. All tube elements show normal or near-normal readings, with or without signal. Variations are so slight that no conclusive evidence is gained as to defective component. Ohmmeter is most useful in isolating open quadrature coil when resistance measurements are made from pin 6 to ground—shows no continuity; normal reading is 5.3 ohms. Open quadrature coil has little effect on bias of stage; therefore DC voltages remain almost normal.

Best Bet: Scope and ohmmeter checks.

No Audio

SYMPTOM 6

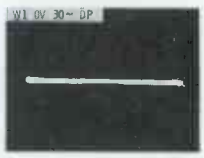
Only Faint Hum

C1 Open

(Grid Coupling Capacitor — 3.3 pf)

Symptom Analysis

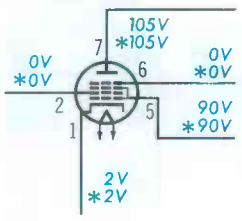
Absolutely no audio can be heard from speaker, even with volume control at maximum; only sound heard is faint hum. Defect could be in either detector or output stage. Buzz control is operative, as it increases or decreases hum level, but still no audio is present.



Waveform Analysis

Output of detector stage (W5) shows complete loss of audio signal—only 60-cps ripple is present. W1, taken at pin 2, shows absolutely no 4.5-mc information at detector input; normal signal at this point is 1 volt p-p (see accompanying normal W1). Picture is normal, therefore video output stage is probably okay. Open C1, or break in printed-circuit board, is probable suspect when picture is normal and signal is missing at control grid.

Voltage and Component Analysis



Without signal, voltage measurements on V1 aren't helpful; all readings are normal. With signal, readings remain same; plate and screen voltage should decrease. Symptoms hint that loss of signal at control grid (pin 2) is responsible for trouble. With troubles like this, scope is more helpful in determining defect than is VTVM. In fact, VTVM will seldom pinpoint fault in signal-handling component such as capacitor. With scope and tests outlined in Waveform Analysis, defective stage and/or components aren't difficult to locate.

Best Bet: Scope is almost necessary.

A fifth wheel? Who needs it?

Does a manual rotator require a *fifth* wire?

Sure. Like your car needs a fifth wheel. Who needs it!

Somebody else maybe. Not us, thank you. Channel Master Tenn-a-Liner rotators are designed to give you more torque on four wires than another rotator does on five.

The other guy may *need* that fifth wire to try to bring his turning power up to ours. (Due to an inherent weakness in his potentiometer circuit). But it may also do more harm than good. Because you're asking for a lot of unnecessary trouble with that fifth wire. And expense.

Like extra callbacks due to a 25% increased chance of connection failure. Not to mention the added cost of the wire itself. At least 25%. Do you need it?

Not when Channel Master Tenn-A-Liners (automatic *and* manual) can turn even the heaviest antenna arrays—under the toughest weather conditions. A 300 lb. ice-loaded installation won't faze a Tenn-a-Liner. Nor will a 70-mile an hour gale. (Tenn-a-Liner "guts" are made of hard steel only—never soft zinc or aluminum. And their thrust bearing, unlike the other guy's, is built-in). What's more, no manual rotator is more accurate. *And none costs less.*

A fifth wire? Like we said: who needs it? You?

Compass, Model 9520

Automatic, Model 9524. The only rotator that can aim an antenna within 1 degree of transmitter location. Only 3 wires. Foolproof Control console. No irritating gear click.

CHANNEL MASTER rotators

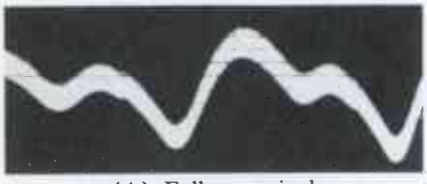
ELLENVILLE, NEW YORK

Circle 12 on literature card

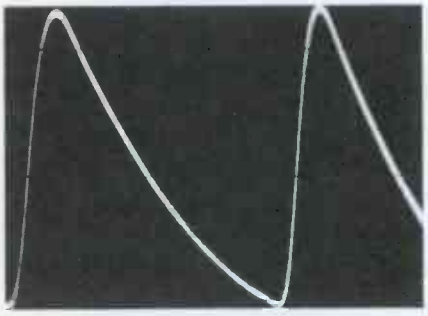
Shop Talk by Allan F. Kinckiner

CURING BUZZ . . . HUM and other Irritating Noises

Reproduction of sound is an integral function of most entertainment equipment service technicians are called upon to repair, and a good portion of servicing time is spent in correcting troubles in various sound circuits. In addition to restoring volume to normal levels, overcoming distortion, and regaining fidelity, sound servicing often involves reducing to an acceptable minimum any buzz, hum, or other unwanted noise that may develop. One of our punning customers described these noises as being "EAR-itating."

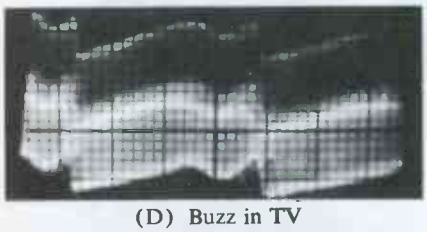


(A) Full-wave ripple



(B) Half-wave ripple

(C) Noise in FM



(D) Buzz in TV

(E) D at 5000 cps

Fig. 1. Ripple and noise waveforms found at plate of audio output tube.

The varying degree of annoyance of the noises to different listeners adds a sensitive human factor to servicing these troubles. While many TV customers often accept without complaint noises of rather high levels, hi-fi listeners are critical of buzz or hum of even the slightest magnitude.

The fact that audibility of the noise depends on speaker conditions also must be considered. Larger, better speakers make noises of any type more audible and therefore more noticeable and annoying. Likewise, mounted speakers present greater audibility (including noise) than do unmounted ones. The small 5″ or 6″ speaker sometimes used for bench servicing does not indicate reliably how acceptable the sound will be when heard through the larger speaker mounted in the equipment. The waveshape, frequency content, or substance of the noise signals can also affect the degree of irritability produced, and certain types of small-amplitude noises can be more annoying than other types that are of much greater amplitude.

Since most troubles that involve noise require bench servicing, and since speakers employed during bench servicing don't always develop these noises at their irritating worst, a noise measurement of some sort is necessary to determine how clean (or unclean) the sound will actually be when played through its proper speaker. One effective technique involves scoping the signal at the plate of the audio output tube. These traces contain information that can be extremely useful in servicing complaints of unwanted noise.

Fig. 1 shows several of these containing noise components. Let's examine them and note a few facts about the various kinds of unwanted noise represented. Fig. 1A shows nominal ripple found in the power supply of small radios using full-wave B+; this signal is not aurally irritating even when its peak-to-peak amplitude rises to more than 8 volts. Fig. 1B is a photo of the more-than-10-volt ripple typical of AC-DC radios using a filter circuit consisting of two high-value electrolytics and a resistor; this is a common circuit which we will cover more fully later. These saw-tooth ripple signals, while not often ob-

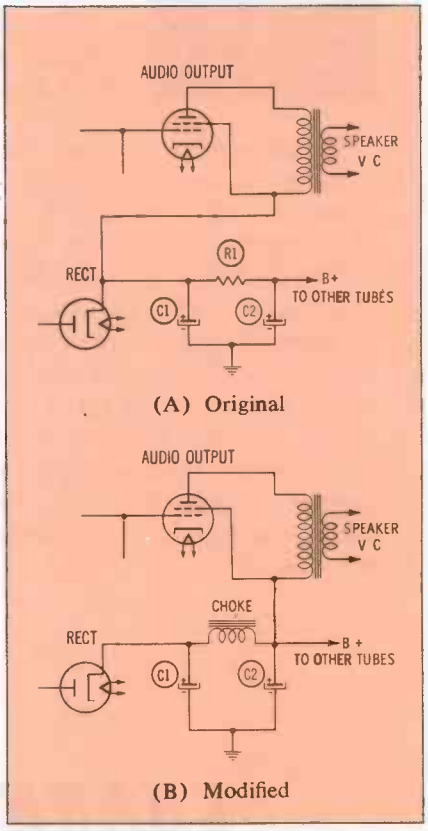


Fig. 2. Supply circuit can be modified to reduce hum level in receiver.

jectionable when applied to the usual small speaker found in these sets or to a small service-bench speaker, can be quite unsatisfactory if fed to larger speakers. In Fig. 1C, the background noise found in a small FM receiver, and in Fig. 1D, the buzz in TV sound, were both objectionable to hear — even on small, unmounted speakers — although their amplitudes were less than one half that of the Fig. 1A and 1B signals. The noise in Fig. 1C was caused by a ratio-detector filter in an FM receiver.

Comparing traces 1A and 1B with 1C and 1D reveals that the actual content or shape of the noise signals is more significant than the amplitude in determining whether the noise will be annoying. Further analysis of irritating signals can be developed by scoping at sweep settings that will present two or three individual cycles of the irritating signals. For example, the signal in Fig. 1D, when viewed at an approximate 5000-cps scope sweep, produced the trace of Fig. 1E. The three sharp pulses in 1E suggest the probability of poor filtering in circuits associated with horizontal deflection, and were eliminated by replacing an electrolytic in that section. The 15,750-cps signal of Fig. 1E, being beyond the response of most TV audio amplifiers, would not ordinarily be expected to produce much audible sound; in this case, the pointed shape of the signal apparently caused intermodulation and created the objectionable buzz that could be heard in the sound, with the horizontal-frequency signal acting as a "carrier."

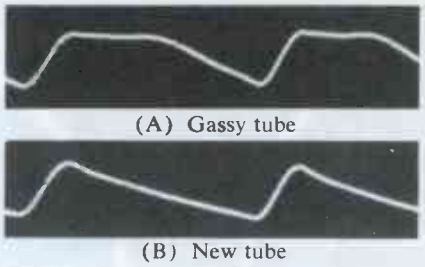
The conditions of taking the waveforms may offer important clues, too. For instance, the normal audio-output plate signals of Figs. 1A and 1B were obtained with the volume control at minimum—excessive hum or noise would be a certain indication of either power-supply or output-stage trouble. Fig. 1C was noted during a lull in the sound from an FM station. Figs. 1D and 1E were taken with the final sound-IF tube removed from the TV set. When normal sound was being fed through to the speaker, these various background noise signals could not be identified, nor scoped, with any accuracy. (At normal listening levels, sound peaks at the audio plate measure around 50 volts.) This will depend somewhat on the output transformer used.

In Radios and Record Players

The B+ filter circuit used in small AC-DC radios and record players is shown in Fig. 2A. Because plate voltage for the audio output tube is generally taken directly from the rectifier cathode, amplitude of the ripple will be relative to the capacitance of the first filter (C1). In sets using 3″ or 4″ speakers, C1 might be as low as 30 mfd; for larger speakers, C1 will usually be more than 50 mfd. In some early sets, C1 is 30 mfd, R1 is 1000 ohms, and C2 is 50 mfd; by merely transposing C1 and C2, ripple and audible hum can sometimes be materially reduced. Increasing C1 to a larger capacitance would be necessary when a customer wants to use a larger 8″ or 12″ speaker with the equipment; and in some cases the dual filter capacitor should be replaced so that C1 could then be at least 60 mfd. When C1 has a high capacitance, a resistance should be inserted between the rectifier and C1 to prevent rectifier damage during the initial charging surge. To bring about even lower hum levels, R1 could be replaced with a small iron-core choke, and the output plate voltage taken off at the top of C2, as shown in Fig. 2B.

Because a great many complaints of hum result from capacitance loss in filters, servicemen develop the habit of testing the capacitors by shunting them with new units. Actually, a scope trace taken at the audio output plate will be more conclusive, indicating more definitely where trouble really lies.

For example: A set with a C1 of 30 mfd evokes a complaint of too much hum. The serviceman shunts C1 with another 30-mfd unit and the hum does decrease slightly, so a new dual filter is wired into the set, using an exact replacement. Result—very little improvement. Why? The original C1 was not really bad and scoping would have revealed a ripple like that in Fig. 1B, with an amplitude of about 12 volts. Shunting C1 with another 30 mfd would decrease the ripple to about 9 volts, but this is due only to the *added* capacitance; when a new 30-mfd unit is installed, ripple again is 12 volts. If, instead



(A) Gassy tube

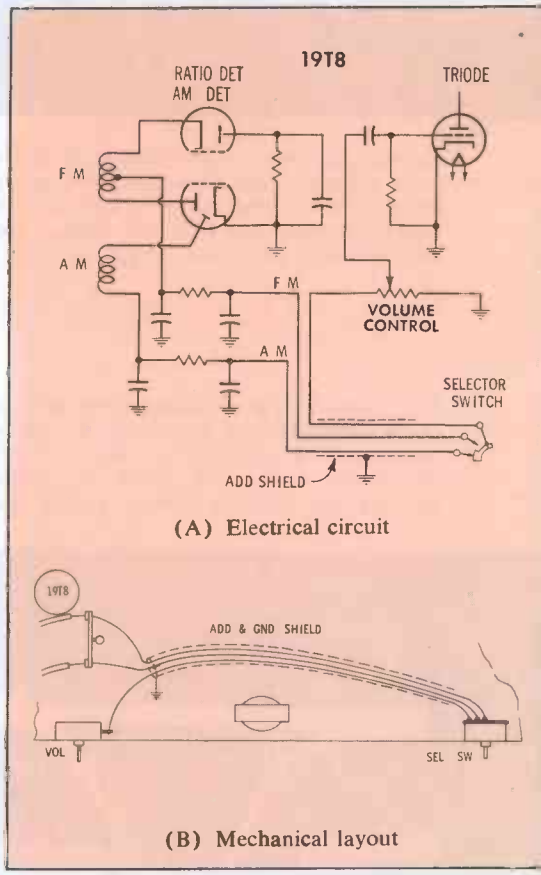
(B) New tube

Fig. 3. Waveforms scoped at output.

of using the shunting test, a scope trace had been taken for analysis, the 12-volt level would have been evidence enough that C1 was not defective, because a 12-volt ripple is not abnormal for 30 mfd. The result might have suggested transposing filter sections (if the original had been a 30-50 unit) or replacing C1 with a unit of more than 50 mfd. If loss of capacitance had been causing the hum, the ripple would have climbed to more than 12 volts. Thus, if a serviceman is aware that a 30-mfd C1 begets a 12-volt ripple (or thereabouts), and 60 mfd a 9-volt ripple, etc., he can quickly decide whether a new filter with characteristics identical to the original will be enough.

Analysis of the ripple shape can be even more helpful, especially in

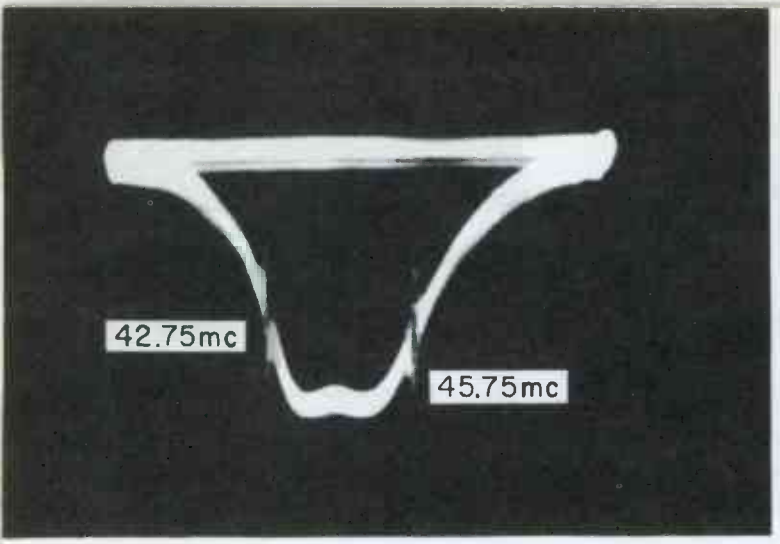
• *Please turn to page 44*



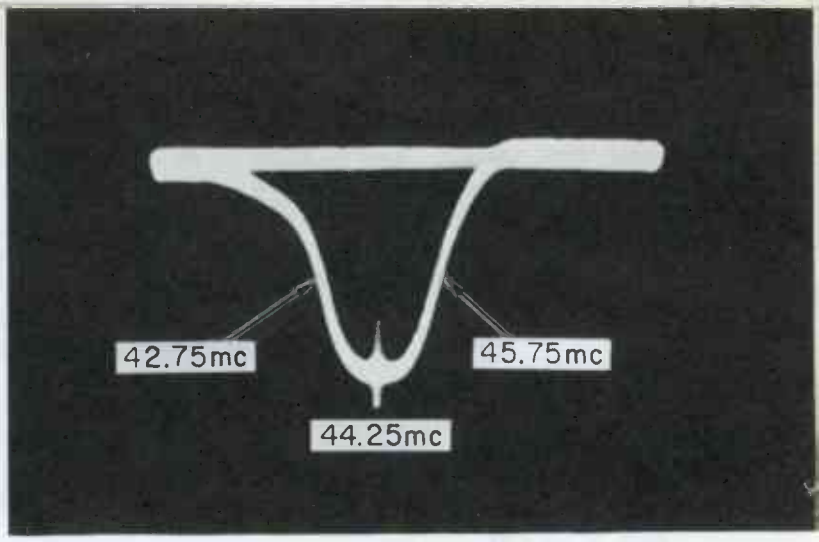
(A) Electrical circuit

(B) Mechanical layout

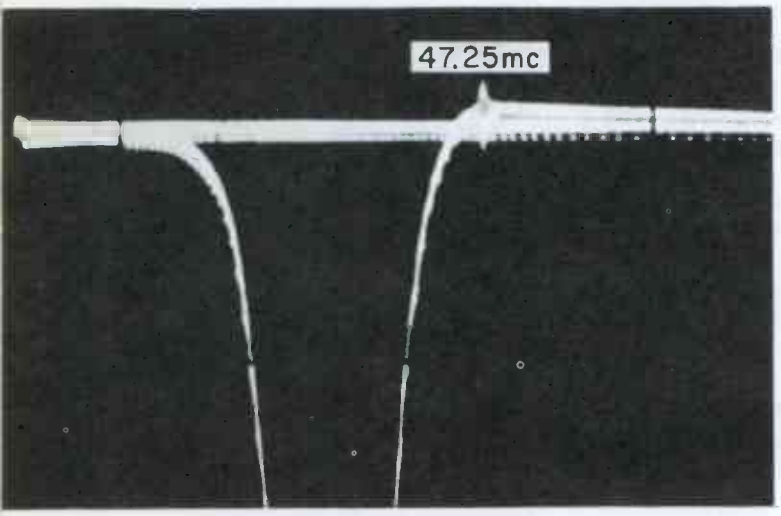
Fig. 4. Zenith Model 8C02 had odd-sounding buzz emitting from speaker.



Most receivers use an overcoupled (double-tuned) transformer preceding the video detector. Preset this coil by connecting the generator to the grid of the final IF stage and adjusting both slugs to position the 42.75-mc and 45.75-mc markers at or near the top of the response curve.



A properly aligned receiver displays an *overall* response similar to the one above. The picture carrier (45.75 mc) should be positioned near the midway point on the slope—50%. The 50% marker on the opposite side of the curve should be at least 3 mc lower in frequency (42.75 mc).

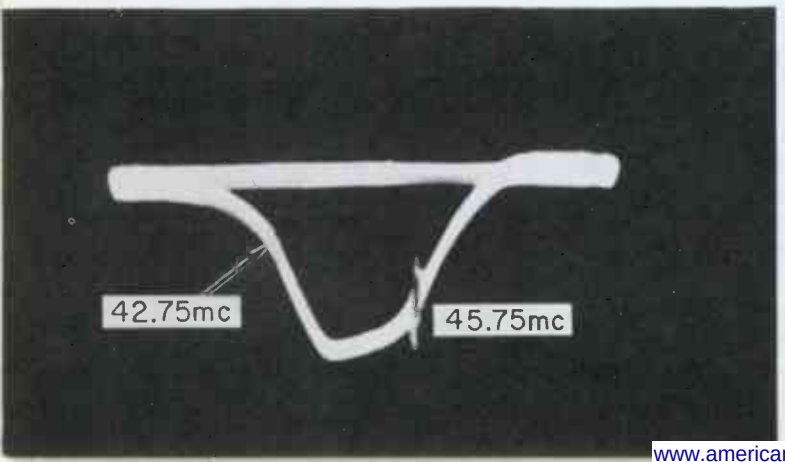


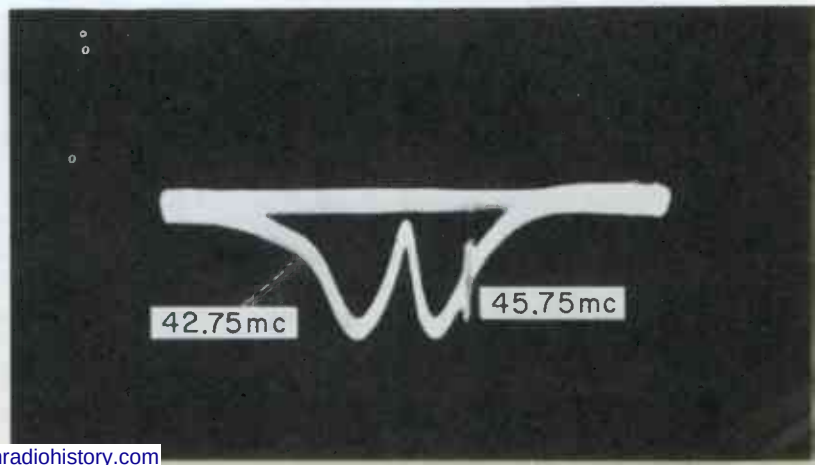
WAVEFORMS
for Sweep Alignment

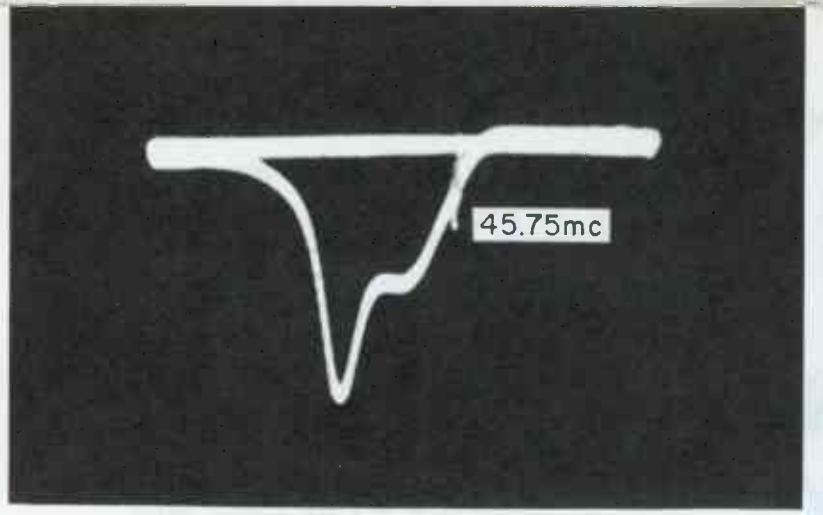
Correct alignment of the trap (or traps) can be determined most accurately by increasing the scope vertical gain (as here) until the trap notch is visible; check to see that the marker (in this case 47.25 mc) falls in the trap notch. Some receivers also incorporate traps at 39.75 and/or 41.25 mc.

