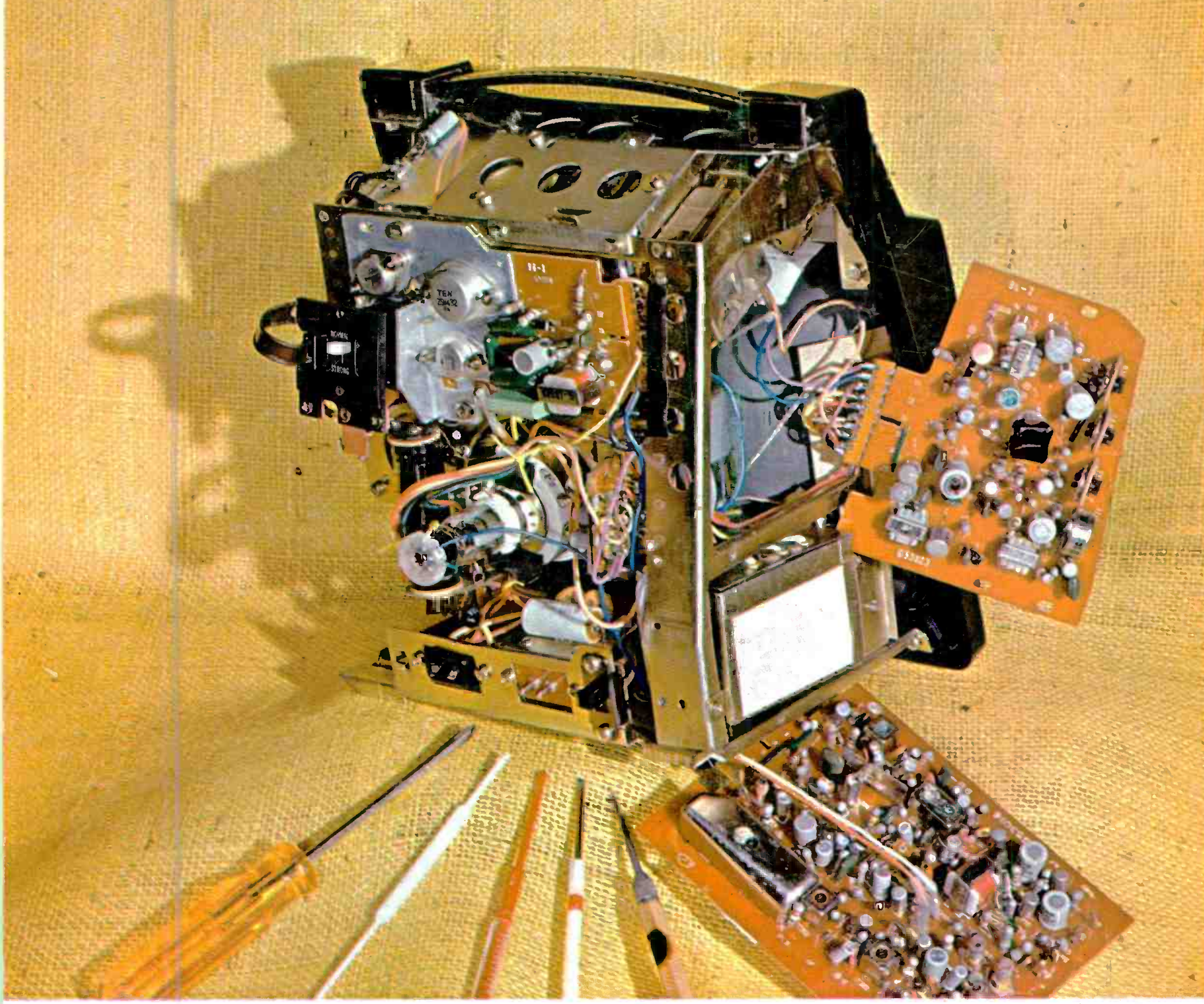
A HOWARD W. SAMS PUBLICATION

JUNE 1967 75¢

PF Reporter®

PHOTOFACT

the magazine of electronic servicing



- TV Alignment
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SWEEP ALIGNMENT FOR TV

Quicker and more accurate alignment is possible if the step-by-step procedures outlined in service data are supplemented by a thorough understanding of the how's and why's involved in each step.

Material for this article has been adapted from the Howard W. Sams book Radio & TV Alignment Handbook by Warren J. Smith.

Although most service manuals include step-by-step alignment instructions, the average service technician often hits a snag because he does not know how to use alignment equipment properly. Moreover, even through capable of following the manufacturer's instructions to the letter, he does not fully understand the exact purpose behind each step in the alignment procedure. As a result, he usually bogs down at some step along the way—or, more commonly, employs someone else to do the job and thus cuts down on his profits.

Need for Alignment

There are many reasons why a receiver may need realignment. In the past, normal aging of components and mishandling were the most common; but in the present era of "do-it-yourself," it is rather commonplace to encounter receivers in which experimental adjustments have been made by the set owner. This generally makes a complete realignment job necessary, and a strong warning against such further tampering should be given. Finally, in order to achieve optimum receiver performance, it is approved service practice to completely realign a receiver after a component or tube is replaced in a tuned circuit.

Occasionally a receiver may exhibit symptoms which appear as improper alignment but actually are not. Conditions such as poor sensitivity or selectivity, distortion, and oscillation can generally be traced to defective components. On the other hand, effects of misalignment are not always immediately evident, or are confused with poor reception. In a TV receiver, the most obvious result of RF or IF misalignment is poor picture quality. Misalignment will always produce a degraded picture, displaying such defects as limited frequency response, ringing, smear, or overload in one or more amplifiers because of high response peaks in some part of the frequency range. A very common indication of misalignment is multiple images; which at first glance appear as "ghosts" caused by multipath reception, but are actually the result of phase shift in the RF or IF amplifiers. Other less obvious defects which can result from misalignment are unstable sync, improper AGC action, and interference from signals which normally would not affect a properly aligned receiver. To further complicate the situation, any one of the defects mentioned may be due to conditions external to the receiver; multipath reception, for example, can produce many of them.

The resolution of the TV picture often indicates whether a receiver needs alignment, or circuit repairs are in order. As a rule, tuner and video IF alignment should be checked if any of the following conditions appear.

Tunable ghosts — Varying the fine-tuning control changes the spacing between images and ghosts if the set needs aligning. Ghosts caused by multipath reception maintain a fixed spacing.

Tunable smears—Sharp edges, particularly on the blacks, are blurred. Appears as a white smear trailing off the black edge, and can be varied by adjusting the fine-tuning control.

Weak-signal reception—This condition causes regeneration in the RF or IF amplifiers and appears as horizontal smearing in the wedges of a test pattern.

Poor low-frequency response—Horizontal wedges in test pattern appear gray, in contrast with darker or black vertical wedges. To check video response, roll picture downward out of vertical sync. Adjust brightness and contrast controls until sync pulse appears darker than blanking bar, which should be at least as dark as any gray in the picture. Sync pulse should remain same shade of gray as it moves downward. If conditions other than those described appear, video amplifier is probably defective or the set needs alignment.

Poor resolution—Appears on all received channels as loss of fine detail, or fuzziness, that cannot be corrected with fine-tuning control or focus adjustment. A test pattern provides the most accurate resolution check. Adjust operating controls for

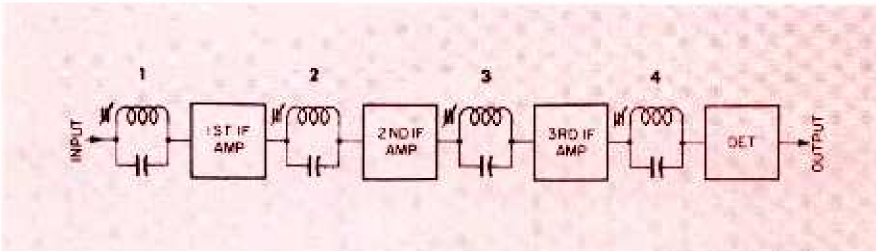


Fig. 1. Typical cascaded IF strip with four tuned circuits.

best possible picture and observe the wedges.

Resolution, or definition as it is sometimes called, is very important to the over-all quality of the picture since it determines the amount of individual detail that can be distinguished by the viewer. When the receiver is not properly responding to all video frequencies, either the vertical or the horizontal wedges of the test pattern appear gray while the others remain a normal black. In the case of poor high-frequency response the vertical wedge turns gray, whereas poor low-frequency response results in a gray horizontal wedge. Generally the majority of receivers exhibiting symptoms of limited frequency response are in need of RF and/or IF alignment.

Conditions which may indicate alignment of the sound section is necessary are as follows:

(a) Distortion which cannot be corrected with the fine-tuning control.

(b) Weak sound.

(c) Noise (ignition or electrical) in the output of split-carrier receivers, which cannot be nulled out with the fine-tuning control.

(d) Buzz. Normally there is a small amount of buzz, due primarily to intermodulation between the video and sound carriers. However, this condition is aggravated when the sound carrier is too high on the response curve. In a correctly aligned receiver this residual buzz can be nulled or minimized with the fine-tuning control. Accurate alignment of the sound IF and detector is important, but buzz can often be eliminated by touching up the sound detector and sound take-off coils slightly.

A few words of caution are appropriate here. Do not attempt random experimental alignment adjustments. This practice is often resorted to by the more venturesome service technicians of limited experience. Such unorthodox adjustments could be disasterous, to the point where the receiver would have to be completely realigned at considerable cost in lost time.

Meaning of Alignment

Alignment is the process of adjusting the tuned RF and IF circuits of a receiver to: (1) make the response broad enough to accept all necessary sidebands of the signal, and (2) to adjust all tuned circuits to the correct band of frequencies.

A cascaded amplifier circuit consisting of three stages and four tuned circuits is illustrated in Fig. 1. A signal must pass through each stage in turn, so misalignment in any one of the stages could distort the signal appearing at the detector. Fig. 2 illustrates some of the conditions which prevail when the different stages are misaligned. In Fig. 2A all tuned circuits are properly aligned and each stage responds to the same 7.5-kHz band. In Fig. 2B the last two tuned circuits are misaligned—the third is tuned too low and the fourth too high. The shaded portion of the curve shows the range of frequencies cut off. If a sweep generator is connected to the input and an oscilloscope to the detector output, a waveshape similar to the unshaded portion of (B) will be seen. As the fourth tuned circuit is readjusted toward the proper frequency, the right side of the waveform will move to the left. Upon reaching the proper position relative to the rest of the curve, the waveshape on the scope will appear as in Fig. 2C. Adjusting the third tuned circuit in Fig. 2B will move the left side of the waveform to the right and produce the desired over-all response curve. In Fig. 2C only one stage is misaligned, but the result is almost as pronounced as in B since all frequencies above 3,500 Hertz are cut off. By judiciously adjusting the tuned circuit, we can move the response curve up in fre-

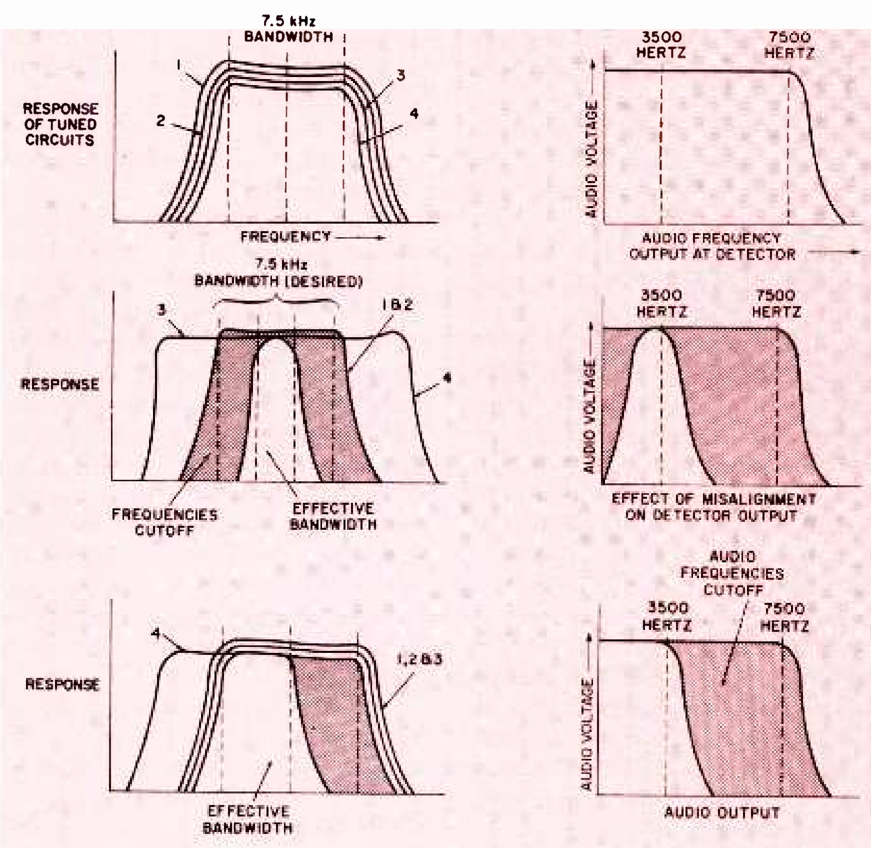


Fig. 3. Effect of misalignment or receiver response.

quency until it coincides with the others as in A.

When readjusting tuned circuits it is very easy to move a curve too far and overshoot the desired position. For this reason it is very important to keep a close check on the frequency of the waveforms (as well as their shape and amplitude). As in the illustrations, the base line on the scope represents frequency. When the frequencies the sweep generator is producing are known, it is possible to estimate the frequency of any point on the base line with acceptable accuracy. With the addition of a marker generator these frequencies can be pinpointed more accurately.

The tuned circuits of a receiver must respond to a certain frequency range which depends on the modulating frequencies of the carrier. All the information transmitted is reproduced only when all these modulating frequencies develop equivalent amplitudes.

Examine the detailed TV transmitter output curve in Fig. 3A. Eliminating one sideband completely would result in detrimental phase distortion, therefore, vestigial-sideband transmission is used. The complete upper sideband and a small portion of the lower sideband are transmitted; the remainder of the lower sideband is suppressed at the transmitter. Since each sideband in an AM signal contains 50 per cent of the modulation energy, the lower video frequencies have 100 per cent modulation; but the higher frequencies have only 50 per cent. Thus the lower frequencies in effect are boosted considerably. In Fig. 3B we have the over-all response curve of a receiver tuned to Channel 2. The tuned circuits are arranged so that the response is nearly linear on the video carrier side of the curve, Therefore, in a properly aligned receiver the video carrier frequency develops only half the signal voltage developed by the higher video frequencies. Because the double sideband, or low frequency, range of the transmitted signal has twice as much modulation energy as the rest of the signal, the attenuation of this range by the receiver corrects for differences in sideband strength introduced at the transmitter. This point is clarified by Fig. 3C. Here we are considering a single video frequency of 500 kHz (0.5 MHz), which lies in the double sideband area of the response curve. Two such side frequencies are transmitted, one 500 kHz above the carrier and the other 500 kHz below. In the receiver, the 500-kHz signal above the carrier develops approximately 75 per cent of the voltage of the signals above 1.25 MHz, and the 500-kHz signal below the carrier develops only 25 per cent. Together, the two side frequencies develop the total voltage of 100 per cent. In other words, the total signal voltage at this frequency is the same as the voltage developed by any video frequency in the single-sideband region.

Fig. 3B illustrates the ideal over-all receiver response curve, showing the response from antenna to detector. Its shape compensates for the distortion introduced by vestigial-sideband transmission. The shape of a receiver response curve is determined primarily by the IF amplifiers. Fig. 4A illustrates the receiver RF response. It obviously is not the same as for the IF systems in B and C; the shape of the IF response curve is the same as the over-all curve of the receiver.

To minimize interference from adjacent television channels, tuned traps are inserted in the IF amplifiers. Being tuned circuits, these traps affect the IF response and thus the over-all IF response curve. The RF response is of course unaffected by traps in the IF's.

Sound signals are handled by the IF amplifiers in intercarrier receivers, and so the shapes of both the RF and the IF response curves differ slightly from those of the split carrier receiver. This can be seen by comparing Figs. 4B and C. In the split carrier receiver curve, there is no response at the sound carrier frequency, whereas in the intercarrier receiver the response extends to approximately 5 per cent above zero.

In Fig. 5A you will note that the RF frequency increases from the

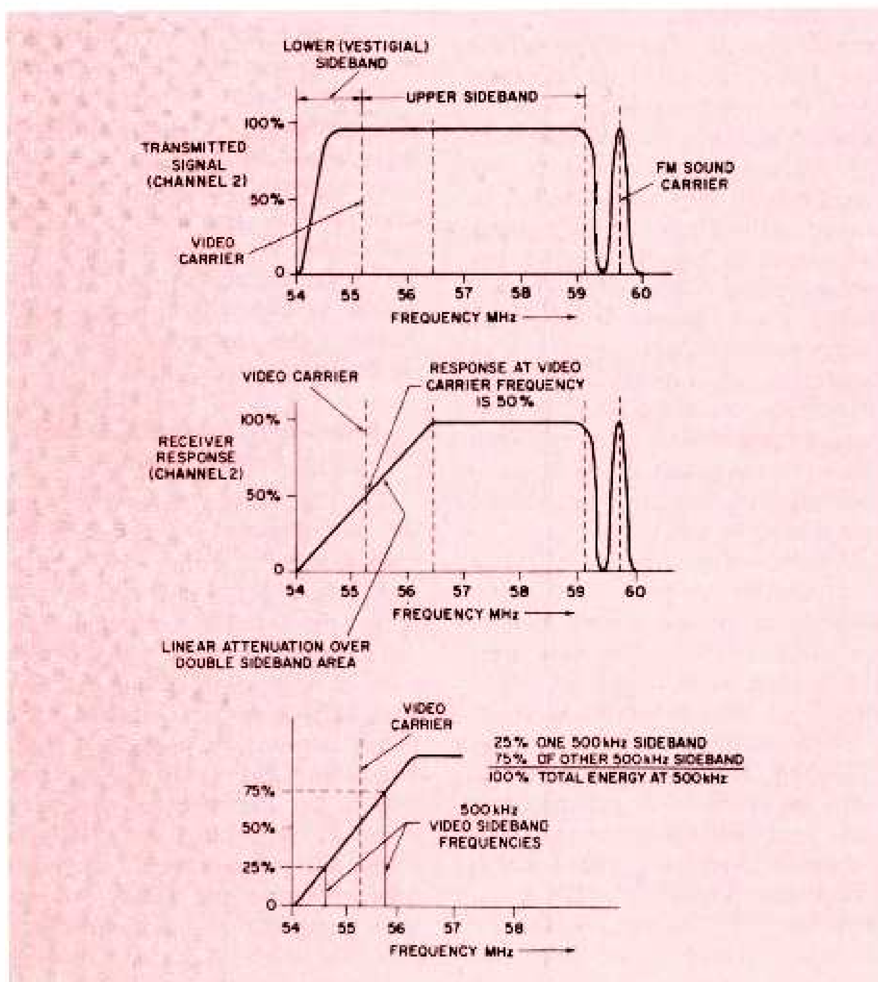


Fig. 3. Method of compensating for vestigial sideband transmission.

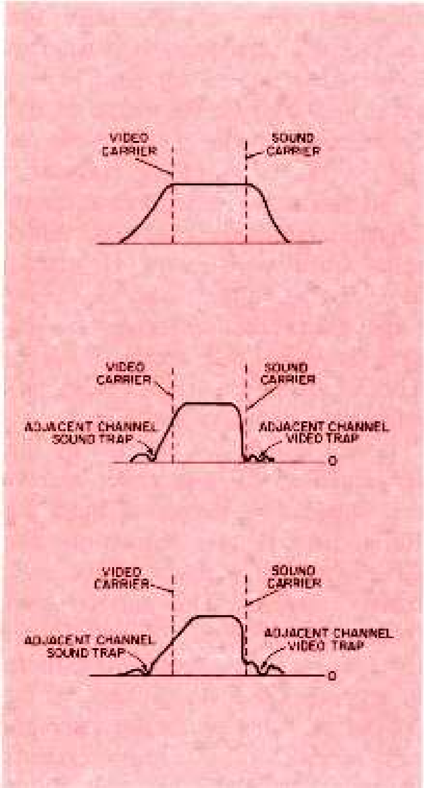


Fig. 4. Typical response curves.

video carrier to the sound carrier, and that the IF frequency increases from the sound carrier to the video carrier. This is always true whenever the local oscillator operates above the frequency of the received signal. Video response is shown in Fig. 5C; zero corresponds to the video carrier. The sound carrier is located in the area of the high video frequencies in the RF and IF response curves. The over-all characteristic curve shown in Fig. 5D always has this shape, regardless of calibration. If calibrated as RF or video frequencies, the frequency increases from video carrier to sound carrier; if calibrated in IF frequencies, the increase is from sound carrier to video carrier.

Certain bandwidths are required in a receiver to pass all the frequencies in the transmitted signals. First, the entire signal must pass unaltered through the RF amplifier; so it must have a bandwidth equal to the transmitted signal, or 6 MHz.

The IF bandwidth required depends on the receiver system being used. In a split carrier arrangement the sound signal may pass through a stage or two of video IF before being taken off. In such a case, the IF's which pass both the video and the sound signals must have a larger bandwidth than IF's which pass video alone. As a rule a video IF amplifier should have a bandwidth sufficient to cover all frequencies in the video region. In split-carrier receivers this would be 4 MHz.

In intercarrier receivers the entire video plus sound signals pass through all IF stages, and for this reason the IF's must have a larger bandwidth. It is common design practice to make the bandwidth of intercarrier receivers at least equal to the frequency separation between video and sound carriers, or 4.5 MHz.

The total width of the sound signal is only about 50 kHz, so the sound IF bandwidth need not be as great as the video IF's. In split carrier receivers the bandwidth may be comparatively broad, however, to compensate for local oscillator drift, which may cut off or distort the sound signal. The actual bandwidth varies from one receiver to another, but we can safely assume it is in the range of 150 to 250 kHz. Local oscillator drift is of no consequence in intercarrier receivers because the IF is determined by the separation between carriers, and this is held within $\pm.004$ at the transmitter. However, maintaining a broad bandwidth is desirable since it provides a linear operating slope at the detector. As a rule, the sound IF bandwidth is about 200 kHz. Of course the IF bandwidths described are simply optimum—some receivers may use wider or narrower ones.

Alignment Difficulties and Precautions

The individual alignment steps for any receiver are given in the manufacturer's service data. However, these brief instructions presume the service technician has some prior knowledge and experience in alignment techniques. We wish to provide you with the additional information needed to really understand the reason behind each step in the alignment procedure.

In the beginning, it is best to follow the manufacturer's alignment instructions to the letter. As you gain experience and learn the short cuts, the service data then becomes a valuable working guide.

Even after observing all precautions in connecting and adjusting the alignment equipment, you may run into trouble. One problem is that various oscillations and small waveforms sometimes appear on the response curve. One type of spurious response, termed "hash" (Fig. 6), is a very common occurrence. This is simply a poor signal-to-noise ratio in the receiver, caused by using a sweep signal of too low a level. Normally the sweep output signal should be kept low, but if "hash" shows up, try increasing the sweep signal level and reducing the vertical gain of the scope. (Be careful not to increase the signal to the point of overload.)

Another type of curve interference resembling hash is pickup from the vertical or horizontal deflection amplifiers of the receiver itself. The solution is the same as before—or as an alternative, disable the offending oscillator.

In the service shop, oscillation resembling a marker pip sometimes occurs because of stray radiation from the local oscillator of a nearby TV receiver. The obvious solution is to change channels or turn off the offending receiver.

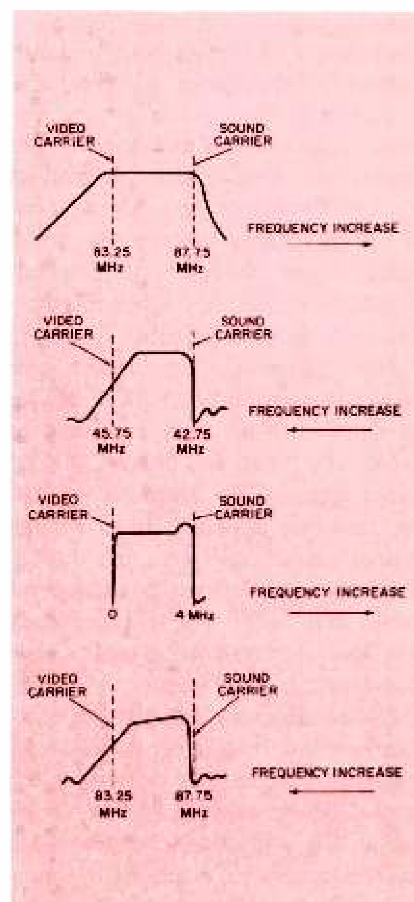


Fig. 5. Frequency increase graphs.

Oscillation in the video IF strip — caused by two stages aligned to the same, or nearly the same, frequency—produces the pattern in Fig. 7. Other possible causes are poor grounding, feedback through a test lead, stray coupling, or an open bypass capacitor.

As in most high-gain circuits, the video-IF amplifiers are highly susceptible to regeneration, a condition of in-phase (positive) feedback from the output to the input circuits. Regeneration greatly increases circuit selectivity and gain, and when it occurs, the normally rectangular IF response curve breaks down into a badly distorted waveform having one or more very high voltage peaks. (A VTVM connected across the video detector load resistor may read as high as 50 volts.) Even slight regeneration will peak the response curve at some frequency.

Because regeneration greatly changes the shape of the IF response, this in turn produces many effects on the screen. Some of these can be very misleading—loss of picture detail, ghosts, weak picture, smearing, negative picture, and herringbone stripes are just a few. The pattern varies with the frequency and amplitude of the regeneration. In many instances you can pinpoint the oscillating stage by bringing your hand close to each circuit and watching for changes in the over-all waveshape.

Since oscillation is most often caused by two IF stages tuned to approximately the same frequency, the first step in correcting the trouble is to align the entire IF strip. Follow the correct instructions, because there's a good chance someone before you didn't.

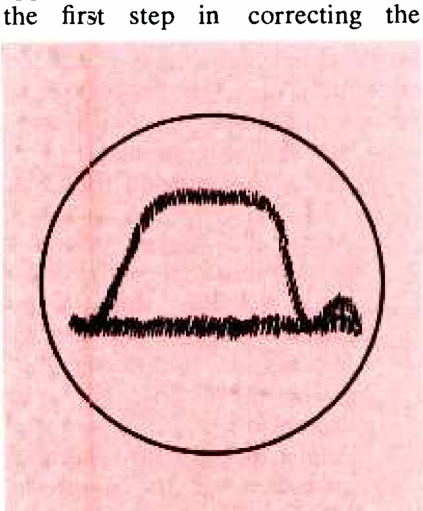


Fig. 6. A spurious response, called "hash," caused by too weak a signal or by pickup from sweep circuits.

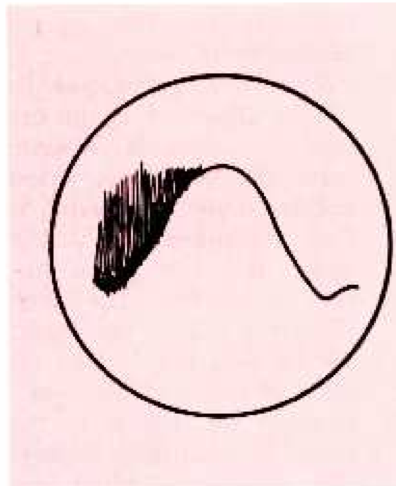


Fig. 7. Pattern produced by oscillation in the video-IF strip.

The first step is to disable each IF stage, except the last, by temporarily soldering a .005-mfd capacitor between the grids and ground. With the VTVM connected across the video detector load resistor, connect the marker generator to the grid of the last IF stage and peak-align it to the correct frequency. Remove the shunt capacitor from the grid of the next-to-last stage, connect the marker generator in its place, and align to the correct frequency. Repeat this procedure for each IF stage, working back from the video detector to the converter.

Misaligned Traps

Off-frequency traps can distort the response curve badly, as illustrated in Fig. 8. Here, a 41.25-MHz trap is misaligned to a point below the video carrier frequency. If some other factor such as narrow bandwidth were to further distort the response, the curve would probably be totally unrecognizable. If a curve similar to this appears, you can quickly identify the trap points by touching each trap with your finger. The added body capacitance will shift the trap frequency and cause the dip to move. Of course you won't know if the trap is off frequency or not until the marker signal is injected. One effect of an off-frequency trap is illustrated in Fig. 9.

When aligning an IF amplifier using overcoupled transformers, you may notice an unidentifiable dip, resembling that produced by a trap, on the response curve. This often baffling effect is produced when the sweep generator swamps out the effectiveness of the IF transformer secondary, while the primary (a resonant circuit) acts as an absorption trap. At the resonant frequency of the primary, some of the sweep signal is absorbed. This reduces the signal reaching the detector, and a dip therefore appears in the response curve. The position of the dip depends on the resonant frequency of the primary, and the exact effect on the curves varies. By shunting the primary with a capacitor of 200pf or so, the resonant frequency is lowered sufficiently to remove the trap effect and restore the curve to normal.

Miscellaneous

Regeneration, oscillation, or response-curve instability is sometimes the result of inadequate grounding. The most common of these is due to power line coupling. This is caused by the receiver and alignment equipment being at different ground potentials, so that feedback occurs between the equipment through the power line. Proper grounding is the only remedy.

Before tuner RF alignment is undertaken, two preliminary preparations—usually ignored or overlooked—should be made. First, to prevent curve distortion caused by hum and trap reflections from the IF strip, disable the video IF input stage by pulling the tube or shunting the grid to ground with a .005-mfd capacitor. The second step, though not always necessary, is to load the primary of the first IF transformer by connecting a resistor of approximately 270 ohms across it, to damp out resonance in the converter plate circuit. Always keep

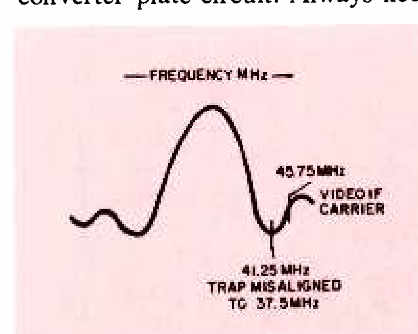


Fig. 8. Effect of a misaligned trap on the response curve.

the oscillator tube in the socket when the RF front end is being aligned. Otherwise, misleading curve distortion occurs if the oscillator bias is removed from the converter.

Practical Alignment Procedure

The following circuits and procedures are intended as a working guide to practical alignment methods, and may be adapted to any TV receiver. Keep in mind that the response curves encountered may differ considerably from the examples presented here, but the basic methods and the results obtained do not.

