A HOWARD W. SAMS PUBLICATION

MARCH 1965/50¢

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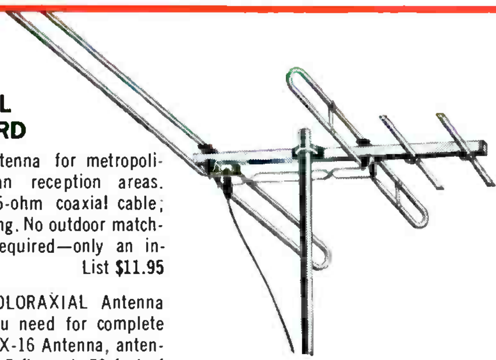

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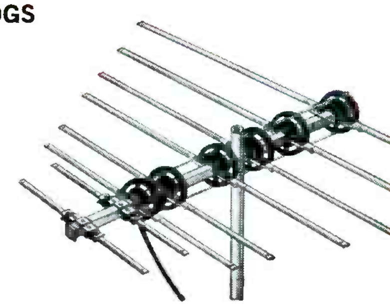

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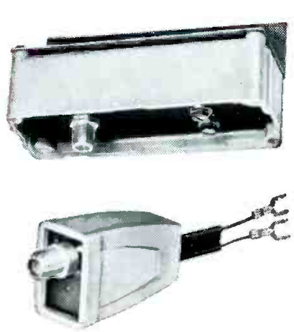

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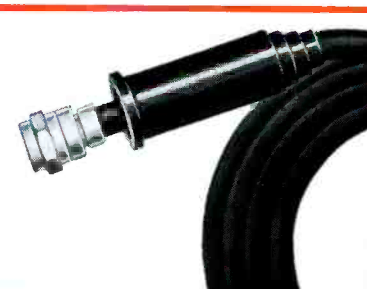

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MODERNIZING YOUR SCOPE

by Robert G. Middleton

You can do numerous things in the way of rebuilding, improving, and modernizing old scopes. Since there are so many improvements possible, it becomes necessary to determine which are really important for service work. For example, you will probably feel the pinch of narrow bandwidth more than that of horizontal nonlinearity. Good 60-cps response is usually more desirable than retrace blanking. High sensitivity is generally more useful than DC response. There are many more, but we'll concentrate here on showing you how you can improve those important qualities already mentioned.

CAUTION: Whenever you remove a scope chassis from its case, remember that the high-voltage power supply is dangerous. Also remember that the high voltage is usually connected to the heater, cathode, and grid of the CRT—this is the opposite of TV-receiver practice. Even with the instrument off, *never* start work on a scope until you have discharged the high-voltage filter capacitors. Although a bleeder is normally provided, it is always possible that the bleeder has become defective, and that the filter capacitors are holding a charge of 1000 volts or more.

Widebanding The Vertical Amplifier

Consider the "old" vertical amplifier depicted in Fig. 1—a configuration typical of many older scopes. Wideband response is not possible because there is no high-frequency compensation (peaking), because plate-load resistors R3, R10, and R11 have high values, and because vertical-gain control R1 has high resistance.

Just why do these considerations limit bandwidth? The input stage uses a 6J5, whose plate capacitance is 5 pf. The output stage employs a 6SN7 with a grid capacitance of approximately 6 pf. There is also stray capacitance to ground from the coupling circuit comprising R3, C3, R4, R5, plus their connecting leads and socket springs. Thus, about 10 pf of stray capacitance exists—not to mention "hidden" capacitance due to Miller effect in the 6SN7; another 40 pf in this case.

As you can see, plate-load resistor R3 (47K) is shunted by a total effective capacitance of 50 or 60 pf, imposing a serious limitation on high-frequency response. Fig. 2 shows why. As the signal frequency increases, the reactance of the 60-pf capacitance decreases. At 55 kc, half the signal is shunted to ground around the 47K resistor, and we can say the bandwidth has an upper limit of roughly 55 kc.

Reduce Load Resistance

Obviously then, one band-widening step is to reduce the load resistance. The 60-pf stray capacitance will then bypass a smaller percentage of the signal. For example, suppose we reduce the plate-load resistance to 3K. Now, only 6% of the signal is bypassed to ground at 55 kc. We can raise the signal frequency to 4.5 mc before half the signal is bypassed to ground. This is obviously an enormous improvement, but naturally at a sacrifice of gain or sensitivity.

In spite of the improved frequency response obtained by using a low value of plate-load resistance, you will still be dissatisfied. What you need is *full* frequency response up to at least 3.58 mc, and preferably to 4.5 mc, for testing color-TV receivers.

Compensate High Frequency

Readers familiar with video amplifiers in TV receivers will immediately recognize the principles of high-frequency compensation in Fig. 3. Two peaking coils are connected into the plate-load circuit. The 120-uh coil is series peaking, and the 93-uh coil is shunt peaking. These values are typical, although the exact inductances required will depend upon the amount of stray capacitance, as well as how much of it is at the input side (in the preceding tube) and how much at the output side (coupling circuit and following grid).

By the same token, a value of 3K for the plate-load resistor is nominal, and you might have to revise this value up or down to obtain a frequency response that is flat from 60 cps to 4.5 mc. For example, one typical stage checked out okay when the plate-load resistor was adjusted to 3300 ohms, but another stage required 2200 ohms to equalize the response at both ends of the bandwidth. Another stage required that both peaking coils have 100-uh inductances to obtain full response at 4.5 mc. Hence, trimming up a vertical-amplifier stage is practically a cut-and-try procedure. Peaking coils with adjustable cores are available, which greatly assist in trimming the high-frequency response precisely.

Modifying the Output Stage

Suppose you are modernizing the vertical amplifier in

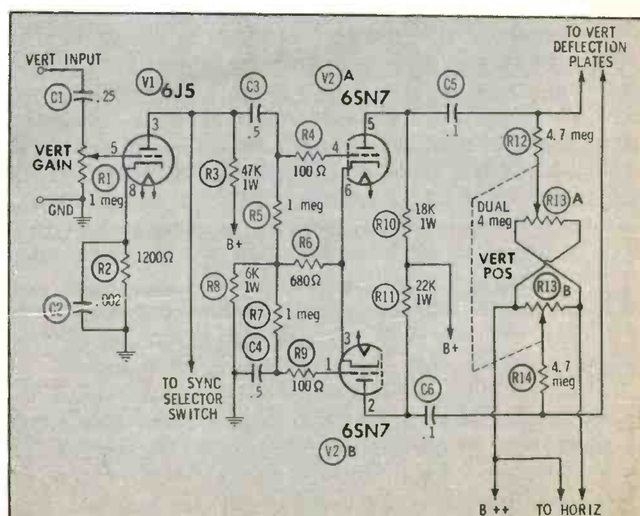

Fig. 1. Modify vertical amplifier to improve its bandwidth.

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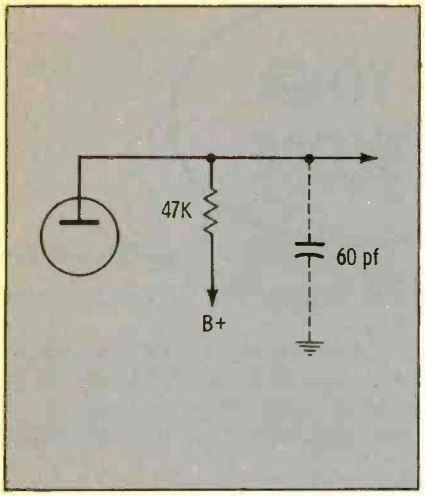


Fig. 2. Half of signal bypassed at 55kc.

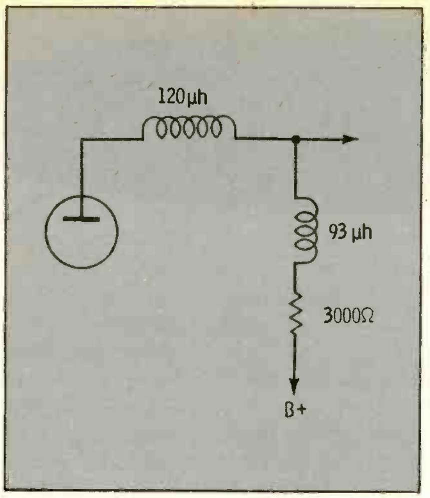


Fig. 3. Peaking coils alter the response.

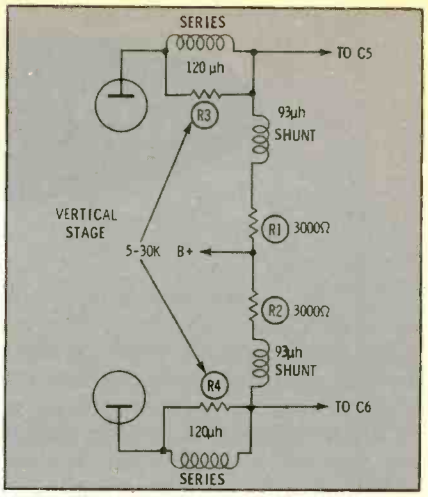


Fig. 4. Modified push-pull amplifier.