This response curve was obtained with the mixer plate coil misadjusted. Overall amplitude is reduced; also, the 45.75-mc marker is too high on the curve. The picture carrier should be at the 50% point, or slightly above. However, be sure the 42.75-mc marker is also 50%—it isn't here.

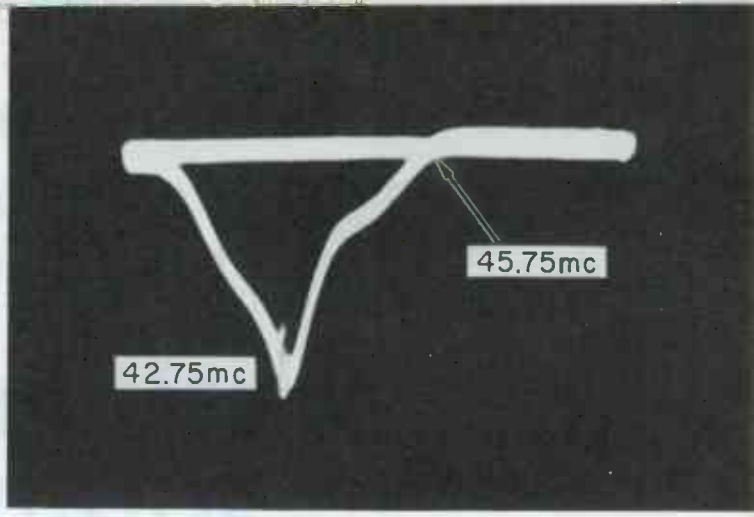
The excessive dip in this response was caused by improper setting of the 42.75-mc trap. The trap is now 44 mc, as indicated by the notch. Notice that the 45.75-mc and 42.75-mc markers are still at 50%. A misadjusted trap alters the shape of the response but does not change the bandwidth.







Misalignment of the first-IF grid coil causes the 45.75-mc marker to appear near the base line. This coil has greater effect on the picture carrier side of the curve, shifting the picture-carrier downward; under these conditions, the entire response curve will be far too narrow in the upper portion.

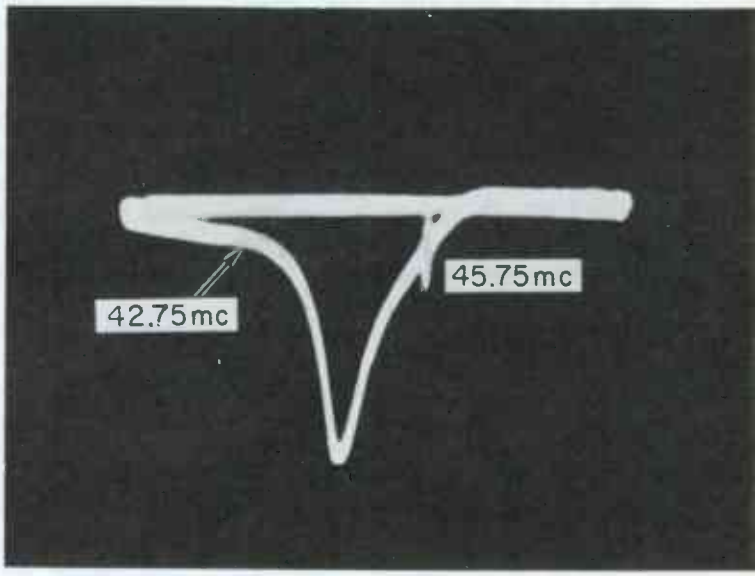


A detuned second-IF coil (in the grid circuit of the second stage) affects both sides of the response curve. It shifts the entire curve, causing the 42.75-mc marker to appear near the top of the curve and the 45.75-mc marker to fall on the base line—bandwidth is reduced at the 50% point.

The picture quality of a television receiver is many times deteriorated because the coils in the video IF strip aren't aligned properly. This need not be the case with any TV set leaving your shop, if you will only familiarize yourself with the correct response curve and the effect that misaligned stages have on this curve. The group of sweep waveform photos shown here displays both the normal (photos 1 through 3) and abnormal (4 through 10) response curves.

All abnormal photos were taken with the individual coils misadjusted to show their effect on the response curve. More or less detuning of any stage will cause a somewhat different response, but the same section of the curve will be affected.

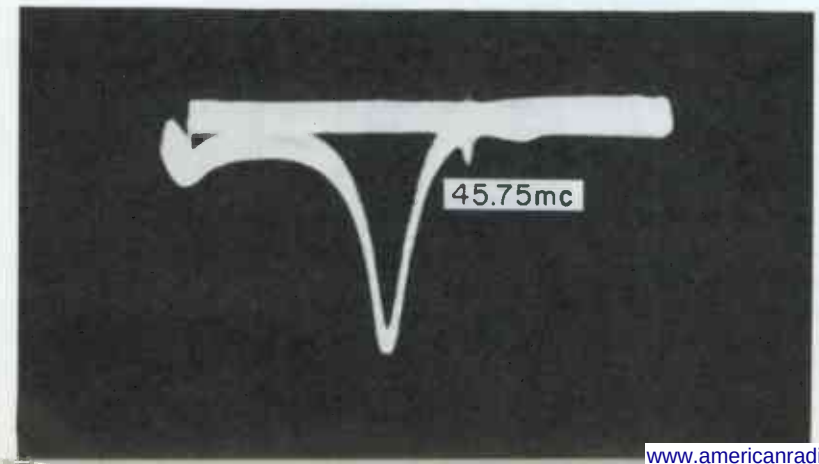
All waveforms (except 1 and 9) were taken with the sweep and marker generators connected to the mixer-grid test point. The scope was connected to the output of the video detector in all instances. A negative bias was applied to the grid circuit of the RF amplifier to prevent overloading of the receiver. Generator output was kept at a minimum. Arrows indicate the relative position of other frequencies on the response curve.

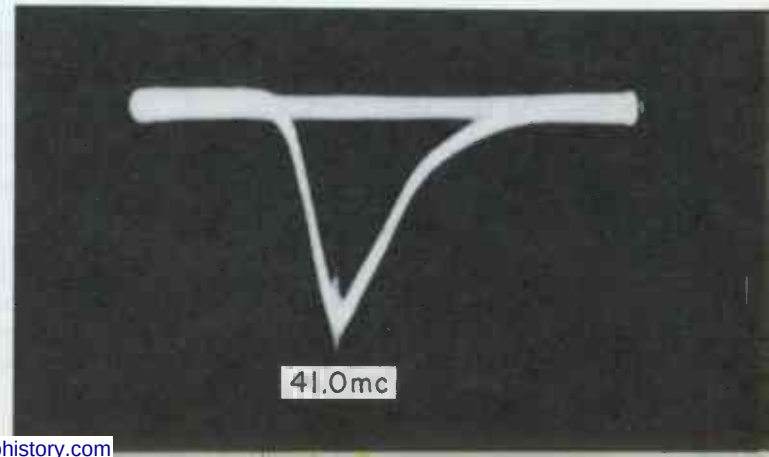


A sharp response (as in this photo) can be caused by misalignment of the overcoupled transformer. Here, the 45.75-mc marker appears near the base line. The 42.75-mc marker is also near the base line, but on the opposite side of the curve. Bandpass of overcoupled transformer is reduced.

With the generator connected to the grid of the final IF tube, misalignment of the overcoupled transformer causes an effect like the one above. The 45.75-mc marker is on the base line—the curve is sharply peaked. A small second peak can be seen at the left edge of the photo below.

A completely misaligned receiver may present any one of various response curves. An example is the one above, in which the center of the curve is at 41 mc. The response curve is quite sharp, and greatly reduced in amplitude. Scope vertical gain was increased for taking this photo.





REPORT ON UHF STATION ACTIVITY

Up-to-date story of TV's "orphan".—by George F. Corne, Jr.

The so-called "all-channel law," which went into effect last April, ushered in what many observers hope and predict will be a continuing period of expansion in UHF television broadcasting. This growth is important to you as a dealer or service technician because the coming of UHF TV to your area means new income from the sale of UHF antennas, converters, all-channel tuners, UHF strips in VHF-only sets, and signal boosters. By keeping informed of station and application activity you can be prepared for new developments when they happen.

Station Status

An idea of the current expansion of UHF broadcasting can be obtained by comparing the number of UHF stations operating at the end of 1963 with the number in operation at the beginning of November, 1964.

The total number of UHF stations authorized in '63—including those granted construction permits (CP's)—was 211. Some of these were in the process of construction; others had operated at one time but were temporarily shut down for some reason (often due to lack of audience and advertising). The total number of UHF stations actually in operation—transmitting programs—in December, 1963, was 120. Of these, 88 stations were providing commercial service, 32 noncommercial. Of the noncommercial outlets, 29 were providing educational services (ETV); the remaining three noncommercial stations included WNYC-TV (channel 31) New York City; WUTV (channel 36) Charlotte, N. C.; and WYAH (channel 27) Portsmouth, Virginia.

As of November, '64, 127 stations were operating, 88 commercial and 39 ETV. This cumulative number makes allowance for stations coming on the air for the first time, those restarting, and those whose authorizations were cancelled. From January to November of this year, then, the number of UHF stations on the air increased by seven—a gain of almost 6%.

The FCC has announced its intention to consider cancellation of some "long-time" construction permits in an effect to speed UHF growth. Some of the stations authorized by these permits were never built; the others have not been in operation for a considerable length of time—years in some cases. The Commission hopes to reactivate these channels or make them available to other applicants.

Application Activity

In 1963, the applications filed with the FCC for UHF stations numbered 74. Of these, 52 were for commercial operation and 22 for noncommercial. In the first 10 months of 1964, 70 applications were filed—59 commercial, 11 ETV. In some cases, more than one applicant is seeking the same channel in the same location (for example, channel 55 in Rochester, Minnesota). Naturally, the FCC can grant only one of the applications in such cases (unless a time-sharing agreement is approved), so the 70 new applications represent only 59 potential new stations.

Status By States

Below, you'll find the UHF station status presented on a state-by-state basis. Given are stations that were transmitting or were holders of CP's as of December, 1963, and stations that began transmitting, were granted CP's, or were applied for during 1964 (up to November). The up-to-date map accompanying this information will give you an overall look at UHF station status for the same time periods. The symbols in black and white indicate commercial and ETV stations at the end of 1963; those in color illustrate the UHF picture since January, 1964. Correlating the listings with the map will help you visualize developments in your particular area.

ALABAMA

Stations Transmitting			
Decatur	WMSL-TV	23	
Florence	WOWL-TV	15	
Huntsville	WHNT-TV	19	
Huntsville	WAFG-TV	31	
Montgomery	WCOV-TV	20	
Montgomery	WAIQ	26	ETV
Montgomery	WCCB-TV	32	
Authorized, Not Transmitting			
Birmingham	WBMG	42	
Birmingham	.....	48	
Huntsville	WAAY-TV	25	
Mobile	WEIQ	42	ETV
Tuscumbia	WVNA-TV	47	
Began Transmitting During '64			
Montgomery	WKAB	32	Mar
Applications Filed During '64			
Anniston	.....	70	Mar
Anniston	.....	70	Apr
Gadsden	.....	37	Mar
Homewood	.....	54	Jan
Huntsville	.....	25	May
Tuscaloosa	.....	51	Mar

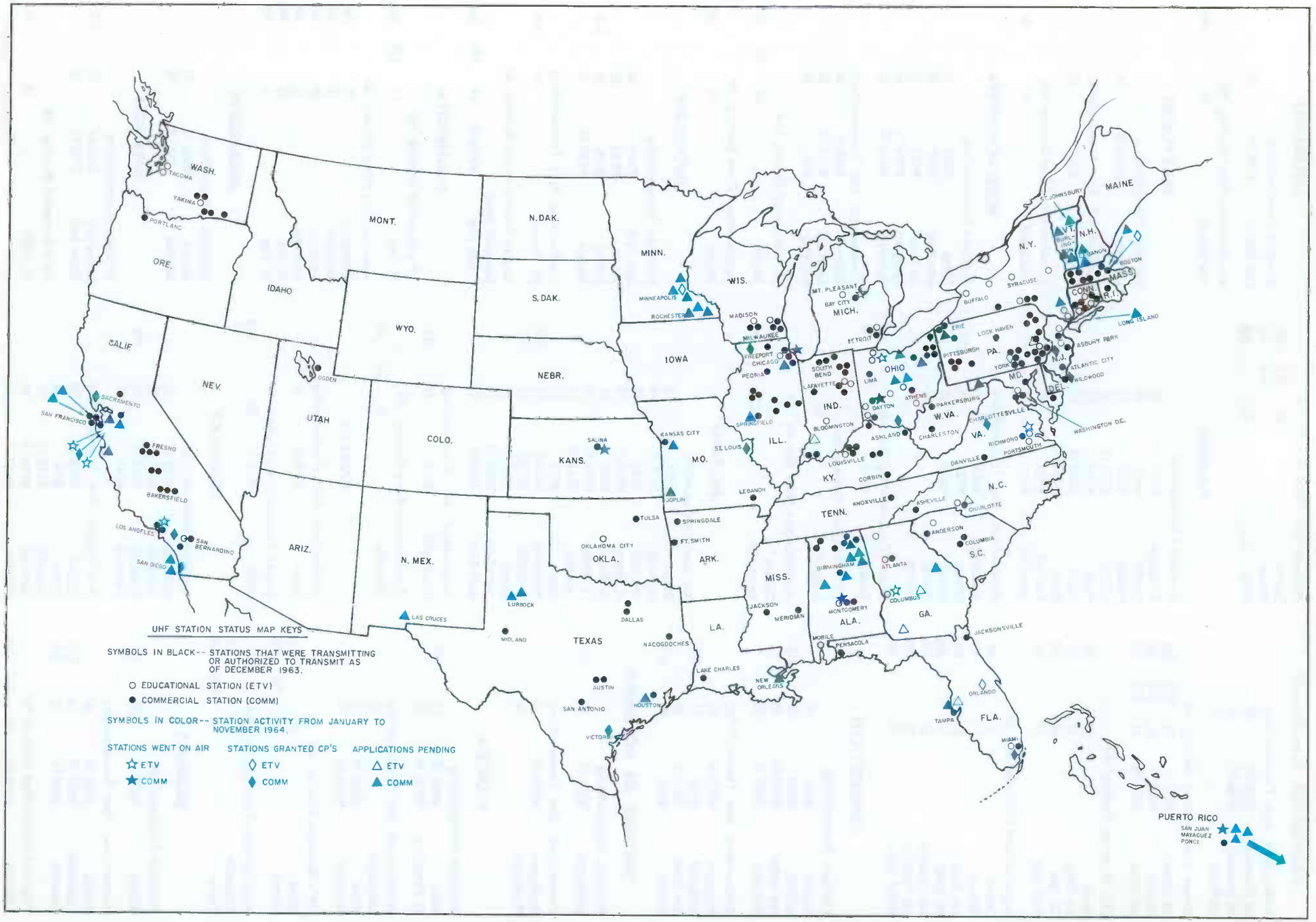
ARKANSAS

Authorized, Not Transmitting			
Ft. Smith	KEFS-TV	22	
Springdale	.....	35	

CALIFORNIA

Authorized, Not Transmitting			
Bakersfield	KERO-TV	23	
Bakersfield	KLYD-TV	17	
Bakersfield	KBAK-TV	29	
Fresno	KMJ-TV	24	
Fresno	KFRE-TV	30	
Fresno	KJEO	47	
Fresno	KAIL	53	
Hanford	KDAS	21	
Los Angeles	KMEX-TV	34	
San Bernardino	KCHU	18	
San Bernardino	KVCR-TV	24	ETV
Stockton	KOVR	13	
Visalia	KICU-TV	43	
Corona	KICB-TV	52	
Los Angeles	KIIX-TV	22	
Sacramento	KVUE-TV	40	
San Francisco	KBAY-TV	20	

Note: Material for a portion of this article was adaptd from the Howard W. Sams book "North American Radio-TV Station Guide" by Vane A. Jones.



CALIFORNIA (Continued)

Authorized, Not Transmitting

San Francisco	KSAN-TV	32		
San Francisco	KFOG-TV	44		
San Mateo		14		

Began Transmitting During '64

Los Angeles	KCET	28	ETV	Sep
San Jose	KTEH	54	ETV	Sep
San Mateo	KCSM-TV	14	ETV	Sep

CP's Granted During '64

Guasti	46		Jul
San Diego	39		Jul
San Jose	48		Oct
Santa Rosa	50		Jul

Applications Filed During '64

Carmel	35		Jul
Modesto	17		Mar
San Diego	51		May
San Diego	51		Aug
San Francisco	26		Feb
San Francisco	26		Sep
Walnut Creek	26		Jan

CONNECTICUT

Stations Transmitting

Hartford	WHCT	18	
Hartford	WEDH	24	ETV
New Britian	WHNB-TV	30	
Waterbury	WATR-TV	20	

Authorized, Not Transmitting

Bridgeport	WICC-TV	43	
Bridgeport	WCTB	71	ETV
New Haven	WELI-TV	59	
Norwich	WCTN	63	ETV

DISTRICT OF COLUMBIA

Stations Transmitting

Washington	WETA-TV	26	ETV

Authorized, Not Transmitting

Washington	WOOK-TV	14
Washington		20

FLORIDA

Stations Transmitting

Miami	WSEC-TV	17	ETV
St. Petersburg	WSUN-TV	38	

Authorized, Not Transmitting

Jacksonville		36
Miami	WGBS-TV	23
Pensacola	WPEA-TV	15

CP's Granted During '64

Miami	33		Sep
Orlando	24	ETV	Mar

Applications Filed During '64

Clearwater	32		Feb
Tampa	16	ETV	Aug

GEORGIA

Stations Transmitting

Atlanta	WETV	30	ETV

Authorized, Not Transmitting

Atlanta	WATL-TV	36	
Chatsworth	WCLP-TV	18	ETV
Columbus	WJSP-TV	28	ETV

Began Transmitting Durlng '64

Columbus	WJSP-TV	28	ETV	Jul

Applications Filed During '64

Cochran	50	ETV	Sep
Pelham	14	ETV	Sep
Wrens	20		Aug

ILLINOIS

Stations Transmitting

Champaign	WCHU	33	
Danville	WICD	24	
Decatur	WTVP	17	
LaSalle	WEEQ-TV	35	
Peoria	WTVH	19	
Peoria	WEEK-TV	25	
Peoria	WMBD-TV	31	
Rockford	WTVO	39	
Springfield	WICS	20	

Authorized, Not Transmitting

Bloomington	WBLN	15	
Chicago	WXXV	20	ETV
Chicago	WCIU	26	
Chicago		32	
Chicago		44	

Began Transmitting During '64

Chicago	WCIU	26	Feb

CP's Granted During '64

Freeport	23	

Applications Filed During '64

Chicago	38	Oct
Springfield	36	Jul

INDIANA

Stations Transmitting

Elkhart	WSJV	28	
Evansville	WFIE-TV	14	
Evansville	WEHT	50	
Ft. Wayne	WANE-TV	15	
Ft. Wayne	WPTA	21	
Ft. Wayne	WKIG-TV	33	
Lafayette	WFAM-TV	18	
Marion	WTAF	31	
Montpelier	KS2ZGA	72	ETV
Montpelier	KS2ZGD	76	ETV
Muncie	WLBC-TV	49	
South Bend	WNDU-TV	16	
South Bend	WSBT-TV	22	

Authorized, Not Transmitting

Bloomington	WTIU	30	ETV

Applications Filed During '64

Vincennes	52	ETV	Jan

KANSAS

Authorized, Not Transmitting

Salina	KSLN-TV	34

Began Transmitting During '64

Salina	KSLN-TV	34	Aug

KENTUCKY

Stations Transmitting

Lexington	WLEX-TV	18	
Lexington	WKYT-TV	27	
Louisville	WFPK-TV	15	ETV
Louisville	WLKY	32	

Authorized, Not Transmitting

Ashland	WALN-TV	59
Corbin	WJSK	16
Louisville	WFPK-TV	21
Louisville	WTAM-TV	41
Newport	WNOP-TV	74

LOUISIANA

Stations Transmitting

Lake Charles	KTAG-TV	25	

Applications Filed During '64

New Orleans	26		Mar

MARYLAND

Stations Transmitting

Salisbury	WBOC-TV	16	

Authorized, Not Transmitting

Baltimore	WTLF	24

Applications Filed During '64

Cumberland	17		Jul

MASSACHUSETTS

Stations Transmitting

Adams	WCDC	19	
Greenfield	WRLP	32	
Springfield	WWLP	22	
Springfield	WHYN-TV	40	
Worcester	WWOR-TV	14	

Authorized, Not Transmitting

Boston	WIHS-TV	38	
Cambridge	WTAO-TV	56	
Pittsfield	WPFL	64	

CP's Granted During '64

Boston	44	ETV	Oct

Applications Filed During '64

Boston	25		Sep

MICHIGAN

Stations Transmitting

Allen Park	WJMY	20	
Detroit	WKBD	50	
Detroit	WTVS	56	ETV
Saginaw	WKNX-TV	57	

Authorized, Not Transmitting

Mt. Pleasant	14		ETV

Began Transmitting During '64

University Center (Bay City)	WUCM-TV	19	ETV	Oct

MINNESOTA

CP's Granted During '64

St. Paul	17		ETV	Aug

Applications Filed During '64

Minneapolis	23		Apr
Rochester	55		Feb
Rochester	55		May
Rochester	55		Jun
St. Paul	23		May
St. Paul	23		Sep

MISSISSIPPI

Stations Transmitting

Jackson	WJAQ-TV	25	
Meridian	WCOC-TV	30	

MISSOURI

Stations Transmitting

Kansas City	KCSD-TV	19	ETV
Poplar Bluff	KPOB-TV	15	

CP's Granted During '64

St. Louis	30		Oct

• *Please turn to page 38*

'63 '64

TV Tube Usage Guide

The past two years have seen the introduction of many new tube types. The following chart gives a complete list of the tubes used in '63 and '64 television receivers, and the manufacturer or brand name using each specific type. The average use per model, along with total usage, is also given. This list will inform you how better to stock your tube caddy, or your shelves, with the tubes needed to service late-model receivers.