Checking RF-IF Response

1. Interconnect the alignment equipment as illustrated in Fig. 10, using the proper matching networks and an isolating resistor of approximately 10K in series with the scope's vertical input lead, shunted by a 330-pf capacitor. (The marker is coupled to the circuit by connecting the "hot" generator lead to the insulated body of the grid resistor.)
2. Turn the channel selector to the highest local channel and the fine-tuning control to a midrange setting.
3. Set the sweep generator to the same channel center frequency and the marker to the video IF carrier frequency.
4. Clamp the IF-RF AGC bus line with the bias voltage recommended.
5. Adjust the operating controls of the alignment equipment until you obtain a response curve of the proper shape and amplitude. Be careful to keep the sweep and marker signals low in order to prevent overloading. The video IF carrier marker pip should fall between the 40 and 60 per cent points on the slope.
6. Readjust the marker to the sound IF carrier frequency. The marker pip should now appear on, or disappear into, the sound trap dip on the curve. After the bandwidth of the first response curve has been checked, the marker can be readjusted to the video IF carrier frequency and left there throughout the remainder of the response check. The width of the other curves on other channels will indicate whether the bandwidth is satisfactory or not.

Check the response on each local channel, changing the sweep generator frequency at each step. Remember that the response will be different on each channel, but must always be within the limits outlined. If the response is not up to par on one particular channel, make a mental note to check its RF response later. If the video carrier marker is outside the specified limits (40 to 60 per cent of the slope) on one channel, check the local oscillator by varying the trimmer slug slightly. This will usually bring the marker pip into line.

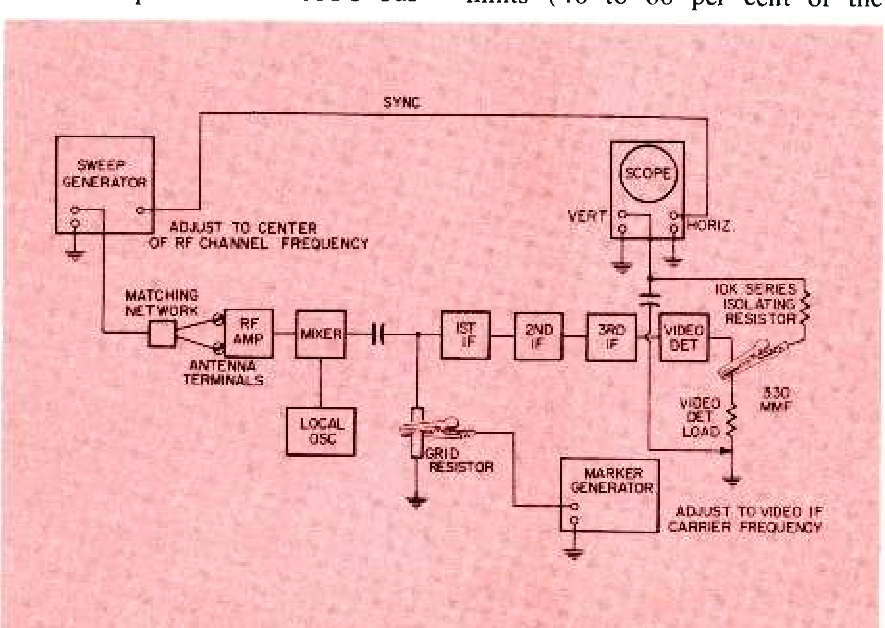


Fig. 10. Method of connecting equipment for checking RF-IF response.

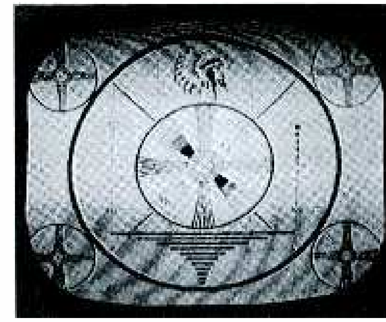


Fig. 9. Effect of an off-frequency trap on picture quality.

When the over-all response curve has the general shape of the IF curve on most of the channels checked, you can assume the video IF alignment is satisfactory. If not, check the video IF response by moving the sweep generator lead to the grid of the converter stage and adjusting the generator frequency to sweep the IF bandwidth. This circuit will probably need to be aligned.

Traps

Image and sound interference in the picture is a common problem, because of the position of the carriers in the channels, the circuit design of TV tuners, and the very nature of TV channel allocations themselves. To eliminate these problems, traps coupled to the IF circuits and tuned to the frequencies of the interfering signals are used. The traps absorb these signals from the IF signal before they reach the video detector. The procedure to use in trap adjustment is as follows:

1. Set up the equipment as in video IF alignment. (See Fig. 10.)
2. Adjust the marker generator to the exact frequency indicated for the trap to be aligned (this value usually appears on the circuit diagram, next to the trap symbol).
3. Adjust the trap for minimum indication on the scope or VTVM. If more than one trap is tuned to the same frequency, adjust each one for minimum output.

4. Increase the marker generator output slightly, and retune the trap (or traps) for minimum output.
5. Repeat the process at all trap frequencies, increasing the generator signal level at each until you have obtained the lowest output. Usually there are at least two different trap frequencies; nevertheless, the procedure for each is always the same.

Peak Alignment

If a receiver is too far out of alignment for ordinary sweep alignment touch-up, a procedure known as stage-by-stage sweep, or peak, alignment will be required. The setup for peak-aligning the video IF strip is illustrated in Fig. 11. Either the scope or the VTVM may be used as a peak indicator, or both may be used together. Using both provides a decided advantage; when you are making adjustments for minimum or maximum meter deflection, a look at the scope pattern will indicate the presence of any signal overload. However, the input signal must be modulated to provide the necessary scope deflection. Modulation is not needed when the VTVM is used alone, because it indicates only the DC voltage developed by the video detector.

Sound traps are generally aligned first. An important point to keep in mind, when aligning traps, is to use a reasonably strong signal. Switch the VTVM to the second lowest scale (3 or 5 volts) and adjust the marker generator output for nearly a midscale reading. In our hypothetical receiver of Fig. 11, we would adjust the first sound trap L7 for a minimum indication on the meter, and then adjust the second sound trap, L11. If you have trouble obtaining a definite dip on the meter when adjusting the first trap, detune the second trap until the meter indicates a higher reading, and then adjust the first for a minimum. If difficulty is still experienced, move the marker generator lead to the IF grid just ahead of the second trap and adjust it for a minimum reading. Reconnect the marker lead to the mixer stage, and then adjust the first sound trap. The meter should now indicate a definite dip in resonance.

Image traps L5 and L9 are adjusted next, using the same procedure. This should be followed by adjustment of adjacent channel video trap L3.

Before making any IF transformer adjustments, set the generator output to minimum and make certain the bias is set at the value recommended.

The service data for any TV receiver will specify that the coils be aligned in a certain order—usually the same as for our typical circuit (L8, L10, L6, and L4). Adjust the marker generator output frequency to that of L8, and increase the signal output until you obtain a legible meter indication. Then adjust L8 for maximum output. Repeat the procedure for remaining coils L10, L6, and L4. This completes the alignment of the traps and stagger-tuned coils.

However, overcoupled mixer-first-IF transformer L1 still remains. The simplest method of aligning L1 is from its response curve, using an RF probe as illustrated in Fig. 12A. The desired response curve is shown in Fig. 12B. Time and trouble can be avoided by using two alignment tools and simultaneously adjusting the overcoupled-transformer primary and secondary while observing the response curve. With a little patience and practice you will be able to tell if the curve is shaping up properly, and if not, which direction to make each adjustment to obtain the desired response.

A 270-ohm resistor is needed across the RF probe input to swamp out the first video IF plate coil because we do not want to see its response. The probe is connected to this point to isolate it from the first IF grid circuit and prevent loading, which would alter the resonant frequency of the transformer. The transformer response curve can be taken off the video detector without an RF probe, but first it is necessary to disable the other IF stages by shunting all coils with 390-ohm resistors. The traps need not be similarly disabled because their only effect is to add dips in the curve, as shown in Fig. 12C.

The response curve of any IF stage or combination of IF stages can be viewed by disabling the others with shunting resistors. Thus, stagger tuned IF amplifiers can be sweep-aligned if alignment data showing reference curves are available.

Step-Sweep IF Alignment

Step-sweep alignment is a little

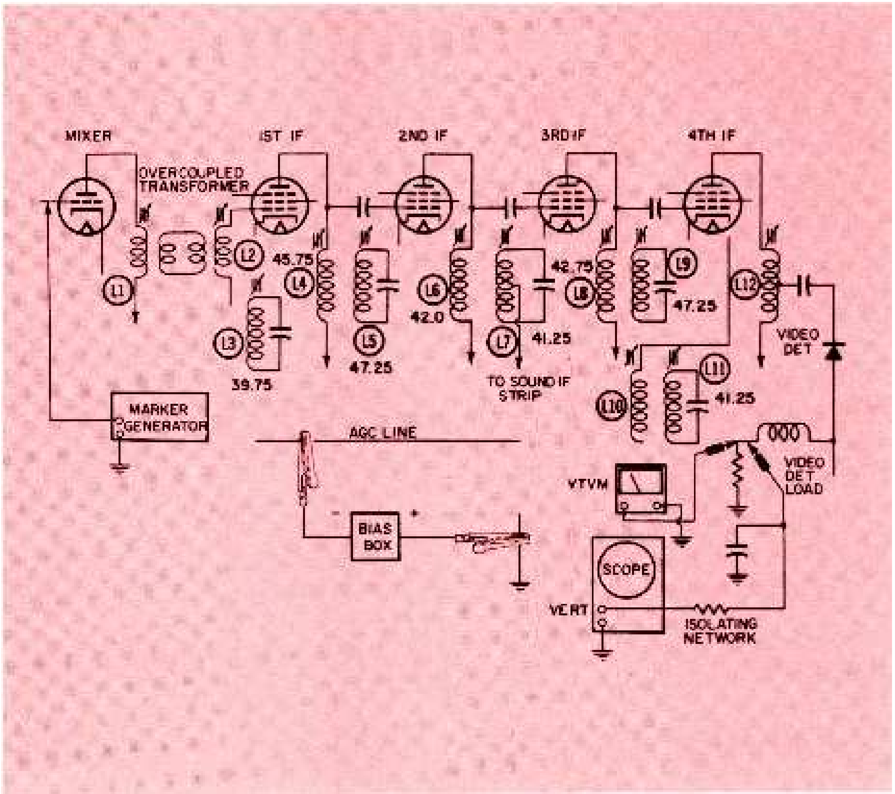
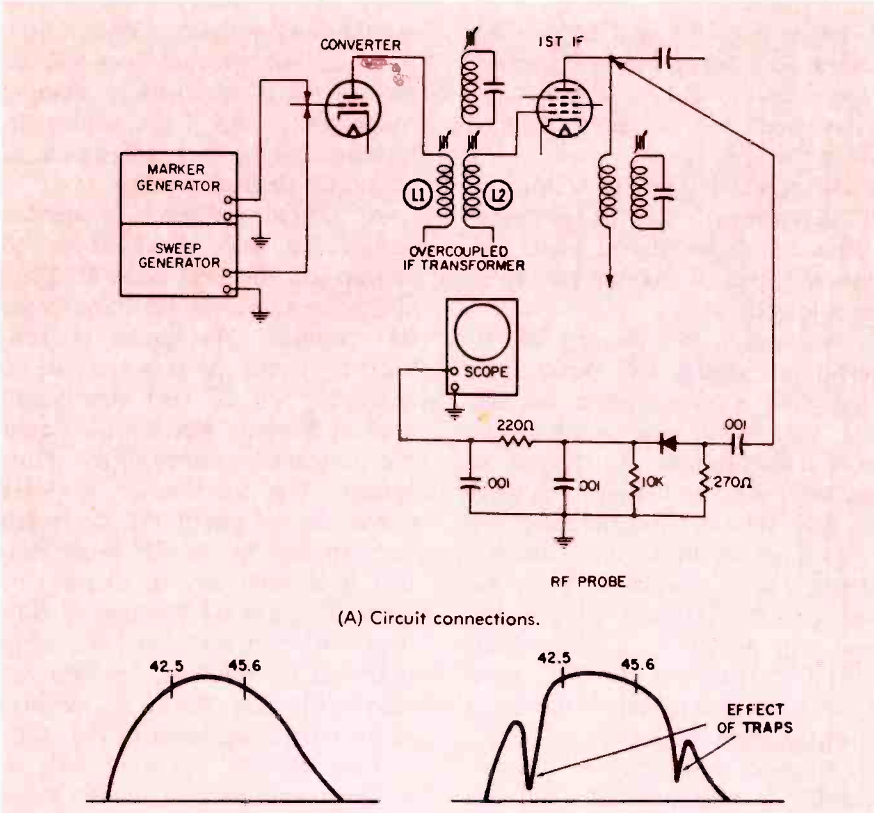


Fig. 11. Test setup for peak alignment of video-IF strip.



(A) Circuit connections.

(B) Curve seen with RF probe.

(C) Effect of traps.

Fig. 12. Using an RF probe to check the response of an overcoupled IF stage.

more complicated than peak alignment, but it is sometimes required in order to obtain the desired result. The equipment is interconnected as illustrated in Fig. 13. The marker signal is injected at the mixer stage, and the scope is connected across the video detector load resistor. The sweep generator lead, terminated with a series capacitor and shunt resistor, is connected to point *A* (the grid of the last video IF amplifier). The sweep generator output frequency is adjusted to sweep the entire IF bandwidth, and the marker is adjusted to 47.1 MHz (the first frequency to be checked). The video IF carrier frequency in this example is 46.6 MHz. To obtain the scope response shown by curve 1, adjust the last IF output circuit for a peak at the 47.1 MHz marker frequency. Set the marker output frequency to 43.75 MHz and adjust the transformer between the detector and last IF stage until you obtain a second peak. The curve on the scope should now resemble curve 1.

Readjust the marker generator to the frequency of the trap just ahead of the third video IF stage. Remove the sweep lead and turn on the 400-Hertz internal modulation of the marker generator. Adjust the trap for minimum modulation amplitude on the scope screen.

Reconnect the sweep lead to position *B* at the grid of the second video IF stage. Turn the sweep generator output attenuator to zero and increase the output until a usable curve is obtained without overloading. Turn the marker modulation off and readjust the output frequency to 43.75 MHz. Adjust the circuits between the second and third IF stages for a response resembling curve 2 but having the main peak at the marker frequency.

Again disconnect the sweep lead, retune the marker frequency to that of the first IF plate trap, turn the internal marker modulation on, and adjust the trap as before.

Most receiver manufacturers recommend aligning the sound IF strip at this time, because of interaction of the sound take-off transformer with the video IF coupling network. After completing the sound IF alignment, connect the sweep lead to point *C* and align the circuits between the first and second IF stages for a response similar to curve 3. There are no traps to be adjusted, so connect the sweep lead to point *D* and make final adjustments at the mixer output and at the input of the first IF stage for the over-all response of curve 4. The video carrier marker should fall near the 40 per cent point on the slope of the curve. ▲

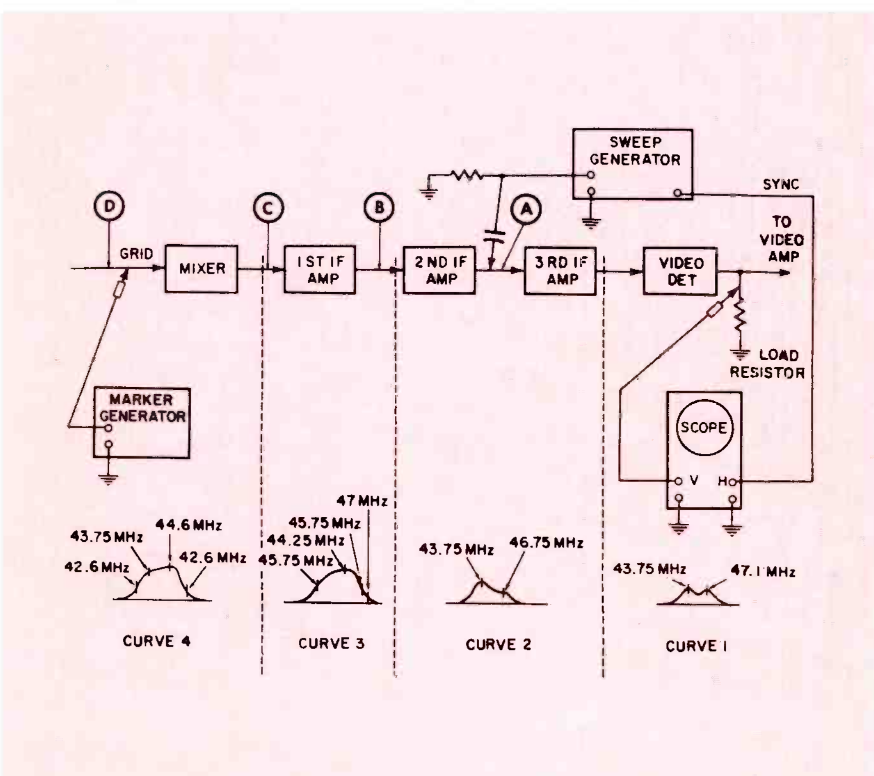
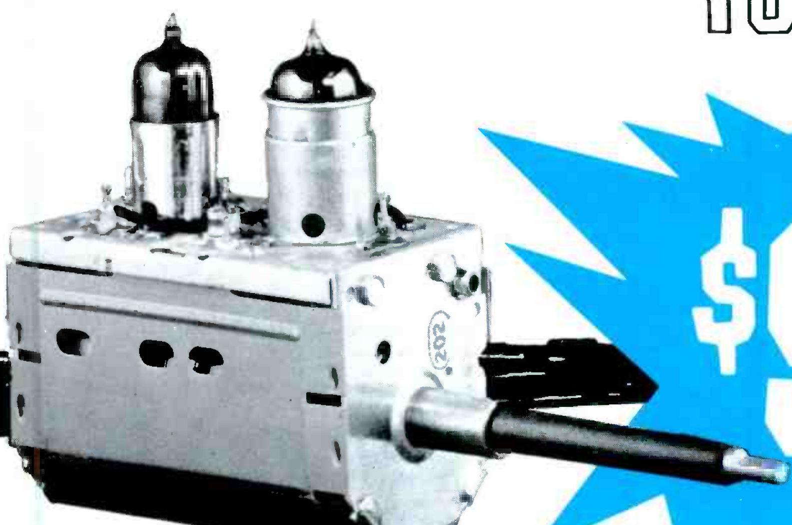


Fig. 13. Method of connecting equipment for step-sweep IF alignment.

Complete TUNER REPAIR for only $9.50



Sarkes Tarzian, Inc., largest manufacturer of TV and FM tuners, offers unexcelled tuner overhaul and factory-supervised repair service. Completely-equipped and conveniently-located Service Centers offer fast, dependable and factory-supervised repair service on all makes and models. Centers are staffed by well-trained technicians, assisted by engineering personnel.

Most Tarzian-made tuners received one day will be repaired and shipped out the next. More time may be required on other makes. Every channel—not just the channels existing in any given area—is checked and re-aligned per original specifications. Exclusive cleaning method makes the tuner look—as well as operate—like new.

Cost, including ALL labor and parts (except tubes) is only $9.50 and $15 for UV combinations. No additional charge. No hidden costs. Too, you get a full, 12-month warranty against defective workmanship and parts failure due to normal usage.

Always send TV make, chassis and Model number with faulty tuner. Check with your local distributor for Sarkes Tarzian replacement tuners, parts or repair service. Or, use the address nearest you for fast, factory-supervised repair service.

TSC

TUNER SERVICE CORPORATION

(Factory-supervised tuner service authorized by Sarkes Tarzian)

MIDWEST — 817 N. Pennsylvania St.
Indianapolis, Ind., Box 1642
Tel: 317-632-3493

EAST — 547-49 Tonnele Ave., Jersey City, N. J.
Tel: 201-792-3730

SOUTH-EAST — 938 Gordon St., S. W.
Atlanta, Georgia
Tel: 404-758-2232

WEST—
SARKES TARZIAN, Inc.
Tuner Service Division
10654 Magnolia Blvd.,
N. Hollywood, Calif.
Tel: 213-769-2720

Circle 2 on literature card

A HOWARD W. SAMS PUBLICATION

PF Reporter

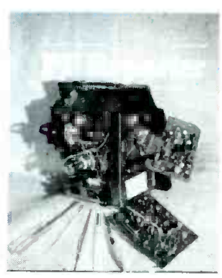
PHOTOFACT

the magazine of electronic servicing

VOLUME 17, NO. 6 JUNE, 1967

ABOUT THE COVER

Tomorrow is here! Not many years ago, the service industry awoke to the dawn of solid-state rectifiers in TV; something that was considered a part of the future had arrived. And so i* is today; yesterday's speculation of the future has suddenly materialized, as though impatient to be a reality. Completely solid-state b-w receivers, such as the portable on this month's cover, are commonplace. The application of integrated circuits in TV is now an accomplished fact. And what of yesterdays' future servicing techniques? Many of them can be found in an article beginning on page 36 of this issue.



2,365 reasons why Sprague Twist-Lok® Capacitors help you to protect your reputation

When you fool around with makeshift or "fits-all" capacitor replacements by substituting sizes and ratings, you leave yourself wide open for criticism of your work, you risk your reputation, and you stand to lose customers. With so much at stake, it just doesn't pay to use makeshifts when it's so easy to get exact replacement capacitors from your Sprague distributor.

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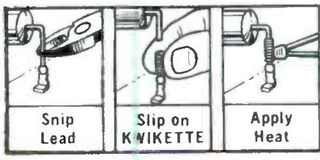

HAVE YOU TRIED KWIKETTE* CONNECTORS?
Not just another wire spring connector! Copperweld wire inner core, a layer of flux, and an outer coating of solder . . . all you supply is heat! They're now being included with all Sprague prepackaged wire-lead service-type capacitors at no extra cost to you!
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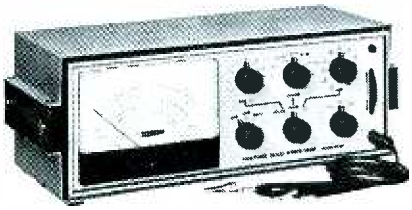


Kit IM-25 **$80.00** Assembled **$115.00**

NEW! Solid-State High Impedance Volt-Ohm-Milliammeter

• Solid-state design for solid-state measurements • All-silicon transistors plus FET's • Full scale ranges down to 150 mv & 15 uA • AC plus battery power for portability • 6" meter with zero center scale for + & — voltage measurements without switching • Accuracy ±3% full scale on DC volts, ±5% full scale on AC volts • New styling & unitized construction • Separate range switches for each function. 10 lbs.

World's Most Popular VTVM . . . Heathkit IM-11

Kit IM-11 **$24.95**

Assembled **$39.95**

• 7 AC, 7 DC, & ohms ranges — easy-to-read scales • 4½", 200 uA meter • 1% precision resistors for high accuracy • Extended frequency response, ±1 db 25 Hz to 1 MHz • Measures RMS and Peak-to-Peak • Single test probe for all measurements • Easy-to-build, electronically stable circuit board construction • Costs just 45c more than its predecessor of 16 years ago. 5 lbs.

Kit IM-13 **$32.95** Assembled **$49.95**

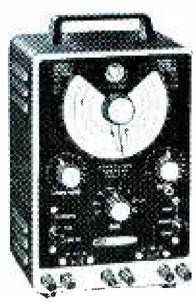
Service-Bench VTVM . . . Ideal For In-Shop Servicing

• Measures AC volts (RMS), DC volts, resistance & db • Separate 1.5 & 5 volt AC scales for high accuracy • Large, easy-to-read 6", 200 uA meter • Zero center db scale • Single test probe for all measurements • Gimbal bracket for bench, shelf or wall mounting • Smooth venier controls for zero & ohms adjust • 1% precision resistors. 7 lbs.

Mutual Conductance Tube Tester

Kit TT-1A **$149.95**

• No finer tube tester anywhere • Indicates Gm to 24,000 micromhos • Ultra-sensitive grid current test • Built-in switch-operated calibration circuit for high accuracy • Built-in adaptor for testing Compactron, Nuvistor, Novar & 10-pin miniature tube types • Includes handsome, easy-to-carry cabinet with handle. 33 lbs.



Capacitor Checker . . . A Direct Reading Bridge

Kit IT-11 **$29.95**

• Tests all capacitor types • Low bridge voltage for safe testing of miniature electrolytics • 16 leakage testing voltages • Direct reading scales — no involved calculations • Measures resistance from 5 ohms to 50 megohms • Measures capacitance from 10 pf to 1000 uf • Comparator circuit — measures "L", "C", or "R" with external standard • "Eye" tube null & leakage indicator. 7 lbs.

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Lab Transistor Tester Provides Complete DC Analysis

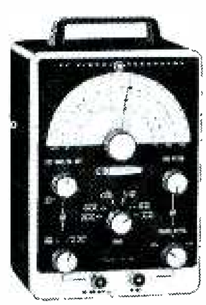
• Ideal for servicing, design work, incoming inspection, production testing, etc. • Provides complete DC analysis of PNP & NPN transistors to 15 amps • DC gain (Beta, Alpha) read direct on calibrated scales • 15 uA basic range for leakage (Icbo, Iceo) tests • Four lever switches for fast, easy test selection • Internal battery supply, provisions for external power. 10 lbs.

Kit IG-112

Was $99.00 Now Only **$69.00**

NEW LOW PRICE! Now Save $30 On FM Stereo Generator

• Provides virtually all signals required for trouble-shooting & alignment of multiplex adaptors, FM tuners & receivers • Switch selection of 400 Hz, 1000 Hz, 5000 Hz, 19 kHz, 38 kHz and 65 kHz or 67 kHz SCA signals • Built-in marker oscillator for I.F. and dial tracking checks • 100 MHz sweep signal (adjustable ±2 MHz) for overall RF & IF alignment on clear area of FM band. 11 lbs.

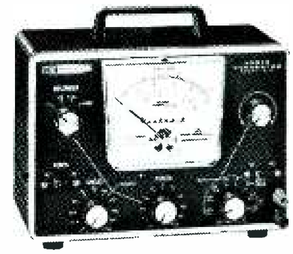


General Purpose RF Signal Generator

Kit IG-102 **$27.95**

Assembled **$54.95**

• Covers 100 kHz to 220 MHz in six bands • Large, accurately calibrated dial scales • Factory wired and aligned coil and band-switch assembly • Modulated or unmodulated RF output up to 100,000 microvolts, controlled by both fixed-step or variable output attenuators • 400 Hz signal modulation and 400 Hz audio output for audio tests • 2% tuning accuracy. 7 lbs.

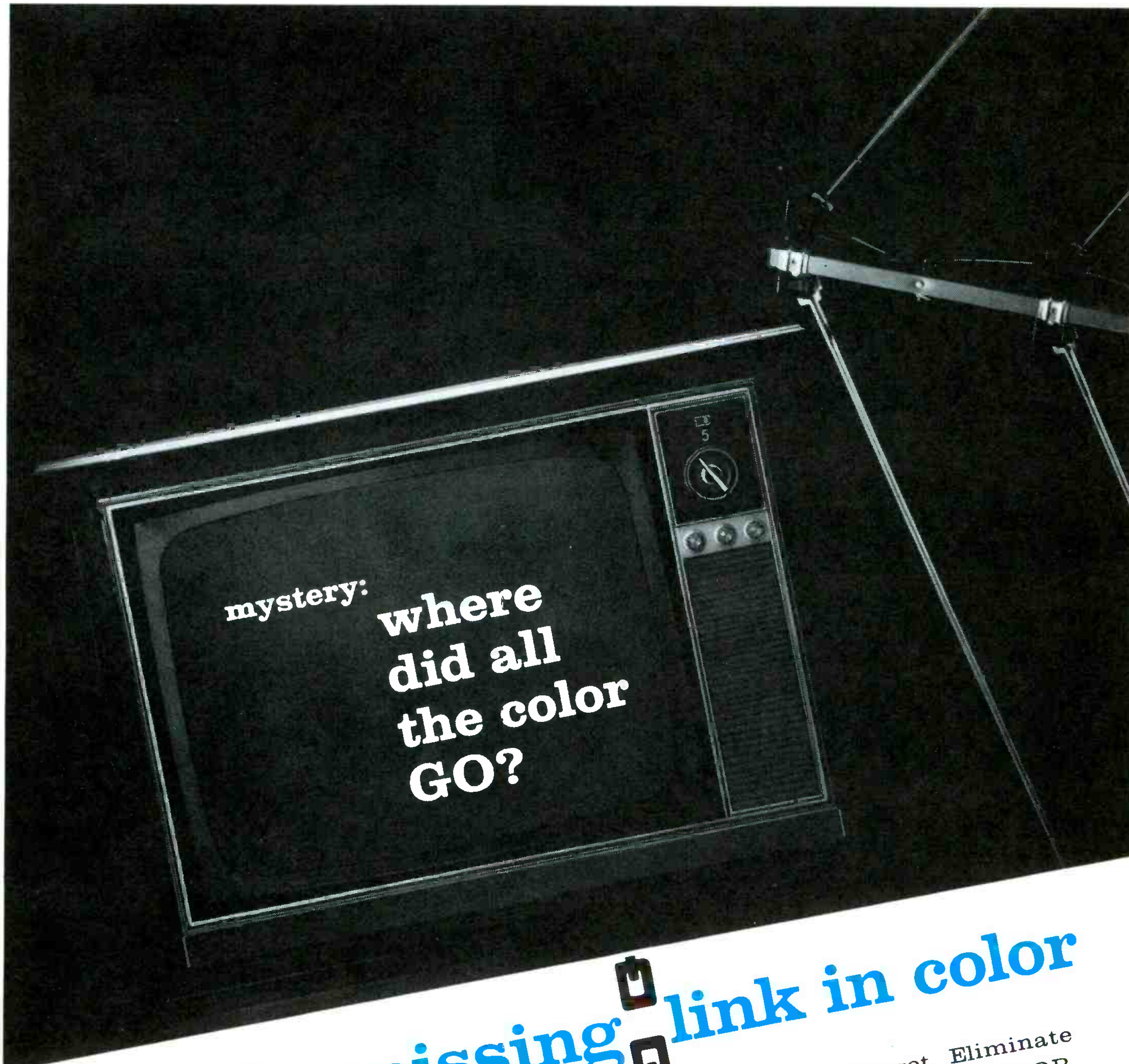


Kit IG-72 **$41.95**

Assembled **$64.95**

Switch-Selected Audio Generator for Near Perfect Sine-Wave Signals

• A near perfect output signal — ideal for servicing or trouble-shooting high fidelity equipment • Switch-selected output frequencies — 10 Hz to 100 kHz • Less than 0.1 of 1% distortion — 20 to 20,000 Hz • Panel metered output is calibrated in volts and db • Output level and frequency accurate to within ±5% • 200 uA meter plus precision resistors for high accuracy. 9 lbs.



here's the missing link in color

Belden's Color Guard Twins deliver full color power all the way to the set. Eliminate many causes of lead-in signal loss. Deliver a ghost-free picture. ■ Belden's COLOR GUARD TWINS are: 8290†† Shielded Permohm with Beldfoil* for congested or high interference areas; and 8285† Unshielded Permohm for rural, low-signal-strength areas. ■ 8290 with patented Beldfoil shielding prevents line pick up of interference signals that produce ghosts and electrical interference. 8285 Permohm's conductors are encapsulated in low-loss cellular polyethylene to maintain a strong signal in all weather conditions, especially in fringe reception areas. ■ 8290 Shielded Permohm is designed so that you can install it without expensive transformers, connectors, and "stand offs." You can even tape it to a mast or run it through a rain gutter. ■ With Permohm lead-ins, the set gets the full color power of the signal (full power for UHF or VHF, too.) Now owners can get the kind of picture they bought a color set for. You get the laurels.