Fig. 1. It would be most advisable to start by modifying the output stage first, and then to work backward stage-by-stage to the input. This procedure immediately brings up the question: "How do I rework the push-pull output stage?" Each side is done in exactly the same manner as for the single-ended stage previously discussed.

Looking at Fig. 4, R1 and R2 (R10 and R11 in Fig. 1) are reduced to 3K each. A 93-uh peaking coil is connected in series with each 3K resistor. A 120-uh peaking coil is connected at the plate of each triode section. C5, C6, and the following network are left unchanged.

Test the Results

A quick way to check frequency response is highly desirable when modernizing an old scope, because point-by-point frequency determinations are very time-consuming. You can use an audio oscillator and an AM generator to make spot checks in the pass band, but the test procedure is much more tedious than a sweep-frequency test. The discussion here assumes a video sweep generator is available, although the same principles apply for ordinary generator tests. (Editor's Note: A television sweep generator, set for 4 mc center frequency and a 6-mc sweep width, can be used—provided the instrument is swept mechanically rather than electronically. Mechanically driven units will sweep through "zero" frequency, even though their lowest center frequency is 4 mc or more.)

From the outset, note that the scope's own CRT is the most convenient indicator to use in frequency-response tests. To check the frequency response of the modified output stage, connect the output from the sweep generator through a .25-mfd blocking capacitor to the grid (pin 4) of the 6SN7 vertical-output tube. You will see an un-demodulated sweep-frequency pattern, as illustrated in Fig. 5. (If you use an audio oscillator or AM generator—set for CW output—you will see a sine-wave pattern on the CRT screen.) If the generator is set to sweep from zero to 5 or 6 mc, you will get a useful evaluation of frequency response, even though a marker is not used.

If you use the spot-frequency method, care must be taken to avoid false conclusions, because many audio and RF generators do not have uniform output from one band to the next, nor even throughout a single band. Hence, it is advisable to monitor the output from the generator with a VTVM using an RF probe. Thus, if the frequency-response test is made at .5 volt, for example, this reading should be checked each time the generator frequency is varied, and the output adjusted to maintain the .5-volt level.

Lastly, to check the output stage for linearity, use an audio oscillator with any handy audio transformer having a push-pull secondary, as shown in Fig. 6. (Note that the lower .25-mfd coupling capacitor has been disconnected from ground for this test and used as a coupling capacitor for signal input; see Fig. 7 for original circuit. A true push-pull drive is required, because the 270-ohm, common-cathode resistor cannot provide complete phase inversion.) Now, increase output from the audio oscillator until you have nearly full-screen deflection. You should see an undistorted sine wave. If the sine wave appears compressed at the top or bottom, simply change the value of the 270-ohm, common-cathode resistor to obtain the best sine wave. In case you have to use a lower value, remember to check plate dissipation once again to make sure the tube is within its maximum power rating. On the other hand, if you increase the cathode resistance much, you may be able to use a somewhat higher plate voltage.

Trim the Response

Your choice of peaking-coil inductances establishes the gain at the high-frequency end. The right-hand portion of the pattern in Fig. 5 changes greatly with different inductance values. On the other hand, the low-frequency response is determined almost entirely by the values of load resistors R1 and R2 in Fig. 4. Therefore, select load values which give the same gain over the left-hand portion as over the right-hand portion of the response pattern. Load-resistance values are somewhat critical—as R1 and R2 are varied, low-frequency gain changes rapidly.

Now, you will probably find that midband gain (in the vicinity of 2 mc) is excessive, and that the pattern rises objectionably near the center. To correct this condition, and make the response flat from 60 cps to 4.5 mc, select suitable values for the damping resistors—R3 and R4 in

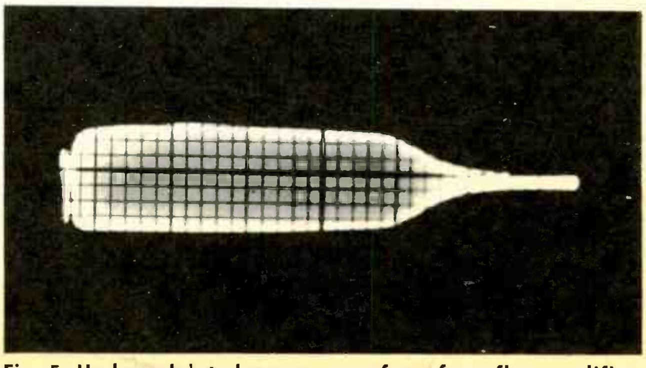


Fig. 5. Undemodulated sweep waveform from flat amplifier.

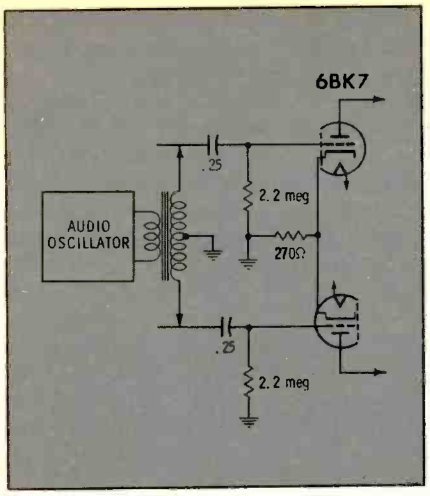


Fig. 6. Testing linearity, vertical amp.

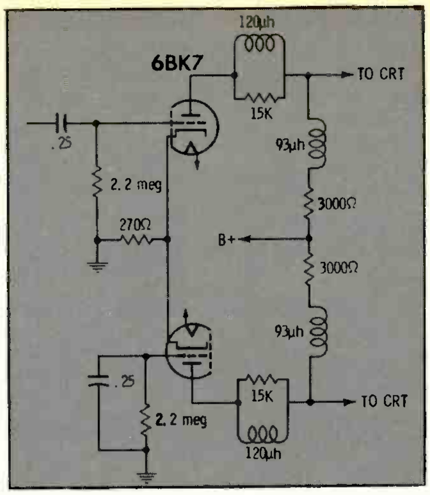


Fig. 7. 6BK7 output gives high gain.

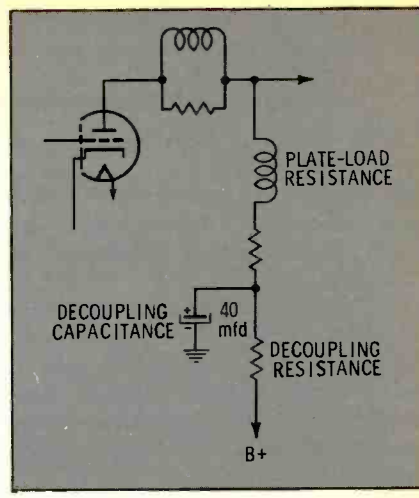


Fig. 8. Capacitor-resistor combination.

Fig. 4. The exact value will fall in the range from 5000 to 30,000 ohms, in most cases. If you cannot flatten the mid-band response satisfactorily with any value of damping resistors, your choice of peaking-coil inductances has been incorrect. Note also that you might have equal response at 60 cps and at 5 mc, with a midband sag. In such a case, the sag cannot be corrected by damping resistors—the shunt peaking coil probably needs a little more inductance.

Incidental Considerations

When modifying a push-pull output stage, always keep the two plate-load circuits symmetrical. Thus, if you reduce the inductance of one peaking coil, be sure to reduce the inductance of the corresponding coil the same amount on the other side of the push-pull circuit. Otherwise, you will observe a nonsymmetrical pattern on the CRT screen. Circuitwise, one side of the circuit should always be a "mirror image" of the other side.

During sweep testing, it is quite likely you will end up with less vertical deflection than you might wish, unless your generator has fairly high output. This brings us to the consideration of stage gain. The 6SN7 tube has a Gm of about 2600 micromhos. If the plate-load resistances have a value of 3K each, stage gain will be less than 10. By substituting another tube type, however, you can improve gain considerably. For example, a 6BK7A has a Gm of 9300 micromhos, or 3.5 times as much gain as a 6SN7.

A 6BK7 can be connected as shown in Fig. 7. A cathode-bias resistor of 270 ohms is about right, although you might wish to determine an optimum value later. I can hear you ask, "Why not use pentodes instead of triodes; a 6CL6 would give 11,000 micromhos instead of 9300?" The answer depends upon your preference, taking into consideration the fact that two 6CL6's must be used instead of one 6BK7. Moreover, additional screen-circuit components are required by the 6CL6. It may appear that the added complexity does not justify the increase of only 1700 micromhos.