Tube Type	Manufacturer or Brand Name	Average Use Per Model	Total Usage
1AD2	General Electric	1	20
1B3	Airline, Andrea, Bradford, Coronado, Sonora	1	16
1G3	Admiral, Airline, Coronado, Curtis Mathes, Firestone, Olympic, Packard-Bell, Philco, RCA, Sylvania, Truetone	1	479
1J3	Sylvania	1	16
1K3	Airline, AMC, Bradford, Catalina, Coronado, Dumont, Emerson, Magnavox, Penncrest, Penney, J. C., Philco, Silvertone, Truetone, Westinghouse, Zenith	1	111
1V2	Admiral, Packard-Bell, Zenith	1	150
1X2B	Admiral, Arvin, Channel Master, General Electric, Magnavox, Penncrest	1	43
2AF4A	Airline, AMC, Bradford, Coronado, Motorola, Olympic, Penncrest, Penney, J. C., Truetone	1	82
2AS2	Zenith	1	86
2CY5	Bradford	1	6
2DZ4	Admiral, Airline, Firestone, Motorola	1	92
2FS5	Penney, J. C.	2	2
2GK5	Admiral, Airline, AMC, Arvin, Bradford, Coronado, Firestone, Magnavox, Motorola, Olympic, Penncrest, Truetone	1	137
3A3	Admiral, Airline, Dumont, Motorola, Packard-Bell, Philco, RCA, Sylvania, Westinghouse	1	263
3AF4	RCA, Westinghouse	1	14
3AT2	Zenith	1	47
3AU6	Arvin	1	1
3AV6	Airline, Firestone	1	26
3AW3	Motorola	1	35
3BN6	Airline, AMC, Bradford, Coronado, Penncrest, Penney, J. C., Truetone	1	53
3BZ6	Airline, AMC, Bradford, Coronado, Firestone, Magnavox, Olympic, Penncrest, Penney, J. C., Truetone	2	150
3CB6	Airline, AMC, Arvin, Bradford, Channel Master, Coronado, Penncrest, Truetone	2	32
3DG4	Dumont, Sylvania, Zenith	1	62
3DK6	Bradford, Channel Master, Coronado, Magnavox, Penncrest, Truetone	2	51
3DT6	Airline, Coronado, Firestone, Olympic, Motorola	1	59
3DZ4	Philco, Silvertone, Sylvania, Truetone	1	96
3EH7	Admiral, Coronado	1	32
3EJ7	Admiral, Coronado, Olympic	1	50
3GK5	General Electric, Philco, RCA, Sylvania, Truetone, Westinghouse, Zenith	1	103
3HA5	Admiral, Silvertone	1	53
3HG8	Sylvania	1	2
3HM6	Westinghouse	1	4
3HT6	Westinghouse	1	4
4BL8	Admiral, Coronado, Motorola	2	80
4BZ6	Admiral, Silvertone	2	59
4CB6	Silvertone	1	16
4DK6	Admiral, Philco, Sylvania	1	76
4DT6	Silvertone, Sylvania, Truetone, Westinghouse	1	48
4EH7	Philco, Truetone, Sylvania	1	62
4EJ7	Philco, Sylvania, Truetone	1	62
4GK5	Motorola	1	21
4HA5	Motorola	1	21
4HS8	Silvertone	1	22
4JC6	RCA	1	10
4JD6	RCA	1	10
4KN8	Penncrest	1	1
5AQ5	Airline, AMC, Coronado, Magnavox, Olympic, Penncrest, Truetone	1	44
5BC3	Sylvania	1	70
5CG8	Admiral, Airline, AMC, Arvin, Bradford, Coronado, Firestone, Magnavox, Olympic, Penncrest, Truetone	1	205
5DJ4	Motorola	1	35
5EA8	Magnavox, Penncrest	2	7
5EW6	Silvertone	1	22
5FG7	Penney, J. C.	1	2
5HG8	Philco, Sylvania	1	59
5JV8	Silvertone	1	22
5KD8	Sylvania	1	5
5KE8	RCA	1	10

Tube Type	Manufacturer or Brand Name	Average Use Per Model	Total Usage
5U4GB	Dumont, Emerson, Packard-Bell, Sonora	1	69
5U8	Channel Master	1	1
6AQ5	Airline, Catalina, Olympic, Packard-Bell, Philco, RCA, Silvertone, Sylvania, Truetone, Westinghouse, Zenith	1	333
6AF4A	Catalina, Dumont, General Electric, Magnavox, Philco, Zenith	1	220
6AF11	General Electric	1	20
6AH5	Admiral, Curtis Mathes, General Electric, Zenith	1	135
6AL3	Motorola	1	35
6AL5	Dumont, Sylvania	1	20
6AL11	Admiral, General Electric	1	149
6AR11	General Electric	1	70
6AS5	Sonora	1	1
6AS8	Andrea, Dumont, Emerson	1	64
6AU4	Packard-Bell, Sonora	1	4
6AU6	Andrea, Dumont, General Electric, Packard-Bell	1	43
6AW8A	Airline, Andrea, Arvin, Dumont, Emerson, Packard-Bell, Philco, RCA, Sylvania, Westinghouse	1	225
6AX3	Admiral, General Electric	1	231
6AX4	Olympic	1	18
6AY3	Airline, Catalina, Magnavox, Packard-Bell, Sylvania, Zenith	1	228
6B10	General Electric	1	20
6BA11	Zenith	1	77
6BE3	Philco	1	10
6BJ8	Magnavox	1	9
6BK4	Admiral, Airline, Packard-Bell, Philco, RCA, Sylvania, Westinghouse, Zenith	1	261
6BL8	Motorola, Truetone	2	106
6BN6	Airline, Catalina, Curtis Mathes, Packard-Bell, Zenith	1	187
6BQ5	Admiral, Airline, Andrea, Catalina	1	306
6CX8	Andrea, Sonora	1	8
6DE4	Andrea, Emerson, Philco	1	89
6DE7	Airline, Catalina, Olympic	1	24
6DK6	Admiral	1	79
6DQ5	Admiral, Packard-Bell	1	73
6DQ6B	Admiral, Andrea, Curtis Mathes, Dumont, Emerson, Motorola, Olympic, Packard-Bell, Philco, Sonora	1	234
6DR7	Philco	1	42
6DS4	Admiral, Airline, Andrea, Catalina, RCA, Sylvania, Westinghouse	1	196
6DT5	Sonora	1	1
6DT6	Andrea, Dumont, Emerson, Magnavox, Motorola, Olympic, Sonora, Sylvania	1	180
6DV4	RCA, Sylvania, Westinghouse, Zenith	1	147
6DW4	Admiral, Airline, Philco, RCA, Sylvania, Westinghouse, Zenith	1	207
6DZ4	Admiral, Airline, Emerson, Magnavox, Motorola, Packard-Bell, Sylvania	1	543
6EA8	Airline, General Electric, Packard-Bell, RCA, Sylvania, Westinghouse, Zenith	1	252
6EH7	Admiral, Dumont, Motorola, Philco, Sylvania, Zenith	2	593
6EJ7	Admiral, Airline, Dumont, Motorola, Olympic, Packard-Bell, Philco, RCA, Sylvania, Westinghouse, Zenith	1	494
6EM5	Andrea, Dumont, Emerson	1	64
6EM7	Curtis Mathes, Dumont, Packard-Bell, Sylvania	1	24
6EW6	Admiral, Airline, Curtis Mathes, Philco, RCA, Sylvania, Westinghouse, Zenith	2	486
6EW7	Admiral, Packard-Bell	1	222
6FD7	Philco, Sylvania	1	81
6FG7	Admiral, Sonora	1	71
6FM7	Zenith	1	86
6FQ7	Admiral, Airline, Andrea, Coronado, Firestone, Magnavox, Olympic, Packard-Bell, Penncrest, Philco, RCA, Sylvania, Westinghouse, Zenith	2	798
6FS5	Sonora	1	1
6FV8	Admiral	1	31
6FY7	General Electric	1	20
6GB5	Magnavox	1	9
6GC5	Magnavox	1	9
6GE5	Admiral, General Electric	1	152
6GF7	Admiral, Airline, Philco, RCA, Sylvania, Westinghouse	1	211
6GH8	Admiral, Airline, Curtis Mathes, Dumont, Emerson, Magnavox, Packard-Bell, Philco, RCA, Sylvania, Silvertone, Westinghouse, Zenith	2	742
6GJ5	Sylvania	1	86
6GJ7	Sylvania, Zenith	1	100
6GK5	Dumont, Emerson, Magnavox, Olympic, Packard-Bell, Philco, Sylvania, Zenith	1	284
6GK6	Motorola, Zenith	2	135
6GM6	Admiral, Airline, Dumont, Emerson, Packard-Bell, Philco, RCA, Sylvania, Westinghouse	1	439
6GN8	Curtis Mathes, Magnavox, Olympic, Zenith	1	58
6GT5	Airline, Catalina	1	6
6GU7	Admiral, Airline, Philco, RCA, Sylvania, Westinghouse	2	422
6GV5	Zenith	1	74
6GW8	Dumont	1	4
6GX6	Admiral	1	79
6GY5	Philco	1	10
6GY6	Admiral, Airline, Philco, RCA, Sylvania, Westinghouse	2	422
6GZ5	Admiral	1	79
6HA5	Admiral, Motorola, Philco, Zenith	1	212
6HB6	Admiral	1	70
6HE5	Zenith	1	47
6HF5	Zenith	1	47
6HG8	Philco	1	80
6HJ8	Philco	1	42
6HL8	Zenith	1	47
6HS8	Curtis Mathes, Motorola, Zenith	1	122
6HZ6	Admiral, Airline, Philco, RCA, Sylvania, Westinghouse	1	221
6JB6	Zenith	1	42
6JC6	Admiral	2	140
6JE6	Airline, Philco, RCA, Sylvania, Westinghouse	1	141
6JE8	Philco	1	53
6JH6	Airline, Philco, RCA, Sylvania, Westinghouse	1	141
6JH8	Zenith	2	94
6JT8	Zenith	1	86
6JU8	Admiral, Airline, Philco, RCA, Sylvania, Zenith	1	238

Tube Type	Manufacturer or Brand Name	Average Use Per Model	Total Usage
6JV8	Admiral	1	211
6JZ8	Philco	2	20
6KA8	Airline, Philco, RCA, Sylvania, Westinghouse	1	141
6KD8	Sylvania, Zenith	1	202
6KT8	Zenith	2	94
6KU8	Sylvania	1	86
6KZ8	General Electric	1	16
6BL8	Philco	1	10
6RK19	Curtis Mathes	1	1
7GV7	Motorola	1	12
8B8	Arvin	1	1
8B10	General Electric	1	23
8BE8	Airline	1	2
8BQ5	Airline, AMC, Bradford, Coronado, Firestone, Penncrest, Penney, J. C., Truetone	1	91
8CG7	Motorola	1	21
8CW5	Airline, Bradford, Penncrest, Truetone	1	17
8CW8	Coronado	1	4
8EB8	Olympic	1	2
8EM5	Airline, Bradford, Coronado	1	5
8FQ7	Admiral, Philco, RCA, Silvertone, Sylvania, Truetone, Westinghouse	1	130
8GJ7	Motorola	1	12
8JV8	Admiral, Silvertone	1	31
9A8	Motorola	3	99
9GV8	Admiral	1	31
10AL11	Admiral	1	31
10CW5	Truetone	1	1
10DE7	Airline, AMC, Arvin, Bradford, Coronado, Magnavox, Olympic, Penncrest, Truetone	1	51
10GK6	Truetone	1	1
10JA8	Westinghouse	1	4
10JY8	Philco	2	104
10KU8	Sylvania	1	5
11AP4	General Electric	1	23
11AR11	General Electric	1	23
11CP4	Admiral	1	15
11JE8	Philco	2	8
11KV8	RCA	1	10
12AF3	Arvin, Magnavox, Penncrest	1	4
12AL11	Admiral	1	15
12AX4GTA	Airline, Bradford, Olympic, Penney, J. C.	1	28
12AX7A	Airline	1	12
12AY3	Airline, AMC, Bradford, Coronado, Penncrest, Truetone	1	62
12AZ7A	Dumont, Emerson, Packard-Bell	1	60
12BE3	Admiral	1	31
12BH7A	Arvin, Channel Master	2	3
12BY7A	Airline, Channel Master, Dumont, Magnavox, Packard-Bell, Penncrest, Philco, RCA, Sylvania, Westinghouse	1	142
12C5	Airline, Firestone	1	11
12CA5	Bradford, Coronado, Penncrest, Penney, J. C., Truetone	1	19
12CU5	Airline, Coronado	1	6
12DQ6B	Airline, Arvin, Bradford, Magnavox, Olympic, Penncrest, Penney, J. C.	1	32
12FX5	RCA, Westinghouse	1	14
12GC6	Motorola	2	24
12GN7	Coronado, Penncrest, Truetone		
12GT5	Airline, AMC, Bradford, Zenith	1	39
12GW6	Airline, Firestone	1	47
12W6GT	Airline, Firestone, Penney, J. C.	1	23
13FD7	Philco, Sylvania	1	25
13GB5	Penncrest	1	9
13GF7	RCA, Silvertone	1	4
15BD11	General Electric	1	23
15CW5	Motorola	2	66
15DQ8	Motorola	2	24
15HB6	Motorola	1	12
15KY8	Silvertone	1	16
15LE8	Motorola	1	12
16A8	Motorola	1	12
16AQ3	Motorola	1	33
16AUP4	Arvin	1	1
16AYP4	RCA	1	10
16BNP4	Airline	1	3
16BSP4	Truetone	1	1
16GK6	Motorola	1	33
17AY3	RCA, Sylvania	1	15
17BE3	Philco, Truetone	1	53
17BF11	General Electric	1	23
17BS3	Silvertone	1	1
17C5	Silvertone	1	16
17CFP4	Penney, J. C.	1	2
17D4	Philco	1	4
17DE4	Airline, Coronado, Firestone	1	27
17DMA4	Westinghouse	1	4
17DQ6B	Philco, Silvertone	1	26
17GJ5	Sylvania	1	5
17JB6	RCA	1	10
17J28	Admiral, General Electric, Philco, Westinghouse	1	94
19ABP4	Philco	1	4
19AFP4A	Andrea	1	7
19AU4	Motorola	2	24
19AUP4	Magnavox	1	2
19AVP4	Dumont, Emerson	1	28
19AXP4	Silvertone	1	16
19BLP4	Philco	1	11
19CHP4	Admiral, Coronado, Penncrest	1	36
19CMP4	Westinghouse	1	4
19CVP4	Sylvania	1	5
19CXP4	Zenith	1	30
19DAP4	Silvertone	1	22
19DEP4	General Electric	1	20
19DFP4	Philco	1	10
19DHP4	Curtis Mathes	1	1
19XP4	Bradford, Coronado, Olympic	1	39
21FBP22	Zenith	1	47
21FJP22	Admiral, Airline, Motorola, Packard-Bell, RCA, Westinghouse	1	192
21FKP22	Philco, Sylvania	1	44
21GY5	Philco, Truetone, Westinghouse	1	57
21HJ5	Admiral, Airline, Coronado	1	38
22BH3	Silvertone	1	22
22JG6	Silvertone	1	16
23AFP4	Dumont, Zenith	1	8
23AHP4	Airline, AMC, Bradford, Catalina, Coronado, Firestone, Penncrest, Truetone	1	58
23ARP4	Motorola	1	35
23AWP4	Bradford, Coronado, Penncrest Truetone	1	13
23BGP4	Sylvania	1	86
23BTP4	Packard-Bell, Zenith	1	49
23BVP4	Philco	1	42
23CP4A	Admiral, Emerson	1	161
23DAP4	Motorola	1	33
23DSP4	Philco	1	52
23EDP4	Zenith	1	44
23MP4	Magnavox, Sonora	1	10
27ZP4	Airline	1	2
33GT7	General Electric	1	23
33GY7	Admiral	1	15
50C5	Airline	1	12
400CB4	Channel Master, Penncrest	1	2

Note: Material in this guide adapted from the Howard W. Sams book "TV Receiver Tube Usage Guide."

MORE EXCITEMENT FROM QUAM!

you can easily handle any auto radio speaker replacement

New Quam Multi-Tap Speakers in 5″x7″, 6″x9″, and 4″x10″ sizes. Taps for 10, 20, and 40 ohm impedances.

with Quam speakers and rear seat kits— multi-taps and exact replacements—

Eight speaker *sizes* handle virtually any auto radio replacement—but size alone is not enough. You need the right voice-coil impedance—and QUAM has it! Choose multi-tapped models for stocking convenience; or, for specific applications, one of the 25 Quam *exact* replacements. (In addition, any Quam speaker may be special-ordered with any voice-coil impedance for an extra $1.00 list. This service is a QUAM exclusive.)

Write for your free copy of the Quam Auto Radio Speaker Replacement Guide, which gives you complete replacement information on front and rear seat speakers for auto radio models from 1955 to 1963.

QUAM-NICHOLS COMPANY, 234 EAST MARQUETTE ROAD, CHICAGO, ILLINOIS 60637

QUAM

Circle 14 on literature card

UHF Station Activity

(Continued from page 32)

NEW HAMPSHIRE

Applications Filed During '64

Lebanon	49		Sep
West Lebanon	49		Jul

NEW JERSEY

Authorized, Not Transmitting

Asbury Park	WRTV	58	
Atlantic City	WHTO-TV	46	
Glen Ridge	WNJE-TV	77	ETV
Linden	WNJU-TV	47	
New Brunswick	WTLV	19	ETV
Wildwood		40	

CP's Granted During '64

Burlington	41		Jul
Wildwood	40		Mar

NEW MEXICO

Applications Filed During '64

Las Cruces	22		Oct

NEW YORK

Stations Transmitting

Binghamton	WBJA-TV	34	
Binghamton	WINR-TV	40	
Buffalo	WNEO-TV	17	ETV
Elmira	WSYE-TV	18	
New York	WNYC-TV	31	ETV
Schenectady	WMHT	17	ETV

Authorized, Not Transmitting

Binghamton	WQTV	46	ETV
New York	WREG	25	ETV
Rochester	WROH	21	ETV
Syracuse	WHTV	43	ETV

Applications Filed During '64

Newburgh	21		Jul
Patchogue	75		Aug

NORTH CAROLINA

Stations Transmitting

Asheville	WISE-TV	62	

Authorized, Not Transmitting

Charlotte	WUTV	36	
Charlotte	WTVI	42	ETV

Applications Filed During '64

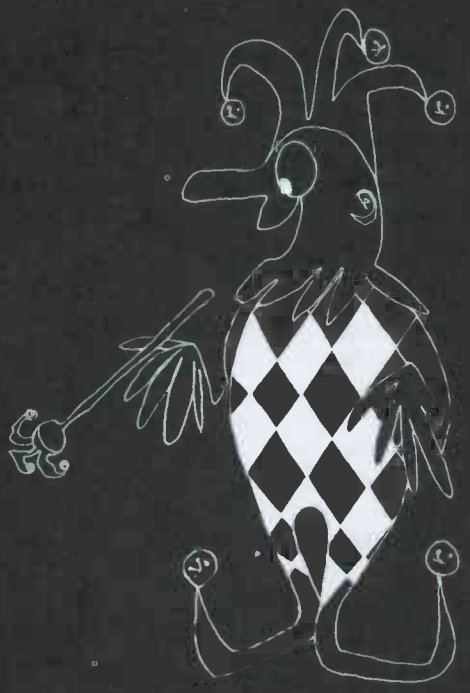
Concord	59	ETV	Oct

OHIO

Stations Transmitting

Akron	WAKR-TV	49	
Athens	WOUB-TV	20	ETV
Cincinnati	WKRC-TV	12	
Cincinnati	WCET	48	ETV
Columbus	WOSU-TV	34	ETV
Lima	WIMA-TV	35	
Newark	WGSF	28	ETV
Oxford	WMUB-TV	14	ETV
Toledo	WGTE-TV	30	ETV
Youngstown	WFMJ-TV	21	
Youngstown	WKBN-TV	27	
Youngstown	WKST-TV	33	
Zanesville	WHIZ-TV	18	

GOOF-PROOF VOM



Here's the most foolproof volt-ohm-milliammeter ever made. Protection approaches 100%. It's the VOM you will want to have on hand where inexperienced people are running tests . . . or will reach for yourself on those days when you're all thumbs. The 260-5P will save you all kinds of headaches from burned out meters and resistors, bent pointers, damaged pivots, cracked jewels, and inaccuracies caused by overheating.