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*Belden Trademark Reg. U.S. Patent Office †Belden Patent No. 2,782,251 ††Belden Patent No. 2,782,251 and Pat. Pending

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New low cost.
New ease of operation.
No waiting. No warm-up.
No adjustments.
Brightest patterns in the industry.

The B&K 1242 Color Generator is all bu$ine$$!

There's nothing else like it. The all-new B&K 1242 represents the highest state of the art today. Go ahead and compare it; it's unique.

Ultrastable solid-state circuits make antiquated heating elements unnecessary. The 1242 works instantly in all service environments—no waiting, no warm-up, no adjustments. Other units have up to 3 times as many front panel controls. For ease of operation, the 1242 has just two: color level and selector switch. It provides dots, crosshatch, horizontal or vertical lines, and color bars. And these are the sharpest, brightest patterns in the industry.

The 1242 handles easily, too. It's the smallest, lightest-weight color generator! Rugged, too; it's all steel with storage space for leads. It's transformer powered and complete with leads. Calls take less time and you make more money, because you can go from a cold or hot truck into a home and get right to work.

On every count, the new B&K 1242 is amazing. In time saved, it will pay for itself in just a few weeks—especially at this low price: **$99.95**

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Where Electronic Innovation Is A Way Of Life

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THE ELECTRONIC SCANNER

news of the servicing industry

Industry Outlook

The annual sales dinner held by **Amperex** preceding the IEEE Show featured a talk by Mr. Frank Randall, President of Amperex. He indicated his displeasure with the pessimistic outlook affecting certain segments of the Electronic Industry.

Mr. Randall stated, "One can only view the present scene with surprise. One cannot expect that the electronic industry will maintain the growth rate it achieved in '66 . . . but to view the immediate future with anything but optimism is ridiculous."

"First," he said, "let's look at the color TV market. Last year the industry sold approximately 4.7 million color TV receivers . . . a mighty jump over the preceding year. But, when we look at the impact of color and its potential, we've only scratched the surface of the market. Sure, some of the early projections of 7 million plus sales in '67 may have been overly optimistic. Maybe the industry will sell only 6 million or even 5.5. What's wrong with that? It's more than last year—and last year was the best we had."

His most challenging remarks were expressed at the conclusion of his talk.

"How," he asked, "can any member of the electronic industry— be he a sales representative or a component manufacturer—view the immediate future with pessimism? There's no part of our daily lives untouched by the dynamic effect of electronic products. Sure, we reach a stage from time to time when one product or another has a slowdown in sales. But, for every one of those, there are two new ones to take its place. My advice is, let us not be concerned about the market. It's there! Let us just be concerned about our share of the market."

New License Law

Indiana has passed a License Law for TV repairmen, to take effect next year. It will require TV repairmen and antenna installers to acquire a license, with the usual testing and "grandfather clauses."

The law has regulatory and penalty clauses designed to protect the consumer from dishonest or incompetent repairmen, and should help "upgrade the image" of Indiana's TV servicemen.

Other states having license or regulatory laws for TV men include California, Connecticut, Louisiana, and Massachusetts. Several cities have similar laws on their books.

Solid-State Color TV?

Rumors are heard from many sources that a completely solid-state color TV receiver will reach the market very soon. We are investigating these stories and will have some solid (state) information in next month's issue.

Receives Award

St. Regis Paper Company recently awarded the Cartonologist Award of the year to the **Oaktron** rear deck speaker kit package. Named as a "unique point-of-purchase package," the Oaktron kit won the award in competition with thousands of cartons.

To Open Training Centers

Permanent training centers to help cope with the serious shortage of experienced television technicians are being established by the **RCA Service Company** in six key metropolitan areas, according to president A. L. Conrad.

Mr. Conrad said the project, first of its kind in the television industry, will enable the RCA Service Company to train some 2,500 technicians in the coming year, twice as many as it trained in 1966. He estimated that 25,000 additional color TV service technicians will be required by the industry in each of the next five years because of the tremendous growth of color television.

The training centers are expected to be operating by mid-summer in New York, Philadelphia, Miami, Chicago, Detroit, and Los Angeles. Both present and newly hired employees will take part in the program.

Several different training courses will be conducted at the new centers, including instruction in servicing, color television, basic TV, and commercial products as well as bench service work and overall refresher courses in servicing. It was emphasized that the courses planned by the RCA Service Company would not be "quickie" courses, but would range up to four weeks in duration.

Light Knife

A new "light knife" has been constructed which allows surgeons to use the focused beam of a laser as easily as they would a scalpel. The device was developed by a group of engineers and scientists at **Bell Telephone Laboratories** to help the medical profession evaluate laser surgery.

The new device guides the beam from the laser source through a hollow, jointed arm to a small probe which is held like a scalpel. The probe is about the size of a fountain pen and can be moved easily in any direction by the surgeon. The probe may also be attached to a surgical microscope for more delicate operations. In this case the beam is transmitted through the microscope, which can be positioned by the surgeon.

Until now, laser devices used in medical experiments did not provide much freedom of movement. Flexibly mounted spherical mirrors or fibre optic systems are used at present to transmit the laser beam to the patient.

One reason laser surgery is of interest is that, according to many medical experts, the light from some lasers, such as the argon ion laser developed by Bell Labs, may cauterize a wound as it cuts, thus stopping the loss of blood—a serious concern in operations near vital organs.

Consolidated net income of **Oak Electro/Netics** increased 81% in 1966 on a sales rise of 23% over the preceding year announced E. A. Carter, president and chairman.

Net income, highest in O/E/N's history, amounted to $2,694,606 for the year ended Dec. 31, compared with $1,492, 712 in 1965. Consolidated net sales totaled $67, 312, 021, also a record, compared with $5,624,-884 in 1965.

Zenith Radio Corporation sales and earnings during the year ended December 31, 1966 were the highest in the Company's history, Joseph S. Wright, President, announced in a preliminary report to stockholders. This marked the sixth consecutive year in which both sales and earnings set new records and the ninth time in ten years that increases were shown over the preceding year.

Consolidated net income was $43,474,626.This represents a 30% increase over the 1965 record earnings of $33,553,069. The earnings increase was achieved despite the burden of major preproduction and start-up expenses at the new Melrose Park color picture tume manufacturing facility.

Consolidated net sales for the year rose to an all-time high of $625,003,460, 33% over the previous record of $470,503,343 reported for the year earlier. Sales for the fourth quarter were the highest of any quarter in Zenith's history. ▲

LETTERS TO the EDITOR

Dear Editor:

Just received the April issue of PF REPORTER and it is very good. The article on troubleshooting with the scope is very good because it helps a fellow on his troubleshooting when he is not sure about how the waveforms should look.

Your Tube Substitution Supplement is also very good. I have Vol. 10 and immediately put the supplement in it. However, there is one tube I am looking for. This is a 12B-B14 tube used as the horizontal output in Muntz TV. I can't find a replacement for this tube and Muntz has it back-ordered. Can you help me?

F. KLEIN

Pittsburgh, Pa.

The 12B-B14 is a Japanese tube and specifications for Japanese tubes are extremely hard to get. We have written many letters and had answers to only a few. We'll continue trying and hope to include these in our Tube Substitution Supplement. —Ed.

Concordia, Kansas

Dear Editor:

The method of "tangent convergence" in the December, 1966 PF REPORTER for obtaining the net resistance of resistors in parallel will never fail because it follows the law of adding reciprocals and then finding the reciprocal of the addition, namely:

$$\frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3} = \frac{1}{Rt}$$

Tangents and cotangents are reciprocals, that is $1 \div \text{cotan} = \text{tan}$ and $1 \div \text{tan} = \text{cotan}$.

Obviously, a table of reciprocals would be more usable than a table of tangents and cotangents. However, a Tan-Cotan table may be used in a better way.

Cotan 4.0008 has tan	.249946
Cotan 8.0094 has tan	.124852
	.374798

Tan .374879 has Cotan 2.667522

The above is more direct than "tangent convergence" described in PF REPORTER.

W. MISIEK

SCOPE or METER which ?

A tough decision? If you like lady luck, flip a coin. But, if you want to make your decision a choice instead of a chance, read the facts presented here.

by Robert G. Middleton

Every service technician, at one time or another, has been faced with this decision. To make the most correct choice of test instrument requires an understanding of the advantages and limitations of the many types of test instruments currently available. Because the meter and scope are considered primary test instruments and are used more often than other types of test equipment, this article will discuss the relative merits of each in an attempt to help the technician make a better choice.

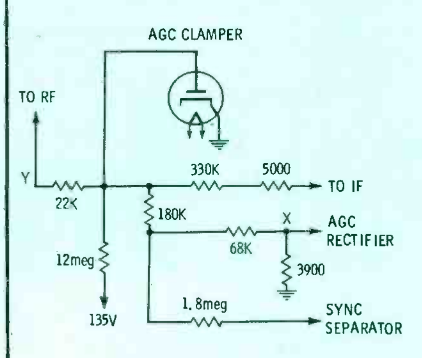
Meters

When the radio-servicing profession started in 1921, few meters were available and scopes were a laboratory curiosity. It was chiefly due to the demands of radio technicians that steady and significant progress was made in meter design. Today, the most sensitive meter movement has a full scale current value of 1 microampere, or a sensitivity of 1,000,000 ohms-per-volt. This DC meter is used only in laboratories. Most service technicians use the VTVM to obtain high input resistance on low-voltage ranges. For exampe, a 1,000,000 ohms-per-volt VOM has an input resistance of 1,000,000 ohms on its 1-volt range; on the other hand, a service-type VTVM has a typical input resistance of 10,000,000 or 20,000,000 ohms on its 1-volt range.

High input resistance is desirable when making DC voltage measurements in circuits that have high internal (source) resistance. This fact is illustrated in Fig. 1. The internal resistance of a circuit often differs greatly from one test point to another. Moreover, the input resistance of a VOM differs considerably from one range to the next. Hence, circuit loading is often a complex problem in practical service situations. As shown in Fig. 1B, the measurement error at a particular test point in an AGC circuit can vary from 78% to 15%, depending upon the VOM range that is used.

DC voltage measurements in high-resistance circuits are more accurate with a VTVM. With an input resistance of 10 or 20 megohms on all DC voltage ranges, the internal resistance of radio and TV circuits can be disregarded, with a few minor exceptions. One exception in routine service tests occurs when a bias system is defective because of an open circuit. In such a case, the operating bias is due to so-called contact potential. Since a contact-potential bias voltage has an extremely high source resistance, tube operation changes greatly when an attempt is made to measure the bias voltage, even with a VTVM.

On the other hand, if a cathode circuit is open, the source resistance is quite low and the cathode voltage is abnormally high. This is a tricky defect that burns out many VOM's, because the operator attempts to measure the cathode bias voltage on a low range. A meter movement is fragile and cannot withstand substantial overloads. The moving coil in a 20,000 ohms-per-volt VOM may be wound with 1500 turns of wire that is finer than a human hair. A coil resistance of 2000 ohms is typical. This coil rotates in an air gap of less than 0.1" with a magnetic field strength of about 2500 gausses. This is 5000 times greater than the strength of the earth's mag-



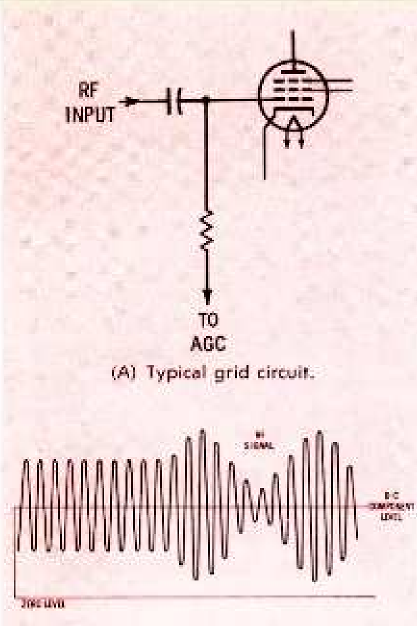
(A) Internal resistance less at X than at Y.

(TRUE AGC VOLTAGE IS -7.8 VOLTS)

RANGE (VOLTS)	INDICATION (VOLTS)	ACTUAL ERROR (%)
2.5	-1.7	78
10	-4.1	47
50	-6.6	15

(B) Voltage error using VOM.

Fig. 1. Voltage measurement in an AGC circuit.



(A) Typical grid circuit.

(B) Signal at grid.

Fig. 2. Measuring voltage at grid with VOM bypasses RF to ground.

netic field that deflects a compass needle.

A VTVM is safer to use in trouble situations than a conventional VOM. Because the tubes in a VTVM operate at comparatively low plate voltage, they will saturate and limit the current flow through the meter movement in case of a substantial overload. However, some VOM's are now available that provide meter protection in the form of silicon-diode shunts. With this protective feature, a VOM is essentially as safe to use in trouble situations as a VTVM. Nevertheless, a VTVM always provides higher input resistance on low-voltage ranges. Conversely, a good VOM provides higher input resistance on high-voltage ranges.

Input Capacitance

Early in the development of VTVM's, it was recognized that input resistance was not the only figure of merit for a DC voltmeter. The reason for this is that most radio circuits operate on the basis of pulsating DC. This means that an AC component rides on the DC voltage level. For example, Fig. 2 shows a grid circuit and an RF signal riding on the DC bias level. If we shunt appreciable capacitance from grid to ground, the RF signal will be bypassed to ground. In turn, there is little or no signal developed in the plate circuit when the meter is connected to the grid terminal of the tube. Of course, this disturbs circuit action and the AGC voltage falls to a low value. Therefore, a grid-voltage measurement would be in error simply because the input capacitance to the meter "kills" the RF signal that determines the AGC bias voltage.

A VOM has a substantial input capacitance. For example, a 100,000 ohms-per-volt VOM has from 15 to 40 pf of input capacitance, depending on how far its test leads are separated. At 100 MHz (a typical FM radio frequency), 40 pf has a reactance of about 40 ohms. If we connect a 40-ohm resistor from grid to ground in the circuit in Fig. 2A, it is obvious that the circuit will not operate normally. To prevent such loading, a VTVM commonly employs a 1-megohm probe, as shown in Fig. 3. The purpose of the series resistance is to reduce the input capacitance of the VTVM. This probe has an input capacitance of approximately 2 pf, producing an input impedance of about 750 ohms at 100 MHz.

An input impedance of 750 ohms might seem to be objectionably low; however, circuit capacitance is always greater than 2 pf. Moreover, in RF circuits, the capacitance is resonated by a coil or tuned transformer. Therefore, we are primarily concerned with the **detuning** effect of the DC probe. Since the 2 pf of probe capacitance is only a small fraction of the grid capacitance, its detuning effect is slight. Therefore, we can use a VTVM to measure the grid bias voltage in a 100-MHz stage without appreciably detuning the stage.

Frequency Response

Beginners occasionally encounter

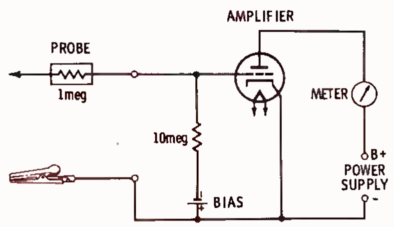
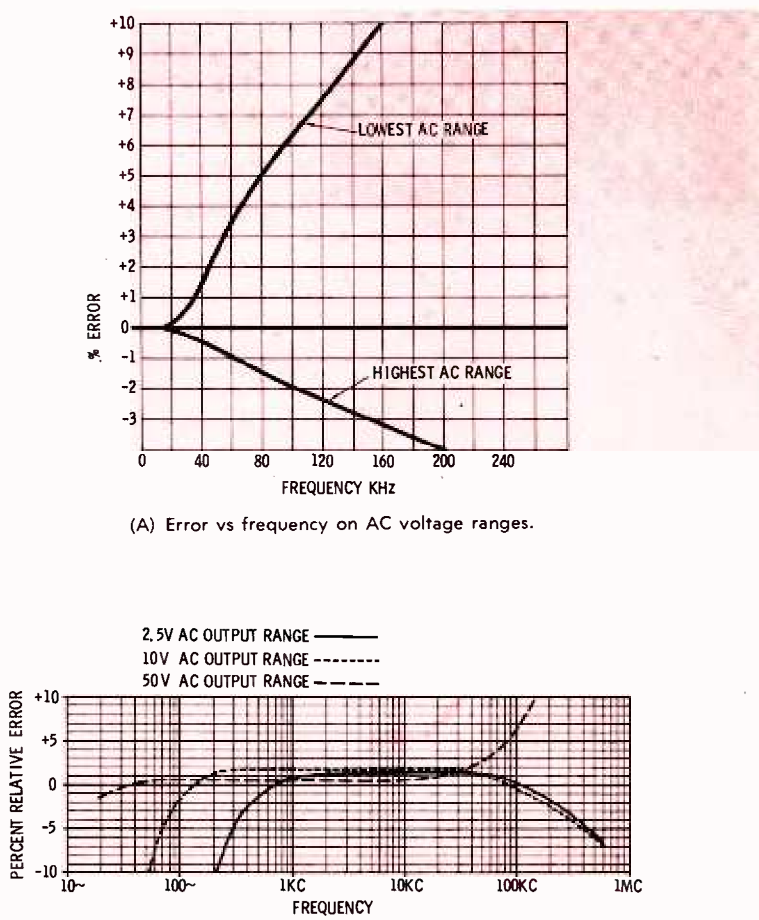


Fig. 3. Input circuit of VTVM using 1-megohm probe.



(A) Error vs frequency on AC voltage ranges.

(B) Error vs frequency on output function.

Fig. 4. Error versus frequency using VOM.

	METER RESPONSE	SCALE READING
SQUARE WAVE	PEAK	0.707P
	1/2 WAVE AVERAGE	1.11P
	FULL-WAVE AVERAGE	1.11P
SAWTOOTH WAVE	PEAK	0.707P
	1/2 WAVE AVERAGE	0.555P
	FULL-WAVE AVERAGE	0.555P
1/2 RECTIFIED SINE WAVE	+ PEAK	0.707P
	1/2 WAVE AVERAGE	0.707P
	FULL-WAVE AVERAGE	0.354P
FULL RECTIFIED SINE WAVE	PEAK	0.707P
	+1/2 WAVE AVERAGE	1.414P
	FULL-WAVE AVERAGE	0.707P

Fig. 5. Different VOM circuit responses to various waveforms.

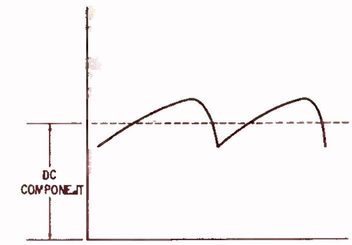


Fig. 7 Ripple is nonsinusoidal.

difficulty in troubleshooting procedures because they do not recognize the frequency limitations of typical voltmeters. Practically all VOM's measure AC voltages accurately over the audio-frequency range. However, if an attempt is made to measure the output of an audio oscillator or high fidelity amplifier at frequencies above 15 KHz, an appreciable error may occur, as illustrated in Fig. 4A. In this example, a measurement at 160 KHz on the lowest AC range results in a +10% error. On the highest AC range, an error of −3% occurs at 160 KHz. This is a curious type of error, caused by the fact that the moving coil of a meter has both inductance and distributed capacitance, plus the series resistance that is connected to the coil on various ranges. On the lowest AC range, a resonant rise occurs at frequencies above 15 KHz, causing the scale indication to read high. On the other hand, the Q of the meter system is so low on the highest AC range that the distributed capacitance is dominant and the scale indication reads low above 15 KHz.

When the output function of the VOM is used, additional factors enter into the test situation because a series capacitor is then connected in the VOM circuit. The reactance of the series capacitor attenuates the meter response at 1 KHz, 200 Hertz, and 30 Hertz (Fig. 4B). Resonance effects over the mid-band frequencies produce an error of 1 or 2%. Above 15 KHz, the errors are substantially the same as on the AC voltage function of the VOM. It is evident that a VOM cannot be used to measure accurately the AC voltages in a radio transmitter or the output from an RF generator.

The AC and DC voltage functions of a VOM have about the same input capacitance. However, the AC ranges of a VOM have less sensitivity than the DC ranges. Thus, 20,000 ohms-per-volt sensitivity on DC ranges might be accompanied by 1,000 ohms-per-volt sensitivity on AC ranges. There is a trend toward higher sensitivity on AC ranges. Some modern VOM's provide a sensitivity of 5,000 ohms-per-volt on AC ranges. In any case, the AC ranges of a VOM will load a circuit more than its DC ranges. However, a VTVM provides the same basic advantages for AC voltage measurements that it does for DC.

The input resistance and capacitance of a VTVM change from one AC voltage range to another. Note the following input values for a typical VTVM:

(1) 1.5-, 5-, 50-, and 150-volt

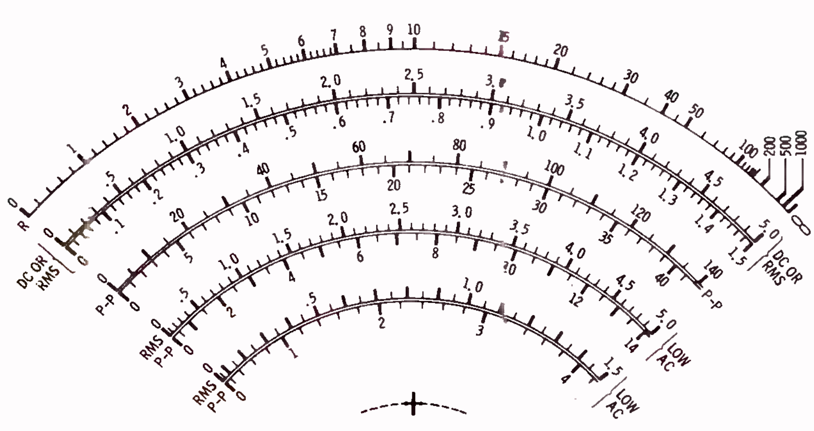


Fig. 6. Typical VTVM scale.

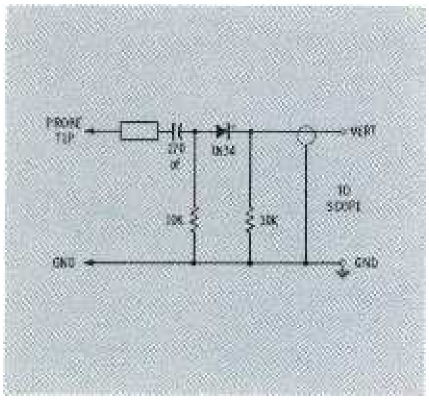


Fig. 8. Typical demodulator probe used with a scope.

ranges: 0.83 meg shunted by 70 pf.

(2) 500-volt range: 1.3 meg shunted by 60 pf.

(3) 1500-volt range: 1.5 meg shunted by 60 pf.

Also, the frequency response of a VTVM is generally much better than that of a VOM. For example, the AC ranges of a typical VTVM have a frequency response from 30 Hertz to 3 MHz. Therefore, we can use a VTVM to measure the output from an audio oscillator over its entire frequency range, or the output from an AM signal generator or RF voltages in many transmitters. Note that any VOM or VTVM can be used with a suitable high-voltage probe to measure DC voltages up to 25,000 volts. Some VTVM manufacturers also provide capacitance-divider probes which permit measurements of high AC voltages.

Waveform Errors

Any VOM will give erroneous AC voltage measurements unless a pure sine wave is applied. In other words, a sawtooth voltage, square-wave voltage, the output voltage from a rectifier, or the ripple voltage from a power supply cannot be measured accurately with a VOM unless a suitable correction factor is used. The correction factor depends not only on the waveform of the AC voltage, but also on the meter circuit. Some VOM's use half-wave rectifiers, while others use full-wave circuits. These factors are summarized in Fig. 5 for some common waveforms encountered in service work.

For practical applications, we need only remember that a VOM will give an erroneous indication if the waveform is not a sine wave. For example, if a defect in an audio amplifier distorts the sine-wave signal, we cannot rely upon voltage measurements with a VOM. Nevertheless, VOM readings will give us a general idea of the AC voltages at various points in the amplifier circuit. When we are concerned with nonsinusoidal waveforms, it is customary to state the AC voltage values in peak-to-peak volts and to make no attempt to measure RMS voltages. Nearly all modern VTVM's measure p-p AC voltages. Let us consider a practical example.

Fig. 6 shows the p-p and RMS scales for a typical VTVM. The p-p voltage of any waveform can be measured with reference to the p-p scales. The RMS scales indicate correct voltage values only for sine waves. Thus, we can use the RMS scales only in situations where a pure sine-wave voltage is present. For sine waves, the p-p voltage is 2.83 times the RMS voltage. This is the relation between the p-p and the RMS scales of the meter in Fig. 6. If we measure a ripple voltage from a power supply, we must read its p-p voltage because its waveform is nonsinusoidal, as shown in Fig. 7.

The RMS voltage of a sine wave or any nonsinusoidal wave can be measured, if we so desire, with a true RMS voltmeter. Some VOM and VTVM manufacturers offer various types of true RMS meters. The electrodynamometer type is best suited for service use because it does not burn out as easily as a barretter-type instrument. Also, true RMS voltmeters and ammeters almost always provide a real-power (wattmeter) function. We can use this wattmeter function to make accurate measurements of power drain and power supply efficiency in any type of electronic equipment. Efficiency is simply the ratio of output power to input power, with both factors expressed in true RMS values.

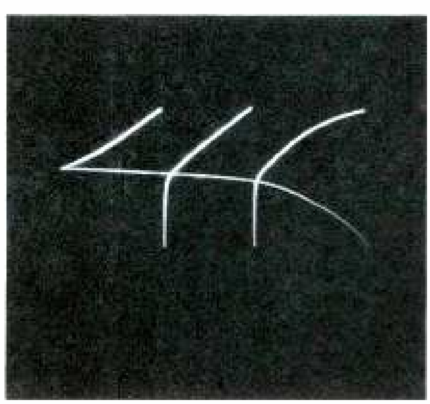


Fig. 10. Effects of poor horizontal linearity on deflection waveform.

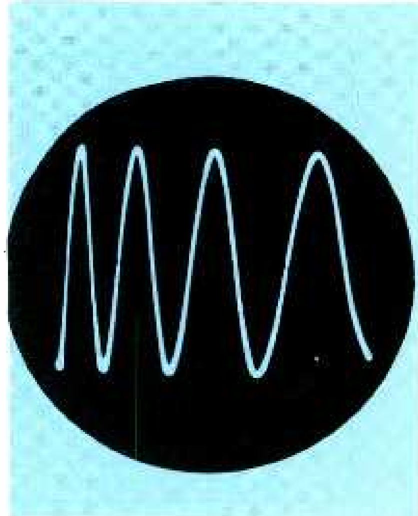


Fig. 9. Poor horizontal linearity cramps sine wave.

Advantages and Limitations of the Scope

As with meters, each type of scope has certain advantages and limitations. Some scopes are more sensitive than others. High sensitivity is an advantage when testing in low-level circuits. For example, if we are using a demodulator probe to signal trace an IF amplifier, high vertical amplifier sensitivity is required to obtain a useful amount of deflection from the tuner output and first IF stage. The circuit for a typical scope demodulator probe is in Fig. 8.

Some scopes have greater bandwidth than others. However, all scopes respond over the audio frequency range. Hence, we can use any scope to check audio amplifier waveforms. It is desirable that the scope have good horizontal linearity; otherwise, a sine wave appears cramped at one end, as illustrated in Fig. 9. If we use the same scope to check a peaked sawtooth deflection waveform in a TV receiver, the waveform will appear distorted, as shown in Fig. 10. Obviously, it is difficult to evaluate waveforms properly when a scope has poor horizontal linearity.

Since both p-p voltages and waveforms are a measure of a circuit's condition, we need to measure these voltages on the scope screen. The majority of present-day service scopes have built-in p-p voltage calibrating facilities. This speeds up voltage measurements considerably. If a scope does not have calibrating facilities, an external calibrator will be required. We will return to this consideration later when the facilities of lab-type scopes are explained.

Greater vertical amplifier bandwidth is required to check the waveforms in a TV receiver than for testing audio amplifiers. If a scope has a flat frequency response out to 1 MHz, waveforms can be checked satisfactorily in b-w receivers. On the other hand, the chroma circuit waveforms in color TV receivers require a flat frequency response out to 4 MHz. It is also desirable to have ample pattern brightness when chroma waveforms are displayed. This is required because the chroma signal moves up and down very rapidly on the screen and a comparatively high brightness level must be used to obtain a clear pattern.

When checking sync and sweep waveforms or the composite video signal in TV receivers, the scope deflection rate is set to either 30 Hertz or 7875 Hertz. It is convenient to have these preset deflection rates provided by the scope controls. Some scopes have "H" and "V" positions provided on the sweep-range control for this purpose. When either of these deflection rates is used, waveforms that have a fundamental frequency of either 60 Hertz or 15,750 Hertz will automatically lock in sync, with two cycles of the waveform displayed on the screen.

For displaying visual alignment curves, it is often helpful to have a 60-Hertz sine-wave deflection voltage with a phasing control provided on the scope. This is because some sweep generators do not have this type of horizontal-deflection voltage built into the instrument. A 60-Hertz sine-wave deflection voltage with a phase control is also very useful in some forms of industrial electronics work. Many industrial processes are accomplished on the basis of sine-wave phase shift. Also, if you are concerned with industrial-electronics servicing, it is very important to use a scope that has a DC response. Ordinary service-type AC scopes cannot display waveforms that have very low frequencies, such as those commonly encountered in industrial control equipment.

The sync facilities provided by a scope are occasionally important. Internal sync is always available, and usually a choice of positive or negative internal sync is provided. Polarity is important whenever we need to display narrow pulses such as the positive ones in Fig. 11. Such waveforms are very difficult to lock-in unless positive sync is used. On the other hand, if the diode in Fig. 11 were reversed, a negative output pulse would be obtained. This negative pulse would be very difficult to lock-in unless negative sync was used. Hence, it is desirable that a scope provide a choice of positive and negative sync.