When you reduce the value of a plate-load resistor, the plate voltage of the tube goes up, and the tube may run too hot. Hence, you should check plate dissipation. To take a practical example, suppose you decided to use a 6BK7. This tube is rated for a maximum plate dissipation of 2.7 watts per plate.

First, measure the plate voltage; then measure the voltage drop across the plate-load resistor. Knowing the value of the plate-load resistor, you can easily calculate the plate current from Ohm's law. If the product of plate voltage times plate current is greater than 2.7 watts, the power-supply voltage must be reduced. On the other hand, if the plate dissipation is less than 2.7 watts, you can increase the power-supply voltage. Unless the output stage is operated near top power capability, you may not be able to get full-screen deflection without compression or clipping.

It is usually easy to obtain the desired value of power-supply voltage. Whatever voltages are available can be dropped down by inserting an RC decoupling circuit in series with the plate-load resistor. Fig. 8 shows how.

On the other hand, the power-supply output may be too low to meet requirements. Try chokes instead of resistances in the filtering networks. Still more output voltage can be obtained, of course, by using the transformer as a half-wave supply, instead of a fullwave supply. However, the ripple frequency becomes 60 cps instead of 120, and you may need to double the filter capacitances.

Once in a while, trouble arises from parasitic oscillations in a wideband vertical amplifier which distort the pattern and, in severe cases, lower the effective gain. The suppression of a parasitic oscillation is simple: Merely connect a 100-ohm resistor in series with the grid lead to each triode (R4 and R9 in Fig. 1). The resistor should be mounted directly to the grid terminal of the tube socket.

Why Push-Pull Output?

Some older-model scopes use a single-ended output stage. However, this is the exception in modern scopes. First, there is the problem of driving the output stage to nearly maximum capability with minimum distortion. This is best achieved by using push-pull output. Furthermore, there is the problem of astigmatism; when a single-ended output

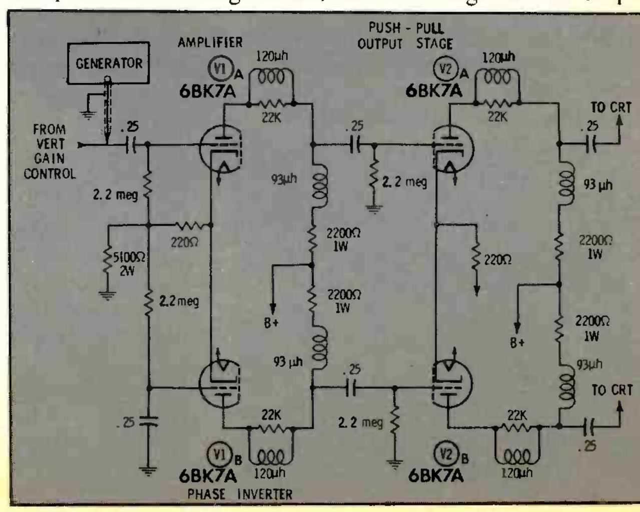


Fig. 9. Driver stage is mirror image of scope-output circuit.

stage is used, it is more difficult to keep the pattern in sharp focus over the entire area of the CRT screen.

Driver-Stage Improvements

After the output stage is completed, attention should be turned to the driver stage. A push-pull stage is advisable here, similar to that shown in Fig. 9. Phase-inverter action occurs prior to the output stage, and the output stage is driven in push-pull. Plate-circuit configurations of both stages are similar.

The cathode network in the driver stage is arranged primarily for large-signal phase inversion. This requires a large amount of current feedback, obtained via the 5100- and 220-ohm cathode resistors. Since the bias provided by 5320 ohms would operate V1 near the cutoff region, the grid resistances are not returned to ground but, instead, to the junction of the two cathode resistors. Thus, only the voltage drop across the 220-ohm resistor is applied between grid and cathode.

Frequency Response

The frequency response of the driver stage is checked through the output stage (which has already been adjusted for flat response). Apply the generator output to the grid lead of V1A. As before, a video-frequency sweep generator provides the quickest test, although an audio oscillator and AM generator can be used. Adjust the plate-load components of V1A and V1B in the same manner as was described for the output stage. This juggling of inductance and resistance values will seem more critical than before, because any variations from flat frequency response are multiplied in the output stages.

When you are satisfied with the overall frequency response, a check should be made to determine the optimum cathode-grid bias for V1A. Apply, to the grid of V1A, an audio signal sufficiently strong that nearly full-screen deflection is obtained. An undistorted sine wave should be displayed. If compression is noticeable along the top or bottom of the pattern, change the value of the common-cathode resistor until the compression is eliminated. The same considerations of maximum plate dissipation apply to the driver stage as to the output stage. Hence, make sure neither triode is dissipating more than 2.7 watts (assuming a 6BK7 tube is used.)

Driver Operation

In case difficulty is encountered from parasitic oscillations at high drive levels, insert 100-ohm resistors at the grid terminals of V1A and V1B.

Ripple (power-supply hum) might be evident in checking out the driver stage, since the gain is now much greater, and because V1 imposes an additional load on the power supply (when more current is drawn from a power supply, the ripple voltage increases). To detect power-supply hum, set the audio oscillator at about 65 cps, and apply a signal strong enough to obtain nearly full-screen deflection. If the pattern "writhes" at a 5-cps rate, better filtering will be required in the power supply.

After the driver stage has been checked out satisfactorily (with or without attention to the power supply), remember to recheck the plate-supply voltage for V2. The current drain of V1 may have lowered the supply voltage for V2. It is even more important to apply maximum permissible voltage to V2 than to V1, because the signal level handled by the output stage is higher.

Testing Sensitivity

At this point, you may wish to make an overall sensitivity test of the two vertical-amplifier stages. Use a VTVM to measure the input voltage applied to V1A (Fig. 9) from an audio oscillator. Adjust the oscillator output for one inch of vertical deflection on the CRT, and note the VTVM reading in rms voltage. You can expect an input of .2 rms volt, or less, to produce a vertical deflection of 1".

Other Stage Changes

Vertical-Gain Control

As indicated in Fig. 9, the grid of V1A is normally connected to a vertical-gain control. This is a comparatively low-resistance potentiometer operating in a cathode-follower stage, as depicted in Fig. 10. A 2000-ohm potentiometer is used for the same reason that low-value plate-load resistors are required: the shunt capacitance associated with the vertical-gain control limits the resistance that can be used without impairing high-frequency response.

It is good practice to situate the cathode follower and vertical-gain control at the front of the scope, while the driver stage and output stage are mounted at the rear, near the base of the CRT. With this layout, the long lead connecting the vertical-gain control and the driver stage is a low-impedance lead which has a minimal tendency to pick up hum. It is usually unnecessary to shield this lead, unless the stray hum level is comparatively high. In case you should require a shielded lead, remember that stray capacitance across the vertical-gain control will be considerably increased as a result, and a 1000-ohm potentiometer may be required (instead of a 2000-ohm unit) to maintain good high-frequency response at all settings.

It is essential that the plate of the cathode follower operate at AC ground. Otherwise, its frequency response and its insertion loss would be excessive. Hence, a 40-mfd capacitor is connected between plate and ground. Any conventional triode may be used; if a high-Gm tube is employed, the cathode follower will have somewhat less insertion loss. Since this is a comparatively low-level stage, less plate voltage is required than for the driver and output tubes. The 1000-ohm cathode-bias resistor is merely a nominal value; the optimum value depends upon the tube type and the plate-supply voltage.

If you do not plan to include a preamplifier, a 6J5 tube

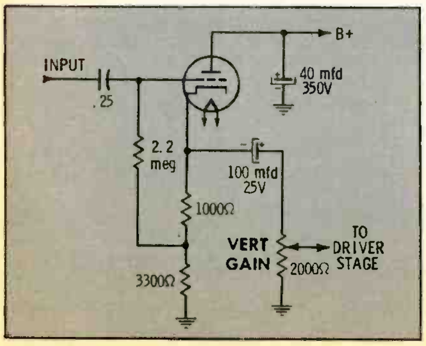


Fig. 10. Cathode-follower gain control.

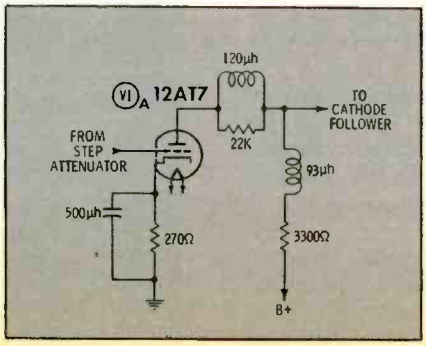


Fig. 11. Partial bypass improves highs.