Combined Protection You Won't Find In Any Other VOM

1. Reset button pops out to indicate overload.
2. You cannot reset circuits while overload is present.
3. Protective circuit does *not require* massive overloads which can cause hidden damage to the instrument.
4. All ranges are protected except those not feasible in a portable instrument—1000 and 5000 volts DC and AC; 10 amp DC.

SIMPSON 260-5P

ONLY $78.95

Write for Bulletin 2066

Ranges—The 260-5P has the same ranges and takes the same accessories as Simpson's famous 260-4 volt-ohm-milliammeter.

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California: Simpson Instruments, Inc., P.O. Box 488, 1130 Simpson Way, Escondido, Calif. • Phone: (714) SH 5-8202
In Canada: Bach-Simpson Ltd., London, Ontario
In India: Ruttonsha-Simpson Private Ltd., International House, Bombay-Agra Road, Vikbrali, Bombay

WORLD'S LARGEST MANUFACTURER OF ELECTRONIC TEST EQUIPMENT

Circle 16 on literature card

Authorized, Not Transmitting

Ashtabula	WICA-TV	15	
Bowling Green	WBGU-TV	70	ETV
Dayton	WONE-TV	22	
Youngstown	WXTV	45	

Began Transmitting During '64

Bowling Green	WBGU	70	ETV	Feb
Dayton	WKEF	22		Sep

CP's Granted During '64

Portsmouth	.....	30	Aug

Applications Filed During '64

Canton	.....	29	Aug
Columbus	.....	40	Apr
Columbus	.....	40	May
Lorain	.....	31	Jun

OKLAHOMA

Stations Transmitting

Oklahoma City	KOKH-TV	25	ETV

Authorized, Not Transmitting

Tulsa	KCEB	23

OREGON

Authorized, Not Transmitting

Portland	KHTV	27

PENNSYLVANIA

Stations Transmitting

Erie	WSEE	35
Erie	WEPA-TV	66
Harrisburg	WHP-TV	21
Harrisburg	WTPA	27
Johnstown	WARO-TV	19
Lebanon	WLYH-TV	15
Philadelphia	WPCA-TV	17
Pittsburgh	WQEX	16
Scranton	WNEP-TV	16
Scranton	WDAU-TV	22
Wilkes-Barre	WBRE-TV	28
York	WSBA-TV	43

Authorized, Not Transmitting

Allentown	WFMZ-TV	67	
Bethlehem	WLEV-TV	51	
Harrisburg	WDTV	33	
Lock Haven	WBPZ-TV	32	
Oil City	WSEW	64	
Philadelphia	WGTI	23	
Philadelphia	WIBF-TV	29	
Philadelphia	WUHY-TV	35	ETV
Pittsburgh	WENS	22	
Pittsburgh	WAND-TV	53	
Reading	WHUM-TV	61	
York	WNOW-TV	49	

CP's Granted During '64

Hershey	.....	65	ETV	Jul

Applications Filed During '64

Allentown	.....	39	ETV	Jun
Erie	.....	24		May

PUERTO RICO

Stations Transmitting

San Juan	.....	18

Began Transmitting During '64

San Juan	WTSJ	18	Aug

Applications Filed During '64

Mayaguez	.....	22	May
Ponce	.....	20	May
San Juan	.....	30	May

RHODE ISLAND

Authorized, Not Transmitting

Providence	WNET	16	

SOUTH CAROLINA

Stations Transmitting

Anderson	WAIM-TV	40	
Columbia	WNOK-TV	19	
Columbia	WCCA-TV	25	

Authorized, Not Transmitting

Greenville	WNTV	29	ETV

TENNESSEE

Stations Transmitting

Knoxville	WTVK	26

TEXAS

Stations Transmitting

Richardson	KRET-TV	23
San Antonio	KWEX-TV	41

Authorized, Not Transmitting

Austin	KVET-TV	24
Austin	KTXN	67
Dallas	KAEI	29
Houston	KNUZ-TV	39
Midland	KDCD-TV	18
Nacogdoches	KTES	19

CP's Granted During '64

Victoria	.....	19	Aug

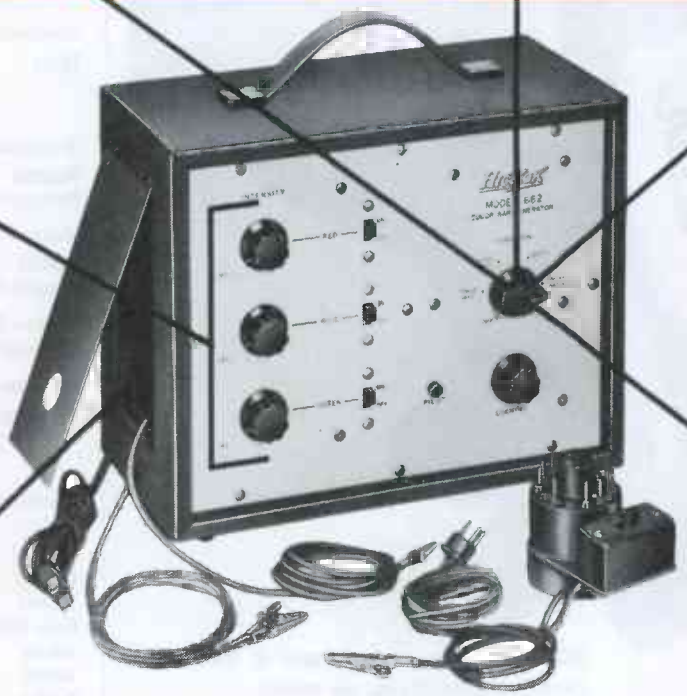
Get The GENERATOR That Has EVERYTHING!

3. EXCLUSIVE 5:4 CROSSHATCH
Faster convergence, easier linearity checks

4. SINGLE COLOR BAR
3.58MC color reference signal, gives *positive*, simple color performance check

5. 500-DOT PATTERN
0.1 μsec dot—smallest anywhere! Complete screen coverage, more accurate convergence

2. GUN KILLERS
Check all three color guns, speed purity checks



6. SEPARATE HORIZONTAL & VERTICAL BARS
Spot vertical and horizontal misconvergence faster, speeds over-all job

1. READY FOR THE FUTURE
Broad-Coverage signal for VHF and UHF. Interchangeable CRT assemblies handle *all* color tubes

HICKOK

Model 662
$159.95

1. **Ready For The Future**—Untuned, broad-coverage RF signal injects signal directly into antenna terminals, covers both VHF and UHF. Interchangeable CRT assemblies assure coverage of all present and anticipated color tubes, including new 25″ tubes.
2. **Gun Killers**—Individual pots and switches control each of the CRT guns separately. You can check the picture for emission, gas, shorts, in addition to individually checking the R-Y, B-Y and G-Y signals.
3. **5:4 Crosshatch**—Means more vertical lines, more horizontal lines and complete screen coverage including hard-to-converge areas at the edges.
4. **Single Color Bar**—Simplified color reference bar at 3.58MC color burst frequency for definite color performance checks, impossible with gated rainbow generators.
5. **500-Dot Pattern**—Superior to 150-dot system because dot size is smaller (actual size, 1 line or 0.1 μsec) for accurate convergence and complete screen coverage—no *blank* spots.
6. **Separate Horizontal and Vertical Bars**—Quickly determines major areas of misconvergence, saves time by showing you where to start first.

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10566 Dupont Avenue • Cleveland, Ohio 44108
Represented in Canada by Stark Electronics, Ajax, Ontario
Internationally by Hughes International, Culver City, Cal.

Circle 18 on literature card

Applications Filed During '64

Houston	29		Feb
Lubbock	20		Aug
Lubbock	20		Sep

VERMONT

Applications Filed During '64

Burlington	22		Aug
Rutland	49		Aug
Saint Johnsbury	30		Aug
Windsor	26		Aug

UTAH

Stations Transmitting

Ogden	KWCS-TV	18	

VIRGINIA

Stations Transmitting

Hampton	WHRO-TV	15	ETV
Portsmouth	WYAH-TV	27	ETV

Authorized, Not Transmitting

Danville	WBTM-TV	24	
Newport News	WACH-TV	33	

Began Transmitting During '64

Richmond	WCVE-TV	23	ETV	Sep

CP's Granted During '64

Charlottesville	64		Jun

WASHINGTON

Stations Transmitting

Pasco	KEPR-TV	19	
Richland	KNDU	25	
Tacoma	KPEC-TV	56	ETV
Tacoma	KTPS	62	ETV
Walla Walla	KNBS	22	
Yakima	KNDU	25	
Yakima	KIMA-TV	29	
Yakima	KYVE	47	ETV

WEST VIRGINIA

Stations Transmitting

Parkersburg	WTAP-TV	15	

Authorized, Not Transmitting

Charleston	WKNA-TV	49	

WISCONSIN

Stations Transmitting

Madison	WMTV	15	
Madison	WHA-TV	21	ETV
Madison	WKOW-TV	27	
Milwaukee	WISN-TV	12	
Milwaukee	WUHF	18	
Milwaukee	WMVT	36	ETV

Authorized, Not Transmitting

Milwaukee	WCAN-TV	24	

Conclusion

We have presented this summary of UHF station activity to give you an indication of local developments in your own area and an idea of the general trends. Nationally, the full growth of UHF will take place gradually over a period of several years. But when one of these new stations does arrive in your town, you'll find yourself in a UHF area seemingly overnight. UHF is coming; be ready for it. ▲

HICKOK GIVES YOU

Speed, Accuracy and Profit, Plus Obsolescence Protection IN AN ALL NEW, NO-COMPROMISE MULTI-SOCKET TUBE TESTER!

From the laboratories of the world's leading tube tester manufacturer comes the model 799 "Mustang"—a completely new tube tester. Built to put profit in your pocket, the "Mustang" checks *more* tubes, checks them *faster* and checks them *honestly*.

Multi-socket tube testers used to have two serious drawbacks: circuit limitations made them obsolete overnight and, at best, no more than 10% of their tests were actually mutual conductance. But the Hickok "Mustang" doesn't compromise; it delivers *honest* mutual conductance tests. And a unique circuit approach, together with an easily replaceable accessory socket panel, makes it "circuit ready" for any possible new tube types.

A solid state power supply gives increased accuracy and dependability. An all-transistorized gas and leakage test circuit sets a new standard of reliability for spotting "tricky" tube defects that can "chew up" your profit.

We call it the "Mustang" because it uses fresh, new engineering ideas and because it gives you a real opportunity to break into new profits.

See it at your Hickok distributor or write for circular TT799.

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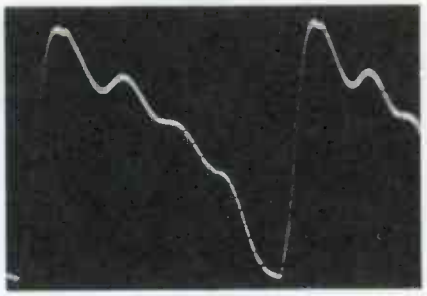
Circle 20 on literature card

Checking Buzz, Hum

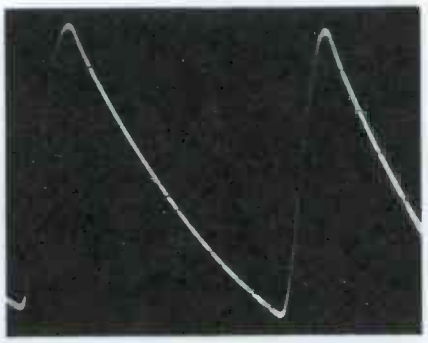
(Continued from page 27)

odd hum conditions. Gassy output tubes distort the ripple in a manner that is usually easily identifiable. The hum or buzz resulting from this fault frequently does not become objectionable until the equipment has run for awhile, but the ripple distortion can be seen on the scope before it can be heard. Fig. 3A shows ripple in a set with a gassy 50C5. Fig. 3B portrays the same ripple with a new 50C5 installed. (Fig. 3B is identical to Fig. 1B, but scoped at a different scope-gain setting.)

Why can 3A cause such an objectionable buzz while the normal ripple is generally accepted? The answer involves an analysis of the two signals. The waveform of Fig. 3A contains the 60-cps fundamental frequency plus high-level odd harmonics, characterized by the clipped appearance of the signal. These odd harmonics, generated by rectifier action in the gassy (thus partially over-conducting) 50C5, are *additive* in nature and transfer efficiently through the output transformer. Fig. 3B consists of both odd and even harmonics; but the high-order harmonics *subtract*, leaving the smooth sawtooth that is handled poorly by both the output transformer and the speaker.



(A) Before



(B) After

Fig. 5. Waveforms in Zenith receiver

A similar type of radio or record-player buzz that is commonly slow in developing is caused by an entirely different condition. In AC-DC sets using 35C5 or 50C5 tubes, the filament voltage is usually about 60 AC volts above ground and is applied between pins 3 and 4. Since pins 2 and 5 connect to the control grid, the tiniest leakage between pins 2 and 3, or between 4 and 5, couples enough raw AC to the grid to create very noticeable hum in the speaker. The condition can be due to leakage in wafer-type tube sockets, suggesting replacement with a molded socket; but more often the cure lies in replacing the tube. Tubes of the 35B5 and 50B5 group are not nearly so susceptible to this weakness. This trouble is easily identified by scoping; the trouble shows up as a sine wave on the *grid*, rather than only at the plate as in the case of other types of distortion.

A most strange case of excessive hum was found in one Zenith 8C02 AM-FM radio, which has the circuit shown in Fig. 4. A scope trace (Fig. 5A) was taken at the output-tube plate, with the volume control turned to minimum. The ringing ef-

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all sockets conveniently grouped

checks all radio & TV types

sensitivity & shorts tests between elements

angle view zig-zag roll chart

fast pushbutton sequence switching

line voltage indicator control

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NEW TUBE TEST DATA ISSUED REGULARLY - KEEPS YOU CURRENT BETWEEN ROLL CHARTS

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Developed over 16 years ago to give the servicemen a tube tester that could be kept up to date without fear of it becoming obsolete in a few short months. A tube tester that was fast and easy to use, while being able to check all radio and TV type tubes. The results are a tube tester that is more profitable. There are over 30,000 servicemen to prove this.

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DON'T BE FOOLED BY INADEQUATE PICTURE TUBE TESTERS

Now a picture tube tester - booster with features wanted most by the TV servicemen. Color keyed - push button operated for ease and speed. Designed to make more accurate tests than any other tester now in existance. Completely versatile for all black and white or color picture tubes. Oh yes! we keep you up to date.

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See These Testers At Your Franchised Distributor and Ask Him About a Trade-In Deal

"Service Engineered Electronic Test Equipment"

The Jackson Electrical Instrument Company Dayton, Ohio

Jackson

Circle 22 on literature card

fect on the trace in 5A could be diminished somewhat by moving the leads connecting the selector switch with the volume control and the AM and FM detectors. A cure was effected by encasing these leads in shielding, after which the normal plate ripple looked as in Fig. 5B. Obviously, the leads were radiating furiously without a shield.

High-Power Audio Amplifiers

Buzz, hum, etc., levels that ordinarily are acceptable to owners of radios and TV receivers will not be tolerated by owners of hi-fi amplifiers. Hi-fi addicts are most critical of, and little likely to accept, unwanted noises of any type. In addition to the critical standards of "Golden-ear" listeners, the natural characteristic of a good audio amplifier can transform the most minimal hum or buzz into irritating sound at objectionable levels. This is due, usually, to the high efficiency of output transformers and speakers used with such equipment. The high gain can also exaggerate any noise that develops in early stages. For example, the hum levels in Fig. 1A or 1B, although acceptable in small radios, could never be accepted in a sensitive audio amplifier.

While minimizing noise in audio

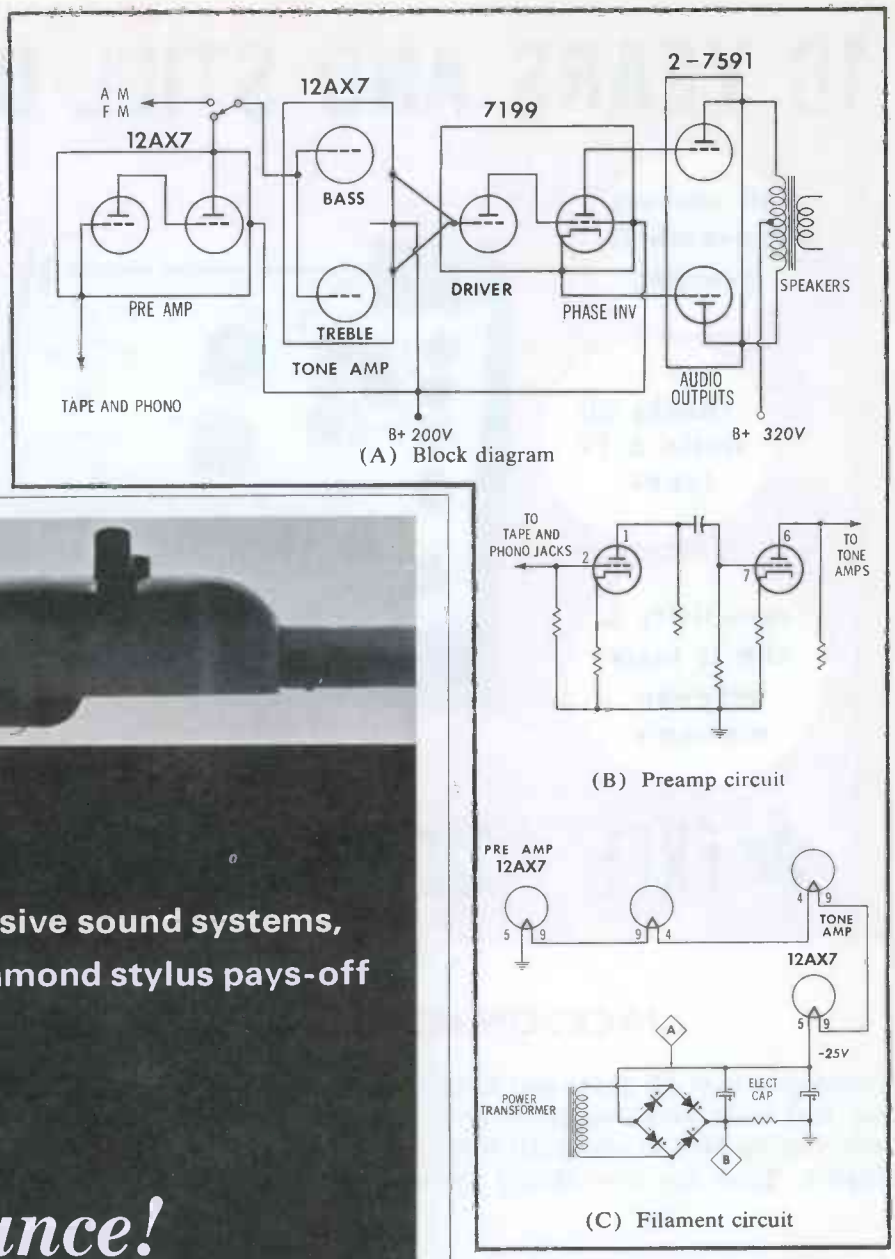

Fig. 6. Hum was from channel B.