External sync is less commonly used; however, there are some types of tests that require the use of a scope's external sync function. For example, a delay line cannot be evaluated for a defective section or component unless external sync is used to display the waveforms at progressive points along the delay line. With external sync, we can determine if each test point provides an additional delay, and if the delays are uniform. Also, external sync is very useful for measuring phase shifts in industrial control circuits. If a scope is to be used in industrial electronics servicing, an external sync function is essential.

At this point, let us return to pulse tests. Perhaps the most common service application of pulse testing is in ringing tests of coils and transformers. A typical test setup is shown in Fig. 12. It is convenient to have a pulse output provided by the scope, so that an external pulse generator is not required. We should recognize that a sharp, fast pulse is necessary to obtain a useful test pattern. This becomes increasingly important when the coil or transformer under test has a small inductance. Thus, it is desirable to choose a scope that has a sharp-pulse, test-voltage output; otherwise, an external pulse generator with fast rise must be employed. One operating advantage of a built-in test pulse is that the scope automatically synchronizes the ringing waveform at any sweep rate, thus speeding up the test.

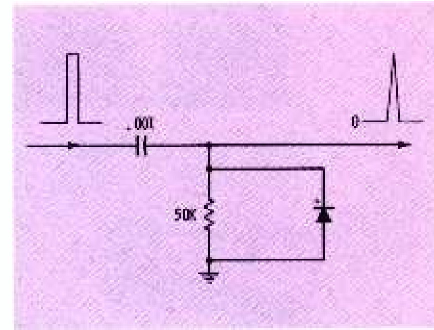


Fig. 11. Positive pulses require positive scope sync for good lock-in.

Some scopes have a terminal board provided at the rear of the case, whereby direct connection can be made to the deflection plates in the CRT. This is a very useful facility, particularly when the vertical amplifier has limited frequency response. A CRT has a frequency response up to several hundred MHz. In turn, we can couple the RF voltage from a radio transmitter to the vertical-deflection plates and measure the percent of modulation.

Horizontal amplifiers in service-type scopes generally have limited frequency response. This is no disadvantage in displaying waveforms using sawtooth deflection, but becomes a difficult problem when vectorgrams are to be displayed

• *Please turn to page 59*

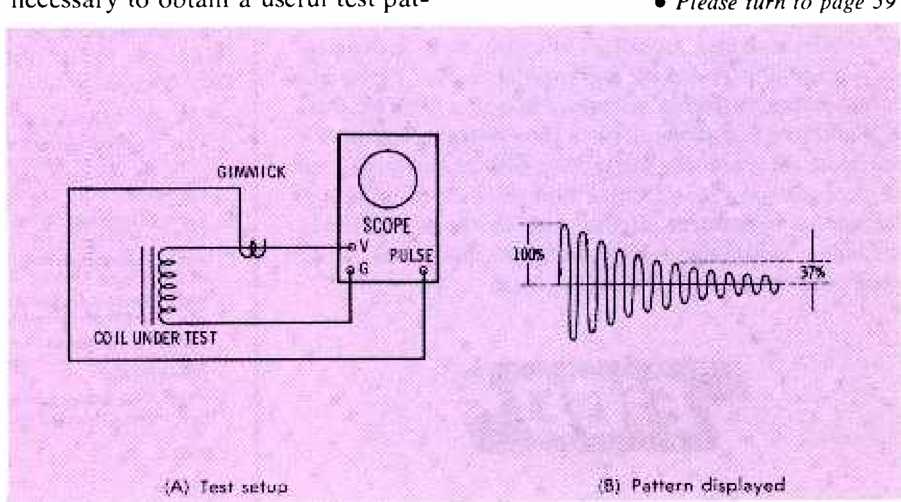
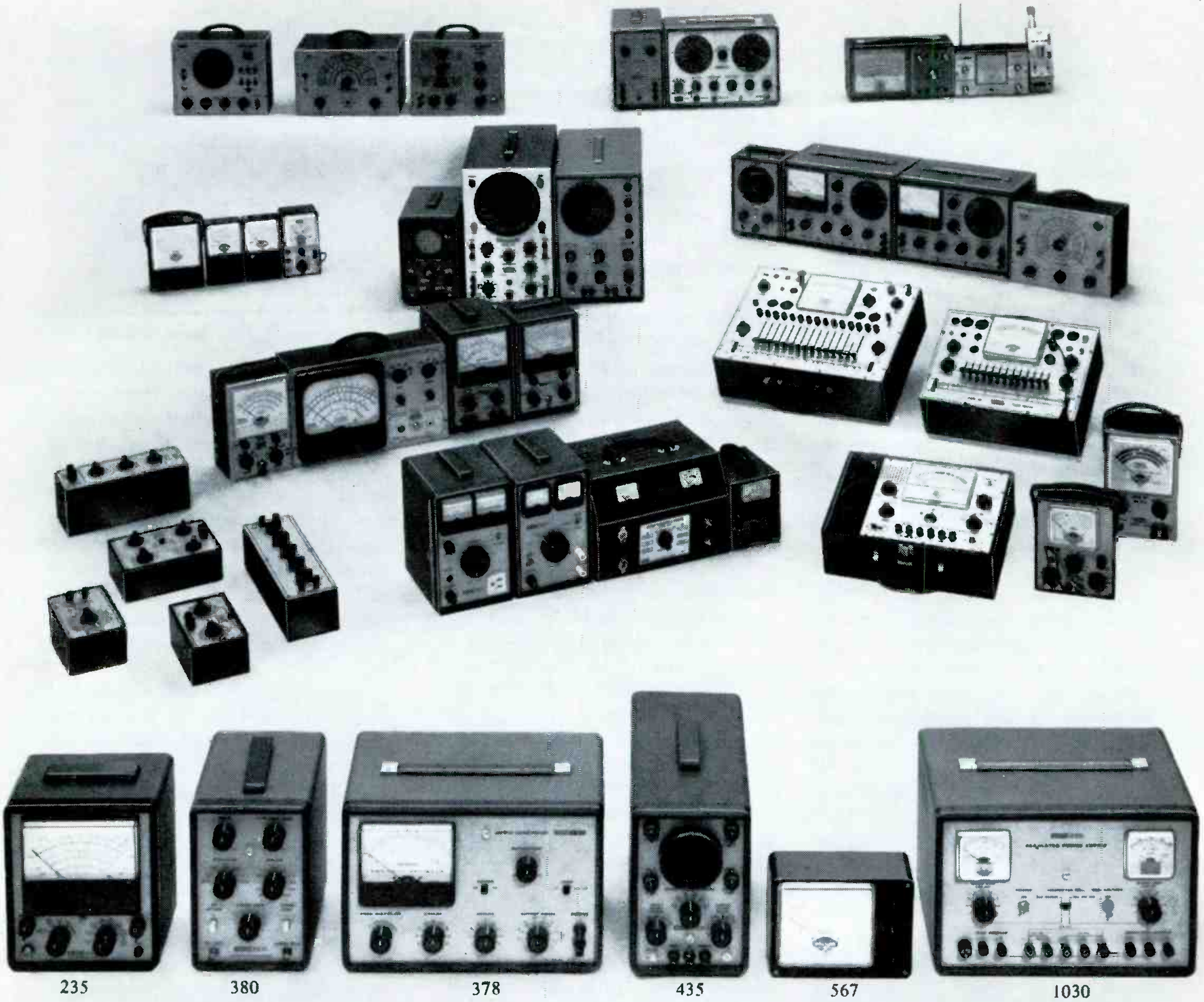


Fig. 12. Ringing test for coils and transformers.



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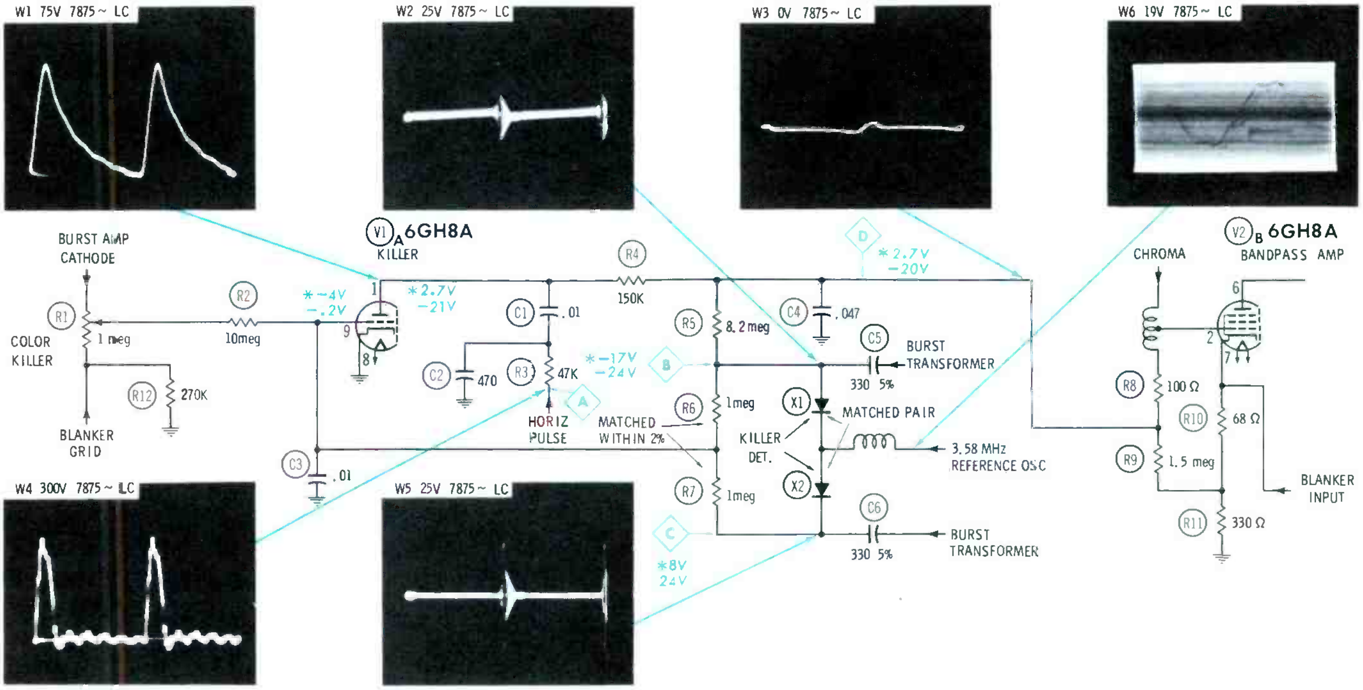
Color Killer



JUNE PFR SYMFACT

WAVEFORMS taken with wideband scope; TV control set to produce normal color. Low-cap (LC) probe used to obtain all waveforms.

DC VOLTAGES taken with VTVM on inactive channel. *Indicates voltage taken with color signal present—see "Operating Varations."

Normal Operation

Color killer stage functions as an automatic switch which turns chroma bandpass amplifier on when a color signal is received, off when signal is monochrome. Blanker stage output to bandpass cathode cuts off tube during horizontal retrace to prevent burst interference on color programs. Killer output to bandpass grid cuts off tube during b-w programs so that only luminance signal reaches CRT. During color reception burst signal is coupled to points B and C with 180° phase difference. Output of chroma reference oscillator connected to junction of killer detector diodes. Phase relationship of burst and reference signal causes both diodes to conduct; however, X1 conducts more heavily and negative voltage develops at detector output (killer grid). With negative potential at grid, killer stage is cutoff and no killer voltage is developed across bandpass amplifier grid bias network R8 and R9—bandpass amplifier free to conduct. Negative voltage at point B varies with burst level (chroma input signal strength) and is coupled to V2 grid through R5 for automatic chroma control (ACC) action. During b-w reception, there is no burst input to killer detectors, conduction is balanced, and no voltage developed at output (V1 grid). Color killer control now establishes conduction point of killer; if set correctly, killer now conducts on horizontal pulses (from flyback) coupled to plate. Tube conduction charges C1. Between pulses, C1 discharges through R4 and maintains a negative charge on C4 of sufficient potential to cut off the chroma bandpass amplifier. Circuit operation is similar when diode vacuum tubes are used as killer detectors instead of solid-state diodes.

Operating Variations

V1, Pin 9 Killer control sets bias when no color received. Adjust control (off channel) for colored snow (killer cut off), then rotate until confetti just disappears (killer conducts). Control varies voltage from −4.4 to +.1 volts—optimum no color reading is near zero. With color signal, grid varies with signal strength—about −3 to −6 volts. About −2.5 volts cuts killer off.

V1, Pin 1 Normal plate voltage reads −21V without color signal,—varies from −18 to −28 volts with killer control setting. With chroma signal, plate voltage same as chroma bandpass grid bias.

B,C No-color readings vary from 8 to 27 volts (negative at B, positive at C). Voltages must be same, except opposite polarity—zero volts at junction of R6 and R7. With chroma signal, voltages are proportional to burst p-p level and unbalanced—voltage at B varies from −12 volts (weak signal) to −60 (local station). C ranges from 8 to 27 volts.

D With no color signal, reading similar to V1 plate. With color signal, ACC action regulates bias from about .8 volts on weak signal to near 3 volts on strong.

Waveforms W1, W3, and W6 constant input signals. W2 and W5 burst signal with 180° phase difference and dependent on chroma signal strength; p-p readings from zero (no color) to about 80 volts (color).

Symptom 1

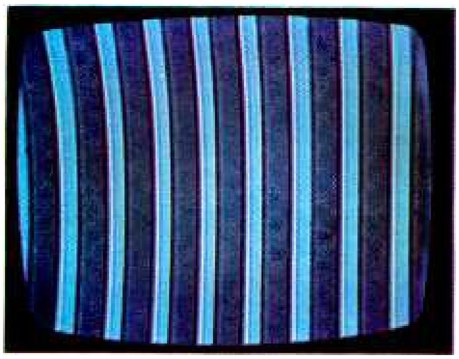
No Color

Killer Control Inoperative

X1, X2 Not Balanced

(Killer Detector Diodes)

Symptom Analysis

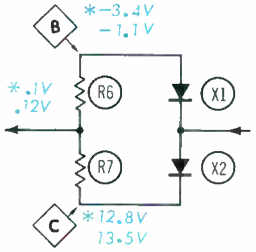


No color on strong or weak station color signal, nor on color generator signal. No colored snow (confetti) off channel at any color killer control setting. Black-and-white picture is normal. Known color programs produce only black-and-white picture.

Waveform Analysis

W1, at 75 volts p-p, only shows pulse is available at V1 plate—tube should conduct if grid bias is correct. Both W2 and W5 show sufficient amplitude—25 and 27 volts p-p—for killer detector operation but content shows excessive 3.58-MHz reference signal. Normally, very little 3.58-MHz signal (about 19 volts p-p) appears in waveforms W2 and W5. Waveform analysis indicates trouble in killer detector circuitry, but does not pinpoint.

Voltage and Component Analysis



Chroma bandpass grid has cutoff voltage, both with and without color signal. Voltages at V1 grid explain—voltages are similar and allow V1 to conduct all the time. Voltages at points B and C, with and without signal, are key to trouble—B measures −1.1 volts and C measures 13.5 volts. Normally, with color signal, voltages at B and C unbalanced; with symptom here, they are unbalanced, but wrong way—point B should be more negative than C is positive so that killer detector output to killer grid is negative to cut off killer.

Best Bet: VTVM will locate.

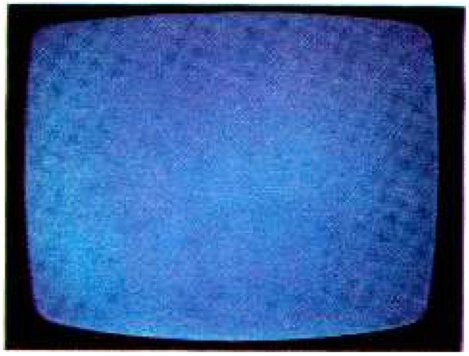
Symptom 2

Color in B-W Picture

Confetti Off Channel

X2 Leaky

(Killer Detector Diode)

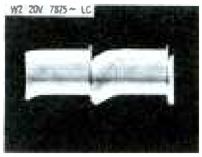


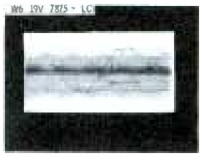
Symptom Analysis

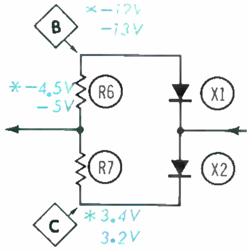
B-w programs have color in them—snow in weak signal picture is colored, as is any random noise. Off channel snow is confetti—impossible to perform correct color killer control adjustment. Color sync may be off, but slight reference oscillator coil adjustment corrects.

Waveform Analysis

W2 and W5 show incorrect content, while amplitude (20 and 22 volts p-p, respectively) is marginal. Burst can be seen in each waveform, but 3.58-MHz reference oscillator output signal is predominant. W6 shows normal 19-volt p-p amplitude. Burst signals at B and C have 180° phase difference. X1 and X2 conduction dependent on phase difference between burst and reference oscillator signals— difference is such that X1 normally conducts more.







Voltage and Component Analysis

DC voltages at points B and C and resultant voltage at V1 grid are key to locating defective component. Voltages with color signal, while not normal, produce desired results—killer is biased to cutoff and bandpass amplifier is allowed to conduct. Voltage readings with no color signal are similar to "with color" signal measuurements—V1 remains cutoff, bandpass amplifier conducts and color circuits are operating on b-w programs. Voltages at point C indicate X2 is not conducting properly. Sync phase may be affected by leaky diode.

Best Bet: Scope helps locate; VTVM isolates.

Symptom 3

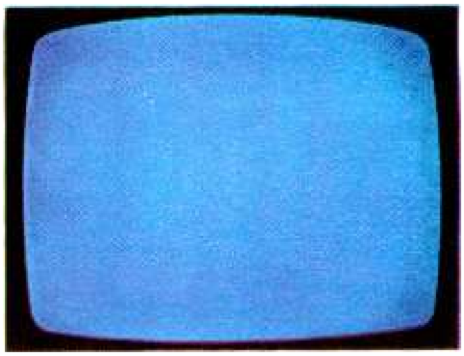
Colored Snow Off Channel

Color Programs Normal

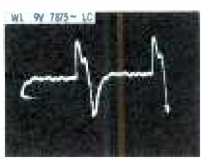
C1 Open

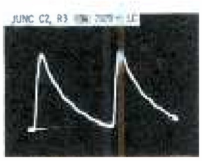
(Coupling Capacitor—.01 mfd)

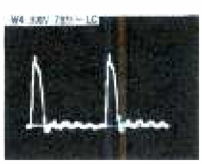
Symptom Analysis



Strong or weak station color programs and color bar pattern from generator are good—color and hue controls operate normally. Off channel snow is colored (confetti) and b-w programs, especially weaker signals or fringe area reception, have random color in them.



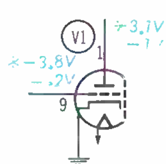




Waveform Analysis

Low amplitude of W1 (9 volts p-p and positive portion only about half of that) is good clue—insufficient amplitude of pulse causes conduction even if grid bias is correct. Second waveform, at junction of C2 and R3, shows expected amplitude of 80 volts p-p and shaping action of C2, R3 network. Point A connects directly to horizontal output transformer winding—W4 is horizontal pulse.

Voltage and Component Analysis



With color signal, voltages at V1 plate and grid are within normal tolerances, as expected since color is normal. On monochrome signal, or off channel, grid bias can be corrected (near zero) by killer control adjustment; but plate, instead of rising to normal cutoff voltage (approximately 20 volts), measures .1 volts—tube not conducting. Normally, V1 conducts on horizontal pulses of 70 volts p-p and charges C1—between pulses, C1 discharges through R4, developing negative voltage at point D to cut off chroma bandpass amplifier.

Best Bet: VTVM; Scope; component substitution.

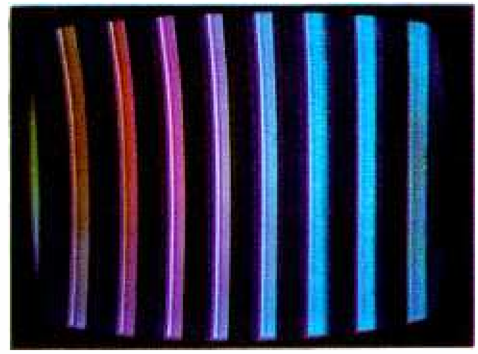
Symptom 4

Weak Color

Color Sync Normal

C4 Decreased Toward Open

(Capacitor—.047 mfd)

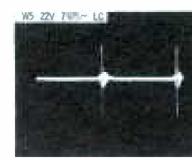


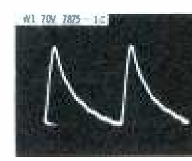
Symptom Analysis

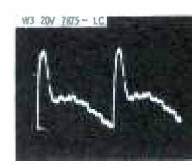
Known color programs may have weak or no color. Color, if received, is in sync. Hue control has no effect on color. With color bar pattern, red is predominant—other colors weak. With receiver off channel, killer control works, but even confetti is weak.

Waveform Analysis

W5 (shown) and W2(not shown) indicate input signal is sufficient for good color. Keying pulse at killer plate (W1) has proper amplitude for killer action. W3 at point D is obvious clue—horizontal pulse near 20 volts p-p, normally only DC voltage here, with or without color signal input. Although not shown, waveform at bandpass amplifier plate is badly distorted by comparatively large pulse input to grid.







NO VOLTAGE CLUES

Voltage and Component Analysis

All DC voltages are within normal tolerances and offer no clues. C4 has three functions: (1) When V1 conducts, C1 is charged by horizontal pulses. Between pulses, C1 discharges through R4—C4 maintains bandpass cutoff voltage. (2) C4 is RF ground for chroma input signal to bandpass grid. (3) C4 is filter for pulses from killer plate. Decreased capacitance (towards open) of C4 causes partial loss of chroma input signal to bandpass grid, as well as allowing horizontal pulse to distort what signal there is.

Best Bet: Scope after circuit analysis.

Symptom 5

Weak Color

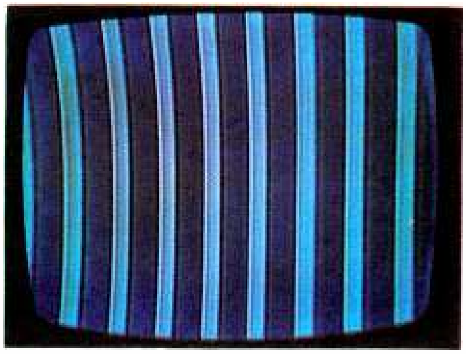
Killer Inoperative

C4 Leaky

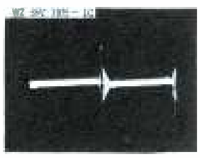
(Capacitor—.047 mfd)

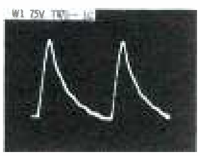
Symptom Analysis

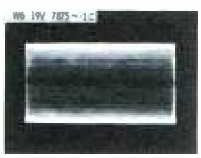
Symptom Analysis



Black-and-white portion (luminance signal) of color program good, but color weak—color control must be at maximum on strong signal—little color on weak signal. Color sync is good. Killer control inoperative—confetti off channel.



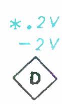




Waveform Analysis

Excellent burst signal, both in amplitude and content, at points B (W2, shown) and C (W5, not shown) indicates good chroma signal is available from video circuits and should be satisfactory signal input to bandpass amplifier. Burst amplifier receives chroma signal before bandpass amplification; therefore, color sync can be normal with weak color picture. Normal waveforms W1 and W6 show circuit has necessary input signals.

Voltage and Component Analysis



With no color signal, voltage at killer plate low (about −12 volts) but should be sufficient to cut off bandpass stage. Under same conditions, voltage at D is only about −2 volts—not sufficient to cut off bandpass amplifier. Voltages point to leaky C4 or increased value of R4. Reading of only .2 volts at D with color eliminates R4—normally would mean very strong color signal causing ACC action to decrease bandpass conduction. Leaky C4 defeats killer action during b-w reception and shorts chroma to ground during color.

Best Bet: VTVM for voltage and resistance.

Symptom 6

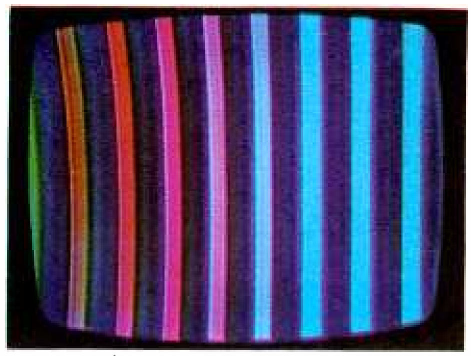
Color Overloaded On Strong Signal

Poor On Weak Signal

R5 Increased In Value

(ACC Resistor—8.2 meg, 5%)

Symptom Analysis

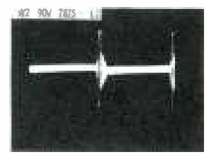


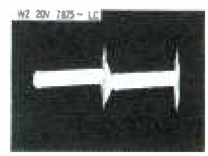
Symptom Analysis

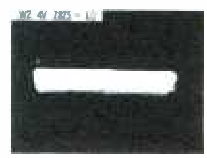
B-w programs normal. Color level control must be adjusted when switching from strong local station color signal to weaker signal. Control must be advanced to get good color. Color overloads when returned to strong signal—control setting must be decreased.

Waveform Analysis

First waveform is W2 at point B with very strong chroma input signal. P-P measurement is 90 volts. Second waveform is also W2, but with weak, barely acceptable, color signal. P-P reading is now only about 20 volts. Third waveform is from point B while b-w signal is being received—contains only low amplitude induced horizontal pulses and noise. Since burst is part of composite color signal, its amplitude varies with color signal strength.







Voltage and Component Analysis

Best voltage clue is obtained by monitoring D while changing chroma input signal level. With weak signal, reading is about 4 volts—slightly high, but acceptable. Voltage drops to about 3 volts on strong station signal—normally drops below 1 volt. Voltage level at B is set by amplitude of burst—varies with chroma signal strength. R5 couples portion of negative voltage to D. Strong chroma signal means higher negative voltage connected to positive bias—lowers bias and keeps bandpass output stable.

Best Bet: VTVM and circuit analysis.

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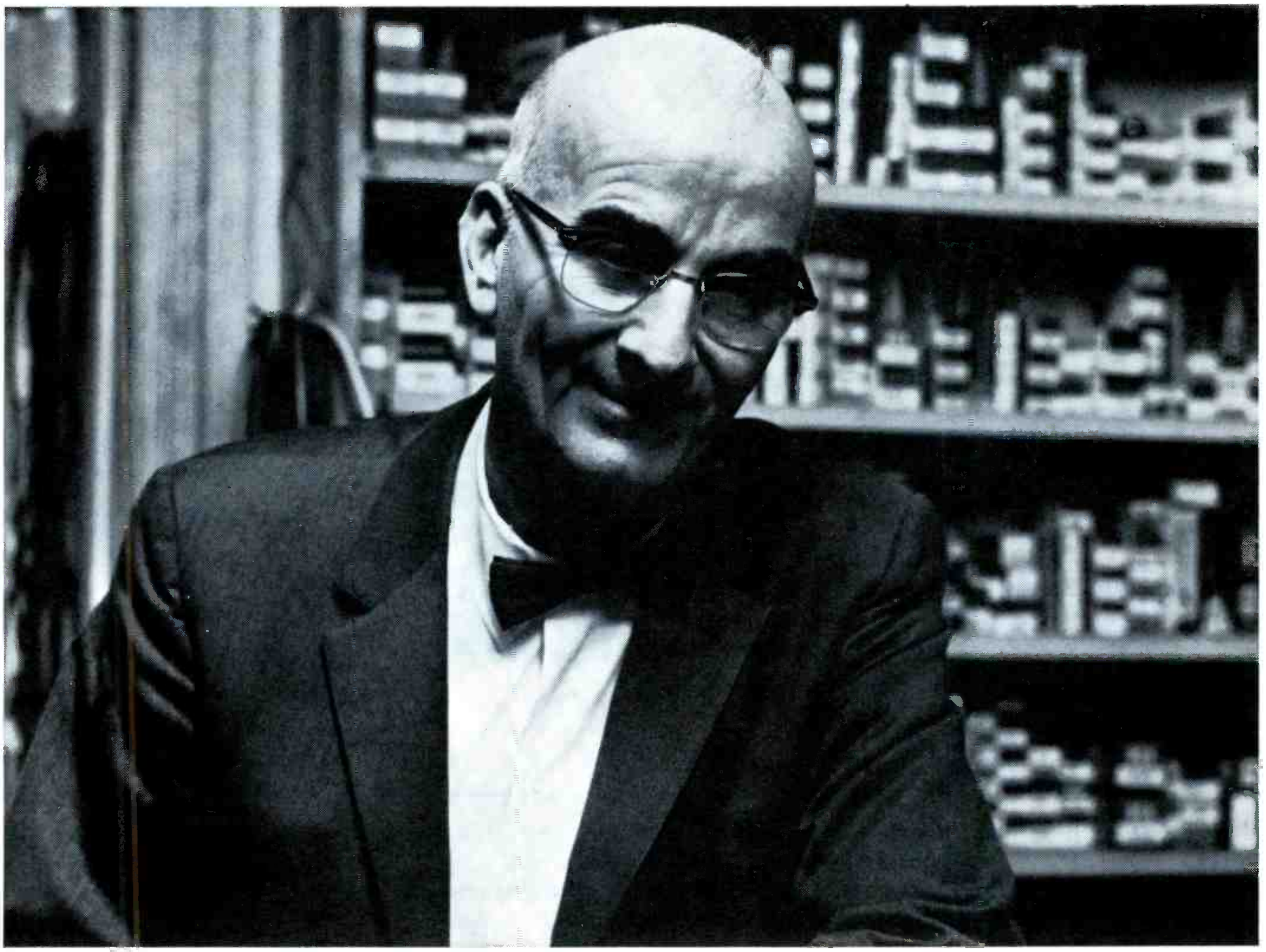

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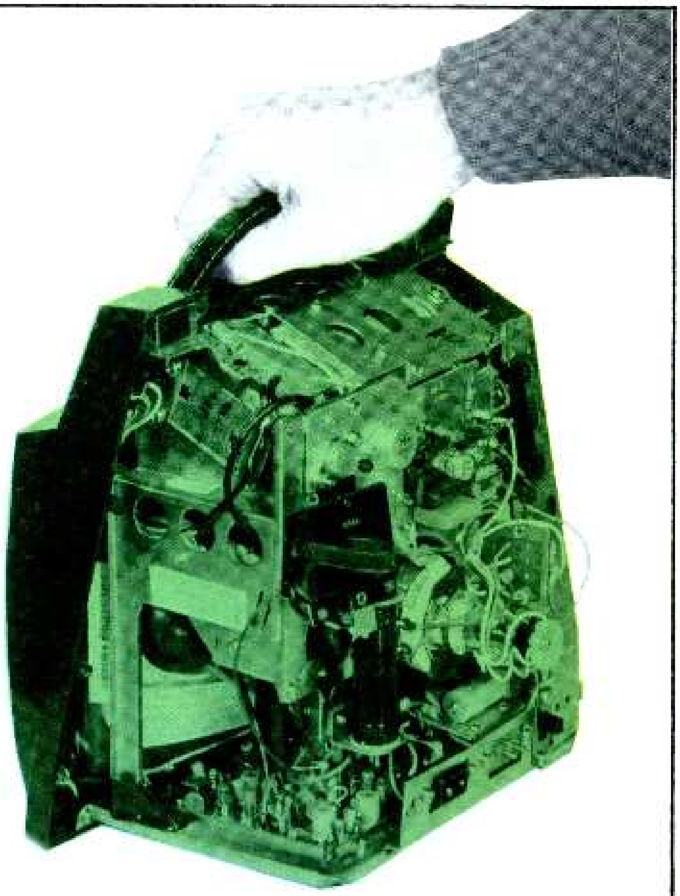
Transistor TV Techniques

by Wayne Lemons



The trouble symptoms are usually the same as those displayed by tube sets. However, some of the troubleshooting methods are different. The practices and procedures outlined in this article point up these differences.