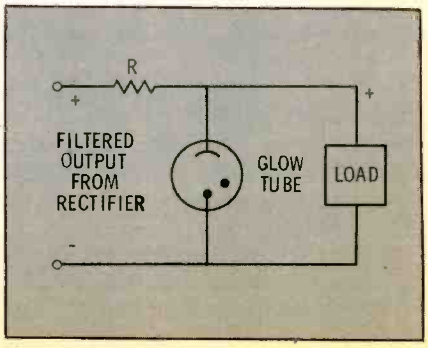


Fig. 12. Add simple voltage regulator.

might be used as a cathode follower. On the other hand, if a preamplifier is contemplated, the cathode follower could be one section of a twin triode, such as a 6BK7. In any case, determine the optimum value of cathode-bias resistance in the same way as for the other stages.

Preamplifier Considerations

The sensitivity of the scope as measured from the grid of the cathode follower should approach .25 volt rms per inch, or better, for CRT's using ordinary values of accelerating voltage. Since this is not a high sensitivity by present-day standards, you will probably wish to add a preamplifier. A simple preamp is depicted in Fig. 11. A single-ended stage is suitable, because signal level is comparatively low and overload distortion is not a problem. On the other hand, the plate-supply voltage to the preamp must be extremely well filtered to avoid even slight hum in the pattern.

Plate-load components in the preamp must be carefully trimmed for flat frequency response as previously detailed for the driver and output stages. The tube need not be operated close to maximum plate dissipation, due to the comparatively small signal level. A bias resistor of 270 ohms is generally suitable for ½ of a 12AT7, for example, but would not necessarily give the best operating point for another tube type. The tube manual is the best guide in determining the bias for a low-level stage.

Note in Fig. 11 that some additional high-frequency response is picked up in the preamp by partial bypassing of the cathode resistor. The 500-pf capacitor has only 75 ohms of reactance at 4.5 mc, but has 5 megohms of reactance at 60 cps. The value of the bypass capacitor is best determined by experiment; use the value which trims the overall frequency response for maximum flatness. Partial bypassing is more helpful in holding up gain at mid-band than at frequencies near the high-frequency cutoff. If you use ½ of a 6BK7 for a preamp, with the driver and output stages previously described, a vertical sensitivity of 25 mv rms per inch is obtainable.

Total gain and response of the vertical amplifier depends considerably upon minimizing all stray capacitances. Hence, all plate-load components should be mounted at least ½″ from any metal surface, and connecting leads in high-impedance circuitry should be kept as short as possible. Coupling capacitors should be suspended by their pigtails from tie lugs, and not permitted to rest against the chassis. When stray capacitances are thus minimized, you may find it possible to use somewhat higher values of plate-load resistance and still be able to trim up stages for flat frequency response to 4.5 mc. If so, vertical gain is thereby increased.

The cathode follower is normally located between the preamplifier and the driver stage. There are certain advantages from an application viewpoint in placing the cathode follower ahead of the preamp, but if you do so you are likely to have a motorboating amplifier to contend with. The simplest way to avoid motorboating with minimum elaboration of circuitry is to place the preamplifier before the cathode follower.

Elimination of Vertical Bounce

One source of annoying vertical bounce in some older scopes is DC flow through the vertical-gain control. Hence, virtually all modern scopes split up the DC and the signal paths in a manner similar to that depicted in Fig. 10. The 100-mfd blocking capacitor prevents DC flow through the vertical-gain control, while passing AC signal current. This might seem like a very large coupling capacitance, but it is required because of the low resistance of the vertical-gain control. At 60 cps, the 100-mfd capacitor has a reactance of about 30 ohms, so less than 2% of the signal voltage is lost at this frequency.

The resistance of the DC path is comparatively high (4300 ohms), in order that not too much signal current will be drained to ground around the vertical-gain control. However, the signal loss is appreciable—nearly one-third. Cathode-bias voltage is developed across the entire 4300 ohms, but if the total were applied to the grid, the tube's operating point would be incorrect. Hence, the grid-leak resistance is returned to the junction of the two cathode resistors; only the drop across the 1000-ohms resistor is applied between grid and cathode.

If line voltage fluctuates appreciably, you may observe an occasional vertical bounce in the pattern. Most noticeable vertical bounce occurs in the preamp stage, because its output (including bounce or jitter) is amplified by the stages that follow. Accordingly, if stabilization is needed, a power-supply voltage regulator should be provided for the preamp stage. Simply connect a series resistor and a voltage-regulator tube in the B+ supply line for the preamp, as depicted in Fig. 12. A VR150 tube will hold the plate-supply voltage constant at 150 volts.

The value of the series resistance R in Fig. 12 depends upon how much voltage is applied to the regulator circuit. You must provide at least 185 volts to make the tube conduct. If a 250-volt source is used, there will be ample

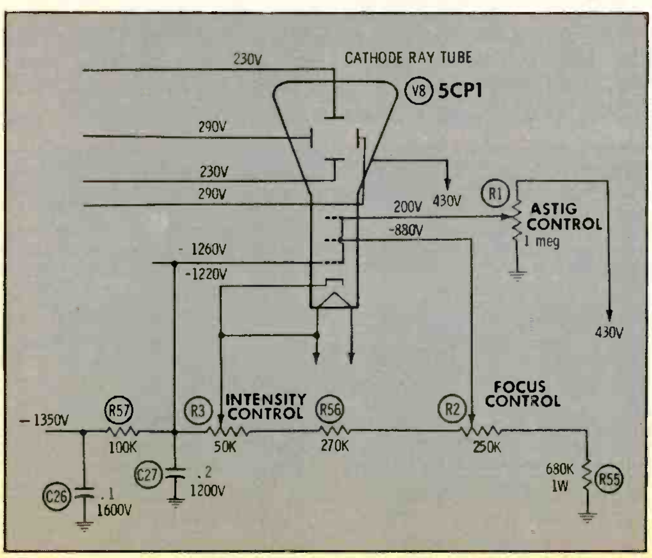


Fig. 13. Astigmatism controls spot shape produced on CRT.

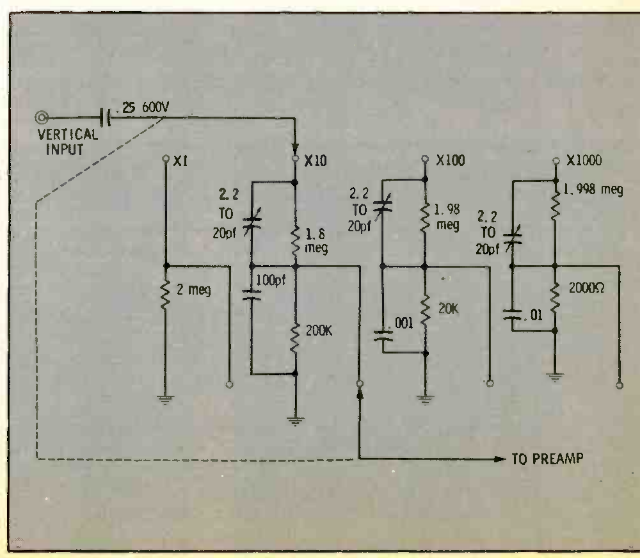


Fig. 14. 4-step compensated attenuator prevents overload.

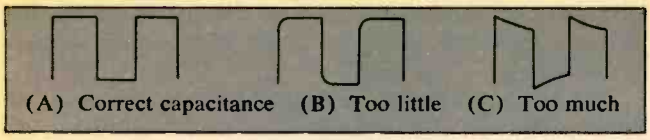


Fig. 15. Square wave viewed on CRT shows compensation.

margin to insure that the VR tube will conduct under load and under conditions of line-voltage fluctuation. Select a value for R which provides a 40-ma current flow when the load is removed (preamp tube unplugged from its socket). This is the maximum current rating for a VR150 tube. Now when the preamp tube is plugged in, its plate-current drain subtracts from the VR-tube current, and the plate-supply voltage remains stabilized at 150 volts.

Astigmatism Control

To obtain sharp focus over the entire area of the CRT screen, all electrode voltages must be correct relative to one another. All old-model scopes provide focus and intensity controls, but many did not provide an astigmatism control. However, you can easily add an astigmatism control using an ordinary potentiometer. A typical configuration is shown in Fig. 13. This control, connected to the accelerating anode, tends to interact with the focus and intensity controls, so you may prefer to mount it on the front panel as an operating control.

Vertical Amplifier Step Attenuator

With so sensitive a vertical amplifier, an input attenuator should feed the vertical-input signal to the preamp, to adjust the signal level so the preamp will not be overloaded. Many old-model scopes provided a simple high-resistance (such as 1 meg) potentiometer to serve as a vertical-input attenuator. However, a high-resistance potentiometer will not work satisfactorily as an input attenuator for a wideband scope; stray capacitances bypass high frequencies to ground, and serious distortion occurs at intermediate settings of the potentiometer.

Consequently, all modern scopes utilize a compensated step attenuator of some kind. A good configuration is shown in Fig. 14, one that can be constructed on a rotary wafer switch. Four steps of attenuation are provided, X1 to X1000, an adequate range for TV receiver testing. The resistors should have 5% tolerance; if you use 1% resistors, decading will be more accurate. The trimmer capacitors provide for adjustment of high-frequency compensation on each step. Fixed-capacitor values shown are nominal, and are chosen to provide a constant input capacitance on each step. (Remember that resistors can be paralleled or connected in series to obtain any unusual values.)