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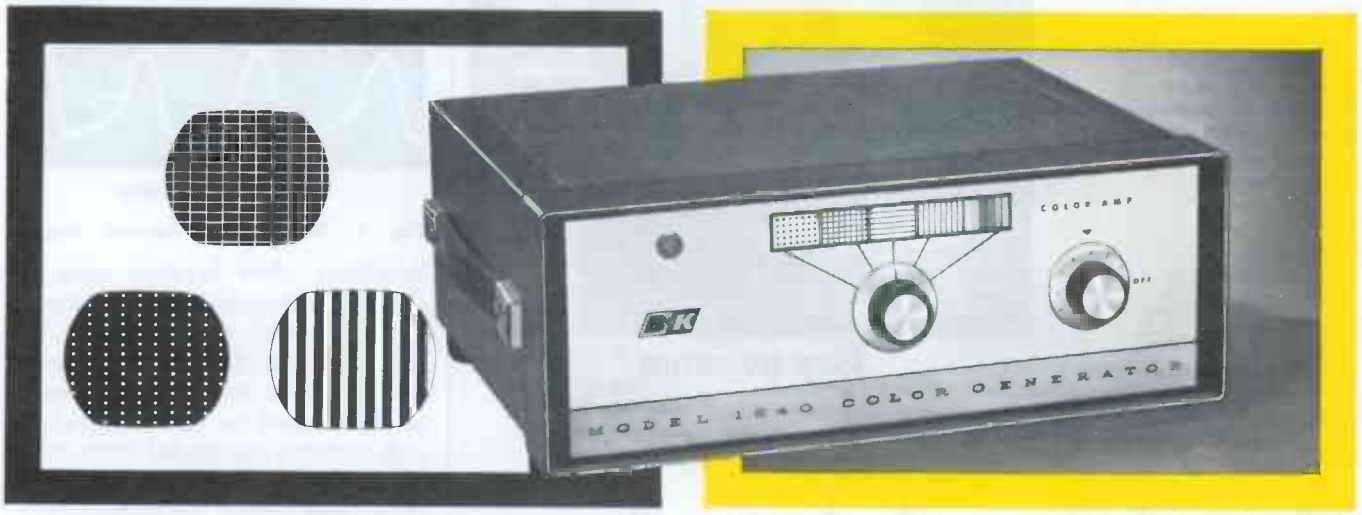

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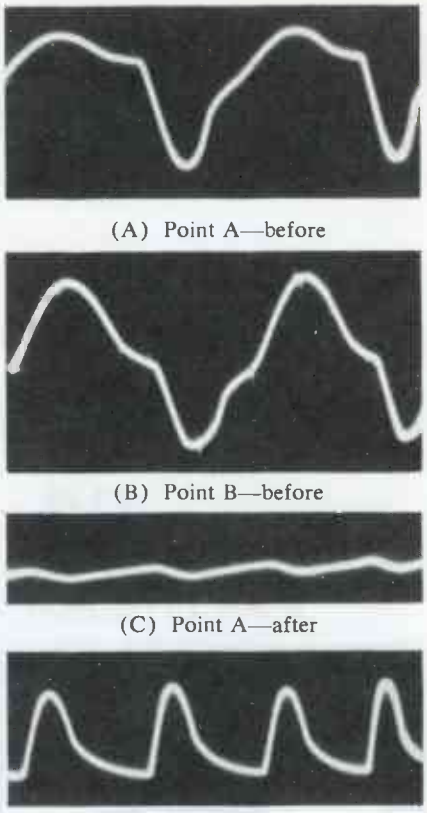

(A) Point A—before

(B) Point B—before

(C) Point A—after

(D) Point B—after

Fig. 7. Signals in filament supply.

amplifiers often involves some tedious troubleshooting, one case of bad hum was cured without any testing at all. This 20-watt amplifier had hum that sounded similar to that caused by an open grid circuit or by an unshielded input cable. It was noted that merely touching the chassis caused the hum to disappear—a clue that led to a cure. Adding a .02-mfd, 600-volt capacitor at the power transformer from the chassis to one leg of the AC power line cured the hum entirely.

The speed and ease of curing this case was more than offset by the trouble created by a hum complaint in a Fisher Model 800. This unit contains a multiplex FM tuner, driver, phase inverter, and push-pull, high-power output amplifier for each channel, plus preamplifiers for tape and phono inputs.

The customer who brought in the unit was less specific in his complaint than are most hi-fi owners; his statement that the unit had too much hum led to assumption on my part that the complaint was present for all types of programing, but this proved not to be the case.

In preliminary troubleshooting of stereo equipment, I usually connect a speaker to one channel and a

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Circle 26 on literature card

dummy load (a 10-watt, 4-ohm resistor) to the other. After apparent trouble has been corrected, speakers are connected to both channels for final tests. With this method there is considerably less cluttering up of the bench. (*Editor's Note:* A transformer similar to the one shown on page 69 of our April 1964 issue will permit checking both channels simultaneously, but with only one speaker.)

With the speaker connected to the output of channel A, and the dummy load to channel B, no hum was heard, regardless of where the selector switch was positioned—for AM, FM, Tape, or Phono. Transposing the speaker and dummy loads resulted in hum with the selector switch in the Tape or Phono positions. Since both channels receive B+ from the same source (see Fig. 6A), the probability of a power supply defect was ruled unlikely. Since hum was present only when the tape or phono preamp was switched in, troubleshooting was directed to that particular stage in channel B.

The signal circuit of the preamp is shown in Fig. 6B. The old trick of shunting the signal to ground through a large capacitor led us to the defect. With the capacitor shunting pins 6, 7, or 1 to ground, hum was virtually nullified; but, when we shunted pin 2, the hum increased. With pin 2 shunted to ground, the input tube in effect became a grounded-grid amplifier, and the hum thus indicated that AC voltage was being picked up by the cathode. This led logically to an examination of the filament circuit.

The heaters for the preamp stages are in series with filaments of the tone-control amplifier, and operate from DC voltage developed by a bridge rectifier, as shown in Fig. 6C. A faculty bridge rectifier or a defective filter could cause the trouble, and the scope is capable of indicating which. At point A, the trace in Fig. 7A was obtained; at point B, that in Fig. 7B. Since these traces indicate a 60-cps ripple, and the normal bridge rectifier output develops only 120-cps ripple, the fault was indicated to be a defective bridge rectifier. After replacing the defective rectifier, the trace at point A appeared as in Fig. 7C and point B viewed as in 7D. The ripple frequency was correct and much lower in value; more important, the amplifier output was entirely free of hum.

Conclusion

Some servicemen might consider scoping hum or buzz in small radios or in amplifiers as rather exotic, but the ability to identify the cause of hum or buzz from the scope trace can't help but save time. A trial of the technique will make believers out of most doubting Thomases. ▲

"Paw, what do you suppose that TV fellow is doing to our set out there?"

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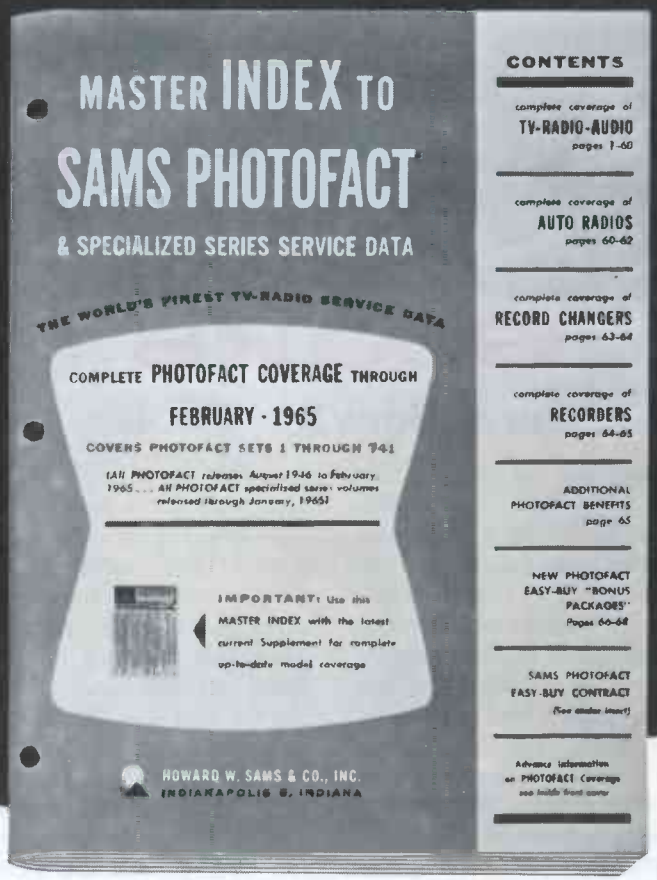

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BOOKS
as a Service Tool

Many practicing service technicians may turn up their noses at the idea of reading books to improve their servicing capabilities or to broaden their servicing talents. However, these technicians are becoming more and more in the minority —technicians the world over are beginning to realize the benefits to be received from a little extra time spent with any of the good technical books appearing on the market. A little space is being set aside on many workbenches for practical collections of case histories and for instruction books covering different types of equipment. Various tube- and transistor-substitution guides are finding their way onto thousands of workbenches and into many tube caddies.

New electronic entertainment devices and new versions of existing devices offer a constant challenge to the service technician. Competition demands that he keep abreast of all the latest developments and be prepared to provide proper service to his customers. Technical books are an ideal source of information for the technician who faces this problem.

Technical publishing is growing rapidly and has become one of the largest and most promising facets of the publishing industry. This is not because someone has a good sales pitch. The publishers are hiring men from the field to write and edit the various books, making the texts present a true and useful picture of the servicing business and the problems that daily face the technician. For two or three dollars, a technician can now purchase a book that, in the long run, may earn him one-third more gross income within a year or two. How? Well, suppose you are a service technician who works primarily with TV receivers and table-model radios. You've thought about getting into automobile - radio servicing, but don't feel you are fully qualified. There are numerous books on the market that can fill you in on the basics and start you on the way to being a top-flight auto-radio technician before you've ever worked on a single customer's set. Or, perhaps you have noticed the increased use of mobile two-way radios and realize the possibilities of supplementing your income by entering this promising field. Here again, a multitude of books are available on this subject. With only a little effort on your part, and with essentially the same equipment you are now using to service TV's, you can break into this new line of endeavor.

What Types of Books Are Available?

There are several distinct types of books published for technicians. These include primers and basics books, case histories, scope broadening, reference and guidebooks, and how-to-do books.

Primers and Basics Books

People who want to get started in a career in electronics can now find scores of basic books which present all the fundamentals of electricity and electronics. These basic books are generally fully illustrated and frequently include projects for the reader to perform so that he can enhance his learning by actual experience with the circuits and equipment being discussed. Many technicians use primer books as refreshers for different phases of electronics.

Case Histories

The case-history book is familiar to most technicians. The author generally reports on his actual servicing experiences. He describes the trouble and tells what he did to improve it, often mentioning his mistakes so that the reader can more readily understand the writer's thought process and therefore understand why a certain solution was chosen.

Years of experience, learning by mistakes, and correct decisions can be invaluable; through the use of a case history book, the technician can truly benefit from the experiences of others. In this way, he can improve his servicing capabilities and avoid costly time delays.

Scope-Broadening Books

Under the category of scope-broadening books are such texts as the guides that teach you new electronic techniques, which, when mastered, will expand your capibilities and perhaps increase your job responsibilities and income. These are not necessarily books that will change your occupation, but books that will open up related areas of servicing in which you can participate profitably. In other words, you can learn how to service mobile-radio equipment, industrial equipment, etc., which may not have been within your servicing capabilities before, by having the fundamentals of the subject and the experiences of others presented to you before you ever start. In this way, you start out with a knowledgeable background and avoid many mistakes and delays.

References and Guidebooks

The term "reference book" suggests a heavy volume that belongs on a shelf in some musty-smelling library, not in a service shop. This simply is not true of many technical references being published today. Technicians can now obtain general reference books that give substitutions for all types of tubes, transistors, printed-circuit components, etc. These don't belong in a library; they belong on your service bench at fingertip distance, or they belong in your tube caddy—some belong in both locations.

The substitution guide is not the

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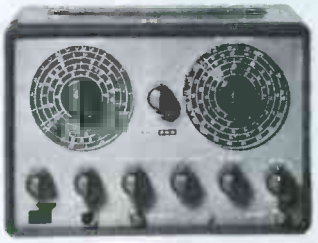

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only reference available—there are also comprehensive collections of schematics and diagrams for a general class of equipment (commercial equipment, for example). Mathematic references kept close at hand aid in working on certain equipment where logarithms or advanced algebra might be required. Manuals for different types of radio stations and broadcasting equipment in general are valuable assets, since they give needed information about the equipment and information about laws and rules governing the use, maintenance, and repair of the equipment. There are several excellent reference handbooks of tables and formulas for solving many problems in electronics.

How-to-do Books

Not all how-to-do books are do-it-yourself books, and anyone who thinks so should examine a recent catalog from one of the larger technical publishing houses. Subject matter ranges from how to use your test equipment to how to program for larger computer projects. The simple, down-to-earth, and straightforward approach is used throughout most of the books. Generally, the author is not a theoretician, but rather a working, practical-thinking individual who knows what reader wants to know.

Maybe you say you know how to use your test equipment, or you wouldn't have it around. This is generally true, but there are often other beneficial ways that you could be using your equipment to speed up your servicing and improve your technique and income. Once again the term "benefitting from the experience of others" applies.

Conclusion

Technical books can effectively serve the technician in both daily routine and in special cases where he wants to advance his theorotical knowledge or tackle a problem that is new or difficult. Books, in essence, become tools for the reader, giving him new skills and confidence that he might not have had before he started reading them. In a world of rapid change and stupendous technical growth, the technician is obligated to keep abreast of what is happening, and books are one of the best sources of up-to-date information. ▲

MALLORY

Tips for Technicians

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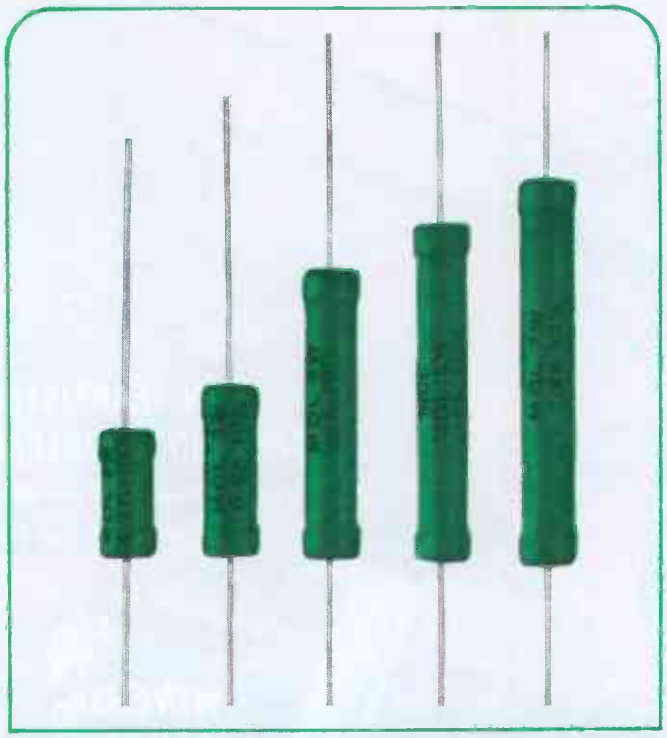
What you should know about film resistors



Typical stability test data: 10,000-hour load cycling test. Average resistance change is less than 1%!

If you've been looking inside some of the recent model television sets, chances are that you've noticed some unusual-looking resistors. Especially in the sizes readily identifiable as under 10 watts. You'll probably find them in spots where you're used to seeing small wirewounds.

There's a good reason. These are metal oxide film resistors. And the reason they're making such a hit is that they have as good stability and life as wirewounds—but they cost only about half as much in most values.

What's different about them?

First, they're made differently. A thin layer of tin oxide is evaporated onto a high quality ceramic rod, at high temperatures. A spiral groove is then cut, by a highly precise automatic machine, to produce a resistance path with the desired ohmic value. Then the end connections are applied and the whole works gets a coating of silicone finish. You can get a lot higher resistance values, size for size, than with wirewounds, because you're not limited by the problems of winding hair-thin wires. Top resistance for the 4, 5 and 7 watt sizes is 120,000 ohms; for 2 and 3 watts, 56,000 ohms. Standard tolerance is 10%.

Second, they behave differently. Their stability is really terrific. We've run them with on-off load cycling for 10,000 hours and measured changes of less than 1%. They'll take heavy brief overloads without damage, aren't bothered by humidity or vibration. And they're noninductive up to 250 mc. The name to ask your Mallory Distributor for is the MOL film resistor. He has them in 2, 3, 4, 5, and 7 watt ratings, in popular resistance values. And when you need a higher wattage (up to 200 watts) ask him for Mallory vitreous enamel resistors—you can't beat them for cool operation and stable life.

Circle 31 on literature card

COLOR COUNTERMEASURES

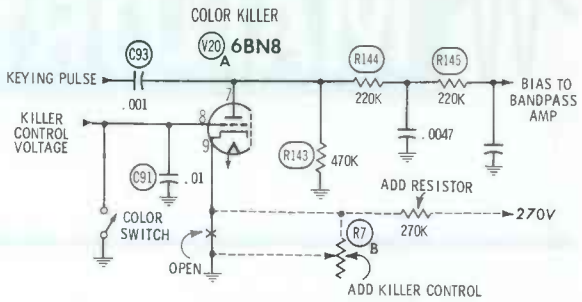
Symptoms and service tips from actual shop experience

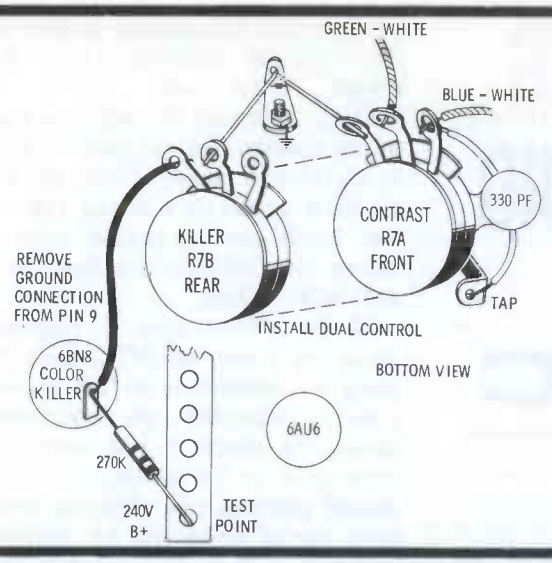
Chassis: Zenith 29JC20 (early run). Covered in PHOTOFACT Folder 599-2.

Symptoms: Difficulty in receiving weak color signals in fringe areas. Color may come and go, and fine tuning is critical.

Tip: The following change will provide better color reception in fringe areas by improving the operation of the killer stage when a weak burst signal is received. Replace the contrast control (Zenith part number 63-4846) with a dual contrast/color killer control (part number 63-4981), and rewire the circuits according to the information here. We've shown both the physical and electrical changes necessary to complete the job.

Front section: R7A contrast control. Look at the control from the rear, with the terminal lugs up. Ground the left lug, connect the green-white wire to the center lug, and the blue-white wire to the right lug. Wire C29 (330 pf) from the right lug to the tap lug. (This portion of the dual control is wired exactly as the original contrast unit.)





Rear section: Ground the center lug of the killer control. Remove the ground connection from pin 9 of the 6BN8 color killer (V20A); connect a wire from the left lug to pin 9 (don't solder). Connect a 270K, ½-watt resistor from pin 9 to the 240-volt B+ (available at the test terminal shown), and solder both this joint and the pin 9 connections.

Testing Procedures: Remove the contrast knob and set the killer control full counterclockwise, using a ⅛" flat screwdriver. Tune in a station telecasting color. If color can't be tuned in, adjust the killer control *clockwise* until normal color appears on the screen. Set the channel selector to a black-and-white program, and check for presence of colored noise (snow). If colored noise appears in the picture, adjust the killer control slightly *counterclockwise*, until the noise is removed. The color killer control is properly set when color programs are produced in color and black-and-white programs are free of colored noise. In the majority of instances, this will occur with the control set at (or close to) its fully counterclockwise position.

SERVICING AUTO RADIO

AGC

Understanding and troubleshooting the solid-state circuits . . .

by Philip R. Powell

In 1964, automobile sales were excellent, and projected sales figures for 1965 indicate another good year. Since nearly all cars are now delivered with radios, this continued growth should prove beneficial to shops specializing in auto radio repair. To realize maximum profit however, repairing each radio in a minimum amount of time is essential. AGC (automatic gain control) circuits are often the stumbling blocks that produce a nonprofit repair.

Two basic AGC systems are in common use since the move to all-transistor automobile radios: The *half-wave system,* using one AGC diode to control the gain of the RF and IF stages—a few sets employing this system supply AGC voltages to the RF stage only; and the *full-wave-doubler system,* with two AGC diodes to control the RF and IF stages. The theory of operation and troubleshooting techniques for each system will be discussed separately.

Half-Wave AGC System

Fig. 1 illustrates the basic DC circuit of a typical half-wave AGC system. The bleeder-current path provides a voltage (about 9.6 volts) across the 470K resistor, biasing the base element of X1 for normal gain during low-signal conditions. (The IF-stage bias divider—the 47K and 18K resistors in Fig. 2—provides similar bias conditions for X2.)

When a strong signal enters the radio, the collector of X2 will swing positive or negative with the incoming signal. During the instant that the collector is positive, additional electrons will flow from gound to

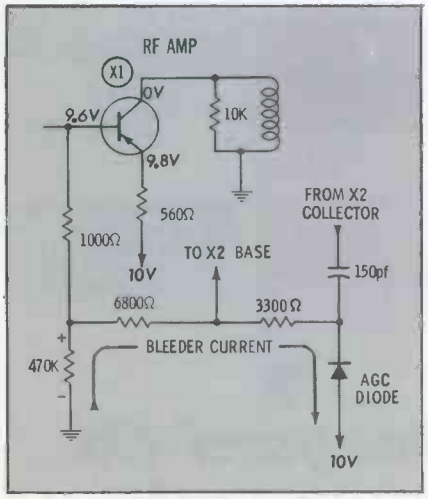


Fig. 1. Bleeder-current path for X1.