The first time I heard about transistors, I reacted like the harness maker must have reacted to the automobile. I hoped it was all a bad dream. Gradually, though, my closed mind opened a tiny bit and I began learning my EBC's.

Just about the time I had the emitter-base-collector concept tied down, I found out that transistors had two sexes—NPN's and PNP's—and two nationalities—germanium and silicon. Not only did we have boy and girl transistors that looked at everything in opposite directions, but we had transistors of one kind that required more motivation than another kind.

It all sounded pretty complex, but it turned out better than I had hoped. Transistors, like most everybody else, have some laws they have to follow. All the technician has to do is learn these laws, and suddenly the transistor starts acting like the fellow you thought you'd never like. When you first met, you wished you hadn't, but he turned out to be your best friend when you got to know him.

That's the way with transistor TV service. You shudder the first time you yank the back off one of those "tubeless wonders" and prepare for the worst. But pretty soon you find the tuner by following the channel selector shaft back from the knob. Then, by looking closely, you find the IF strip snuggled in between the tuner and the video amplifiers. What do you know, it's a lot like a tube set, except a bit of a runt!

So, then what about service? Slowly it dawns on you that the symptoms in a transistor set will have to be pretty much like those in a tube set. If you have sound, a raster, but no picture, you can rightfully suspect the video amplifiers. If the picture won't hold, you can expect sync circuit trouble. If you have no vertical deflection—well—.

The point is this: Finding the **stage** giving trouble should be no more difficult than on a tube set. Finding the trouble **in** the stage is something else again. These are the techniques we want to talk about.

Some Basic Facts

To make sure that we are all in this thing together, let's start with a few basic facts about transistors. Then we will decide how the troubles in a transistor circuit can be diagnosed. The transistor in its basic form, be it NPN, PNP, germanium, or silicon, acts like a variable resistor whose resistance from emitter to collector changes in proportion to a change in voltage between the base and emiter. (Yes, I said voltage. I know it also uses current, but you can hardly have one without the other, and voltage is the easiest for us technicians to measure.)

This variable resistor has the highest emitter to collector resistance when there is zero voltage between the base and the emitter. It moves toward a lower resistance between emitter and collector as we increase the base-to-emitter voltage.

Let's go over that again. A transistor with no bias has little or no emitter-collector current flow, and so it has a high resistance. A transistor with correct bias voltage and polarity has current flow from emitter to collector (or vice versa) depending on the value of that voltage.

Bias voltage and polarity vary with different transistors. Only .4 volt will probably cause saturation (almost zero resistance from emitter to collector) in a germanium transistor. It may take around 1 volt to do the same thing in a silicon transistor. Average bias for germanium transistors is about .2 volt, but approximately .6 volt is normal for silicon transistors.

The polarity of the bias is determined by the transistor type—PNP or NPN. I prefer to use the middle letter of this designation as a place to hang my memory hat. An n**P**n transistor uses a **P**ositive bias voltage (and a positive collector voltage as well). A p**N**p transistor uses a **N**egative bias voltage and negative collector voltage. (Polarity is measured with respect to the emitter.)

In-Circuit Testing

Fig. 1 is the circuit of a PNP transistor stage using resistor R3 as a collector load. The transistor is biased from a bleeder across the same battery that supplies the collector voltage.

When the switch is closed, there is zero bias on the transistor. A voltmeter connected from the emitter to the collector would read the supply voltage since there is no current through R3 and consequently no voltage drop. However, with the switch open, the transistor is biased and current flows in the emitter-collector circuit, producing a voltage drop across R3. Therefore, collector voltage drops to a lower value. Normally, the collector voltage in a circuit of this kind is about half the supply voltage. With the switch closed, the collector voltage rises to the supply potential. The precise voltages are not nearly as important as the fact that the voltage changes. A fairly large change tells the story—the transistor is good.

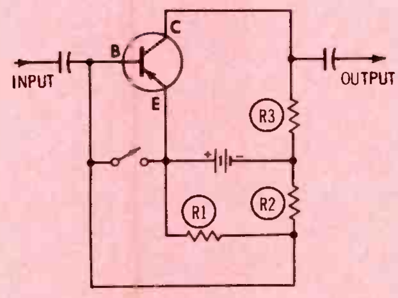


Fig. 1. PNP transistor circuit.

This suggests a means of "in-circuit" checking of any (well, almost any) transistor. As long as there is a resistor in either the collector or emitter circuit, this check is possible. A jumper connected between the base and emitter should cause a change in either the collector or emitter voltage, whichever can be checked.

Let's carry this thinking into the typical IF amplifier circuit of Fig. 2. Here we have resistors in both the collector and emitter circuits. The voltage drop across either resistor can be used to determine if the transistor is good.

First measure the voltage from the collector to ground. If it is much below what it should be (roughly −6 volts) there are two likely causes of the trouble: a shorted or leaky transistor, or excessive bias. Both possibilities can be checked by a simple jumper connection between

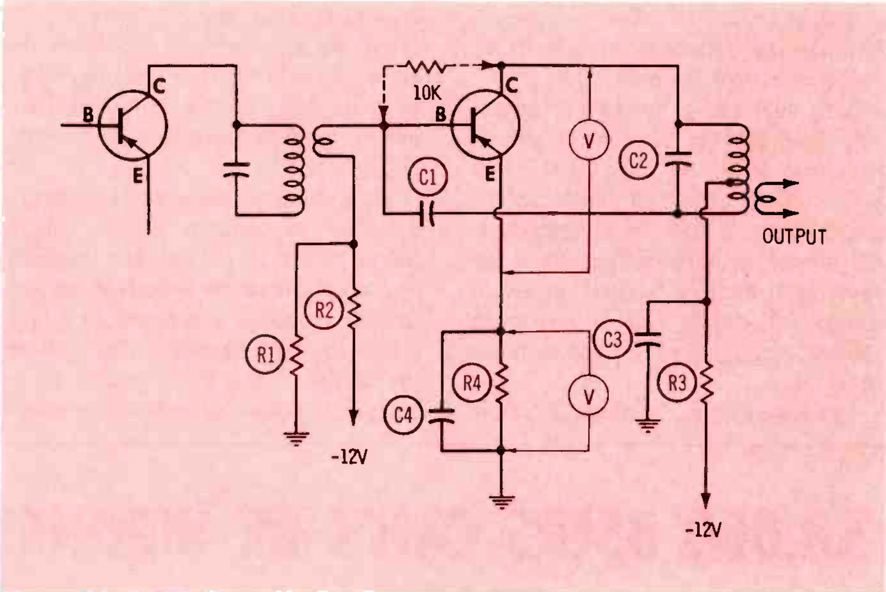


Fig. 2. IF amplifier stage using PNP transistor.

the base and emitter. The jumper will zero-bias the transistor, and if the transistor is good, the collector voltage will rise to the supply voltage. If not, look for trouble in the bias circuit.

If shorting the base to the emitter has no effect on the collector voltage, the transistor is at fault. (Another possibility is leakage through C3.)

But what if the collector voltage is already the same as the supply voltage? Since there is no collector current, the transistor is open or there is no bias voltage. To check this, use a 10K-ohm resistor as a jumper connected between the collector and the base. Caution: **Do not short directly between collector and base.**

This resistor, shown in Fig. 2, will bias the transistor toward "turn on" since the base bias is always the same polarity as the collector. If the collector voltage goes down (or the emitter voltage goes up), you know that the transistor will respond to a bias voltage on the base, and it is not defective.

If the voltage remains unchanged, either the transistor is open or the emitter circuit is open. A simple ohmmeter check will determine if the emitter circuit is defective.

Regardless of whether PNP's or NPN's are used, you may find either the emitter or the collector at ground potential. For this reason, it is usually best to measure voltages from the emitter rather than from the chassis. Bias voltages, which are always small, are easier to measure in this manner than by taking separate base and emitter readings and then subtracting.

Let's go over this again. A good transistor can be turned off by shorting between the base and emitter. It can be turned on if a small voltage of the same polarity as the collector is applied to the base. If the transistor is good, the collector or emitter voltage can be changed by one of these two methods. The transistor can be checked by either increasing or decreasing the bias from base to emitter, and it can be done in-circuit!

No emitter voltage means no emitter current, and that means either an open transistor or no bias. Measure the bias voltage between the base and the emitter. As we mentioned earlier, a germanium transistor should have around .2 volt bias in class-A circuits, while silicon transistors must have around .6 volt bias. If the bias is about right, you should use the "jumper" check to see if the transistor will respond.

Using Ohm's law, you can calculate the current of a transistor by measuring the emitter resistor voltage drop. For each 1000 ohms of resistance, there is 1 volt of drop per milliampere of current. Transistors operating in low level circuits usually operate with .5 to 3 ma of current.

Special Circuits

The circuits we have discussed so far are class-A circuits. That is, they are biased so that the input and output signals have virtually the same waveform. Audio amplifiers, IF amplifiers, video amplifiers, etc.,

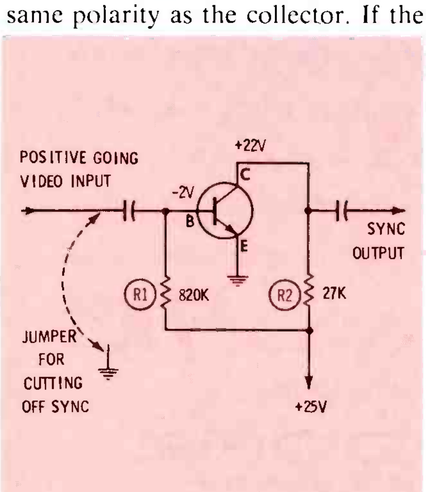


Fig. 3. Sync separator circuit using class-C bias.

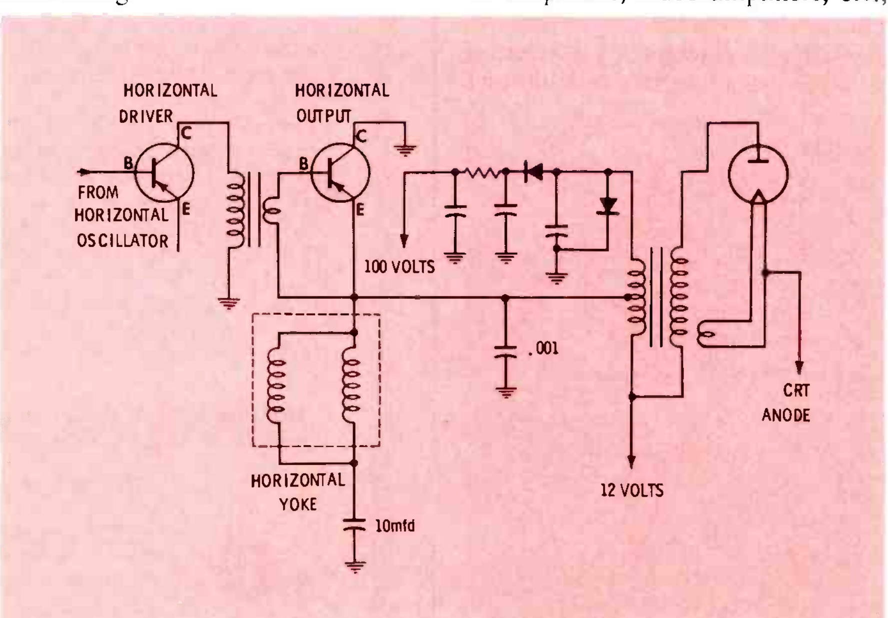


Fig. 4. Transistorized horizontal output is zero-biased.

normally have class-A bias. This means that the collector current is about half-way between cutoff and saturation.

Transistor TV's also use circuits which are biased class-B or class-C. Circuits that depend on a pulse input to the base to turn them on are biased class-C.

Fig. 3 is a typical sync separator circuit that operates with class-C bias. The voltages shown are those measured with a DC voltmeter when a station is being received. Since this is an NPN transistor (emitter arrow pointing away from base), it requires positive bias for "turn on." However the bias here measures −2 volts.

The circuit action is very similar to a sync circuit using a tube. The positive going input signals cause base current to flow through R1 to the emitter. This causes an average negative voltage to develop on the base side of the resistor, so that only the most positive going part of the composite video signal (the sync pulses) will turn on the transistor. Of course, this is what we want—only the sync signals appear in the collector circuit.

Checking this circuit is fairly simple. Shorting the incoming signal with a jumper will remove the bias produced by the signal, and the base will return to approximately .6 volt. Turning the channel selector to an unused channel will cause a somewhat different action.

With the signal input shorted, the collector voltage will drop to approximately 2 volts. Turning the channel selector to an unused channel will not drop the collector voltage to much less than 12 volts because the inherent noise will continue to provide some bias. However, either method works because there will be no change in the collector voltage if the transistor is defective. Of course, we must assume that a scope has been used to make certain that the sync pulses are actually arriving at the base.

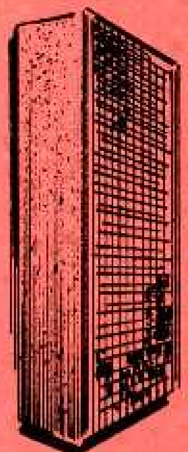
If the collector voltage does change, and there is still no sync, the most likely trouble is an open output coupling capacitor or an open circuit in the output of the sync stage.

Horizontal Circuits

It is interesting to note that a defective horizontal oscillator or driver stage will **not** (in all the circuits we are familiar with) cause any damage at all to the horizontal output transistor. The reason for this is that the horizontal output transistor is zero-biased (no collector current) and conducts only when a horizontal pulse from the oscillator or driver stage is present. When the oscillator is working, the horizontal output transistor is pulse biased so that current flows during trace time and is driven sharply into cutoff during retrace time.

Fig. 4 is a typical horizontal output stage. Note that the collector is grounded and that there is a low resistance winding between the base and emitter. This transistor is zero-biased. Therefore, our method of using jumpers in diagnosis can't be used too well. A scope is probably the best bet here. Check the incoming waveform. In this circuit, the negative portion of the waveform turns the transistor on during trace

• *please turn to page 62*



Solid-State STEREO Revisited

by David Held

Another look at the test equipment and troubleshooting techniques employed in this area of electronics will increase your mental inventory of solid-state servicing practices.

Most prosperous radio and TV businessmen are now getting their share of the AM-FM and stereo phonograph repair business. If you are turning down solid-state repair, take another look at the market. With solid-state TV now firmly entrenched, today is a good time to learn all you can about solid-state repair—tomorrow may be too late.

Methods of Troubleshooting

There are several methods of locating troubles in a solid-state AM-FM receiver. Signal injection has been used for years, in tube equipment, and can be applied equally well to transistor instruments. Signal injection is nothing more than the application of a noise or tone generator to a spot in the circuit which will give a meaningful response.

Noise Generators

A good place to start is at the volume control. With the control wide open, apply the noise generator signal to the center terminal. If the audio stages are working properly you will hear a loud tone in the speaker. Of course the actual volume will depend upon the design of the circuit. When you start at the volume control you are breaking the overall circuit in half and then can work either way to find the trouble.

The noise generator works wonders in the audio sections. In cases of weak or no volume, start at the base of the final output transistor. Apply the noise injector probe to the base of each transistor in turn, working back to the volume control. At each stage you should have an increase in signal. When the signal becomes weak or is lost entirely, you have located the defective stage.

To narrow down to the actual defective component, use a good VTVM to measure the collector, emitter, and base voltages. Be especially careful not to accidently short out any transistor terminal to ground or to another transistor terminal. A direct short from base to collector can very easily damage a transistor.

If the audio stages seem to be good, proceed from the volume control back through the detector and IF stages. Inject a signal at the base of each IF, the converter, and the RF stages until the defective stage is located. As before, voltage measurements will then reveal the defective component.

Signal Generators

Many technicians use signal generators rather than noise generators although the method is a little more complicated. The advantage is that it is very easy to check alignment of the chassis while troubleshooting. Most RF generators have an audio output which can be used in the audio stages.

After the audio stages have been checked out, inject a 455-kHz modulated RF signal at the base of the first IF stage. You can use the speaker as a tone indicator while troubleshooting, but clip an output meter across the voice coil of the speaker for alignment. Be sure the volume control is set at maximum position. Reduce the generator output as needed, to keep the AVC circuit inoperative. If the IF stages are good, go to the base of the converter stage. The RF and oscillator stages can be checked with a loop of several turns of wire laid next to the receiver antenna. Feed the signal generator output directly to the loop. For correct IF, RF, and oscillator alignment, it is best to follow either the manufacturer's alignment procedure or the data found in the appropriate Howard W. Sams PHOTOFACT folder.

Transistor Checking

The transistor tester is a must for anyone attempting to service solid-state equipment. This instrument is just as valuable as a tube tester would be for tube sets. The transistor does cause less trouble than the vacuum tube, but we still have plenty of problems with them.

With most of the older transistor testers it was necessary to unsolder the transistor from the PC board before testing. Today we have in-circuit transistor testers that very quickly check the quality of the transistor right in the circuit. Some service technicians quickly check all of the transistors in the whole receiver, others try to find the defective stage before unleashing their transistor tester. We prefer the latter method.

The transistor in-circuit tester will quickly check the AC beta of a high or low powered transistor right in the circuit. A transistor can also of course be checked for beta and leakage out of the circuit. Diodes and rectifiers can also be checked for opens or shorts in the circuit with an in-circuit transistor tester.

Characteristics

Beta and leakage are two of the most important characteristics of a transistor. Beta is the current amplification factor, similar to Mu in a vacuum tube. DC beta is the ratio of collector current divided by the base current. AC beta is the ratio of the change in collector current divided by the change in base current, while keeping the collector voltage constant. The AC beta measurement is the most revealing because it more closely matches the actual operating conditions of a transistor. However, a DC beta measurement is about as useful as an emission test would be for tubes in a similar circuit.

Leakage current is another important parameter of a transistor. Leakage current can increase as a transistor ages, and it is generally leakage current that causes problems in circuits operating at high and low temperatures. Silicon transistors normally have a very low leakage current, but germanium transistors may have from fairly low to quite high leakage, depending on the application. See chart I.

Typical Germanium Transistor Leakage

Chart I

Application	Leakage
RF - IF	0-5 ma
Audio	5-50 ma
Power	50-500 ma

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A Few Tips

When troubleshooting, the service technician is interested if the transistor is open or shorted. Any beta indication measured is considered good, but beta normally doesn't change with age. The beta factor is important when replacing a defective transistor. For example, if a given audio transistor is shorted and an exact replacement transistor isn't available, another one with the same beta factor can be substituted.

Open or shorted transistors can be easily located with an in-circuit transistor checker. However, if a diode or another transistor is directly coupled to the suspected transistor, the suspected transistor may have to be removed from the board for a good test. If a transistor checks defective in-circuit, but good out of the circuit, look for defects in other components.

Likewise, if a transistor checks bad in or out of the circuit, the connecting components should be checked to see if they have caused the failure.

When you have a weak output or poor selectivity on the AM or FM bands, check the RF, oscillator, and IF stages. RF and IF alignment should only be made if the need is obvious.

In case of a station fading on any portion of the dial, check the converter transistor by replacement. Noisy reception can be caused by shorted IF transformers, bad capacitors, or noisy transistors. Noisy transistors, however, are generally found in the audio stages.

Weak audio or phono output signal can be checked from the phono stereo cartridge through to the speaker. Many times one side of the phono cartridge will become weak or defective, resulting in low or distorted sound. If you suspect one side of the cartridge to be defective, reverse the cartridge output leads. The symptoms will appear in the other channel if the cartridge is the source of trouble.

Audio distortion is generally found in the last two audio stages. Check suspected transistors with a transistor tester. Before replacing the good transistor be sure the base or emitter resistors are not burned or changed in value. After installing a new transistor, take voltage measurements on all three terminals.

Most power supply troubles are caused by the silicon diodes. In bridge rectifier circuits you'll often find more than one defective diode, so it is best to unsolder one lead of each diode when checking them.

The transistor of course must be removed from the PC board if found defective. To speed up the servicing time, use a small de-soldering iron with a suction bulb. These irons also are less likely to overheat the board, so there's less chance of breaking the foil. When installing a new transistor, don't cut off the leads until after testing. You may have to try another transistor even if the replacement is good. It helps to match the beta to the counterpart in the opposite channel.

Be sure to place silicon grease on all replacement power transistors, and watch for correct body alignment. It is very easy to short the prongs against the chassis. Most

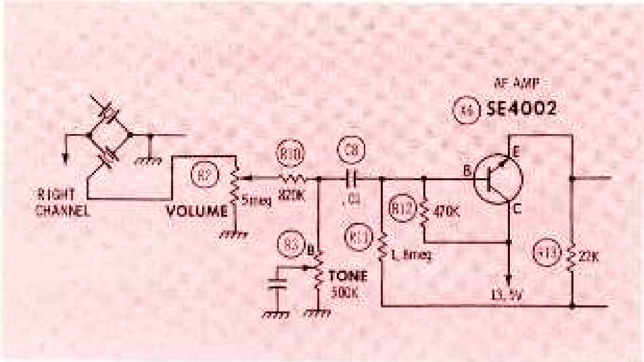


Fig. 1. Leakage in R2 caused low volume.

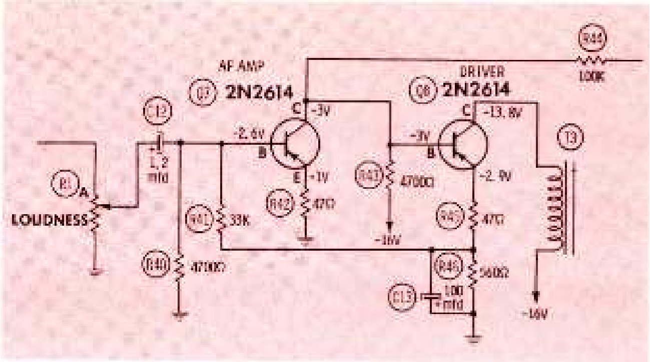


Fig. 2. Defective C13 caused lost signal.

power output transistors will run warm in actual operation. But if any other type transistors run warm or real hot, there's some trouble indicated.

Case Histories

In a GE AM-FM stereo chassis the left channel was intermittent on both radio and phonograph positions. We knew therefore, that the trouble had to be in the left audio channel of the chassis. With the noise generator we traced the trouble to the first AF and driver stages.

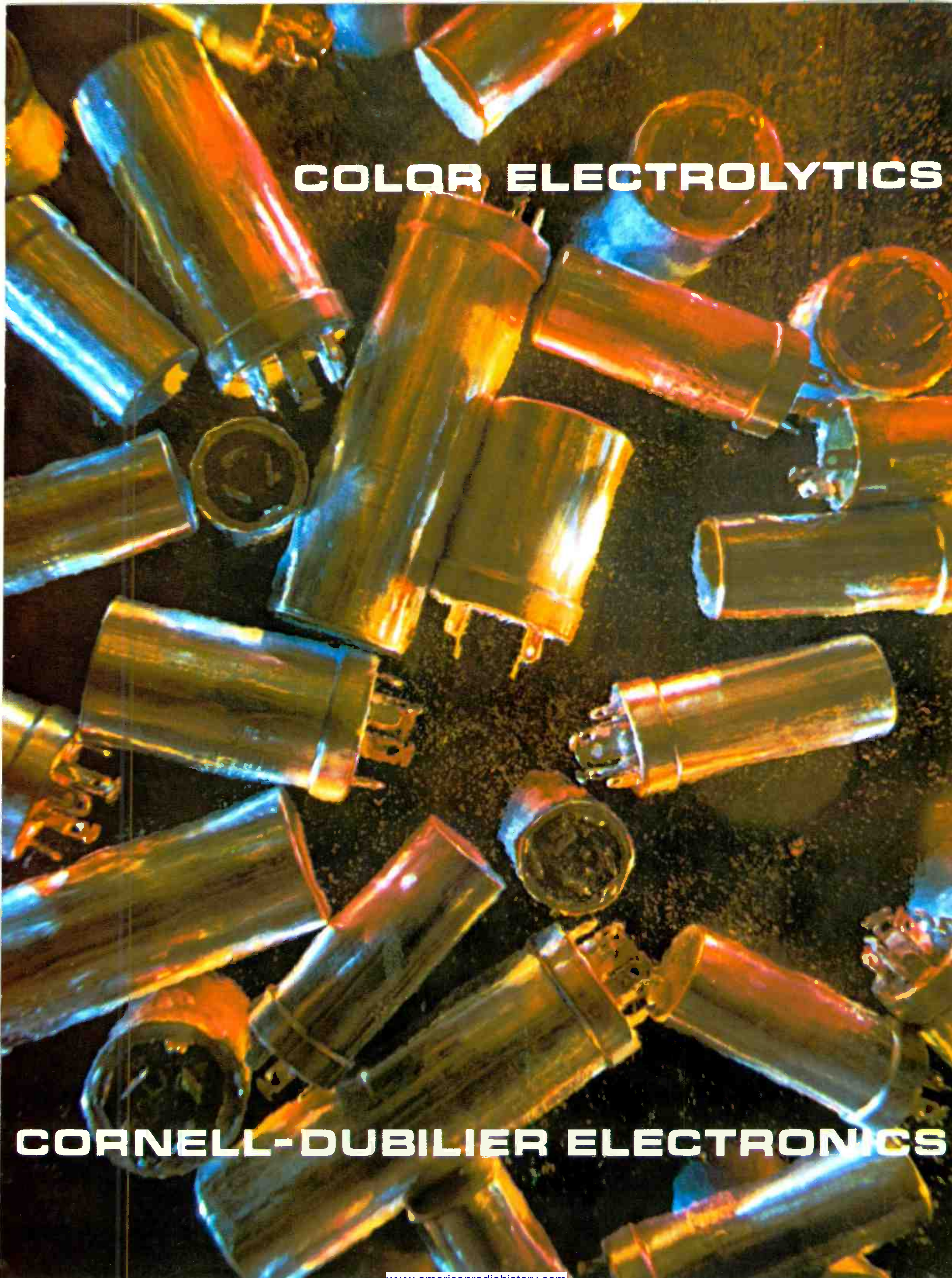
After clipping the dynamic in-circuit transistor checker to the suspected transistor everything worked perfectly. This is like going to the dentist and when you get there, the toothache is gone. So we unsoldered the two transistors from the the PC board for out-of-circuit checks.

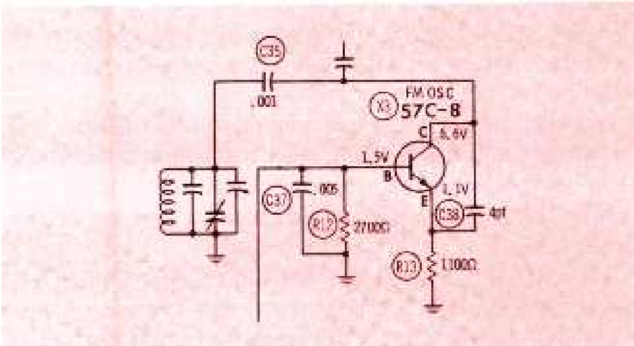
The first AF transistor checked good. But the driver transistor when first hooked up appeared to be open— and then it checked good. By tapping on the transistor, it really acted up. A replacement was installed, and another customer satisfied.

Low Volume

The right channel of an RCA VFP32E stereo phono amplifier had very low volume. At first we suspected a bad cartridge but this time we guessed wrong. The audio stages were checked with an audio signal generator and they tested perfectly from the base of the first AF amplifier to the speaker. But from the phono input to the base terminal there was a big loss of signal.

Checking the circuit, we found an 820-K resistor and an .01-mfd capacitor were in series with the volume control and base terminal. See Fig. 1. The volume was


COLOR ELECTROLYTICS
CORNELL-DUBILIER ELECTRONICS



good on both sides of the capacitor, so we suspected the 820-K resistor. Again the ohmmeter proved we were guessing.

But upon checking the resistance from the center lug of R2 to ground, we measured only 400 ohms. No matter to what position the control was turned, we still had only 400 ohms resistance. We removed R2 from the chassis and found a leakage between the control shaft and the center lug. This particular trouble is very rare, but variable resistors can cause plenty of other troubles.

Weak Right Channel

In an RCA model VGP82 (Fig. 2) we had another weak right channel audio problem. Sometimes the volume would rise and then again become very weak. We decided to use the noise generator on this one and started checking at the audio output stage. At the same time we compared the signal gain with the left channel.

At the base of Q8 we found a very weak signal. Since the first AF transistor was tied directly to the base of Q8, we removed them from the PC board. Both transistors were checked and found perfectly good.

The two transistors were replaced and we resumed signal tracing the circuit. We found that the signal on the emitter of Q7 was just as strong as it was on the base terminal. Things didn't add up. After further testing we found C13, a 100-mfd capacitor, was partly open. Replacing the capacitor brought the volume back to normal.

Motorboating

This RCA AM-FM chassis definitely had a putt-putt sound. The motorboating was pounding the left speaker even with the volume turned way down, so we knew the trouble was after the volume control and only in the left channel.

We quickly checked all of the transistors with an in-circuit tester. The two power output transistors were removed from the PC board for more accurate checks. In one power output transistor we found a 100-microamp leakage. After replacing the defective transistor the motorboating sound disappeared.

No Oscillation

The symptom on an Admiral 20C4A chassis was poor FM reception. In fact all we heard was a loud rushing noise in the speakers. We guessed that the oscillator

The solid-state technician hard at work.

stage was not functioning.

The FM oscillator transistor (Fig. 3) was checked in the circuit. The first RF and mixer transistors also tested normal. Going back to the oscillator circuit we started to take voltage measurements. On the base terminal we found zero volts. Using the ohmmeter, we found a direct short between base and ground. To make sure the transistor was not causing this low reading, it was removed from the circuit.