Adjusting the Attenuator

After the step attenuator is wired up and installed on the front panel, the three trimmers must be properly adjusted. The quickest and easiest method utilizes a square-wave generator. Set the generator to approximately 15 kc and feed the square-wave voltage to the vertical-input terminals of the scope. No compensation adjustment is provided on the X1 step, because the input signal has a direct connection to the preamp in this position.

Hence, the first adjustment is made with the switch set to the X10 position. Adjust the generator output to avoid overloading the preamp, and observe the square wave on the CRT screen. Fig. 15 shows both correct and incorrect patterns. The "A" pattern will be obtained at a critical adjustment of the trimmer, if your square-wave generator has undistorted output.

Square-wave generators differ considerably in maximum available output. Thus, you might not have signal voltage sufficient for a satisfactory test on the X100 position of the step attenuator. In such case, some other method will be required to determine the correct setting of the trimmer on this step. A useful expedient is to use a 60-cps sine-wave source and a 15,750-cps source from the horizontal oscillator in a TV receiver. A VTVM is used to measure the 60-cps and 15,750-cps voltages, and the appropriate compensating trimmer is set so that exactly equal voltages produce the same peak-to-peak deflection on the scope CRT. Finally, the trimmer on the X1000 step can be adjusted in the same general manner, using suitable input levels from power-line and TV-receiver sources.

Low-Frequency Boost

When you check 60-cps square-wave reproduction, you will observe that the waveform is not flat-topped, but has a substantial down-hill tilt. This is, of course, differentiation of the square wave, noticeable because of the RC coupling. To compensate for this distortion, a low-frequency boost circuit can be connected in the plate-return lead of the preamp, as shown in Fig. 16. The 18K resistor is partially bypassed by C1, the low-frequency boost capacitor. The value of C1 in Fig. 16 must be determined experimentally, to obtain the best 60-cps square-wave reproduction. A typical value is 2 mfd. You may also need to try higher or lower values in place of the 18K resistor.

Cathode-Follower Input

Although the amplifier configuration developed so far is satisfactory for most service work, there is one limitation which you may wish to consider. Since the output from the step attenuator is fed into a triode preamp tube, the grid-plate capacitance acts as a coupling device. This means that if you connect a 4.5-mc sound-IF coil (for

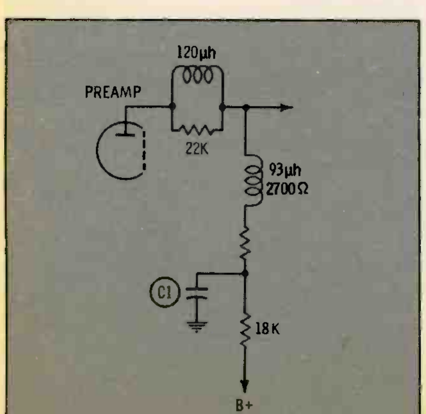


Fig. 16. Network may need alterations.

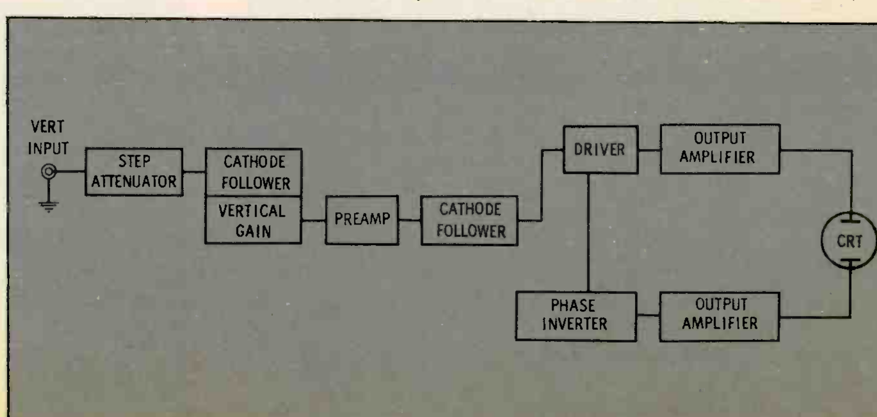


Fig. 17. Cathode-follower stage is added before the preamp.

example) to the vertical-input terminals of the scope, it is easily possible that, when the step attenuator is set to its X1 position, the preamp will break into oscillation—in other words, it operates as a tuned-plate tuned-grid oscillator.

To avoid this limitation, you can add a cathode-follower stage ahead of the preamp, as depicted in Fig. 17. In this layout, the vertical-gain control is advantageously placed in the first cathode-follower stage, while the second cathode follower is operated with fixed maximum output. Detailed circuitry with nominal component values is shown in Fig. 18. Use of an input cathode follower eliminates any instability or oscillation, even when high-Q tuned circuits are under test.

Remember that the plate-load values will usually require juggling to match the particular stray-capacitance values which are present, in order to obtain a flat frequency response from 60 cps to 4.5 mc. By the same token, the 270-pf partial-bypass capacitor in the cathode circuit of the preamp may need to be increased or decreased somewhat, for flattest midband response. Optimum grid bias depends upon the particular B+ voltage available from the power supply. Hence, if you observe any tendency for the top or bottom of the pattern to be compressed at full-screen vertical deflection, change the cathode-bias resistors for best linearity; the bias resistors in Fig. 18 have nominal values of 1000 ohms for the 6J5, and 500 ohms each for the 6BK7.

Hum Problems

There are several sources of hum interference which can be quite baffling if they are not understood. The necessity of good power-supply filtering, especially for single-ended input stages, has been mentioned repeatedly.

Another offender is stray hum pickup by the step attenuator and the lead from it to the grid of the input cathode follower. This is a very high-gain, high-impedance section; it is quite easy for 60-cps hum pickup to be noticeable at maximum vertical gain. In such case, you may have to enclose the step-attenuator assembly in a metal box or shield, well grounded to the front panel. Try to place the input cathode follower near the step attenuator. If your particular situation requires a grid lead of appreciable length, it may be necessary to use a section of coax cable to eliminate hum pickup.

Another source of hum interference is heater-cathode leakage in any of the tubes. Still another troublemaker consists of untwisted heater leads routed too close to high-impedance grid leads or grid components. It is *not* good practice to use the chassis as a heater-return circuit.

Crosstalk

Sometimes after completing modification of the vertical amplifier, everything works fine except that the left-hand end of the scope trace becomes bent up or down when the amplifier is operated at maximum gain. This is due to crosstalk between horizontal-deflection circuitry and the vertical amplifier—it will disappear when the high-impedance section of the vertical amplifier is suitably shielded, or when the horizontal-deflection leads are routed well away from the vertical circuitry.

High-Voltage Hum

Objectionable hum in the high-voltage power supply appears as intensity modulation of a 60-cps pattern on the screen. For example, if you display two or three cycles of a 60-cps sine-wave input on the screen, intensity modulation shows up as excessive brightness followed by excessive dimness within each cycle of the pattern. The remedy is simply to increase the filter capacitance in the high-voltage power supply. Remember that these capacitors must be rated for the prevailing accelerating voltage, which usually falls in the range from 1 to 2 kv.

Trace Brightness

You may wish to increase the brightness of the pattern, especially for displaying chroma waveforms; this can usually be done by raising the CRT's high voltage. If pattern brightness is marginal, even a moderate increase is helpful. Inspect the high-voltage filter circuitry, to see whether a high-value filter resistor is present. Fig. 19A shows a commonly used RC pi filter. R56 has a resistance of 1 megohm, and C20 and C21 have a capacitance of .1 mfd each. A drop of 260 volts appears across the 1-meg resistor.

If you reduce R56 to 100K and increase C20 and C21 to obtain adequate filtering, you will gain more than 200 volts and an appreciable increase in screen brightness. In situations of this kind, it is advisable to split the filter resistance into two parts and use a double-pi circuit like that in Fig. 19B. The double pi gives much better filtering action than a single pi and avoids the necessity for overly large capacitors.