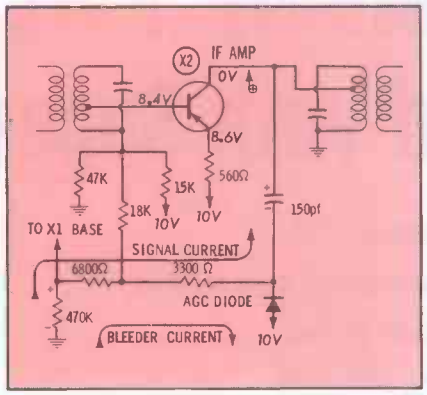


Fig. 2. Signal-current path for AGC.

the bottom plate of the 150-pf capacitor; this current adds to the bleeder current and increases the voltage across the 470K resistor. The net effect is a small increase in the bias voltage, at the base of X1, which reduces the gain of the stage. When the incoming signal swings negative, the 150-pf capacitor discharges through the diode to the 10-volt source. This "pump" action—drawing current through one circuit and discharging it through another—is necessary for proper AGC-system operation.

Troubleshooting

The usual AGC complaint is of distortion on strong stations. Back in the vacuum-tube days, we checked for AGC action by measuring the grid voltage; in this case, however, the base voltage of 9.6 volts may change only .2 volt, a change that will be difficult to determine accurately on the 15-volt meter scale. The best point at which to measure AGC action (see Fig. 3) is across the emitter resistor of the stage in question. Using the lowest meter scale (VOM or VTVM), connect the negative lead to the emitter and the positive lead to the 10-volt supply. When the receiver is tuned to a strong station, the .2-volt reading should drop to nearly zero, which will indicate normal AGC action.

If the circuit fails to respond, check for a shorted AGC diode by using an ohmmeter on the Rx100 scale. Connecting the ohmmeter across the diode in one direction, then again in the reverse direction, should produce two different readings, one of which will be approximately ten times greater than the other. Failure to get a ten-to-one difference in the two readings indicates a defective diode. This test should be performed with the diode removed from the circuit.

A reading, two or three times higher than the normal .2 volts across the emitter resistor, can indicate the following troubles:

1. A leaky transistor—Read the emitter-to-base voltage by placing the negative lead of the meter on the base and the positive lead on the emitter. When no station is tuned in and the voltage drop across the emitter-resistor is two or three times normal, an emitter-to-base reading of .2 volt indicates a leaky transistor. If the emitter-to-base bias has changed for increased conduction, the transistor is probably okay.
2. Open in AGC bleeder-current path — A high emitter-resistor voltage reading, along with a high emitter-base bias reading,

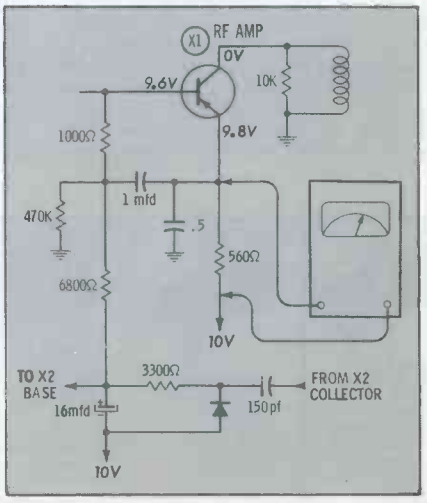
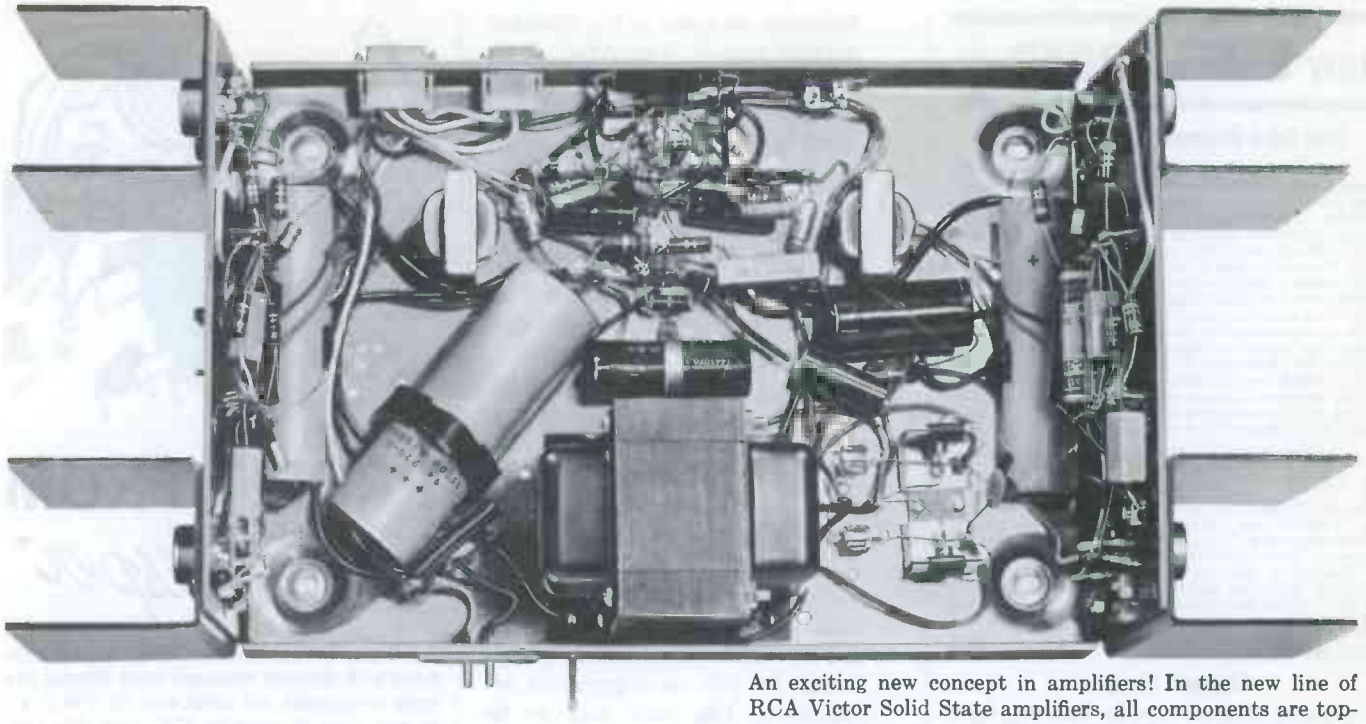


Fig. 3. Measure AGC voltage at emitter.



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indicates an open in the bleeder-current circuit. The AGC diode should be suspected first and checked with an ohmmeter. Forward and reverse readings across the diode should produce one reading under 1000 ohms and another that is approximately ten times greater. The ohmmeter can also be used to check continuity of the complete bleeder-current path.

One problem that occasionally pops up is a diode that is placed backwards in the circuit; the symptoms are the same as for the open circuit mentioned above. This wiring fault could happen in several ways: carelessness on the part of the manufacturer, error in the markings on the diode, or error in installation by you or a previous repairman. The only way to be 100% safe is to check the diode's polarity with an ohmmeter.

Trace the internal wiring in your ohmmeter to determine which lead, red or black, goes to the negative post of the battery; the lead that does is the true negative lead. Place this lead on the cathode of the diode to be checked and the other lead on the anode (arrowhead). The low reading should be obtained with this connection, and reversing the probes should give the high reading. Defects like these, which throw the stage into heavy conduction, cause the radio to be weak; often, the AGC circuit is overlooked as a source of trouble.

3. Capacitor failures — Open capacitors result in oscillations and can be checked by parallel-

"So, you gave up and called me!"

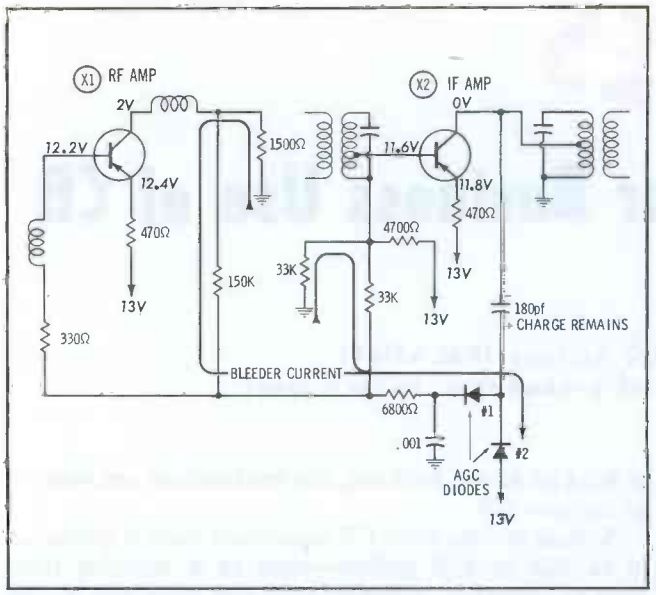


Fig. 4. Full-wave AGC system has two bleeder circuits.

ing a capacitor, which is known to be good, across the suspected one. Leaky or shorted capacitors can throw the RF and IF transistors into heavy conduction. A high emitter-resistor voltage, along with a high emitter-to-base voltage (see 1), indicates the transistor is not at fault; the transistor's emitter-resistor voltage should be observed with a meter while the suspected capacitor is disconnected from the circuit. If conduction returns to normal with a capacitor disconnected, the capacitor is defective.

Full-Wave AGC System

The full-wave system, similar in most sets to the half-wave system, has two bleeder circuits (see Fig. 4). One is composed of the 1500-ohm and 150K resistors in the collector circuit of XI, and the other consists of the two 33K resistors in the base circuit of X2. The two diodes conduct in the proper direction to allow bleeder current to flow.

The major difference in developing full-wave AGC is that following a positive-to-negative signal swing on the collector of X2, the 180-pf capacitor is left with the charge shown. As the next positive swing occurs on the collector, the signal's positive voltage is added to the capacitor's charge to produce a larger positive voltage at the junction of the two diodes. This, in turn, produces more AGC current as the strength of the incoming signal increases.

Troubleshooting

Troubleshooting techniques for the full-wave circuit are identical to those of the half-wave system; however, be particularly on the lookout for either or both of the diodes being defective. As outlined previously, ohmmeter checks will point out defective or improperly installed diodes.

The inherent simplicity of AGC circuits in transistorized auto radios, coupled with an understanding of time-saving checks, will speed your repair of AGC problems. Keep up-to-date on these new semiconductor applications, and you'll keep your cash register ringing. ▲

RULES

Spur Business Use of CB

Latest FCC actions that affect operational procedures... by Leo G. Sands

The roof is about to fall in on the Citizens Radio business, unless manufacturers and dealers alike turn to other than the hobbyist market. Revised CB rules have been announced that, even though temporarily postponed, are slated to become effective eventually. Several companies have already petitioned the FCC to hold public hearings, hoping something can be done to stay the adoption of these new rules which specifically prohibit the use of CB radio where the equipment "is operated as a hobby, in and of itself, or for the exchange of aimless small talk." The FCC's announcement of the new rules, however, was followed quickly by a letter to manufacturers from the Federal Trade Commission requesting them to include in their advertisements a statement that the equipment is not for hobby use. So, in spite of the efforts of some companies to hold on to the hobbyist, the implications are clear—go business CB.

Annual income from CB equipment sales is estimated to be $25 to $50 million—most of it resulting from sales to hobbyists; manufacturers and large distributors naturally don't want this market to disappear. While some manufacturers, as noted above, are fighting the rule changes with the hope that hobby-type operation will be allowed to continue—although it never has been lawful—most are planning to put more effort into building up the CB business market.

CB Brighter for Business

The CB business market has suffered from lack of attention and many potential users have been discouraged by the monopolization of channels by hobby-

ists. But, under the new rules, only seven of the 23 channels in the 27-mc band will be available for use by stations not controlled by the same licensee. The other 16 channels will be reserved for communications between units (base and mobile or portable) covered by the same station license. Therefore, if the rules actually go into effect as proposed, business users will have 16 channels that should be free from interference by hobbyists.

Since the introduction of 23-channel sets about two years ago, full-channel coverage has become very popular. Most manufacturers now offer all-channel sets, and other multichannel units are almost ready for the market.

Informing the Businessman

Enterprising dealers and distributors are using local advertising to sell CB to businessmen. Many use direct-mail letters sent to all known businesses in their service area. Dealers using this approach report many telephone calls in response, requesting a demonstration. While some prospects will write letters containing specific questions, return-reply postcards included with the direct-mail pieces have not proved as effective for CB selling as they have in some other fields. Advertising in newspapers and on local radio stations is relatively inexpensive and highly productive. The most effective means of finding live prospects, however, remains the old canvass of every business that could benefit from the use of radio communication.

Manufacturers generally agree that their toughest job is finding "aggressive" dealers and motivating other dealers into action. Some prepare dealer sales-training manuals, direct-mail pieces, and nontechnical sales literature to sell the concept and benefits of CB radio. Manufacturers' advertisements can often be used locally for dealer tie-ins.

The CB dealer who sells to the business market runs head-on into competition from sellers of FM-mobile radio equipment. And, this competition will be intensified as some CB manufacturers expand into the FM-mobile field. CB equipment must be sold on the basis of *lower cost*, and the price gap between CB and FM-mobile radio is narrowing.

Manufacturers' Analysis

The problem facing manufacturers is to determine the kind of product they should offer the business market. The sales director of one large manufacturer has said he expects to sell 23-channel sets for use as

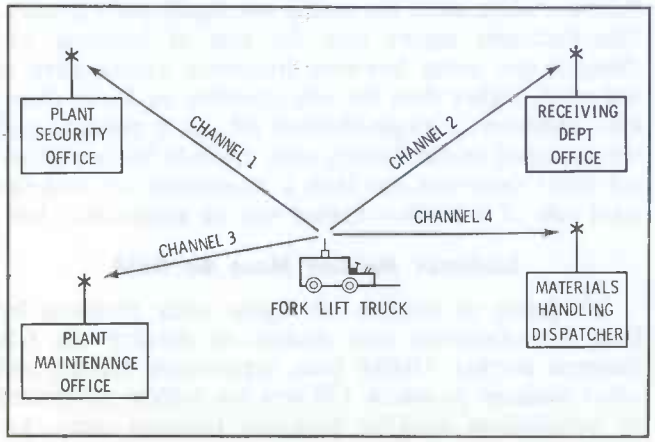


Fig. 1. Multichannel CB for warehouse use.

base stations and 8-channels sets for use as mobile units. Other sales directors believe there will be a big demand for 23-channel sets by business users; some indicate they believe single-channel sets will be the best sellers.

Business Applications

Let's look at a few typical requirements of business users. A small taxicab company, for example, could get by with a single-channel set, assuming use of a frequency that is not unduly congested. On the other hand, a multichannel set would enable the dispatcher or the driver to switch to an uncrowded channel when interference arose.

A larger cab company could make use of multichannel sets by having each driver monitor a different channel as he moves from one zone to another. To call a cab in the northeast zone, for example, the dispatcher would transmit on one specific channel and on a different channel to contact a cab in another zone.

Radio and TV service technicians, as well as nearly all other kinds of service and delivery organizations, usually need only one channel. Those who venture out of base-station range could make use of a second channel, such as Channel 10, the new unofficial Travel-Aid Channel for summoning aid when on the road.

Only a single-channel set is required on fork-lift trucks operating within a plant area, since lift drivers normally communicate only with their supervisor. There might be several systems within a single plant area, each operating on a different channel. In sparsely populated areas where there is no channel congestion, single-channel sets should be satisfactory. Multi-channel sets, however, will add flexibility to intraplant systems, when there is a need for mobile units to communicate with various base stations for differing reasons (see Fig. 1).

It is apparent, therefore, that single-, multi-, and all-channel sets each will continue to find a market, which types will find the largest market will be determined only after more sales experience, user evaluation, and market analysis. The price differential between a 6-channel set and a 23-channel set has been narrowed considerably, and manufacturers seem to feel that business users will prefer to buy sets with all the major features, because they cost but little more than sets with fewer features. Even if only one or two of the 23 channels are actually required, consumer buying habits suggest that 23-channel sets will be bought by most business users, since the cost is not significantly greater. Manufacturers report that the cost of building 23-channel sets using low-cost frequency synthesizers is not much higher than for sets operable on fewer channels. However, a single-channel set (or a multichannel set equipped at the factory with crystals for one channel only) does cost less than a 23-channel set, and the total cost of a multiset system can be appreciably less.

Business Market Must Be Sold

It's going to require intelligent sales planning by both manufacturers and dealers to develop the CB business market. Unlike tires, typewriters, trucks, and other business products, CB sets are seldom advertised in publications read by potential business users. Instead, they are advertised in magazines read by hobby-

ists, CB dealers, and radio parts distributors. The ultimate user has not become CB brand-conscious, except through word-of-mouth boosts or knocks. Most prospective business CB users have not even heard of CB radio, except for hobby use.

The time is ripe for CB manufacturers to publicize CB use as an effective business tool, in publications read by prospective users. But, while some advertising in such publications would undoubtedly be very beneficial, the cost would be prohibitive unless supported by intensive consumer-market analysis. Most CB manufacturers will continue to concentrate their advertising dollars in publications read by prospective dealers, not consumers. Thus, the burden of advertising to the end-user rests upon the shoulders of the dealers.

Servicing Considerations

Under existing FCC rules, the user can adjust his own transmitter without having to possess a radiotelephone operator's license. The new rules stipulate that a licensed operator (first or second class) must check the operation of a CB set after it has been repaired. This requirement changes the complexion of the CB service business.

While a service shop has been able, in the past, to operate a CB service business without having licensed personnel, such operation soon will be impossible. The shopowner interested in two-way service should employ at least one licensed technician in order to participate legally in CB service. He will then also be able to service FM-mobile equipment. There are several FM-mobile equipment manufacturers who seek competent independent shops to service their equipment locally.

The new CB rules do not constitute a change in FCC policy; they are only a clearer definition of the Citizens Radio Service which was always intended to be a short-range communications service for "citizens" for business or personal use. It was never intended to be a means for engaging in ham-type operations by persons disinclined to learn code at five words per minute and to spend a few hours studying basic radio laws and elementary electronic fundamentals.

Education Leads to Sales

While it is unfortunate that the hobbyist took over CB en-masse, his activity gave the electronics business a new market, one which may be lost because of the redefined role of the citizens' band. The CB dealer and

"Now, if you'd like to take out a year's service contract on it . . . "

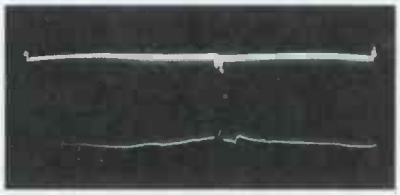
service shop technician must look to the business market and act quickly to stay in the CB business; and, manufacturers must lend support with sales training and sales aids. The hobbyist market need not completely disappear, however, if CB manufacturers make an all-out push to convert CB hobbyists into hams—most of whom are capable of learning enough code and theory to pass the novice ham license test—and come up with low-cost equipment for the ham bands in which novices are permitted to operate.

Conclusion

The market potential for business use of the citizens' band is tremendous. Every one of the nation's thousands of hotels and motels, and countless service stations, are prospects for CB communication with motorists on the Travel-Aid Channel 10. Of the nations 80,000,000 motor vehicles, of which some 12,000,000 are trucks, only about two million have been equipped with CB or FM-mobile radio. These items just scratch the surface. The market is there, but it must be sold. ▲

What's Wrong With This Waveform?

Clues: It was taken at the plate of the sync separator. The scope's horizontal sweep was expanded for a better look at the details of the waveform.



Ans. —This waveform—taken at 30 cps—should display both vertical and horizontal sync pulses of nearly equal height. Both should be of negative polarity. The horizontal pulses actually are present—their tips form the characteristic "fringe" along the bottom edge of the waveform — but something is wrong with the vertical pulse. It should make a bright spot at the bottom center of the waveform. representing a large, heavy negative pip. There is a spot, but it's almost level with the base line along the top of the waveform. This means only a weak vertical pulse is getting through the separator.

This fault would cause vertical rolling—at least intermittently—without affecting horizontal sync. It could be due to a weak sync separator tube, with enough cathode emission to supply the brief bursts of current for horizontal pulses, but not enough to conduct for the longer interval needed to produce a vertical pulse. If this isn't the trouble, no other faults in the sync separator seem likely, since the horizontal pulses are being cleanly separated from the video signal. Weak vertical pulses will probably be noted in the signal at the grid of the separator, as well as in the plate signal. The most likely culprit is poor low-frequency response in some circuit through which the TV station signal must pass before it reaches the sync separator. Defective coupling capacitors in the video or sync-input circuits are common faults; another possibility is misalignment of the RF or IF stages.

The Troubleshooter

answers your servicing problems

Volume Comes and Goes

I am having difficulty locating the trouble in a Zenith radio, Model L507 (covered in PHOTOFACT Folder 229-18). The receiver loses reception when tuned to stations near 600 kc. It will operate for a short time, then there seems to be an AGC defect that cuts out the reception. I have tried all tubes, also the oscillator coil and oscillator trimmer capacitor. When reception is lost there is no static, only a rapid fading out of the station signal. It would be unreasonable to assume a defective tuning capacitor for this reason, I believe. I would certainly appreciate any help you might offer in this matter.

EDWIN C. MYHRE

Carlton, Minn.

Since the symptoms you describe indicate that the trouble is dependent on the frequency to which the radio is tuned, the source is most likely in the RF or converter stages. If the 610-kc station is strong and then reception is lost entirely, chances are the trouble is in the oscillator. Since you have checked the tube, the fact that the defect is somewhat voltage dependent points first suspicion at a defective capacitor in the converter stage. The absence of static does seem to rule out the tuning capacitor (although strange things sometimes happen).

The best way to start, then, would be to check, by substitution, capacitors in the converter stage. Or you might try bridging them momentarily with good capacitors; this could cause the bad one to "snap back" and reveal itself.