Sure enough, C37 had a dead short. Be sure to use an ohmmeter or VTVM with not more than a 3-volt internal battery when checking resistance around transistor circuits, so as not to damage them.

Frigid Baby

We had a Silvertone 528.63430 AM-FM chassis that would not perform when first turned on. Sometimes a half-hour would go by before music came through the speakers. One cold winter day the receiver took two hours before operating as it should.

A quick check was made on the audio section with a noise generator. The audio was working but there was no RF response. If you quickly rotated the volume control up and down you could hear a rushing in the speaker.

The chassis was pulled from the cabinet and placed on the service bench. Right away the receiver started to play. Of course this always happens (and it performed the rest of the day).

Early the next morning the chassis was dead again and we quickly ran through the transistors with an in-circuit checker. The first and second IF transistors were pulled for a closer check. A beta reading of only twenty was found in the first IF transistor. We suspected this transistor and sprayed some circuit cooler on it.

When clipped back into the beta tester the beta hand would move from open to middle scale and then drop down towards zero. The warmer the transistor became the closer the beta moved toward zero. A new transistor cured the problem.

If coolant spray is not handy, simply run cold water from a faucet over the suspected transistor. (Out-of-circuit of course!) A good transistor, after cooling down, may show a 2% change on the beta scale. But a cold-shouldered transistor, when cooled down, will vary the needle on the beta meter all over the place. ▲

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Circle 22 on literature card

NOTES ON TEST EQUIPMENT

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

by T. T. Jones

Compact Color Generator

B & K's new Model 1242 color generator is by far the smallest we've seen. Completely solid-state, and with but two operating controls, it nevertheless produces a full-sized signal with all patterns. Gun killers are also included.

We weren't expecting the Model 1242 when it was delivered to the lab, so we had no idea what we'd see when we unpacked the box. Of course we were surprised with the unit's small size, so we decided to get right to work and see what it could do.

There's a door at the rear of the 1242, and we figured that's where the leads were stored (they were) and that we could install the batteries back there. That was our second surprise. The Model 1242 isn't a battery instrument; it has a transistor and zener regulated AC supply. The line cord stores in the rear compartment with the other cables. The power transformer projects into the storage compartment and it's as small as the rest of the unit. The transformer measures only 1¼ × 1½ and more closely resembles an audio interstage transformer than a power transformer.

We had our third surprise when we hooked the 1242 up to a color set. At a flip of the off-on switch, there was our pattern—rock solid. It's a good pattern too, with narrow lines and small dots.

The color position of the function switch produced a good keyed-rainbow pattern with very well defined edges on the bars. Those of you who may have noticed smear at the trailing edges of the bars on some sets probably realize that it's not really a problem when using a generator—just annoying.

Actually, the smeared trailing edges can be caused by many things. One is rounded keying pulses in the color generator. Another common cause is a mismatched delay line in the set under test, producing a poor color fit. Of course any IF or bandpass deficiencies will also cause smearing. But let's get back to the 1242.

A simplified block diagram of the generator is shown in Fig. 2. Not shown are the power supply, gun killers, or function switch. As shown the generator is in the color mode. Note how few stages are used, as compared to earlier models, such as the 1245. This is possible because the divider stages are unijunction transistors. Due to their inherent stability it is possible to divide by larger sub-harmonics and still maintain an accurate output. The 1242 also uses many RC

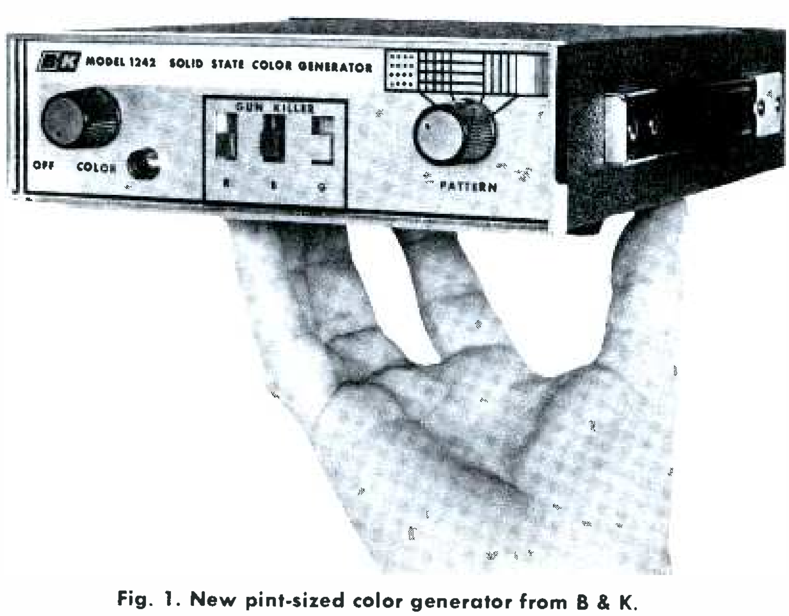

Fig. 1. New pint-sized color generator from B & K.

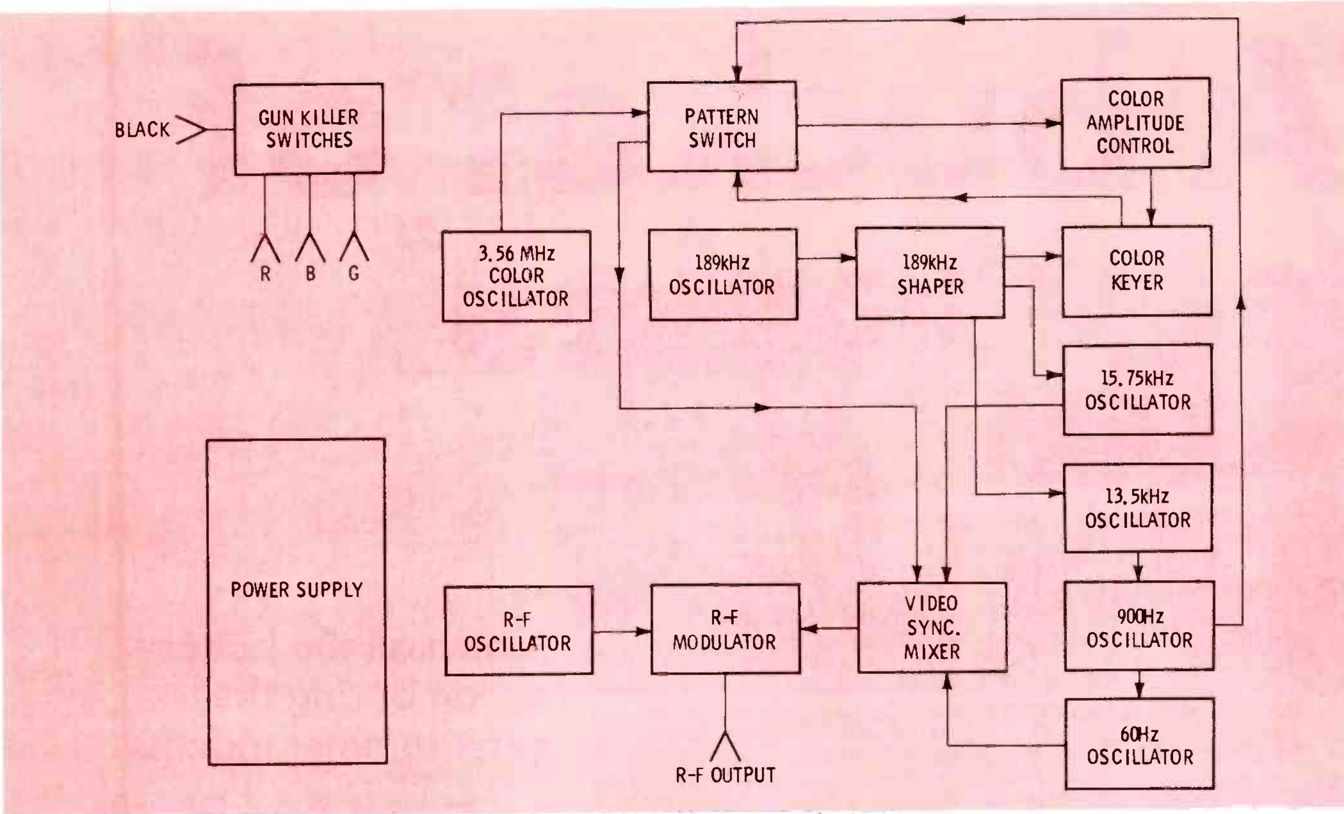

Fig. 2. Partial block diagram of the 1242.

PHOTOFACT™ BULLETIN

PHOTOFACT BULLETIN lists new PHOTOFACT coverage issued during the last month for new TV chassis. This is another way PF REPORTER brings you the very latest facts you need to keep fully informed between regular issues of PHOTOFACT Index Supplements issued in May and September.

Airline	GEN-8147A, GEN-8157A	886-1
Ambassador	A-1901	882-1
Arvin	67K48 (Ch. 1.27801)	884-1
Bradford	BMAT-56614, 60400, 60418	883-1
	BWGE-56499A/499B/507A/507B/ 648A, BWGE-60459A/-91660B	887-1
	WTG-61622, WTG-61630, WTG-61663	885-1
Clairtone	Chassis C11	883-2
Emerson	12P51	886-2
General Electric	M213CWD (Ch. HC)	883-3
Magnavox	Chassis T-923-01-AA	882-2
	Chassis T or U911/919/920 series	887-2
Packard Bell	CSW-502/-602/-606/-702 1-804 (Ch. 98C15)	884-2
Philco	Chassis 17MT80/A/B	885-2
Sony	CVM-2300U	882-3
	TV-700U	885-3
Toshiba	711T1 (Ch. TAT-1001)	884-3
Westinghouse	BC12A870 (Ch. V-2490-2)	886-3
Zenith	X1315C/L/P/X, X-1325W (Ch. 13X18)	887-3

The following TV sets are given schematic coverage in the Extra Contents.

Crosley	JR-21CDBF/CDBU/CDTMF/ CDTMU/CGDBF/CGDBU (Ch. 474, 475)	886-Cont.
General Electric	M420DEP, PAM424CVY, PAM451CWD (Ch. DD)	883-10-S
Heathkit	GR-180	882-Cont.
Motorola	XP201CL/CN/CR/CU, XP-202CE/CH (Ch. C9TS/9TS-460)	887-9-S
Olympic	9P56, 9P57, 9P58	887-9-S

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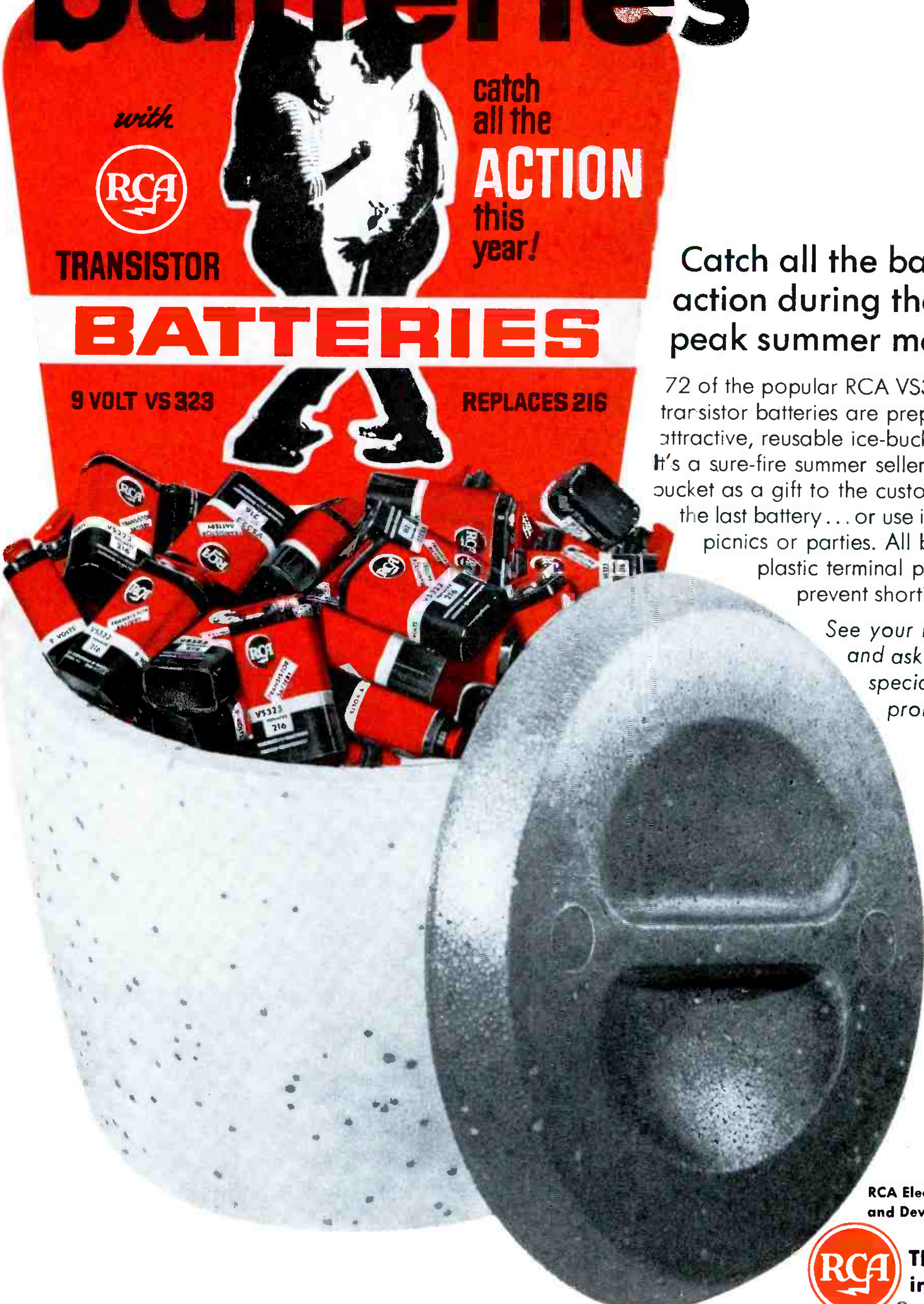

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and diode networks to shape the stage outputs; many other generators use extra transistors for this purpose.

The generator uses 14 diodes, one of which is a zener reference in the power supply, and 10 transistors. Again, one is in the power supply, used as a regulator. The supply will maintain a constant output with line voltage varying from 110 to 130 VAC.

The 1242 exhibits high quality throughout, from the neat layout on the printed circuit board, through the careful assembly, to the eye-catching style. The bezel is a metalized plastic, which is quite attractive. It looks just like chrome, and we'll bet that a few 1242 owners will discover the bezel is plastic only after they lay a hot soldering iron on it.

We loaned the 1242 to a few friends to try out "on the job." The substance of their comments was "It's a good outsideman's generator," and "I'll bet B & K sells a lot of these."

B & K Model 1242 Specifications

Outputs:
14 Vertical lines.
10 Horizontal lines.
10 x 14 Crosshatch.
140 Dots.
Keyed Rainbow.

RF Output:
5 mv channel 3 or 4.

Gun Killers:
100 K ohms.

Power Requirements:
110-130 VAC 3 watts.

Size (HWD)
2-1/4" x 7" x 9-3/8".

Weight:
3 pounds.

Price:
$99.95.

For further information circle 56 on literature card

ERRATUM

In the March "Notes on Test Equipment" review of the Mercury Model 1900 color generator, we erroneously reported the price as $89.50. The actual price of the Model 1900 is $99.95.

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BOOK REVIEW

Directory of Electronic Circuits: Matthew Mandl; Prentice-Hall Inc., Englewood Cliffs, N.Y., 1966; 226 pages, 6¼" x 9¼", hard cover; $10.00.

This book provides a comprehensive, individual analysis of more than 150 circuits commonly employed in television, communications, computers, and industrial control applications. The function, design, and operation of each circuit is discussed, along with component values, applicable equations, and formulas. An illustration of each circuit supplements the text.

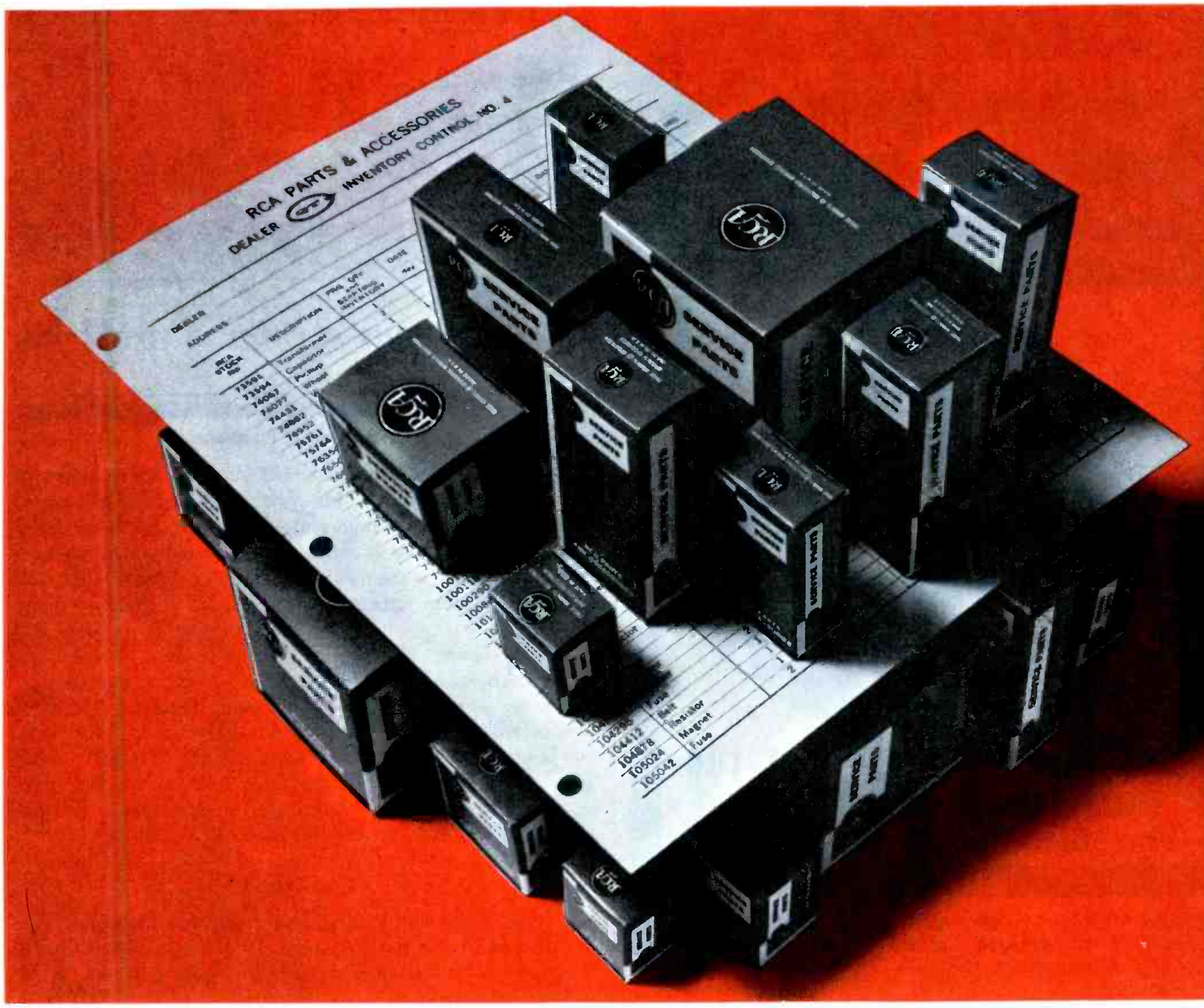
The first section of the book is devoted to amplifier circuitry. Types of amplifiers and classes of operation are covered, as well as coupling and decoupling methods. Tone-control circuits, inverse feedback (both current and voltage), and magnetic amplifiers are also included.

Section Two examines a variety of bridge circuits. Demodulation circuitry is the subject of Section Three. AVC, AGC, and de-emphasis circuits are also treated in this section. Filters, attenuators, and pads are discussed in Section Four. Gating and combining circuits are analyzed in Section Five.

Plate modulation, grid modulation, FM, and pre-emphasis circuits are found in Section Six. Section Seven covers oscillators, both sinusoidal and nonsinusoidal. Power supplies and power control circuits are discussed in Section Eight. Voltage regulators, chopper circuits, DC inverters, and thyratrons are also included in Section Eight. Pulse modifiers such as integrating and differentiating circuits, combined ID circuits, clippers, and limiters are the subject of Section Nine. Sections Ten and Eleven cover reactance circuits and servo- and synchromechanisms. Cathode followers, discharge circuits, dividers, frequency multipliers, flip-flops, frequency comparators, and photocell circuits are grouped with the special circuits analyzed in Section Twelve.

A glossary of electronic terms and an appendix containing units of measure, formulas, color codes, and frequency designations complete the book.

Engineers, technicians, and students alike should find this book informative and easy to understand. ▲



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Inherent Problem

I have a Pontiac Model 983873 auto radio that operates normally on the beach, but when replaced in the car it will not work on the high end of the band. I replaced the DS25 converter and it returned to normal operation (on the bench and in the car) for about a month, then the original symptom returned.

DILLINGER RADIO AND TV

Scranton, Iowa

The symptom you have described is fairly common to transistor auto radios. In many cases involving this particular auto radio, the trouble has been cured by replacing and adjusting trimmer capacitor C16. Other cases required replacing X2, as you have done. Some real stubborn cases have been solved by connecting a resistor (about 22k ohms) between the base of X2 and ground.

TVI Traps

I have a problem setting TVI traps (mostly series) on CB receivers. We have channel 5 TV in this area and it occasionally causes intereference on some CB sets. What is the common procedure for setting such traps and what test equipment does it envolve?

G. POPDAVID

Canton, Ohio

Setting TVI traps on CB receivers is not complicated. The usual method is to set a TV receiver on the problem channel (in your case Channel 5) and adjust the trap until the intereference is negligible. In extreme cases it may be necessary to spread the coil turns slightly and readjust the trap to completely remove all traces of interference.

Hot Transformer

A Zenith Chassis 16E25 (PHOTOFACT Folder 507-2) had intermittent video and sound. After this was corrected, the chassis was cleaned and visually inspected. I noticed that the "tire" on the upper coil of the flyback was lying, in the form of a blob of wax, beneath the transformer.

Two coats of compound were applied to the transformer, and after the compound was dry, the set was turned on. The transformer got very hot after a few minutes of operation.

I changed V9, V10, V11, V12, and V14. Because their plate supply is from the boosted B+, I then changed V4, and V5. Next, I changed C50, C56, C57, C58, C59, C60, C61, C1A, C1D, and C31. R73 was cracked, so I changed it. Then I replaced R80 with a 10-watt resistor, and finally I changed R75 and R8.

The horizontal output transformer was replaced with

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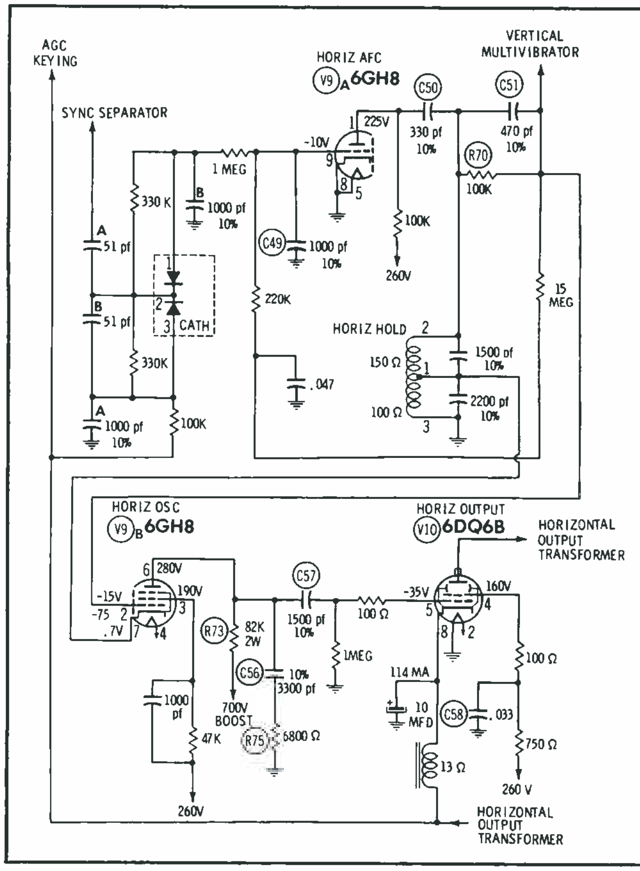
an exact replacement which also got hot. I substituted the yoke with a universal replacement, and then with a yoke from another 16E25 chassis. Incidentally, the horizontal output transformer in this second chassis also runs hot.

Using a VTVM, I measured the tube socket voltages of both chassis. The voltages were nearly the same in both chassis. Most of the voltages were close to those specified; but the horizontal AFC plate voltage measured 125 volts instead of 225; the horizontal oscillator grid grid voltage was −75 volts while −15 volts is specified; and the horizontal output grid was −42 volts instead of −35. The horizontal output tube cathode is 114 ma, and the screen current is 12 ma. The raster is full size; the video and sound are normal, and the sync is stable.

FRED FINE

Baltimore, Md.



There are so many possible sources of overload in the horizontal sweep system that it is very difficult to pinpoint the exact cause. To simplify troubleshooting, divide the system into three parts such as AFC and oscillator, horizontal output tube and transformer, and the loads on the transformer.

The series of abnormal voltages which you discovered begins in the AFC and oscillator, and so this is the area which should be examined first. Apparently, a large correction signal is being developed by the AFC tube to keep the oscillator in sync. By using your scope, you can verify that the drive pulse at the grid of the horizontal output tube is distorted. This will change the operating conditions of the tube and transformer, and can result in overheating.

This points to trouble somewhere in the frequency-determining circuits. You will probably find that the waveforms in this area are greatly modified from their normal appearance. By further use of your scope, you will be able to locate the component which is at fault. ▲

Scope or Meters

(Continued from page 29)

from the output of a color TV receiver. The basic test setup and resultant pattern is shown in Fig. 13. If the pattern appears distorted (as is usually the case), simply disconnect the leads from the vertical and horizontal input terminals, and couple the test voltages directly to the deflection plates of the CRT.

More sophisticated tests require the use of a lab-type scope. Typical lab-type scopes have considerably greater frequency response than service types. For example, a small lab scope has flat frequency response up to 15 MHz. Other basic features of lab scopes include:

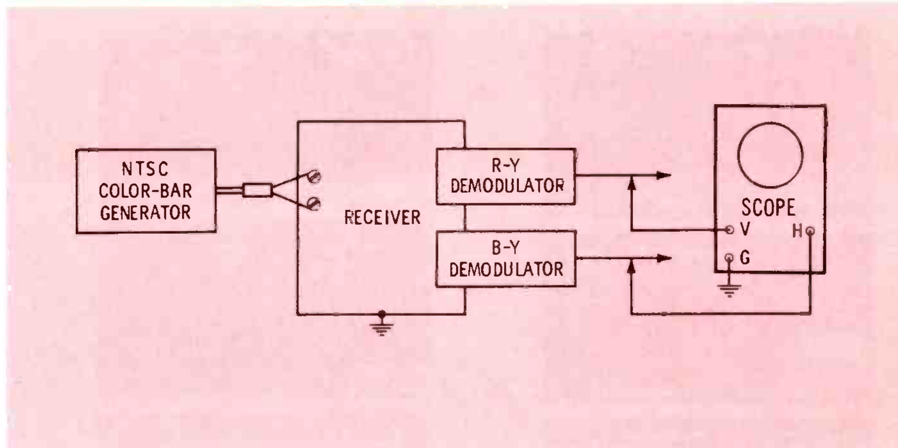
1. An accurately calibrated time base. This permits easy measurement of rise time, as illustrated in Fig. 14. Rise-time measurements are fundamental in square-wave and pulse test work.

2. Stable vertical amplifiers accurately calibrated in terms of p-p voltage. In other words, waveform voltages are read directly from the setting of the vertical attenuator.

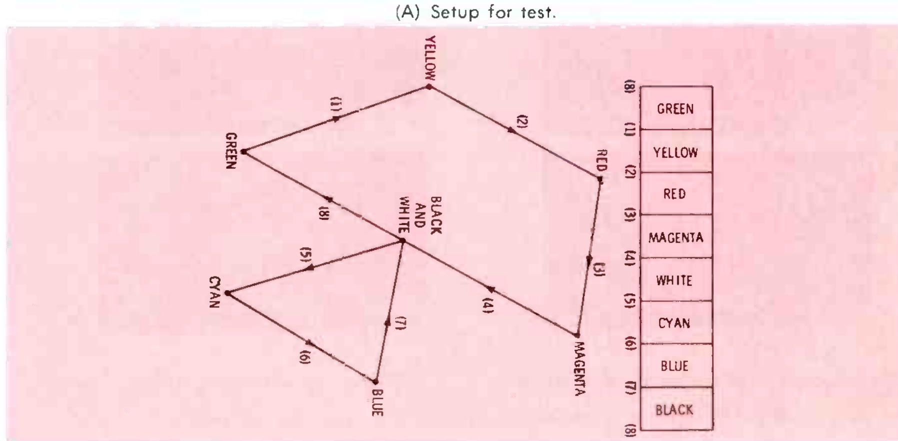
3. Better transient response than service-type scopes, as shown in Fig. 15. As a result, better evaluation of the characteristics of wide-band circuits is obtained.

4. Triggered sweep which permits effective expansion of steep leading edges for rise-time measurement. Also, a delay line is included in the vertical-amplifier circuit so that none of the leading edge is lost in the screen display.

5. A wide range of trigger facilities is provided to facilitate expansion of a chosen interval in a waveform. These triggering functions are illustrated in Fig. 16; the trigger controls can be set to start the displayed pattern at any desired point in the waveform. For example, a color burst can be picked out of the composite color signal and expanded, as illustrated in Fig. 17.



(A) Setup for test.



(B) Display for NTSC color-bar signal.

Fig. 13. Vectorgram test of color receiver.