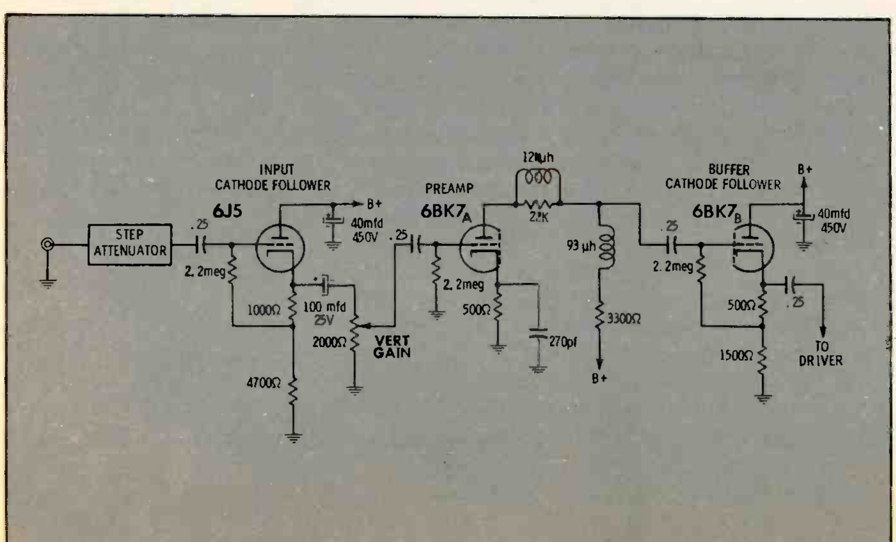
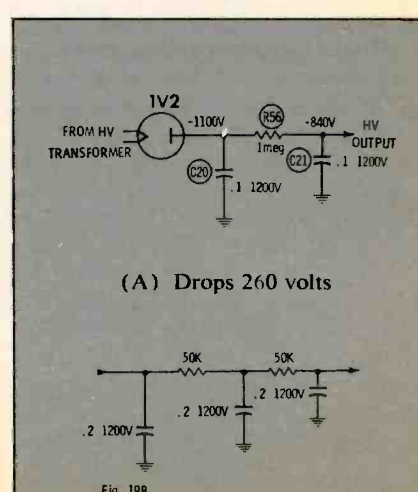


Fig. 18. Schematic showing circuit of cathode follower.



(A) Drops 260 volts

(B) Double-pi, low R

Fig. 19. Network may need alterations.

In other cases, the high-voltage filter cannot be modified to increase its output voltage. The alternative in such a case is to replace the power transformer with one that provides higher voltage. Remember that high-voltage rectifier tubes often use unexpected filament voltages, which must be observed in selecting a replacement transformer. For example, a 1V2 operates at .625 volt and draws .3 amp of filament current. Just as in TV-receiver practice, you can use a filament-dropping resistor if necessary. Never forget the danger of making voltage measurements here.

If you must measure filament voltage for the high-voltage rectifier, first turn off the scope and discharge the high-voltage filter capacitors. Then, connect a VOM (never a VTVM) across the filament terminals. Stand back, and turn the scope on to measure the filament voltage. After taking the reading, never attempt to touch the VOM or its leads until after the scope is turned off and the high-voltage filter capacitors have been discharged.

DC-Response Considerations

To obtain DC response, the vertical amplifier must be DC-coupled throughout. This requires consideration of the DC power distribution, to obtain correct grid and cathode voltages for the tubes in the absence of blocking capacitors. Furthermore, screen- and cathode-bypass capacitors cannot be used because their reactance would make the high-frequency gain greater than the DC and low-frequency gain. On the other hand, you will still use capacitors in the vertical step attenuator as before, since this is a compensated configuration which must have response from zero through 4.5 mc. By the same token, you can use capacitors in other stages of the vertical amplifier when compensation of some sort is needed.

Note the DC-coupled vertical-amplifier configuration in Fig. 20. A two-stage amplifier is used, with cathode followers between the first and second stages to simplify the DC-voltage distribution. However, a -45 volt source is still required for the cathodes of the input stage. While this entails some elaboration of the low-voltage power supply, it is the price that must be paid for DC response.

Observe that the basic plan of the vertical amplifier is the same as for AC-coupled arrangements. In other words, a balanced configuration is used, and peaking coils are employed to obtain wideband response. The 1000-ohm bias-adjustment control is a maintenance adjustment which is set to make the vertical-positioning control operate over the desired range. The vertical-positioning control, of course, is a front-panel control, just as in an AC-coupled scope.

Note the vertical-gain control. It operates in the common-cathode circuit of the vertical-output stage. Functionally, it varies the amount of cathode degeneration to provide continuously variable control of vertical gain. The bias-balance control in this circuit is a maintenance control which is set for proper grid-cathode bias.

A vertical-polarity reversing switch is provided between the cathode followers and the vertical-output stage. This is a supplementary feature which can be omitted; however, you will find a reversing switch helpful if you are most familiar with waveform displays which are "right side up." Pentodes instead of triodes are employed in this arrangement to get high gain with a minimum of circuit complexity.

Standard sync-takeoff points are in the output load circuit, just as is common practice in AC-coupled amplifiers. The 27K series resistors provide effective isolation to avoid noticeable loading of the vertical-output circuit. Two tapoffs are utilized, to provide a choice of positive or negative sync, chosen by a switch in the horizontal section.

You must be able to switch the amplifier of Fig. 20 to AC-coupled operation at will. When the DC component in the signal is high, the pattern would otherwise be driven off-screen. A choice of AC or DC response is obtained by inserting a .25-mfd coupling capacitor at the input and providing a switch to short it out when DC response is desired. The vertical step attenuator employs the same configuration as for AC scopes.

The foregoing points cover the chief considerations for DC scopes. You should have little difficulty in modernizing an old DC scope for wideband DC response. Just clean up the response stage by stage, the same as you would for an ordinary AC scope. ▲

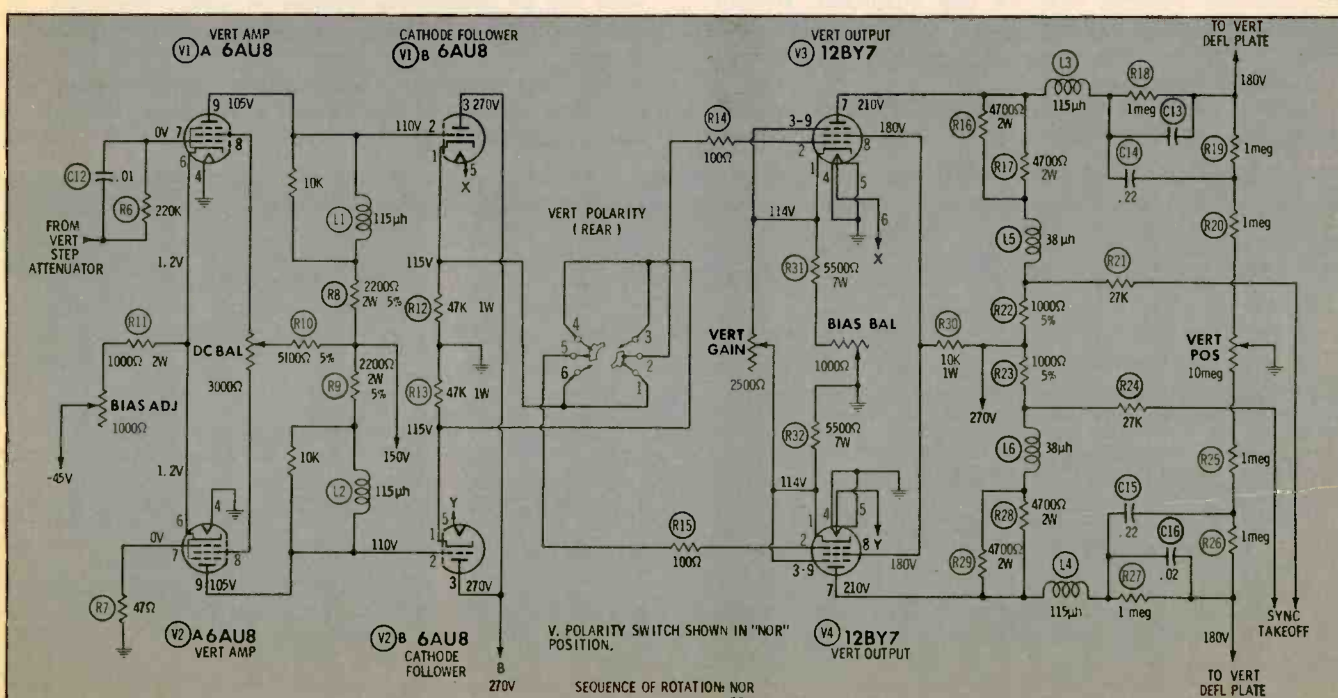


Fig. 20. DC-coupled vertical amplifier is similar to AC type.