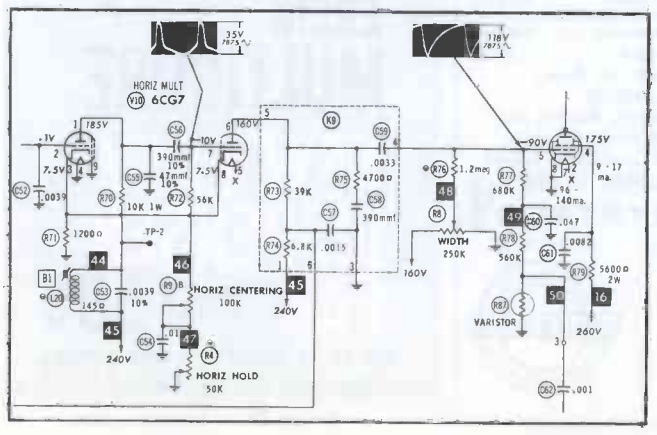
Narrow Picture

I am servicing a Philco TV Chassis 12N51A, covered in PHOTOFACT Folder 590-2. The trouble is insufficient width. All voltages in the horizontal oscillator section are normal; however, on the grid of the horizontal output tube (6DQ6) there is only —30 volts (schematic shows —90 volts). I checked the components in K9—all are within tolerance. Also, the resistors in the grid circuit of the output tube are okay. The only abnormality is the lowered reading on the output grid. Could you give me some hints as to what is causing the narrow picture?

TED POULEY

Monon, Ind.

Your description of the symptoms points to trouble in the horizontal-oscillator stage. You mentioned checking



the components in K9, but did you check C59 (which is a part of the component network) for leakage? I suggest you open the circuit at terminal No. 4 and connect a VTVM (set to read voltage) from this point to ground. Now, turn the receiver on and check for the presence of positive DC voltage on the meter; if DC voltage is present, C59 is leaky, and the component pack should be replaced.

With your oscilloscope, check to insure the proper drive waveform is being fed from the oscillator section to the output grid. An improper waveform could be causing the low bias.

Won't Be Still

I have a Philco Chassis 8L71 in my shop for repairs. The problem is the picture has vertical bounce or jitter. The bounce can be stopped temporarily by varying the height control, but at this setting the height of the picture is insufficient to fill the screen. I have changed the vertical output transformer, and tried a replacement yoke—both to no avail. Most of the capacitors in the vertical oscillator and output-circuits have also been substituted. The height and linearity controls have been replaced, too.

I fed a drive signal from my sweep analyst to the grid of the output stage, but the bounce was *still* present. All voltages are well within tolerance; however, the waveforms are distorted by the unstable picture, as the condition seems to be radiated back into the vertical input stage. Any suggestions will certainly be appreciated.

MOORE'S ELECTRONICS

Barbourville, Ky.

Philco Chassis 8L71 is covered in PHOTOFACT *Folder 403-2. From the symptoms you describe and the trouble-shooting procedures you have taken thus far, it looks as if you have pretty well isolated the trouble to the vertical output stage. My first impression is that you have improper B+ filtering— either on the main B+ line or on the boost line. Be sure to scope the supply lines, looking for some odd pulse that may be interfering with the vertical circuit.*

Another possibility is trouble in the printed circuit board; an intermittent open joint could be causing the trouble. It is also possible that you have a bad tube socket, especially in the vertical output stage. The output stage develops considerable heat, and the tube socket (mounted on the printed board) is prone to develop crystallization at the pin contacts on the upper side. I've had this trouble in several receivers of this vintage.

It is also possible that the trouble may be caused by stray coupling from another circuit; perhaps by a wire that is not dressed properly. Try moving some wires that are in close proximity to the vertical circuit to see if any change takes place on the screen. And don't fail to change that socket!

What's A Sure Cure

Lately I have been plagued with several AC-DC radios in which the volume intermittently "goes up and down." The tubes have checked okay, yet occasionally changing the 'BA6 corrects the condition. Other times, I have found an intermittent open or thermal capacitor to be the cause; in some cases, I have been unable to find a cure.

Some of my customers claim to correct the trouble by striking the set; however, I don't prefer this idea. Is there a sure cure for this type trouble? If not, would you please give me a reasonable procedure to follow?

GEORGE O. THOMPSON

Montreal, Quebec

Variations in volume such as you describe can be due to any number of causes. Frequently the defective component isn't revealed by routine voltage and resistance

checks. About the best thing you can do is to consider the exact nature of the symptom and try to deduce where the trouble should logically be (for example, a sudden drop in volume accompanied by "static" could indicate a loose or dirty volume control or bandswitch). The "sledgehammer" approach is to be avoided, but light tapping of a component (or working the shaft, if it has one) frequently localizes the trouble. If the difficulty appears to be associated with heat, the judicious application of heat, with a soldering iron or gun, can sometimes give a clue.

There is one other point to keep in mind with AC-DC radios. Most of these sets use a built-in loop antenna, and the ground return for the received RF signal is through the power wiring. The switching on and off of appliances in a building frequently changes the RF characteristics of this return path, and the volume of the set consequently rises and falls in an intermittent fashion. There isn't much that can be done about this when it occurs, but being aware of it could save time spent in futile troubleshooting attempts.

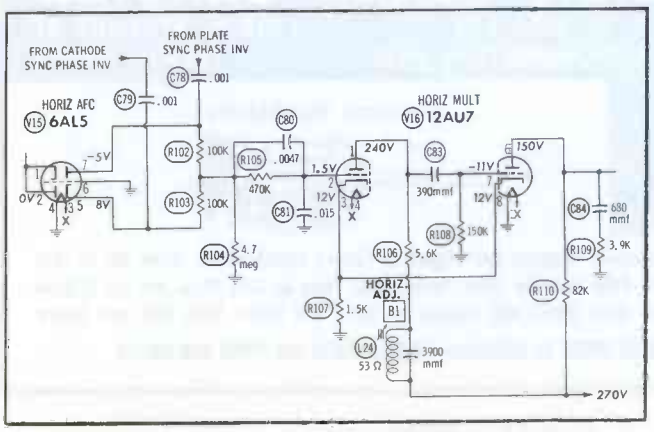
What Did I Miss?

I have an Admiral TV receiver, Model 20SY4LS (PHOTOFACT Folder 326-2), which has the following symptoms: low boost voltage (240 volts) and no bias on grid, above-normal screen voltage, and 240 volts on top cap of horizontal output tube. All voltages in the horizontal-oscillator section are normal. I have substituted all the filter capacitors, replaced the yoke and flyback transformer, and almost all the capacitors and resistors in the horizontal oscillator and output stage. However, the trouble is still present. I suspect that the trouble lies in a section of the receiver that I have overlooked, although I can't see what else could affect the boost voltage. Please advise me where to look for the trouble.

ARTHUR DIFRANCESCO

West Hartford, Conn.

According to your description of the symptoms, the trouble is most likely in the horizontal AFC section. An explanation for each symptom is: the boost voltage is low because the horizontal oscillator is not running. Absence of bias and increased screen voltage on the horizontal output tube are results of the same defect—the oscillator is dead. The flyback isn't open because you are measuring B+ voltage on the plate of the horizontal output tube; this is normal under the above conditions. You state the voltages in the horizontal oscillator section are normal. This clue brings us to the horizontal AFC section. You will probably find capacitors C78 and/or C79 to be leaky —placing a positive voltage on the horizontal AFC stage and shifting the horizontal oscillator so far off frequency that it becomes inoperative. This can be checked rather easily—simply ground pin 2 of V16 and see if high voltage returns. ▲



Notes on Test Equipment

analysis of test instruments . . . operation . . . applications

by Allen B. Smith

Versatile 5" Lab Scope

The Heath Model IO-12 oscilloscope pictured in Fig. 1 has been available for over two years, and in that time has proved itself in many shops. The instrument has vertical bandpass sufficient for viewing chroma and color-burst signals in color TV sets and has several features to speed repair of black-and-white sets. The IO-12 is very similar in electrical design to the previous Model O-11, although the controls and panel have been changed to present a more attractive exterior. The horizontal- and vertical-amplifiers are essentially identical to those in the O-11, but the sync-sweep-and-blanking section has been altered to achieve greater stability and versatility.

Fig. 1. 5-mc scope has front-panel adjustment for two preset sweep freqs.

Functions of the Model IO-12 are relatively straightforward as can be seen from the block diagram shown in Fig. 2. A signal applied to the vertical-input terminals is coupled through the frequency-compensated vertical-attenuator network to the input cathode follower, through the vertical gain control to the vertical amplifiers and the deflection amplifier. Of particular interest are the input attenuator network, which has no noticeable effect on waveform shape at any frequency or at any attenuator position, and the positive and negative synchronizing pulse, which are picked off the plate of the push-pull deflection amplifier for internal synchronization. The SYNC - SELECTOR switch chooses pulses for internal, external, or line synchronization, and applies the choice to the cathode of the first half of the sweep generator.

The nine-position HORIZONTAL FREQUENCY (sweep) SELECTOR switch adds frequency-determining capacitors of various values into the cathode circuit of the second half of the sweep multivibrator to determine coarse sweep frequencies, and a 7.5-megohm potentiometer provides fine adjustment (FREQ VERNIER) of the sweep frequency. In each preset sweep position, there is a separate 7.5-megohm control (PRESET ADJ) for fine adjust-

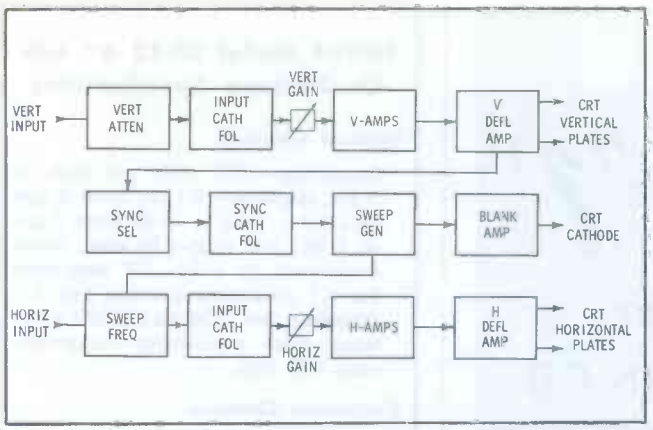


Fig. 2. Sync, sweep, and blanking circuits have been modified from previous 5" scope to provide greater utility.

ment. These preset positions enable the scope to be preset to two often-used frequencies—usually 30 cps and 7875 cps for TV servicing. The retrace-blanking pulse (applied during less than 30% of the sweep time) is fed to the CRT cathode through a blanking amplifier.

The output waveform from the sweep generator (or the external or line-sweep signal) is fed through a cathode follower to the horizontal amplifier, then to the push-pull deflection amplifier, and finally to the horizontal plates of the CRT.

Power for all critical circuits (sweep and deflection, primarily) are provided by a supply that features electronic regulation. The same supply provides all necessary calibration, sync, and sweep reference voltages—plus, with a separate rectifier, unregulated high voltage for the CRT.

The particular Model IO-12 evaluated in our lab was constructed from kit form in approximately ten hours. Assembly was accomplished with no problems, and the instructions and check-off system were easy to follow. The individual small components (resistors and capacitors, particularly) must be identified by color code or by marking, as they are not called out by part number on cards as in some kits. In all, however, the entire construction procedure through final evaluation and checkout went without a hitch.

As mentioned previously, the scope can be used with good results for tracing color waveforms in color sets. The waveform shown in Fig. 3 was taken from the 5UP1 CRT with our lab camera to illustrate the output signal of a typical single-stage chroma bandpass amplifier. Stability and fidelity of the waveform are excellent, even making no allowances for the instrument's price.

In the field, our Model IO-12 was used to service several black-and-white home TV sets for sweep, video, and sync problems. Those using the scope reported nothing but

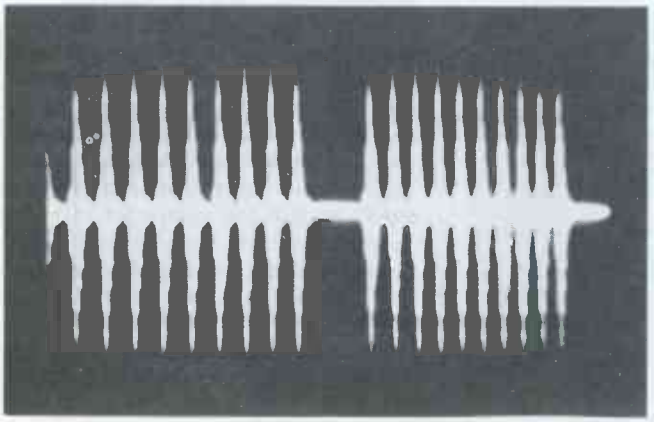


Fig. 3. High-frequency response of the output signal from chroma bandpass amplifier shows scope's service capability.

HEATH Model IO-12 5" Lab Oscilloscope Specifications

Vertical Channel:

Sensitivity—.025 volts per inch @ 1 kc; response—±1 db from 8 cps to 2.5 mc, +1.5 to –5 db from 3 cps to 5 mc; rise time—.08 usec; input impedance @ 1 kc—2.7 megohms for X1 attenuator position and 3.3 megohms for X10 and X100 positions; trace positioning—instantaneous DC type.

Horizontal Channel:

Sensitivity—.3 volts per inch @ 1 kc; response—±1 db from 1 cps to 200 kc, ±3 db from 1 cps to 400 kc; input impedance @ 1 kc —4.9 megohms; trace positioning —as for vertical channel.

Sweep Generator:

Range—10 cps to 500 kc in 5 steps; preset ranges—#1, 10 cps to 100 cps, and #2, 1000 cps to 10,000 cps, the two being changeable to any two frequencies between 10 cps and 500 kc; sync—automatic, using self-limiting cathode follower, for synchronizing on positive or negative internal, external, or line sources.

Features:

Retrace-blanking amplifier; phase-shift control for line-synchronized waveforms; built-in voltage calibrator; provision for Z-axis modulation; low-voltage supply fully regulated.

Size (HWD):

14⅛" x 8⅝" x 16".

Weight:

20½ lb.

Power Source:

105-125 volts, 50-60 cps AC, 80 watts.

Price:

$76.95 kit.

favorable comment for its sensitivity, stability, and ease of operation. The scope has also been used to service a closed-circuit color-TV system with perfectly acceptable performance.

The assembly-instruction manual accompanying the kit devotes several pages to general scope-operating techniques and waveform analysis and shows several test setups for servicing various items of equipment. The accessory use of demodulator and low-cap probes is also touched upon briefly.

We have used both this scope and its direct ancestor the O-11 in the preparation of many articles for PF REPORTER and in securing the normal and abnormal waveforms for illustra-

tions for *Symfact* and other features. Correct use of the instrument and its accessories will enable you to speed your servicing and increase your shop's efficiency.

For further information, circle 61 on literature card.

Color Bars in Kit Form

The PACO Model G-36 Color Bar Generator (Fig. 4) offers the color TV serviceman a chance to acquire a useful instrument and save a few dollars by building it himself. The Model G-36 is nearly identical to the Precision Apparatus Model E-450 Color Generator; the kit form of the G-36, however, helps the manufacturer attain a lower price.

Simple operation has been stressed in the design of this generator, with only three controls and the RF-output connector on the front panel. The first control is a switch marked DISPLAY and selects the video pattern desired (H BARS, V BARS, CROSSHATCH, DOTS, or COLOR BARS); the second is a potentiometer marked CHROMA and sets the color-saturation level of the color-bar pattern; the third is a switch marked SELECTOR and provides one of five desired output functions (POWER OFF, STANDBY, DISPLAY OFF, DISPLAY, and DISPLAY + SOUND). The varied video patterns and output functions provide the necessary signals for convergence and deflection linearity adjustments as well as for chroma alignment.

Fig. 4. Kit-built instrument provides stable patterns for servicing color TV.

Ten color bars are generated by the keyed-rainbow method using a 3.563795-mc crystal-controlled oscillator to provide a signal that is 15,750 cps lower in frequency than the 3.579545-mc chroma-reference oscillator in the color receiver. The frequency difference between the two reference oscillators produces a signal that varies in phase from 0° to 360° during the period of one line, in which the three electron beams from the red, blue, and green guns trace one horizontal scanning line on the face of the color CRT. This phase shift is repeated for each scanning line. Since color is generated by varying the phase of the receiver's subcarrier oscillator in reference to the transmitted color-burst signal, the 0° to 360° phase shift noted above provides a continuous spectrum, from yellow (through red and blue) to green, across the face of the color CRT.

To establish separate bars of color for adjustments in the phase-shift and matrix circuits of a receiver, the main 189-kc crystal-controlled oscillator is used to key (or blank) the 3.563795-kc oscillator (see Fig. 5) at regular intervals during each scan period. This keying action produces 12 bars of color, 10 of which appear on the CRT (of the other two, one is blanked during retrace time, and the other serves as the reference burst).

The various black-and-white video patterns available from the Model G-36 are produced by using a series of blocking oscillators as dividers to re-

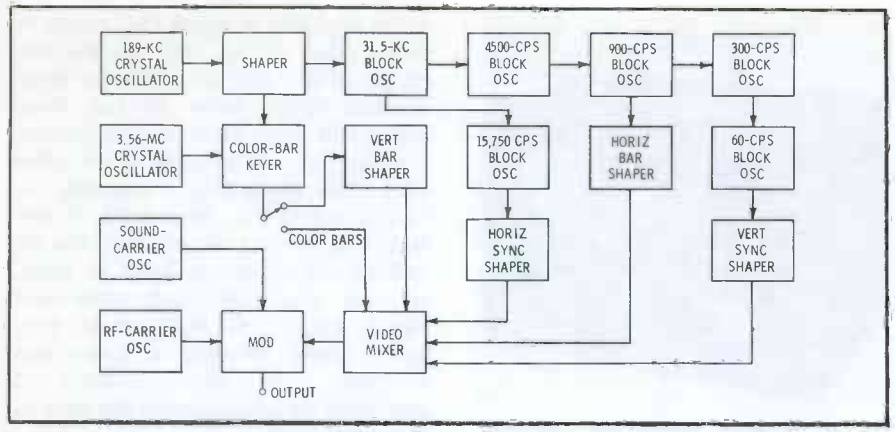


Fig. 5. Blocking-oscillator stages provide bars and pulses for synchronization.

PACO Model G-36 Specifications

RF Output Frequency:

Either channel 3 or channel 4 (for unused local channel). Video and sound carriers are both provided.

RF Output Level:

Approximately 20,000 microvolts video and 2000 microvolts 4.5-mc (unmodulated) audio.

Output Impedance:

Balanced 300-ohm output for direct connection to antenna terminals of receiver using output cable and clip leads.

Patterns available:

Keyed rainbow bars, vertical lines, horizontal lines, crosshatch, dots, white raster (carrier only).

Size (HWD):

8" x 13" x 7".

Weight:

12 lb.

Power source:

105-120 volts AC, 60 cps, 60 watts.

duce the frequency of the 189-kc reference signal to give 15 horizontal or 10 vertical white lines, or a combination of the two simultaneously (crosshatch). The vertical lines are formed by the same keying action of the 189-kc reference oscillator that generates the color bars, except that, before being fed to the video mixer, the keyer output is fed through a shaper circuit that develops narrow pulses. As in the case of the color bars, 12 lines are generated, but 2 are lost during retrace and blanking.

To provide horizontal lines, the 189-kc signal is fed from the shaper to the 31.5-mc blocking oscillator, where every sixth pulse triggers the divider. The signal is further divided by the 4500-cps (by 7) blocking oscillator and the 900-cps (by 6) blocking oscillator to provide, after further shaping, 15 pulses during the receiver's 60-cps vertical-scanning period; these pulses form the 15 horizontal lines.

"If you see any thing crawling around in there he's mine."

Horizontal and vertical lines are combined for the crosshatch pattern. Dots are developed from crosshatch; a diode is used to eliminate or clip out the crosshatch interconnection, leaving only the intersected points, providing a pattern 10 dots wide and 15 dots high.

Horizontal- and vertical-sync pulses are provided by the G-36 to assure a stable video presentation on the receiver under test. Horizontal sync pulses come from the 15,750-kc blocking oscillator (once again, see Fig. 5). The signal is shaped by the horizontal-sync shaper and fed to the video mixer. Vertical sync pulses are derived in an identical manner from the 60-cps blocking oscillator at the end of the long divider chain.

The signals that provide all video displays pass through the video mixer to the modulator stage where they are impressed on the RF carrier generated for channel 3 or 4, depending on the user's choice. The modulated carrier output of the Model G-36 is fed to the set through the panel-mounted connector and the clip-lead cable.

A 4.5-mc crystal oscillator generates a sound-carrier signal which is mixed (in the modulator) with the RF carrier to provide a signal displaced 4.5 mc from the RF carrier. This signal can be used to align the set's sound-IF and detector circuits.

In our lab, where the unit was assembled, we found that the construction procedures outlined step-by-step in the instruction booklet were easy to follow and accurate. An errata sheet listed several changes that had to be made before construction was begun. Assembly of the kit required about 10 hours from plugging in the iron to using the generator for alignment checks.

Stability of the video patterns is very good, and the range of color saturation provided by the chroma control was satisfactory. ▲

For further information, circle 62 on literature card.

now in our lab . . .