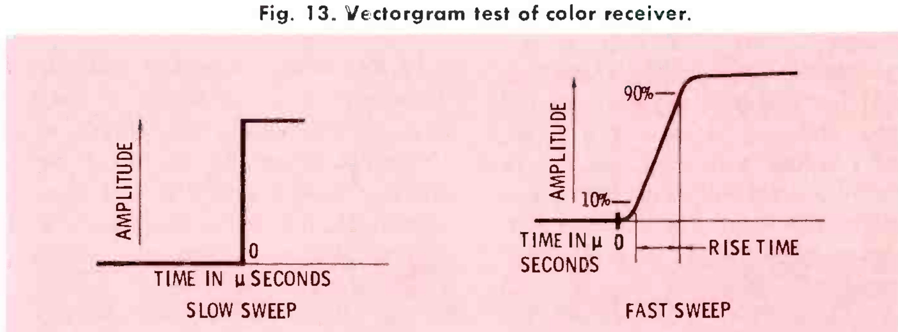
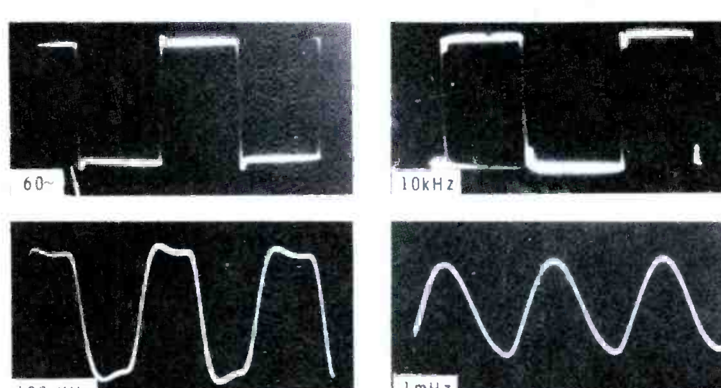
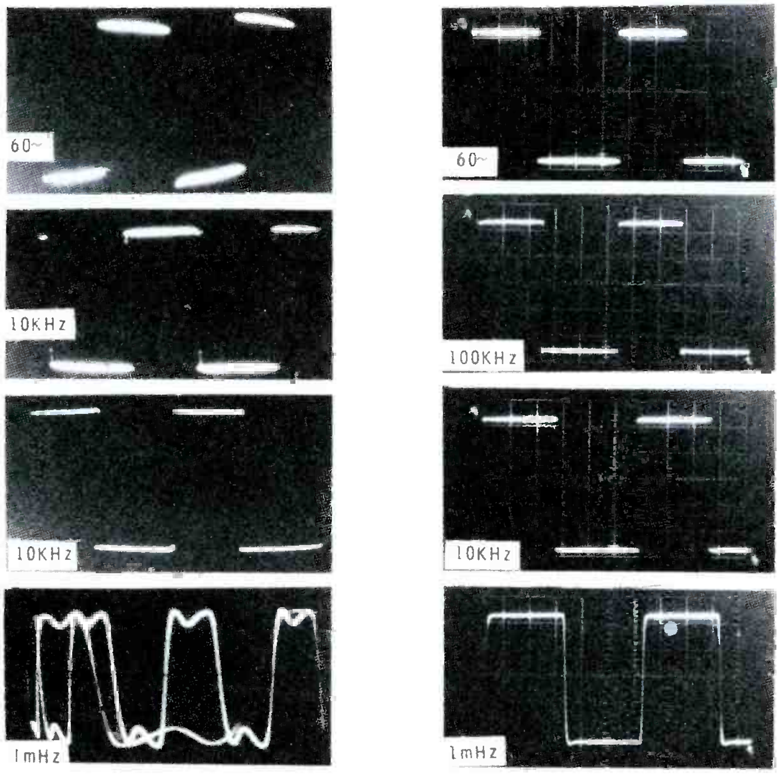


Fig. 14. Measurement of rise time.



(A) Response of service-type, 100-KHz scope.

Fig. 15. Transient responses of lab- and service-type scopes.



(B) Response of service-type, 4-MHz scope.

(C) Response of lab-type, 15-MHz scope.

Fig. 15. Transient responses of Lab- and service-type scopes.

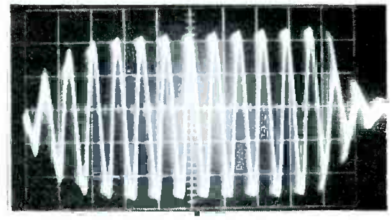
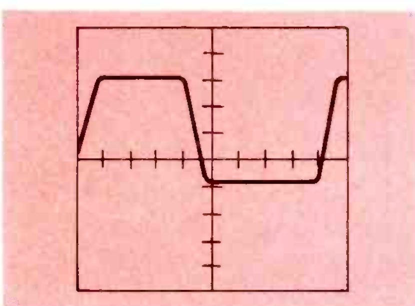


Fig. 17. Expanded color signal.

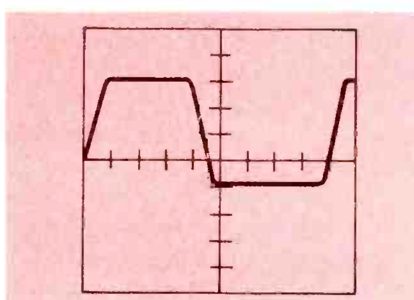
Conclusion

We have reviewed the more basic advantages and limitations of various meters and scopes. Although many features have to be considered when choosing a test instrument, cost is often a deciding factor. In general, instruments with fewer limitations are more costly. However, a very costly scope, for example, might be useless to the beginning technician because he cannot cope with the many unfamiliar controls. Therefore, it is advisable to start one's apprenticeship with simple instruments. After the technician becomes familiar with the operation of controls and the limitations of his instruments, he can "graduate" to more elaborate instruments.

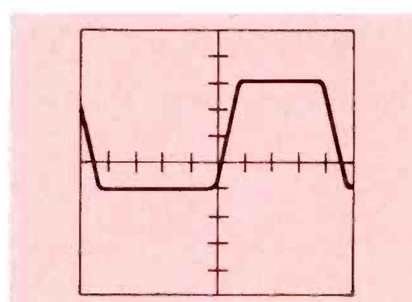
The necessity for understanding circuit action is sometimes overlooked. That is, unless we know how circuits work, we cannot evaluate instrument data to troubleshoot the circuits. An understanding of various circuits is gained slowly, both through study and practical experience. An apprentice who has not become familiar with AC circuit action, for example, should limit his activity to VOM and VTVM tests. Then, after he has gained an understanding of AC circuits, he can progress to basic scopes with more confidence and proficiency. After he has become familiar with the advantages and limitations of the basic scope, he will be qualified to tackle a lab-type scope. In any event, understanding circuit action and the operation and limitations of various test instruments go hand-in-hand. ▲



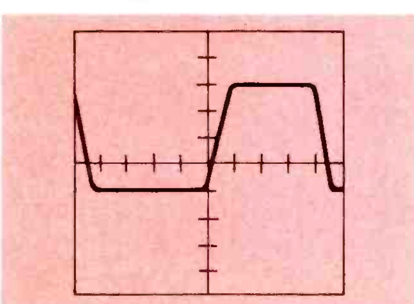
(A) Trigger selector set to +Int.



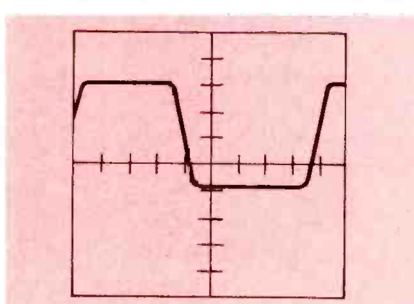
(C) Triggering at low point on leading edge.



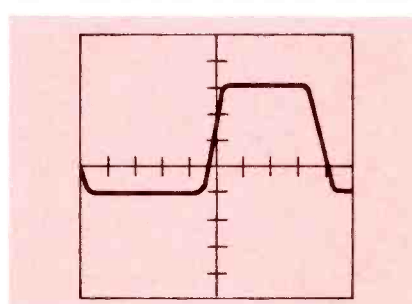
(E) Triggering at low point on trailing edge.



(B) Trigger selector set to —Int.



(D) Triggering at high point on leading edge.



(F) Tirggering at high point on trailing edge.

Fig. 16. Trigger controls enable display to start at any point in waveform.

Circle 30 on literature card

Transistor TV Techniques

(Continued from page 39)

time, and the positive portion of the waveform cuts the transistor off during flyback time.

The damper circuit uses a silicon diode. Another diode is often used to rectify a pulse from the high-voltage transformer to provide approximately 100 volts for the video amplifier. To troubleshoot the damper-circuit, follow standard practices: Check the diodes and capacitors for shorts, and the transformer windings and resistors for opens.

Vertical Circuits

These are essentially transistor counterparts of the tube multivibrators that have been in use for years. A pulse is fed back from the output of the circuit to the input to sustain oscillation. For this reason, a fault in any part of the stage will stop vertical deflection and there will be no waveform available anywhere in the circuit for scope tracing.

A multivibrator is really just an amplifier with a portion of the output fed back to the input. Therefore, a small signal can be introduced into the input circuit from a signal generator always through a capacitor), and followed using a scope as a signal tracer to find the defective stage.

For problems of insufficient height or poor linearity, be sure to check any electrolytic capacitors in the circuit for us to discuss all of them here. One thing that we do suspected one is the quickest test you can make.

AGC Circuits

There are too many different kinds of AGC circuits AGC polarit in the direction to cut off the transistor, it want to point out is that just about all(if not all) transistor TV circuits use "saturation" AGC.

Saturation AGC means that instead of having the AGC polarity in the direction to cut off the rtansistor, it is in the opposite direction. Therefore, the transistor is driven toward, or into, saturation. Thus, a PNP IF or RF transistor will have more negative voltage applied to its base when the incoming signal increases, even though a PNP transistor requires a positive bias voltage for cutoff.

The reason for using saturation AGC is demonstrated by the circuit in Fig. 5. As the collector current increases (due to the increased negative AGC bias), the voltage on the collector is reduced because of the increased drop across R3. The decreasing collector voltage quickly

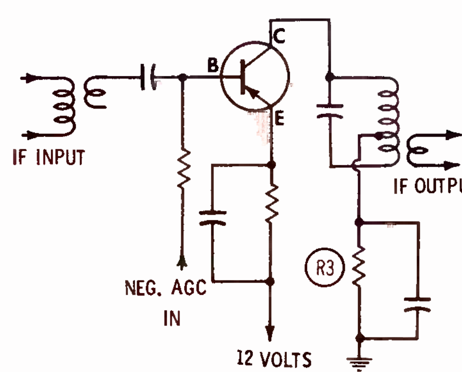


Fig. 5. AGC applied to transistor base saturates transistor.

Will solid state technology stump your TV technicians?

Not if you take advantage of all the training help made possible by Motorola's greatly expanded field-service staff.

Read what it can mean to you.

No question about it. A technological revolution is now underway in the home entertainment business. Radios are solid state. Stereos are solid state, and now TV is rapidly going solid state. And, the trend is bound to continue as customers seek other products with advanced space-age reliability. But, if your men understand tube technology—they can learn transistor technology quickly.

That's why Motorola has introduced the new "Professional Technician Program." Our training staff of technical representatives has been greatly expanded to handle the program. These men will work with Motorola Distributor Service Representatives . . . and in some cases with your own men in your own shop to help them learn the new technology.

With the help of P.T.P., Motorola distributors have strengthened their own service training programs, too. Some have training facilities set up in their own places of business so you can send your technicians in for "refresher courses."

Many hold periodic training meetings for large groups. Motorola Regional Service Managers are often in attendance at these meetings to provide detailed information about design and service features.

Just talk with the service manager from your Motorola Distributor's. He is well prepared to help you with training for solid state circuitry. Motorola is the television industry's largest producer of solid state components and a leader in solid state technology.

MOTOROLA®

Circle 32 on literature card

drives the transistor toward saturation, and so a kind of "amplification" of the AGC occurs. Another advantage of this circuit is that the load on the input circuit remains fairly constant. Detuning of the IF stage does not occur, as it might if the transistor were cut off.

Precautions in Transistor TV Service

1. The first precaution is not to be overly cautious about using normal service procedures. Transistors will forgive a lot of mistakes—not all, but a lot.

2. Don't turn up the volume control without a speaker connected to the set. This can damage the audio output transistor.

3. If transistors use sockets, don't pull them from their sockets while the set is turned on. In most circuits it won't hurt a thing, but once in a while, the surge might ruin one.

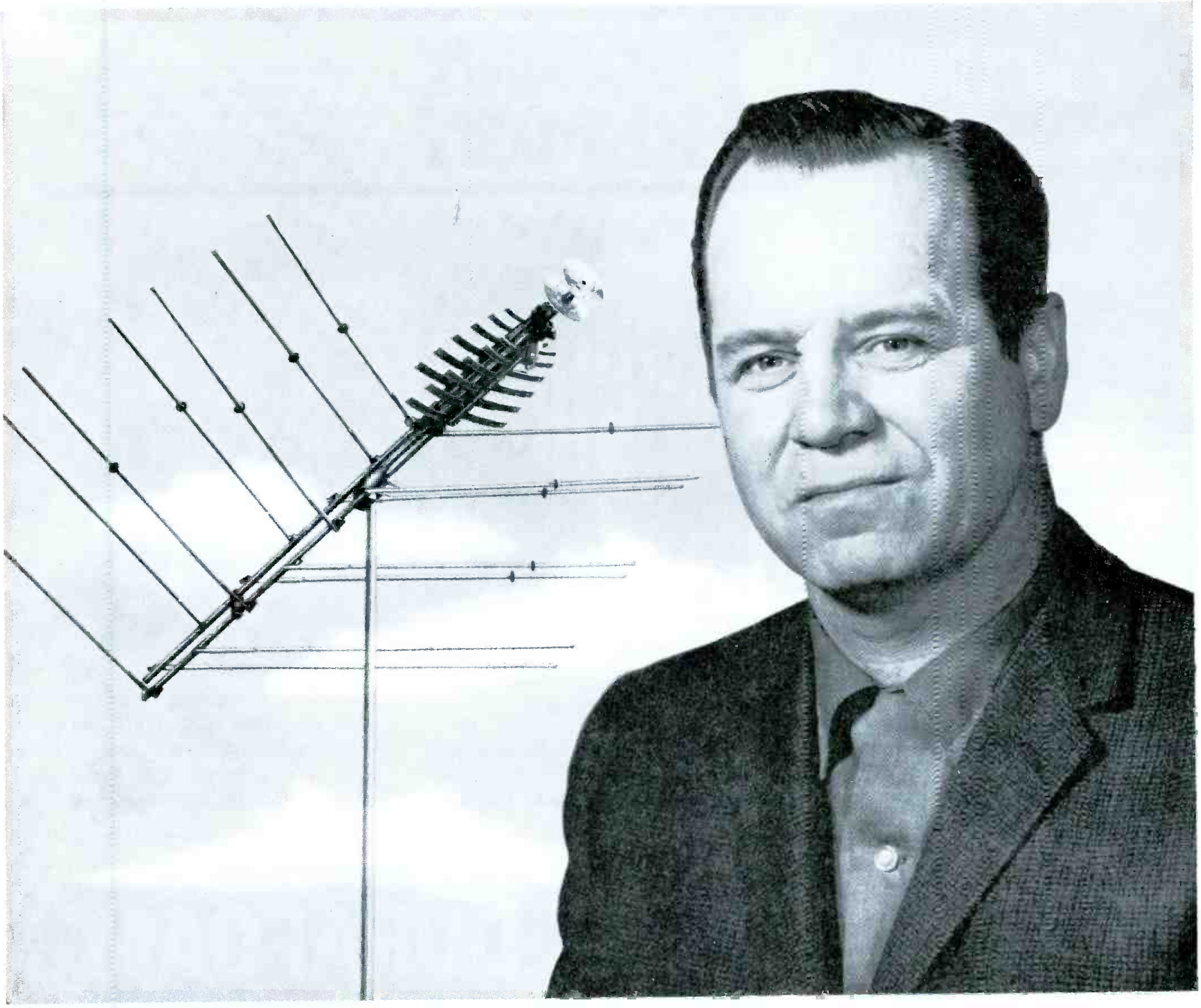
4. Don't discharge high voltage too close to a transistor. Under some conditions this may damage a transistor—again not too often, but then one time is too many.

5. Diodes are often used in transistor TV circuits and are notorious offenders in some circuits of some sets. Usually, a check with an ohmmeter will find the culprit.

6. Manufacturers like to sell exact replacement transistors, and we recommend their use if it is possible and convenient. However, many circuits will work well with substitute transistors. For example, an auto-converter transistor often makes an ideal video driver. Don't interchange germanium and silicon types. If you are in doubt about which kind is used, check on the schematic for the bias value. If it's about .2 volt, it's germanium; if it's higher than about .5 volt, it's silicon.

7. Re-read precaution 1.

Now would you believe—interesting? ▲



"Out here in the fringes, your reputation depends on the pictures you deliver...

That's why we stick to JFD Color Laser antennas," affirms HARRY MELANDER, of Melander's Appliance Center, Alta, Iowa.

"The nearest TV stations to us are channels 4 and 9 from Sioux City, over 60 miles away and channel 21 from Fort Dodge, some 70 miles away in the opposite direction. And on their way here the signals have to get through some heavily wooded hills. This makes it real easy for snow and ghosts to creep into the pictures—especially in color.

"We rely on JFD LPV antennas exclusively because they always come through with reception that's ghost-free and color-true—despite this distance and terrain."

Harry Melander depends on both LPV-TV Log Periodics and Color Lasers—like other professionals—to deliver the performance his customers expect from a professional.

Here's why:

☐ **W-I-D-E BAND LPV LOG PERIODIC DESIGN** delivers *more* gain, *higher* signal-to-noise ratios, *pinpoint* directivity that kills ghosts—VHF and UHF.

☐ **SHOWROOM QUALITY COLOR**—*flat* response across each channel. No "suck-outs" or "roll-off." *Out-performs* any other antenna in *color* or black/white-*keeps* customers sold.

☐ **CAPACITOR-COUPLED ELEMENTS** work on *both* fundamental and harmonic modes. *Entire* antenna (not just part of it as in other antennas) responds to *every* channel.

☐ **RUGGED NEW "FLIP-LOK" ASSEMBLY** snaps out elements—keeps them *tight* and right on target.

Switch to the JFD LPV—the professional's antenna • Your JFD LPV distributor can prove it to you!

JFD®

JFD ELECTRONICS CO.
15 Avenue at 62 Street, Brooklyn, N.Y. 11219
JFD International, 64-14 Woodside Ave., Woodside, N.Y. 11377 JFD Canada, Ltd., Ontario, Canada
JFD de Venezuela, S.A., Avenida Los Haticos 125-97, Maracaibo, Venezuela

LICENSED UNDER ONE OR MORE OF U.S. PATENTS 2,958,081; 2,985,879; 3,011,168; 3,108,280; 3,150,376; 3,210,767; RE. 25,740 AND ADDITIONAL PATENTS PENDING IN U.S.A. AND CANADA. PRODUCED BY JFD ELECTRONICS CO. UNDER EXCLUSIVE LICENSE FROM THE UNIVERSITY OF ILLINOIS FOUNDATION. LICENSED UNDER ONE OR MORE OF U.S. PATENTS 2,955,287 AND 3,015,821 AND ADDITIONAL PATENTS PENDING.

Circle 34 on literature card

PRODUCT REPORT

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

CRT Tester
(60)

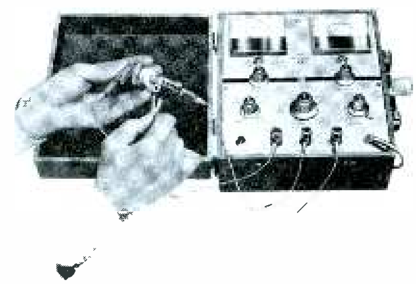
A new CRT Analyzer/Rejuvenator, designated CR-35, has been announced by **The Hickok Electrical Instrument Company.** The instrument tests all color and black-and-white television picture tubes for gas, emission, shorts, opens, grid cutoff, and cathode life. It also rejuvenates, re-

Circle 35 on literature card

pairs shorts, and determines booster effectiveness. The SCR circuitry employed in this unit provides continuously variable, meter-monitored, test voltages which assure availability of correct heater potentials and provides protection against obsolescence. It is small, lightweight, and mounted in a portable carrying case. Price of the tester is $99.95.

Circuit Breaker Kit
(61)

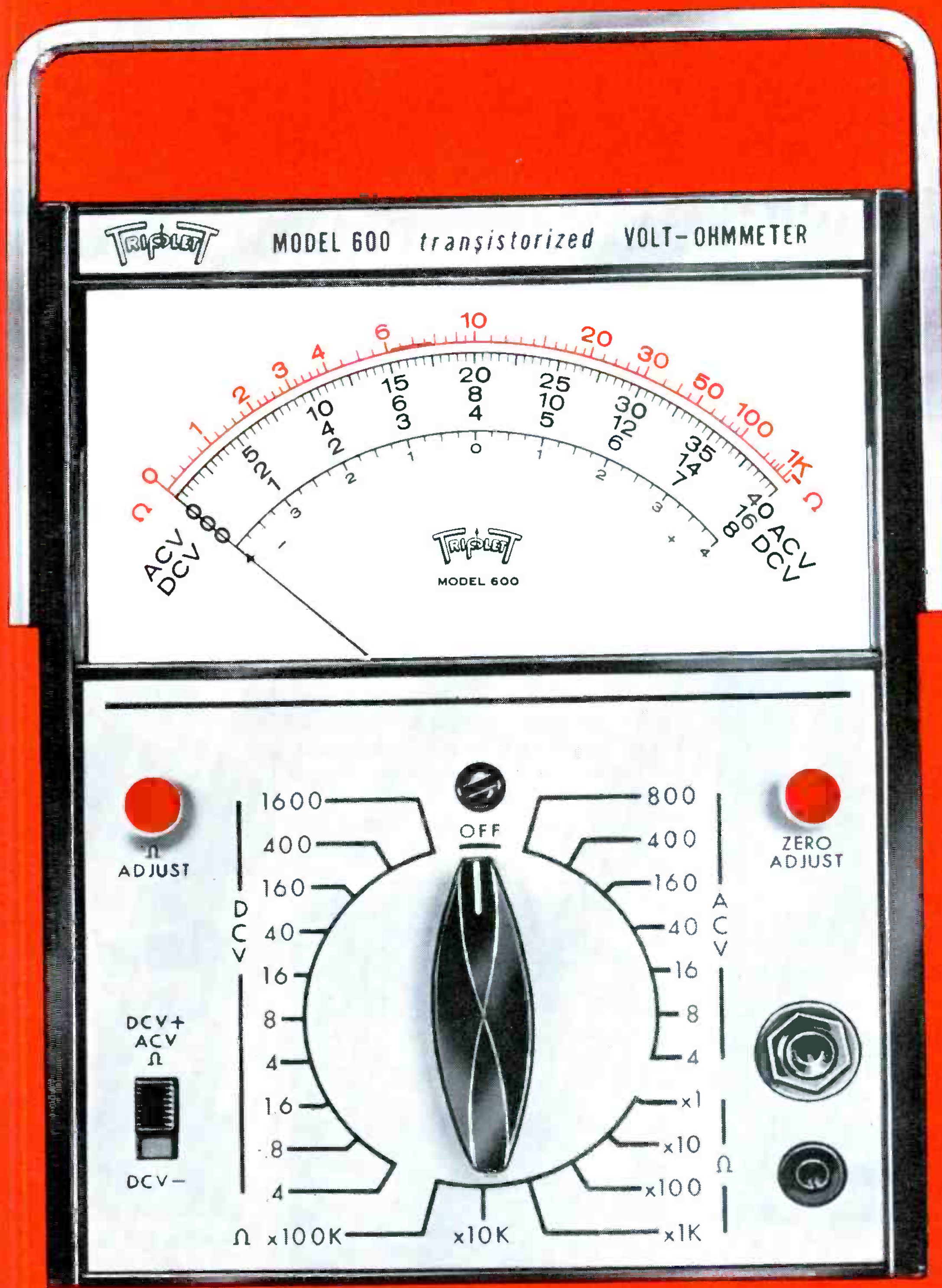
An assortment of 12 popular circuit breakers for TV sets is available in kit form from **Mallory Distributor Products Company.** The circuit breakers are exact replacements packaged in a handy plastic box that fits into most tube caddies. Each breaker is equipped with an "anti-cheat," noncycling reset action and is tab mounted. The kit, complete with cross-reference, is priced at $9.95.



Thyristor (SCR) Analyzer
(62)

As silicon controlled rectifiers and other types of thyristors continue to gain popularity as circuit components for industrial equipment and home appliances, technicians have become increasingly aware of the need for a test instrument to check these new components. Recognizing this need, **Seco Electronics** has developed the Model 240 Thyristor Analyzer, a compact, solid-state instrument designed to provide information on gate firing voltage and current and peak forward and peak reverse voltage and current.

The new unit, completely self-contained, is designed for plug-in connection to any 115-volt AC outlet. It provides accurate, simultaneous readout on two separate meters. Gate voltages and currents can be checked for matching and sorting to firing circuit requirements. The unit also provides an accurate check of peak forward voltage and current, as well as peak reverse voltage and current to predetermine the proper SCR to use for various operating conditions. Because the analyzer is fast and relatively easy to operate, it is useful for matching SCR's to specific voltage and current parameters, or for sorting SCR's into matched pairs (or threes)



ACTUAL SIZE

NEW SOLID STATE VOLT-OHMMETER

1. F-E-T Circuitry—Battery Operated with 11 Megohm Input Impedance (Field Effect Transistor).
2. 400 DC MV range at 2.7 Megohm Impedance for Solid State circuit testing.
3. One Selector Switch with 23 ranges plus a Polarity Reversing Switch.

Circle 39 on literature card

Model 600 on stand handle leather case, $14.00

Model 600 TVO
(Transistorized Volt-Ohmmeter)

$78

Suggested U.S.A. User Net
Available Now At Your
Local Distributor

TRIPLETT
ELECTRICAL INSTRUMENT COMPANY
BLUFFTON, OHIO

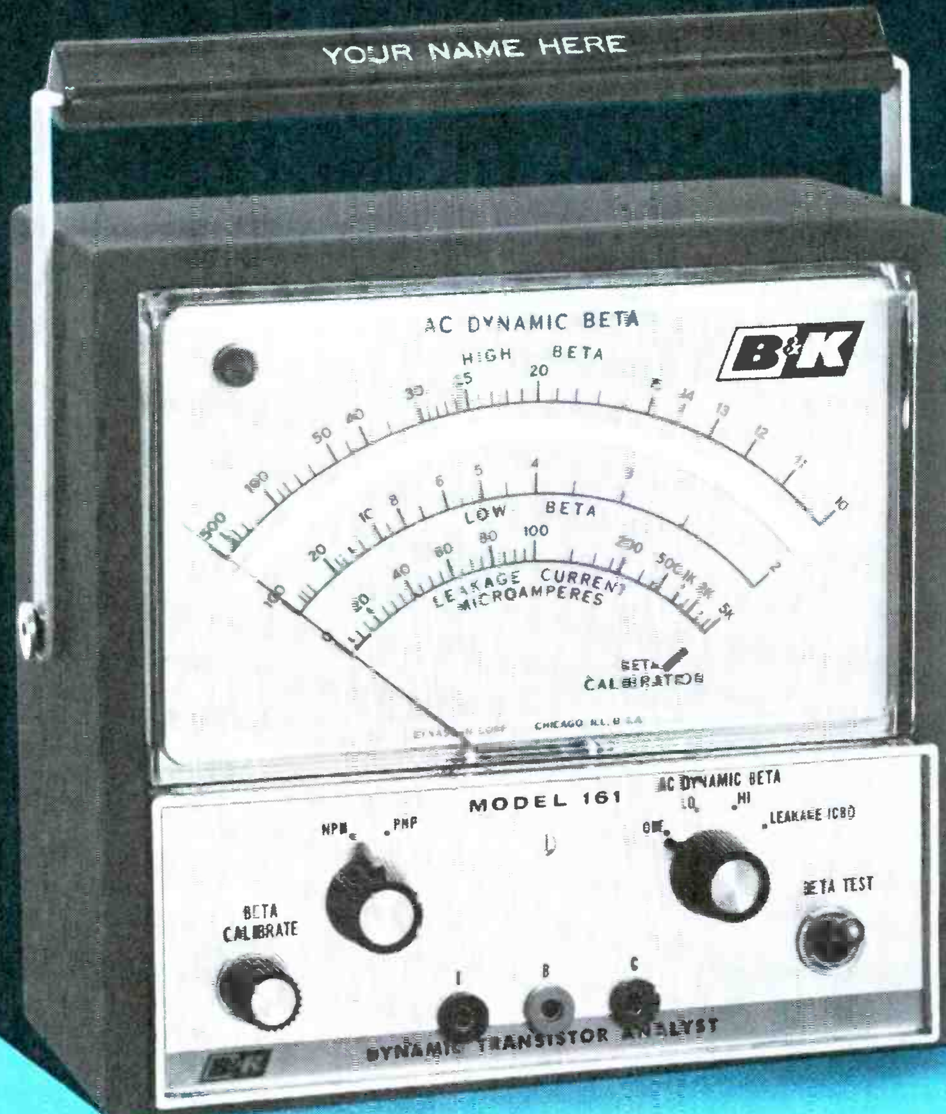
to share work loads evenly in full-wave or three-phase applications.

The Model 240 is mounted in a vinyl-covered carrying case measuring 10½″ high by 9″ wide by 5″ deep. It is equipped with insulated binding posts that accomodate either "tip" or "banana" plugs. A power cord for plug-in connection is also furnished. Price is $144.50.

Video Tape Recorder
(63)

A new, solid-state, industrial video tape recorder, designated NV-204, has been announced by **Matsushita Electric Corp. of America,** which markets its radios, TV receivers, phonographs, and video and audio tape recorders under the Panasonic

New B&K Dynamic Transistor Analyst



Simple to operate... fast ... safe to use.
In-Circuit Transistor Tester.
Personalized for professional pride.

B&K ends the mystery, fears and misunderstanding surrounding transistor servicing, application and theory. With every Model 161 Transistor Analyst, you get *two free reference manuals:* the new edition of Howard W. Sams' Transistor Specification Handbook, plus the all-new, years-ahead B&K Basic Course on Transistors—everything you need to know to test and service unfamiliar solid-state sets. You get ahead of your competition and stay ahead of the market.

The new B&K 161 means fast, accurate, *in-circuit* testing of transistors for AC Beta. With the same simple procedures, the 161 makes out-of-circuit tests, too, including Icbo (current leakage) and front-to-back conduction of diodes and rectifiers. There's no chance of damaging transistors or components; special circuitry protects all parts, even if leads are connected incorrectly.

The huge 7" mirrored meter insures accurate readings on three separate scales. Two ranges check AC Beta: 2 to 100; 10 to 500. For leakage tests, Icbo range is 0 to 5000 microamps on an expanded scale for better readability. A flick of the switch checks polarity. It's so simple, you don't need any set-up book.