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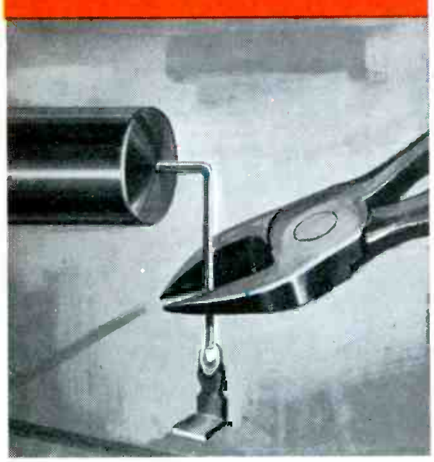

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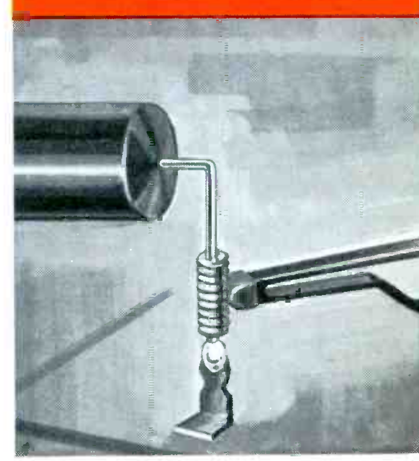

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the magazine of electronic servicing

VOLUME 15, No. 3 *MARCH, 1965*

CONTENTS

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Indexed in Lectrodex.
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Letters to the Editor

Dear Editor:

Why is the power switch in an AC-DC set usually wired between the chassis and the line?

JOHN V. RUDOLPH

Ridley Park, Pa.

For safety reasons. To understand why, consider the alternatives. The person who touches a chassis is in danger only if he is simultaneously "grounded" through some other part of his body. In Fig. 1, the switch is connected between one input lead and the load (filament string and power supply); the other end of the load goes to chassis ground, as does the other input lead. In Fig. 1A, the plug is

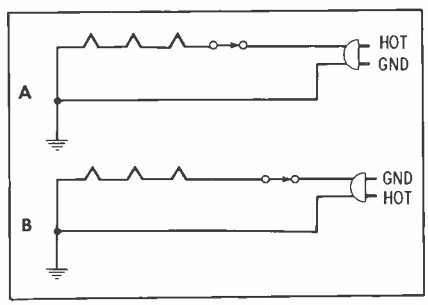


Fig. 1. Switch at "high" end of load.

inserted in the wall socket so the top input lead connects to the hot side of the house wiring. With the switch open or closed, the chassis is at ground and isn't dangerous. With the plug reversed, as in Fig. 1B, the chassis is dangerous whether the set is on or off. Consider next Fig. 2, where the switch is between the line cord

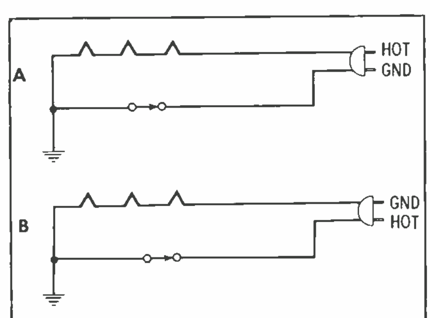


Fig. 2. Safer location next to ground.

and chassis ground. In Fig. 2A, with the plug inserted "correctly" in the wall socket, the chassis is hot when the switch is open, but anyone who touches it is protected somewhat because the load is in series and will reduce current to a non-lethal level. With the plug reversed as in Fig. 2B, the chassis becomes hot only when the switch is on; with the switch open, chassis isn't connected at all to the hot side of house voltage. Now consider the odds. In Fig. 1, the chassis can be dangerous under two circumstances; if the plug is inserted incorrectly (switch on or off), the chassis is dangerous. In Fig. 2, the chassis is dangerous only if the plug is inserted incorrectly and the switch is on; thus only one of the four possibilities is potentially dangerous. Two-to-three odds is sufficient to justify putting the switch on the chassis side.—Ed.

Dear Editor:

One of the handy features of PF REPORTER is the annual tube listing that shows how many are normally used ("TV Tubes Stock Guide"—every April or May). I'd like to see a similar table for picture tubes. Many dealers would prefer to handle only a small stock of fast-moving types.

R. H. BACHMAN

Lakeside, Cal.

The builders of picture tubes have solved most of these problems for you, R.H. Presently, about ten types will replace the majority of tubes found—even older types that aren't available any more.— Ed.

Dear Editor:

I noticed the letter on page 12 of the January 1965 issue, in which J. Ullman asked about a German radio that tunes only from 88 to 100 mc. He's right. The set is an *AKKORD* AM-FM transistor set that can be used as a car radio or carried as a portable. German FM radios formerly covered only as far as 100 mc; later they were designed to reach 104 mc. Only recently have German manufacturers started producing sets that cover the entire American FM band.

HAROLD E. KIRSCH

Fort Belvain, Va.

Thanks, Harold. The situation you describe is similar to that with AM-band sets built in Germany. Until recently, they covered only frequencies to 1500 kc, instead of 1600 kc as used in the United States.—Ed.

Dear Editor:

I understand there's a likelihood that dual-channel sound transmission may soon accompany television programs. I suggest that it be called *"Stareo."* No pun intended—honestly.

ROBERT M. GLOVER

Carmel, Indiana

Sure, Bob. How about dishonestly? —Ed.

Dear Editor:

After reading "Horizontal Troubleshooting From A to Z" in the January 1965 issue, I feel an urge to shoot some trouble in the schematic diagram (Fig. 1) on page 2. I'd like to take a potshot at the grounded end of R3 and move it instead to B+. Your trigger-happy reader. . . .

MELVIN T. HYATT

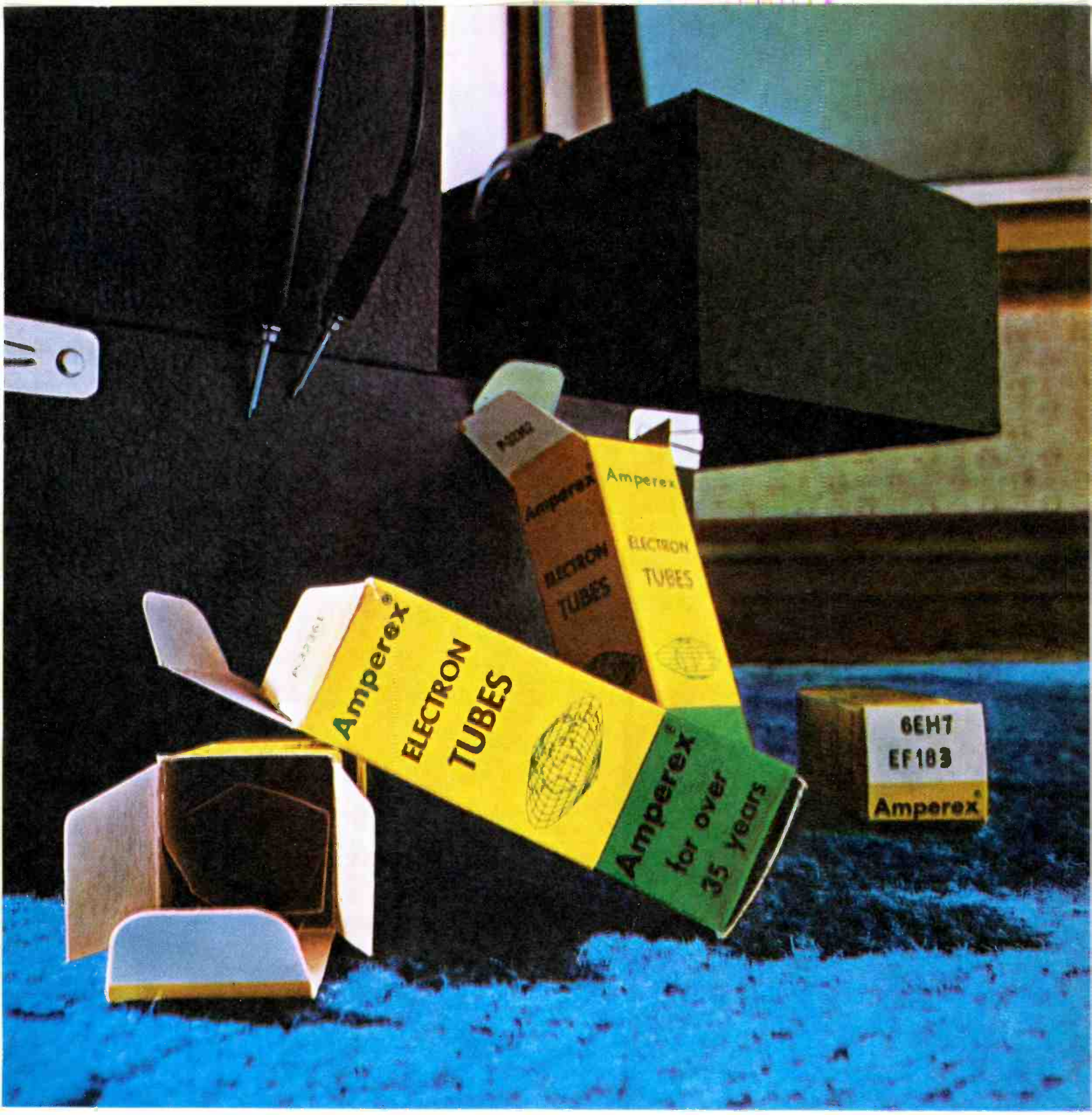
Prairie Village, Kan.