The latest test instruments being analyzed for future "Notes" columns:

Lectrotech Model V7 Color Vectorscope

RCA Model WT-115A Color CRT Tester

SENCORE Model PS127 Oscilloscope

Triplett Model 3490A Transistor Analyzer

Sprague Model TO-6 Capacitor Analyzer

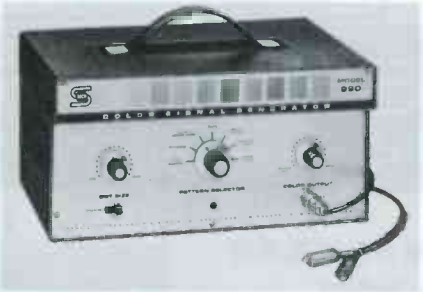
Jackson Model 825 CRT Tester

Product Report

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

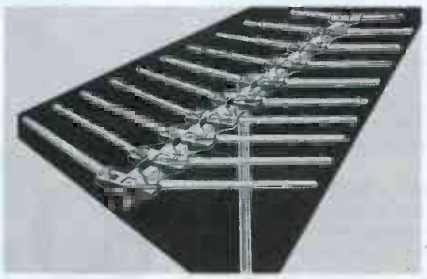
Whisper Fan (127)

A fan that will cool and extend the life of television sets and hi-fi equipment is being offered by **Rotron.** Known as the "Whisper Fan," it is extremely quiet and will move 60 cubic feet of air per minute. The fan can be installed to operate in any position. Prices range from $8.15 to $14.10, depending upon the quantity purchased. Accessories such as filter, grill, guards, etc. are additional.



Color-Bar Generator (128)

This new color-signal generator provides numerous video test patterns: gray raster, rainbow, keyed color bars, dots, crosshatch, vertical lines, and horizontal lines. The **Seco** Model 990 also features several variable patterns. The operator can select 54 or 144 dots, a crosshatch pattern of 6 or 16 horizontal bars with 9 vertical bars, and 6 or 18 horizontal bars. The RF-output frequency is factory adjusted to channel 3 but can be retuned to either channel 2 or 4. Net price is $149.50.



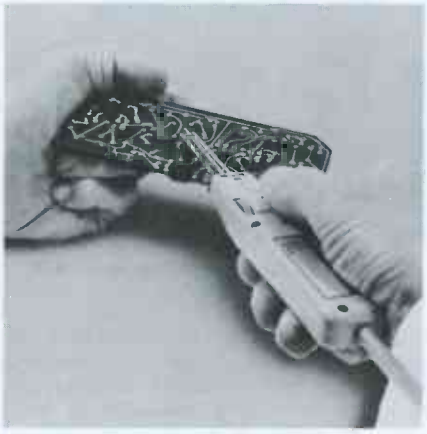
VHF-FM Antenna Line (129)

The sweptback element design of a new series of antennas by Finco provides improved reception of color, black-and-white, and FM signals—both monaural and stereo. The **Finney Co.** has incorporated several features in the construction of these antennas to make them as trouble-free and weatherproof as possible. All carry an unconditional guarantee.

8-Track Stereo Head (130)

A new 8-track stereo-head for ¼" tape offers twice as much playing time as a standard 4-track stereo tape system operating at the same speed. A 100 micro-

inch gap assures quality performance at 3.75 ips. The **Nortronics** head is mechanically indexed to four discrete positions to provide four stereo, or eight mono channels. Available in either solid or laminated core versions, the Model B2L head is available in various impedances to accommodate all types of circuitry.



Probes for PC Boards (131)

Two new tri-contact probes for making tests on printed circuit boards are adaptable to all types of in-circuit semiconductor testers. The probes from **American Electronic Laboratories,** have stainless-steel tips whose vertical and lateral positions are controlled by individual thumb wheels. They are available with a standard connector, or with optional connectors to meet MIL specifications.

Contact Cleaner (132)

A new "dry" cleaner, Relay Kleen, is a degreaser and general solvent for cleaning gummy deposits from relays and contacts. **GC Electronics'** new chemical is nonoily, nonflammable, leaves no residue, and does not contain carbon tetrachloride. Each 6 oz. pressurized can is furnished with an easily attached pin-point spray attachment for servicing hard-to-reach areas. Net price is $1.89.

Portable Communications Kit (133)

Instant 2-way radio communication is the purpose of this compact, lightweight, completely self-contained communications kit. Each **E. F. Johnson** kit contains two hand-held transceivers with rechargeable batteries, leather carrying cases, and flexible fiberglass antennas—plus two extra batteries. The units each contain 11 transistors and four diodes and operate in the 25- to 50-mc range. All items are packaged in a rugged carrying case that is 5" wide, 11" high, and 17" long. Fully equipped, the case weight only 10 lbs.

Rebuild Picture Tubes (134)

Owners of television repair shops can obtain the equipment required to set up their own low-cost picture-tube rebuilding plant. Picture tubes can be rebuilt, using techniques and equipment obtained from **Windsor Electronics,** with a cost for materials of $1.50, and one hour's labor. Complete plants are priced from $2990.00, including training on how to operate the equipment.

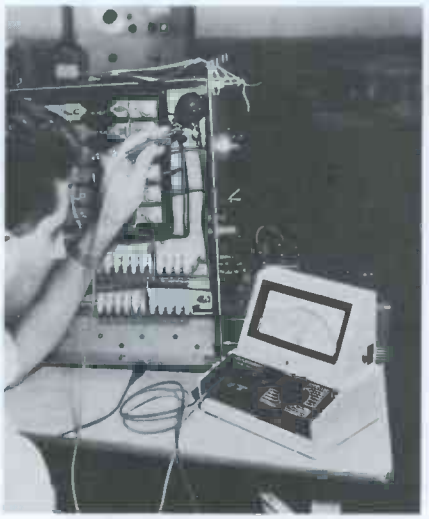
Solid-State Stereo (135)

An all-transistor FM stereo receiver with an extended frequency response (5 to 60,000 cps) is **Harmon-Kardon's** Model SR900. This unit features a stereo logic circuit which automatically switches the

receiver from stereo to mono operation, if the stereo signal becomes too noisy. This one-chassis receiver has fingertip rocker switches for selection of contour, tape monitor, tone control defeat, and mono-stereo. Music-power output is 75 watts and harmonic distortion is less than .2%. List price is $469.00.

CB Communications (136)

A completely transistorized 11-channel Citizens-band transceiver that is only one half the size of tube models, and uses only one fourth as much power, is **Raytheon's** Ray-Tel TWR-5. The front panel location makes numerous installations possible: under a dashboard, on an overhead, against a side wall, or on top of a desk. The use of 14 transistors and 5 diodes contributes to its compact size (8¼" x 3¼" x 10¼").



Multipurpose Meter (137)

This portable volt-ohm-milliameter, packaged in a console-type case, has a tilted meter face and refractive antiparallax scale. The **Weston** Model 80 has DC voltage scales from .25 to 5000 volts; AC voltage scales from 2.5 to 5000 volts; and DC current scales from 50 uamps to 10 amps. A reversing switch on the side panel enables the user to change polarity under load without changing lead terminations. List price is $79.50; carrying case is optional.

Speaker Enclosure (138)

This compact speaker system, consisting of a 6" woofer and a high-frequency tweeter, is capable of handling 40 watts of continuous power. The enclosure, 14½" x 10½" x 7¼", is constructed of high-stress, nonresonant panels and is finished in hand-rubbed walnut veneer. Known as the Sonomaster®, the **Sonotone** Model RM-1 has a consumer net price of $42.50. ▲

INDEX TO ADVERTISERS

FREE Catalog and Literature Service

*Check "Index to Advertisers" for further information from these companies.

Please allow 60 to 90 days for delivery.

ANTENNAS & ACCESSORIES

65. *ANTENNACRAFT* — Latest information on FM antennas, featuring new omnidirectional model for multiplex or monophonic broadcasts.
66. *ALLIANCE* — Colorful 4-page brochure describing in detail al lfeatures of the famous *Tenna-Rotors*.
67. *FINNEY*—Catalog No. 20-291 gives information on single-channel couplers.*
68. *G. F. WRIGHT*—Catalog sheets on guy wire used with outside antenna installations.
69. *GC ELECTRONICS*—Complete TV antenna brochure No. FR-632-G representing latest *Colormagic* antennas.
70. *JFD*—Literature on complete line of antennas for VHF, UHF, FM, and FM-stereo. Brochure showing converters, amplifiers, and accessories; also complete '64-'65 dealer catalog.
71. *MOSLEY ELECTRONICS* — Illustrated catalog giving specifications and features on large line of antennas for Citizens band, amateur, and TV applications.*
72. *MULTITRON*—Illustrated literature on FM-stereo antenna No. MA-44 and Multituner Model M-11.
73. *SPAULDING*—Specification booklet on all types of antenna towers for TV, ham, and commercial applications.
74. *STANDARD KOLLSMAN* — Catalog sheet on UTC-051 transistor UHF converter kit with IF amplifier.
75. *TRIO*—Brochure on installation and materials for improving UHF translator reception.*
76. *ZENITH*—Informative bulletins on universal loudspeakers and a new line of log-periodic vee-type antennas for FM and monochrome or color TV.

AUDIO & HI-FI

77. *ADMIRAL*—Folders describing line of '65 equipment; includes black-and-white TV, color TV, radio, and stereo hi-fi.*
78. *ATLAS SOUND*—Illustrated data sheet describing C-46 and C-66 sound columns, two-way wall speaker system, and bidirectional baffle speaker combinations.
79. *BENJAMIN*—Brochure on *Miracord* record changers and *Elac* phono cartridges.
80. *CADRE*—Bulletin No. CM-84 gives features and specifications on "Consort" FM wireless microphone.
81. *GIBBS SPECIAL PRODUCTS*—Folders describing principles of sound reverberation and *Stereo-Verb* reverberation units for automobiles.
82. *OAKTRON*—"The Blueprint to Better Sound" an 8-page catalog of loudspeakers and baffles giving detailed specifications and list prices.*
83. *OXFORD TRANSDUCER* — Product information bulletin describing complete line of loudspeakers for all types of sound applications, including replacements for public address and intercom systems.
84. *PERMA-POWER* — New catalog sheet describing Ampli-Vox Model S-300 and Sound Cruiser sound system Model S-310.*
85. *QUAM-NICHOLS*—Catalog No. 64 listing over 30 speakers and transformers for sound system applications.*
86. *SONOTONE* — Cross-reference crystal cartridge replacement chart.*
87. *SWITCHCRAFT*—New product bulletin No. 147 describing new slimline and compact 4-pin connectors.
88. *UNIVERSITY* — Guide to high fidelity and new catalog on line of "Mustang" loudspeakers.

COMMUNICATIONS

89. *MULTITONE*—New 8-page color brochure on pocket-paging system for instant communications.
90. *PEARCE-SIMPSON* — Specification brochure on *Companion II*, *Escort*, and *Guardian 23* Citizens-band transceivers.
91. *SONAR RADIO*—Specification sheet on Model FM-40 business radio.
92. *TURNER*—Brochure No. 1025 on new line of microphones for base-station and mobile use; includes list prices.

COMPONENTS

93. *AMPHENOL* — Complete comprehensive catalog of microminiature, rack and panel, and printed-circuit connectors.
94. *ANTRONIC*—Catalog sheet on new products being introduced to the industry; includes tube and continuity checker.
95. *BUSSMANN* — Bulletin SFUS listing complete line of Buss and Fusetron small-dimension fuses by size and type. Indicates proper fuse holders and gives list price.*
96. *IEH*—Data sheet on *Vi-Tran* transistorized vibrator eliminator.
97. *MASTRA*—Information concerning "Totemaster" tube caddy; four layers convert to any desired size.
98. *PERMACEL* — Product specifications on plastic tapes listing types, technical data, uses, and product features.
99. *SPRAGUE* — Latest catalog C-616 with complete listing of all stock parts for TV and radio replacement use, as well as *Transfarad* and *Tel-Ohmike* capacitor analyzers.*

SERVICE AIDS

100. *CASTLE*—How to get fast overhaul service on all makes and models of television tuners is described in leaflet. Shipping instructions, labels, and tags are also included.*
101. *CHEMTRONICS* — Colorful catalog No. 64 contains information on chemicals as aids to the electronics serviceman.
102. *MID-STATE TUNER* — Information on rebuilding tuners—VHF, UHF, or combination types. Special get-acquainted offer is now in effect.*
103. *PRECISION TUNER*—Literature supplying information on complete, low-cost repair and alignment services for any TV tuner.*
104. *YEATS*—The new "back-saving" appliance dolly Model 7 is featured in a four-page booklet describing feather-weight-aluminum construction.*

SPECIAL EQUIPMENT

105. *ATR* — Descriptive literature on selling new, all-transistor *Karadio* Model 707, having retail price of $29.95. Other literature on complete line of DC-AC inverters for operating 117-volt P.A systems and other electronics gear.*
106. *GREYHOUND* — The complete story of the speed, convenience and special service provided by the Greyhound Package Express method of shipping, with rates and routes.
107. *STACO*—Information on Adjust-A-Volt type T1520U variable transformer.
108. *VOLKSWAGEN*—Large, 60-page illustrated booklet, "The Owner's Viewpoint," describes how various VW trucks can be used to save time and money in business enterprises, including complete specifications on line of trucks.
109. *WALLIN-KNIGHT* — Folder on Reflect-O-Scope, an effective tool for static convergence of color TV receivers.
110. *WORKMAN* — Catalog on transistorized products — battery chargers, power converters, CB vibrators, and test equipment.

TECHNICAL PUBLICATIONS

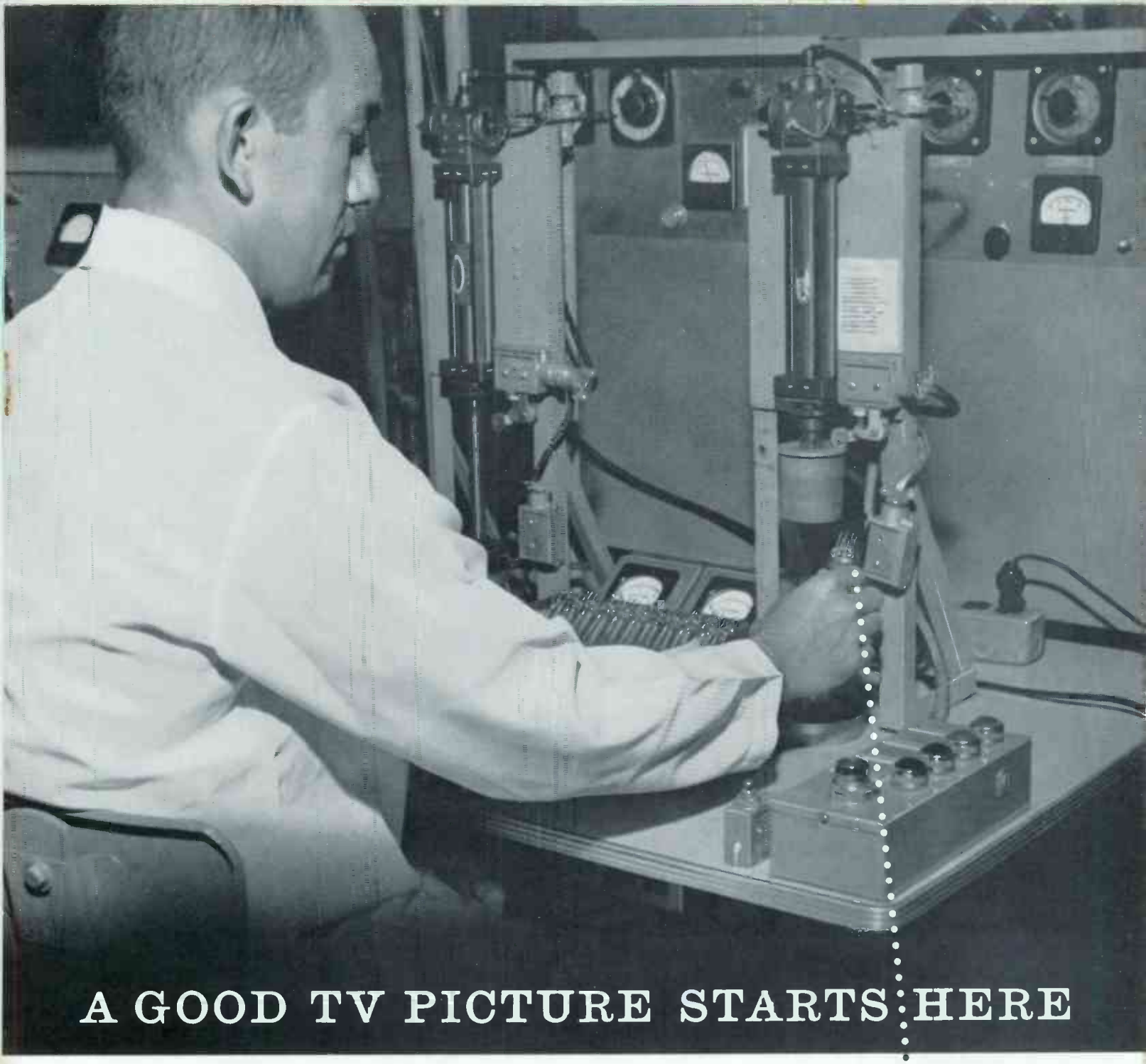
111. *CLEVELAND INSTITUTE OF ELECTRONICS* — "Pocket Electronics Data Guides" and handy conversion factors, formulas, tables, and color codes. Additional folder, "Careers and Opportunities in Electronics," describes home-study electronic training program, including preparation for FCC license exam.*
112. *RCA INSTITUTES*—64-page book, "Your Career in Electronics," detailing home study courses in TV servicing, communications, automation, drafting, and computer programming; for beginners and experienced technicians.*
113. *HOWARD W. SAMS* — Literature describing popular and informative publications on radio and TV servicing, communications, audio, hi-fi, and industrial electronics, including special new 1964 catalog of technical books on every phase of electronics.*

TEST EQUIPMENT

114. *B & K*—Bulletin No. 124-R on new Model 1240 color generator. Catalog AP-21R describing uses for and specifications of Model 1076 Television Analyst, Model 1074 TV Analyst and Color Generator, Model 700 and 600 *Dyna-Quik* Tube testers, Model 445 CRT Tester-Rejuvenator Model 960 Transistor Radio Analyst, Model 360 *V-O-Matic* VOM, Model 375 *Dynamic* VTVM, Model 1070 *Dyna-Sweep* Circuit Analyzer, and Model 230 Substitution Master.*
115. *EICO*—New 1965 catalog listing over 200 products including color bar generator, oscilloscopes, and others; all available in kit form.*
116. *HICKOK*—Complete description and specification information on newly introduced Model 662 installer's color generator, portable FM multiplex generator, Model 235A VHF-UHF field strength meter, and Model 800 tube tester.*
117. *JACKSON* — Complete catalog describing all types of electronic test equipment for servicing and other applications.*
118. *MERCURY*—Complete catalog on line of test equipment to help the serviceman.
119. *SECO*—Data sheets on self-service tube testers and caddy-pack tube testers that carry over 200 tubes.
120. *SENCORE*—New color catalog on complete line of company products; oscilloscopes, generators, testers, and many others.*
121. *SIMPSON*—Complete 16-page brochure on entire line of electronic test equipment; also, catalog on line of panel meters.*
122. *TRIPLETT*—All new test-equipment catalog No. 46-T showing complete line of VOM's, tube testers, transistor analyzers, and signal generators.*

TOOLS

123. *ENTERPRISE DEVELOPMENT*—Time-saving techniques in brochure from Endeco demonstrate improved desoldering and resoldering techniques for speeding up and simplifying operations on PC boards.*
124. *LUXO LAMP*—New catalog No. 114-2 showing illuminated magnifiers and low voltage lights.
125. *ONEIDA*—Brochure on soldering-gun attachment that cleans printed-circuit terminals in seconds.
126. *VACO*—Folders on complete line of hand tools and solderless terminals.



A GOOD TV PICTURE STARTS HERE

It Depends on a Leakproof Stem Seal

The slightest leakage of air weakens the high vacuum of a TV picture tube... resulting in a costly callback and a dissatisfied customer for you. This is why RCA takes extra precautions to maintain the vacuum in Silverama picture tubes.

Potential trouble spots are the glass-to-metal lead-wire seals in the electron-gun stem assembly (below). At RCA, stem assemblies are batch tested for leakage in a supersensitive leak detector *before* they go into electron guns.

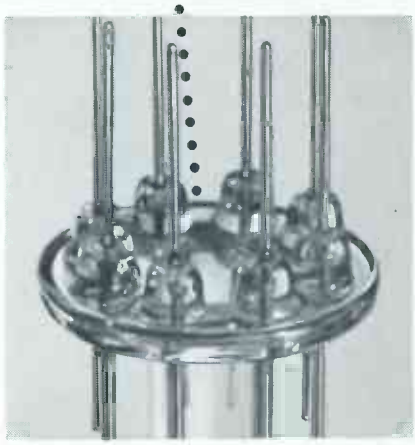
So sensitive is this detector that it can pinpoint a leak that would not affect tube performance for years... a leak so tiny that no other inspection method could hope to find it.

Yet the slightest sign of a leak is cause for rejection of a stem. This extra precaution is one more example of the care that goes into every phase of Silverama manufacture ...and one more reason why RCA Silverama should be your first choice in replacement picture tubes.

Silverama is made with an all-new electron gun, finest parts and materials, and a glass envelope that has been thoroughly cleaned and inspected prior to re-use.

RCA ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

The Most Trusted Name in Electronics



Stem assemblies are tested on a special high-vacuum leak detector. Detector is a helium mass-spectrometer, detecting passage of helium "tracer" gas through any of the glass-to-metal seals. A stem assembly passing this rigorous test is ready to become a vital part of an RCA Silverama® Picture Tube.