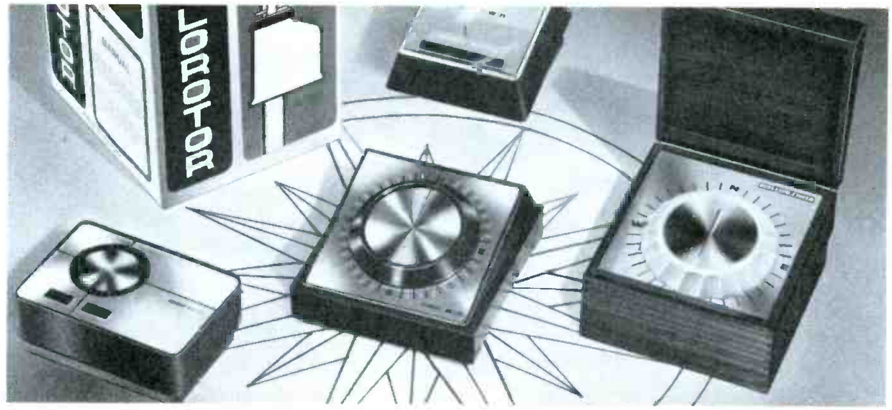
To stay ahead of the game, get the B&K Model 161 with a scuff-proof case and the two exclusive B&K Transistor reference manuals. A complete transistor service package with all leads included and your personalized name plate—for only **$89.95.**

B&K Division of Dynascan Corporation
1801 W. Belle Plaine • Chicago, Illinois 60613

B&K
Where Electronic Innovation Is A Way Of Life

Circle 43 on literature card

label in this country. The unit employs five motors, records on a 1" magnetic tape, permits reduction of tape speed to two frames per second, in addition to "stop frame", forward or reverse. A special "pause" lever allows instant "stop action." Other features include a picture resolution of 350 lines, color compatibility, and fast forward or rewind in 2¾ minutes. The recorder can be operated in either vertical or horizontal position. A complete remote control unit and microphone with stand are available as optional equipment. Price is under $4,000.



Antenna Rotators

(64)

A new semi-automatic antenna rotator is included in **Channel Master's** new Colorotor line, which also features a manual rotator and two different console stylings in automatic models. In addition to changes in styling, the drive units for all new models have been designed with increased torque to handle heavy fringe area color antennas and stacked arrays.

The Semi-Automatic Colorotor, designated Model 9513, incorporates a motor in the control console instead of a meter. The motor drives the position indicator dial and is synchronized with the exterior drive unit motor to provide precise aiming and relocation of stations. Installation of the new semi-automatic model is simplified through the use of three-conductor wire.

New control console styling has also been incorporated in manual Model 9503, automatic Model 9512, and deluxe wood cabinet, automatic Model 9516A. All motorized control units utilize quiet-running polyurethane gears and acoustically "re-designed" housings for maximum sound dampening. Prices include $39.95 for the manual model, $44.95 for the semi-automatic, $49.95 for the automatic, and $59.95 for the automatic model with a wood cabinet control console.

ERRATUM

In the April Product Report we erroneously reported the price of Nortronics' Model WR-30 full-track conversion kit as being $75.00. The correct price is $57.00.

This *Remington* PREMIER PORTABLE TYPEWRITER

FREE

WHEN YOU BUY THIS RCA WR-64B COLOR BAR/DOT/CROSSHATCH GENERATOR...THE ESSENTIAL COLOR TV TEST INSTRUMENT

Here's a deal you can't afford to miss! A FREE Remington portable typewriter—yours when you purchase the most essential color-TV test instrument—the RCA WR-64B!

Just imagine how handy your new typewriter will be—in the shop or at home. You'll use it almost as much as you use the RCA WR-64B—standard of the color TV servicing industry.

Here's how to get your FREE Remington Typewriter. Mail in the warranty card plus the gold label from the shipping carton of your new RCA color bar generator to RCA Test Equipment Headquarters, Bldg. 17-2, Harrison, N. J. We will ship your new Remington portable typewriter to you direct, freight prepaid. But remember—this offer covers only equipment purchased between February 1, 1967 and July 15th, 1967. To allow for postal delay, we will honor cards postmarked up to July 31st.

Plan NOW to take advantage of this BIG offer—a FREE Remington portable typewriter with your purchase of an RCA WR-64B color bar/dot/crosshatch generator.

The standard of the Color-TV Servicing Industry. Generates all necessary test patterns—color bars, crosshatch, dots plus sound-carrier. *Only* **$189.50***

*Optional Distributor resale price. All prices subject to change without notice. Price may be slightly higher in Alaska, Hawaii, and the West.

Ask to see it at Your Authorized RCA Test Equipment Distributor

RCA Electronic Components and Devices, Harrison, N. J.

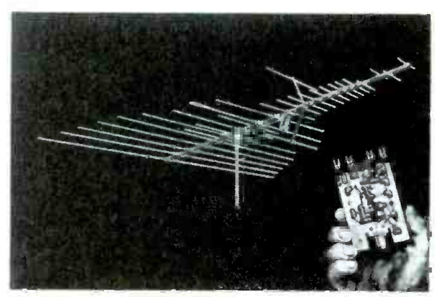
RCA®

The Most Trusted Name in Electronics

Sweep Generator
(65)

Alignment and peaking of color TV and FM stereo receivers is aided by a new sweep generator and marker adder introduced by **Precision Apparatus.** Designated Model E-410C Sweep Generator and Marker Adder, the new instrument combines a wide-range, frequency-modulated signal source with complete marker adder circuitry specifically designed for the alignment and maintenance of TV, FM, and other high-frequency, wide-band receivers and circuits.

Six-band frequency coverage extends from 3 MHz through 1080 MHz. Features include continuously variable sweep width, marker adder, internal blanking, automatic gain control, and fixed frequency markers. Dimensions of the unit are 13" x 8½" x 7". Price is $169.95.

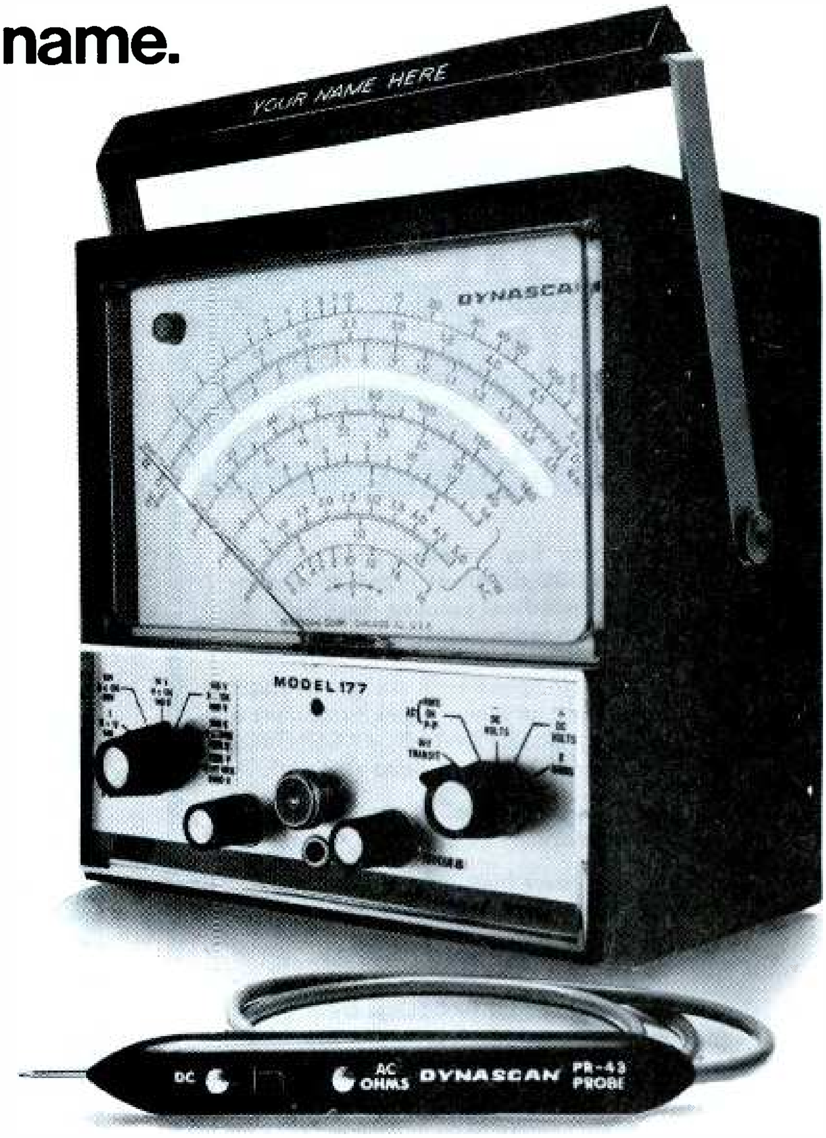


New Antenna Line
(66)

New electronic and construction designs are featured in **Winegard's** new Super Colortron antenna line. Among the electronic features are instant-loading, solid-state cartridge pre-amps and terminal cartridges that slip into a totally enclosed, weatherproof cartridge housing at the point of signal interception. Both 300- and 75-ohm VHF, UHF, and 82 channel cartridge preamps are available—six models in all. Three other cartridges are also available. A color spectrum filter cartridge passes only pure TV signals and shuts out all other electromagnetic frequencies. The 300-ohm or 75-ohm

There's a heckuva lot of VTVM units around.

Only the 177 "Professional" has battery eliminator, mirrored scale, half volt scale for transistor circuits and—your name.



If you're one of the skeptics who think one VTVM is pretty much like another, the B&K 177 "Professional" will change your mind. This one stands out from the crowd.

A gigantic 7" mirrored scale reads faster, more accurately. An extra-sensitive 0.5 VDC range will check transistor circuits.

A zener diode regulated power supply insures reliable ohmmeter performance. No batteries required. A single probe ends cable fumbling. Transit switch position protects the meter on the road. The vinyl covered steel case is good-looking and tough. Its appearance symbolizes your professional status and, above all, it has B&K quality.

Any way you look at it, the 177 "Professional" is really different and it's all *yours*—the handle is personalized with your name. Cost? Just **$79.95.**

B&K Division of Dynascan Corporation
1801 W. Belle Plaine • Chicago, Illinois 60613

B&K

Where Electronic Innovation Is A Way Of Life

Circle 48 on literature card

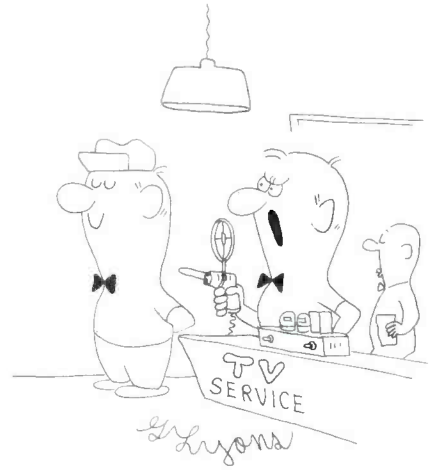
terminal cartridges give complete weather protection when a pre-amp or color spectrum filter is not used.

Other electronic features include impedance correlators that automatically increase 75-ohm driven elements to 300-ohms, providing 100% signal transfer from antenna to set. Another new electronic feature is the vertical resonant reflectors that provide increased vertical capture area and greater gain on channels 14 through 83. Special UHF control elements provide peaking for channels 52 to 83 in areas where higher gain on these channels is desirable. The same feature is available on the FM band, permitting attenuation in areas where strong FM signals interfere with TV signals.

In addition to the many electronic features of the new line, construction innovations have also been employed. A built-in weatherproof cartridge housing is an integral part of the antenna and completely eliminates exposed terminals. The blue anodized boom on the Super Colortron is ellipsoidal, specially engineered for antennas to provide greater strength and rigidity. A special aluminum alloy is used for all antenna elements, making the elements more resistant to bend and wind distortion. New hi-impact Polystyrene wrap-around insulators completely encapsulate and weatherproof elements at the point of electrical contact. They provide perfect alignment of elements by locking the entire circumference.

All antennas in the new line are completely anodized for sunfast, permanent weather protection. There are five 82-channel antennas from $21.50 to $69.95, four VHF models from $24.95 to $64.95, and three UHF models from $14.95 to $32.95. ▲

Circle 45 on literature card

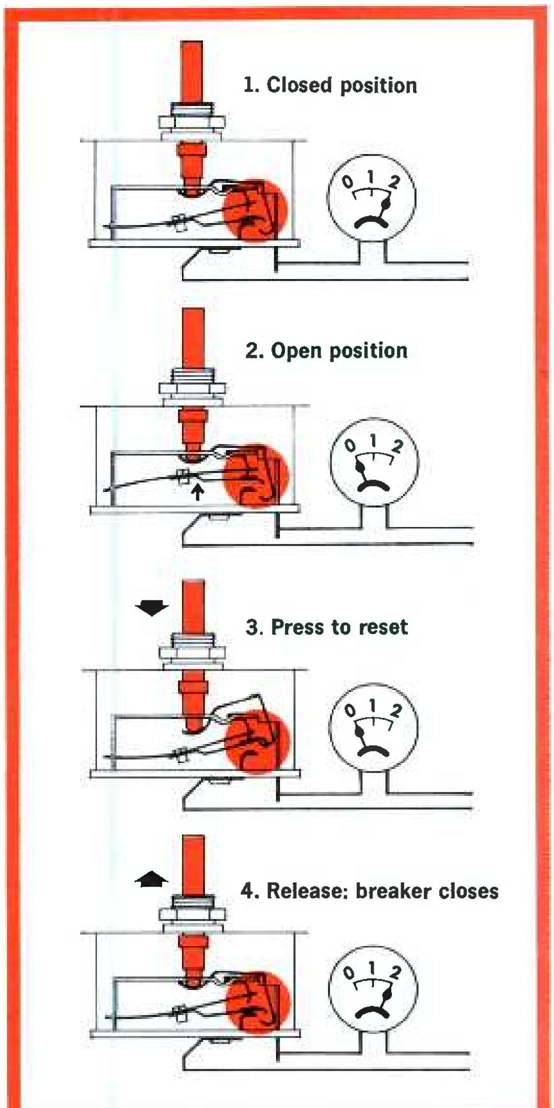


"OKAY, WHO'S THE WISE GUY?"

Circle 49 on literature card

MALLORY **Tips for Technicians**

Tips on replacing circuit breakers



That little red "breaker reset" button that sticks out of the back of nearly every television chassis can be a time-saver or a trouble-maker, depending on what's wrong inside the set, and who's pushing the button. As you well know, when a transient fault has popped the breaker, youcan get the set back in business just by pressing the reset. But if there has been a short-circuit failure and some uninformed tinkerer presses the button and *keeps* it pressed, there's a good chance that more power keeps flowing into the fault. Result: a minor trouble becomes a calamity.

This is why Underwriters' Laboratories require that breakers should be "cheat-proof"—that is, they should not allow current to pass when the reset button is held depressed. Some of the replacement breakers you'll find on the market *aren't* cheat-proof. We have one that *is*. It has features that you'll find valuable any time you need to install a new breaker, or when you're working on a breadboard circuit that needs over-current protection.

Take a look at how this breaker works, and you'll see what we mean.

At top (Picture 1) is the way the breaker mechanism looks when it's in the "on" position.

Along comes an overload (Picture 2). The bi-metal strip heats, snaps into the "break" position, opening the current carrying contacts.

Now you press the button to reset (Picture 3). As long as you hold the button down, the contacts at the right remain open. Release the button and the contacts go back to closed (Picture 4). If the overload is still there, the breaker will open again. You can't keep it closed on a short circuit!

No wonder this particular breaker is used as original equipment on the majority of all television sets. They're made for Mallory by Mel-Rain Corp. to the same specifications as for original equipment, and they're available from a Mallory distributor near you. Off-the-shelf ratings go all the way from 0.5 to 7 amperes break current, and include all the values you'll need for service replacement or for industrial equipment maintenance. And as an extra convenience, you can get them with either a twist-tab or bushing mount. For your copy of our new 24-page cross-reference guide to circuit breaker replacement in all popular TV sets, see your Mallory distributor, or write to Mallory Distributor Products Company, a division of P. R. Mallory & Co. Inc., P. O. Box 1558, Indianapolis, Indiana 46206.

Circle 50 on literature card

Circle 53 on literature card

INDEX TO ADVERTISERS

June, 1967

Circle 54 on literature card

Circle 52 on literature card

$ FREE $ CATALOG AND LITERATURE SERVICES

***CHECK "INDEX TO ADVERTISERS" FOR FURTHER INFORMATION FROM THESE COMPANIES**

ANTENNAS

75. *ALLIANCE* — Colorful 4-page brochure describing in detail all the features of Tenna-Rotors.
76. *ANTENNACRAFT* — 12-page catalog listing complete Antennacraft line of UHF, VHF & FM antennas for all types of installations.
77. *BLONDER-TONGUE* — Compact brochure detailing a line of all-channel products expressly designed to improve reception in the home and small MATV systems.*
78. *COLORMAGIC*—Form FR-28-C describes a complete line of antennas and accessories.
79. *CORNELL-DUBILIER* — 16-page booklet illustrates color, black-and-white TV, and FM-stereo reception problems that are eliminated by the installation of a CDE antenna rotor system.*
80. *DELHI*—Twelve-page catalog introducing a complete new line of home TV towers, ham towers, citizen's band towers, masts and telescoping masts.*
81. *FINNEY* — Forms 20-338, 20-356, and 20-357 describing distribution amplifiers and antenna amplifiers for 300-Ohm and 75-Ohm TV and FM systems.*
82. *JERROLD* — New 4-page full-color catalog describes the new Paralog Plus antennas.*
83. *JFD* — Color Laser and LPV antenna brochures. New 1967 dealer catalog covering complete line of log-periodic out-door antennas, rotators, and accessories.*
84. *MOSLEY* — Information on new Mosley MATV system for up to 8 TV/FM sets. Includes TV antenna, distribution system and outlets.
85. *WINEGARD* — 8-page color brochure on new Super-Colortron antennas: 5 VHF-UHF-FM, 4 VHF-FM, 3 UHF. Includes information on 6 new solid-state preamplifiers and 82-channel booster-couplers.*

AUDIO

86. *ATLAS SOUND* — Catalog 556-67 illustrates and describes many new models of public address loudspeakers, microphone stands, and accessories for commercial sound applications.*
87. *DUOTONE* — Catalog of accessory and maintenance items for the audiophile.*
88. *ELECTRO-VOICE* — A comprehensive guide to microphones and microphone accessories is offered in pocket-sized brochure form.
89. *JENSEN*—New electronic musical instrument louspeakers brochure, NY-2, containing newest additions to the line.
90. *KOSS*—Brochure about selected components from the Acoustech line.
91. *NUTONE* — 16-page full color booklet illusrating built-in stereo music, intercom, and radio systems.
92. *OXFORD TRANSDUCER* — Catalog sheets featuring speaker systems for automobiles.
93. *TENATRONICS*—Flyer sheet about a home stereo cartridge player.

COMMUNICATIONS

94. *AMPHENOL* — 2-color spec sheets on new Model 650 CB transceiver and Model C-75 hand-held transceiver.*
95. *COMCO* — Spec sheet on the Model 626 marine radio-telephone.
96. *FANON* — 24-page handbook on intercom systems.
97. *GENERAL RADIOTELEPHONE* — Flyers on the Fieldmaster and MC-9 CB transceivers.
98. *MOTOROLA* — New brochure tells how to reach people on-the-move through use of personal two-way radio.*
99. *PEARCE-SIMPSON* — Brochures and flyers on the complete line of CB transceivers.

COMPONENTS

100. *BUSSMANN* — Bulletin on BUSS Fustat Box Cover Units offers simple, low-cost way to protect work bench tools against damage and burnout. Units fit standard outlet or switch box, have fuseholder plus a plug-in receptacle, pilot light, switch, etc.
101. *CENTRALAB* — 24-page replacement parts catalog No. 33GL.
102. *COLUMBIA WIRE* — 8-page supplement lists wire, cord, and cable.*
103. *LITTELFUSE* — Pocket-sized TV circuit breaker cross-reference gives the following information at a glance. Manufacturer's part number, corresponding Littelfuse part number, price, color or b/w designation. A second glance gives trip ratings and acquaints you with a line of caddies. Ask for CBCRP.*
104. *MALLORY* — New 1967 full-line catalog.*
105. *QUAM-NICHOLS*—1967 general catalog of speakers.
106. *SONOTONE*—Data reference catalog on a line of nickel-cadmium batteries.
107. *SPRAGUE*—C617, a complete catalog of the Sprague line.*
108. *TRIAD* — 1967-68 replacement catalog. D-816 describes Switchcraft's new "traffic-tailored" audio dealer and distributor accessory merchandiser program.
109. *WORKMAN*—New coil catalog lists general and exact replacements for radio and TV schematic drawings and illustrations of all coils.*

SERVICE AIDS

110. *CASTLE TUNER* — 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.*
111. *ELECTRONIC CHEMICAL* — Catalog sheets on aerosol sprays for servicemen.
112. *G.C.* — FR-67G flyer on color harnesses. FR-67A complete Audio-tex catalog.
113. *INJECTORALL* — New 1967 catalog of chemicals and alignment tools.
114. *MIDSTATE TUNER* — 24-hour service on any make tuner is described in a color-ful brochure.
115. *PERMA-POWER* — Chart shows correct brightener for every TV set in the field.*
116. *PRECISION TUNER*—Mailing kit and replacement tuner list for same-day service.
117. *QUALITY TUNER SERVICE* — Introductory letter describing costs and service on all makes of TV tuners. Repair tags and shipping labels included.
118. *RAWN*—Bulletins on repair ideas using Plas-T-Pair knob and plastic repair kits. Also, bulletins on tuner cleaners and circuit coolers. Includes price sheets.
119. *SPRAYWAY* — Brochure on C-60 solvent cleaner and degreaser.

SPECIAL EQUIPMENT

120. *VACO* — 28-page, 4-color catalog on solderless terminals.

TECHNICAL PUBLICATIONS

121. *CLEVELAND INSTITUTE OF ELECTRONICS*—Free illustrated brochure describing electronics slide rule and four lesson instruction course and grading service.*
122. *PHILCO*—Information about Tech Data & Business Management service. Also, free parts catalog.*
123. *RCA INSTITUTES* — New 1967 career book describes home study programs and courses in television (monochrome and color), communications, transistors, industrial, and automation electronics.*
124. *RIDER*—Brochures on TV Tech/matics.
125. *SAMS, HOWARD W.*—Literature describing popular and informative publications on radio and TV servicing, communications, audio, hi-fi, and industrial electronics, including special new 1967 catalog of technical books on every phase of electronics.*
126. *SIMPSON*—88-page booklet "1001 uses for the 260 VOM."

TEST EQUIPMENT

127. *B & K*—New 1967 catalog featuring test equipment for color TV, auto radio, and transistor radio servicing, including tube testers designed for testing latest receiving tube types.*
128. *EICO*—New long-form catalog of the complete Eico line.*
129. *HICKOK*—Short form catalog plus specification sheets on the Models GC 660 color generator, CR-35 CRT analyzer/rejuvenator, and 860 Injecto-Tracer.
130. *JACKSON*—New line folder on "Service Engineer," test equipment includes push-button-operated color-dot/bar generator.
131. *LECTROTECH*—Two-color catalog sheet on new Model V6-B color bar generator, the latest improved model of the V6. Gives all specs and is fully illustrated.*
132. *MERCURY*—All-new-low-price color dot bar generator and Model 2000 conductance tube checker all for under $100.
133. *PRECISION APPARATUS*—Illustrated catalog describing signal generators, oscilloscopes, and meters.
134. *SECO*—Operating manual for the HC8 in-circuit current checker.*
135. *SEMITRONICS*—Brochure on the new Model 1000 transistor tester.
136. *SENCORE*—8-page full color catalog plus a new 4-page supplement catalog.*
137. *SIMPSON*—New 1967 16-page test equipment brochure featuring a palm-sized VOM, Model 160.
138. *SINGER*—Catalog GD-1 describing frequency meters and standards receivers for the two-way radio communications service.
139. *TRIPLETT*—Literature sheet on the new Model 600 transistorized VOM.*

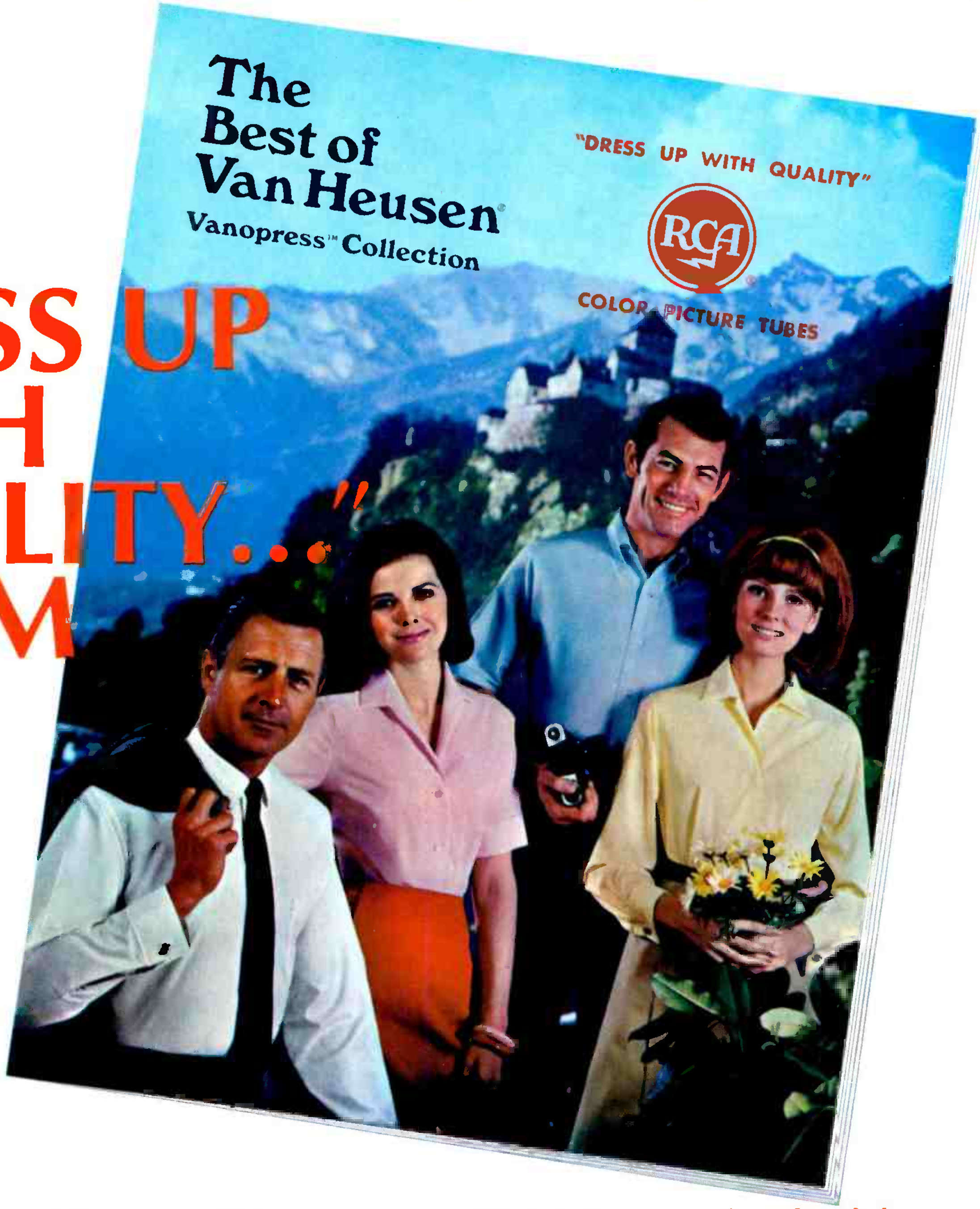
TOOLS

140. *ARROW*—Catalog sheet showing 3 staple gun tackers designed for fastening wires and cables up to ½" diameter.
141. *ENTERPRISE DEVELOPMENT* — Time-saving techniques in brochure from Endeco demonstrate improved desoldering and resoldering methods for speeding and simplifying operations on PC boards.*
142. *XCELITE*—Bulletin N367 on a new 14-piece nut and screwdriver kit.*
143. *GENERAL SEMICONDUCTOR* — 26-page reference list covering 3000 zener and reference diodes.

TUBES AND TRANSISTORS

144. *IR*—Transistor cross reference guide—22 pages of detailed specifications on universal silicon and germanium transistors and a complete listing of more than 5000 devices which they replace.
145. *RADIO CORP. OF AMERICA*—PIX 300, a 12-page product guide on RCA picture tubes covering both color and black-and-white. Includes characteristics chart, terminal diagrams, industry replacement, and interchangeability.*

"DRESS UP WITH QUALITY..." FROM RCA



Earn a FREE Van Heusen® Vanopress™ Shirt for each eligible* RCA HI-LITE or Colorama Color TV Picture Tube you purchase between now and July 31, 1967.

Now from RCA, the quality leader in color television, comes the chance for you to "dress up with quality" in Van Heusen shirts, a quality leader in ladies' and men's fashions! And the offer is FREE.

What a selection! You have a 20-page catalog to choose from. *And all are Vanopress ... the permanently pressed shirt that never needs ironing!*

You get one shirt FREE through each purchase of any of the four eligible tube types—and there's no limit on quantity.

The details are simple. Complete the Registration Postcard portion of the warranty card, attach it to the Carton Identification Card that comes with each eligible* tube and mail *both* to RCA, Box 1140, Lancaster, Pa. 17604. They must be postmarked no later than July 31, 1967. Your Van Heusen gift certificate will be sent to you by return mail.

If you have any questions, just call your Authorized RCA Distributor. But don't wait. The more RCA HI-LITE and Colorama tubes you purchase... the more you can dress up with Van Heusen Vanopress shirts. Start now and you can have a whole new wardrobe of shirts by the time this offer ends.

*HI-LITE types H21FJP22A, H21FBP22A

*Colorama types C21FJP22, C21FBP22

RCA Colorama Picture Tubes contain used materials which prior to reuse are carefully inspected to meet our high quality standards.

RCA Electronic Components and Devices, Harrison, N.J

The Most Trusted Name in Electronics

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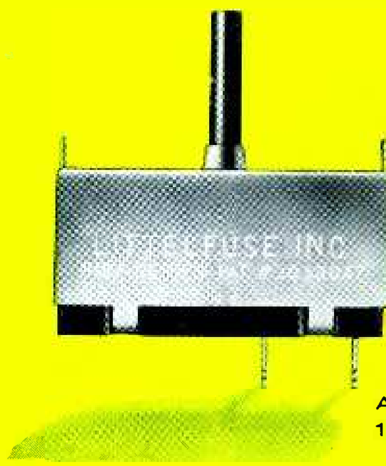
Introducing a Complete Line of Littelfuse Quality Circuit Breakers



Actual Size
$1\frac{3}{4}'' \times 1\frac{3}{16}'' \times \frac{1}{2}''$

Exact replacement from factory to you

Designed for the protection of television receiver circuits, the Littelfuse Manual Reset Circuit Breaker is also ideally suited as a current overload protector for model railroads and power operated toy transformers, hair dryers, small household appliances, home workshop power tools, office machines, small fractional horsepower motors and all types of electronic or electrical control wiring.

LITTELFUSE DES PLAINES

Circle 55 on literature card