You won't mind if we place one near-sighted schematic-checker in the line of fire, will you, Melvin?—Ed.

Dear Editor:

When checking individual parts such as capacitors and resistors, we circle the part lightly with a pencil on the PHOTOFACT schematic. This reminds the technician what has been checked, in case he's called away from the bench or another serviceman has to take over on the job. On the hard surface of PHOTOFACT, the marks are easily erased.

ROBERT G. LYONS



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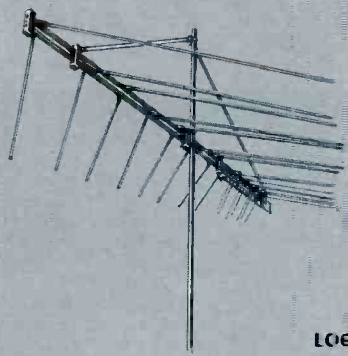

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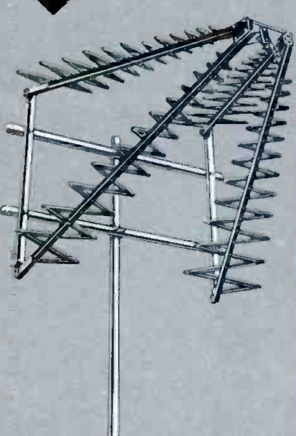

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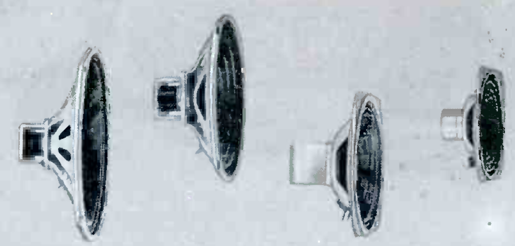

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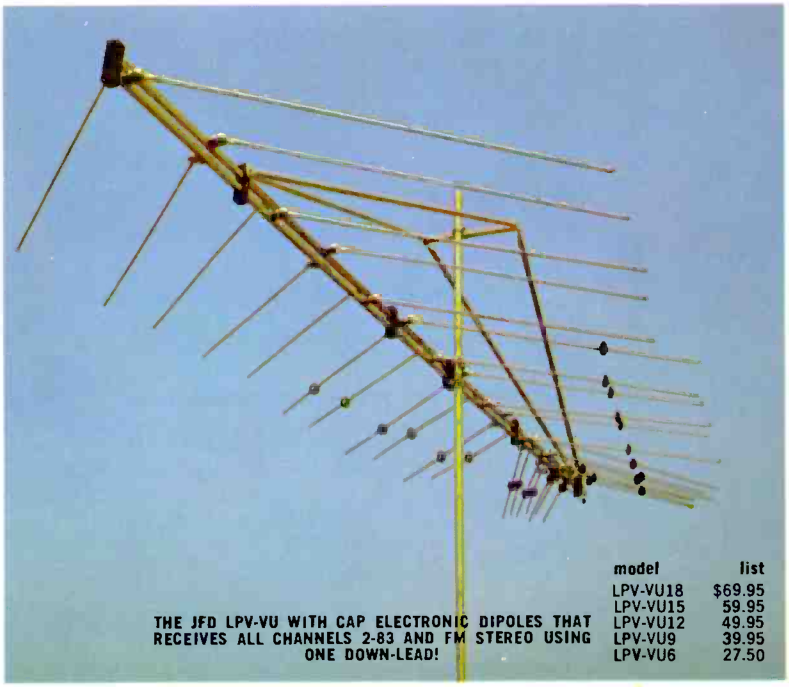

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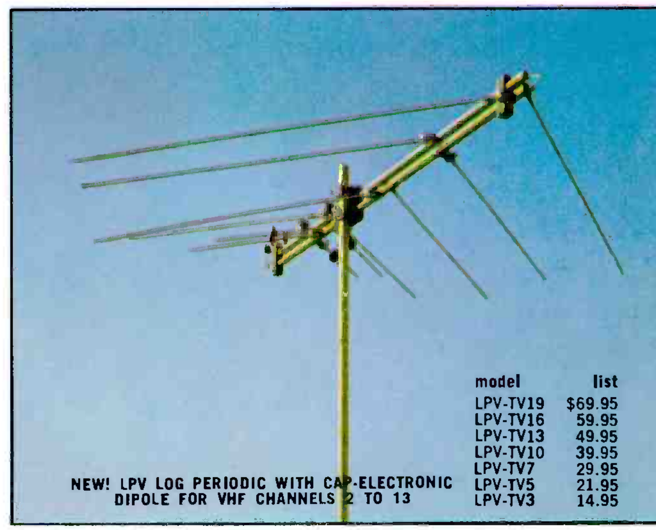
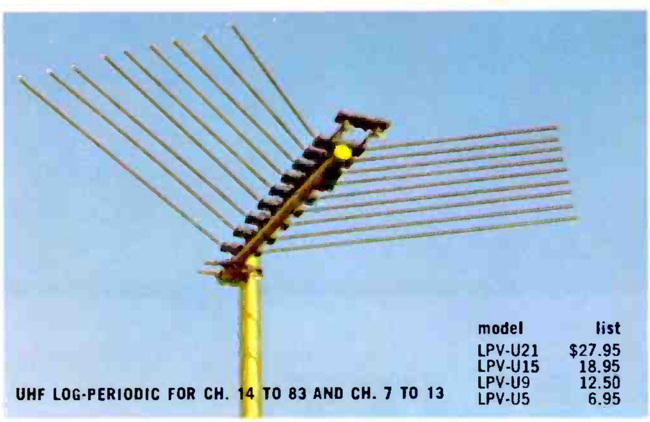


NEW! LPV LOG PERIODIC WITH CAP-ELECTRONIC DIPOLE FOR VHF CHANNELS 2 TO 13

model	list
LPV-TV19	$69.95
LPV-TV16	59.95
LPV-TV13	49.95
LPV-TV10	39.95
LPV-TV7	29.95
LPV-TV5	21.95
LPV-TV3	14.95



UHF LOG-PERIODIC FOR CH. 14 TO 83 AND CH. 7 TO 13

model	list
LPV-U21	$27.95
LPV-U15	18.95
LPV-U9	12.50
LPV-U5	6.95

UHF ZIG-A-LOG ANTENNA FOR CHANNELS 14 TO 83

model	list
LPV-ZU20	$34.95
LPV-ZU10	15.95

Only JFD offers You LPV Log Periodics for VHF (Ch.2-13)...UHF

GET THE LION'S SHARE OF ANTENNA BUSINESS (FLATTEN CATV COMPETITION, TOO) BY FEATURING THE JFD LPV-VU LOG PERIODIC! THIS NEW GENERATION OF LOG PERIODIC ANTENNAS DELIVERS WHAT VIEWERS WANT—MANY MORE STATIONS...VHF CHANNELS 2 TO 13...UHF CHANNELS 14 TO 83...FM/STEREO. GIVES THE CLEAN, UNIFORM SIGNAL SETS NEED ESPECIALLY FOR VIVID COLOR RECEPTION.

Only the LPV follows the patented frequency independent Log Periodic antenna formula developed by the Antenna Research Laboratories of the University of Illinois. This new log periodic cellular concept provides you with a combination of gain, bandwidth, directivity and impedance match never before possible with conventional antenna designs.

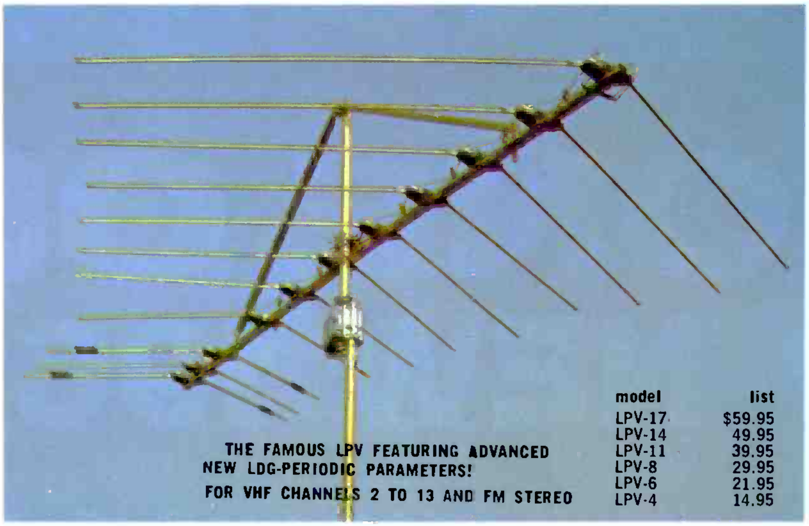
You can actually see the difference in truer color purity, in greater contrast, in finer detail—not on just some of the channels but all of the channels! Small wonder more JFD Log Periodics were installed in the last 12 months than any other brand.

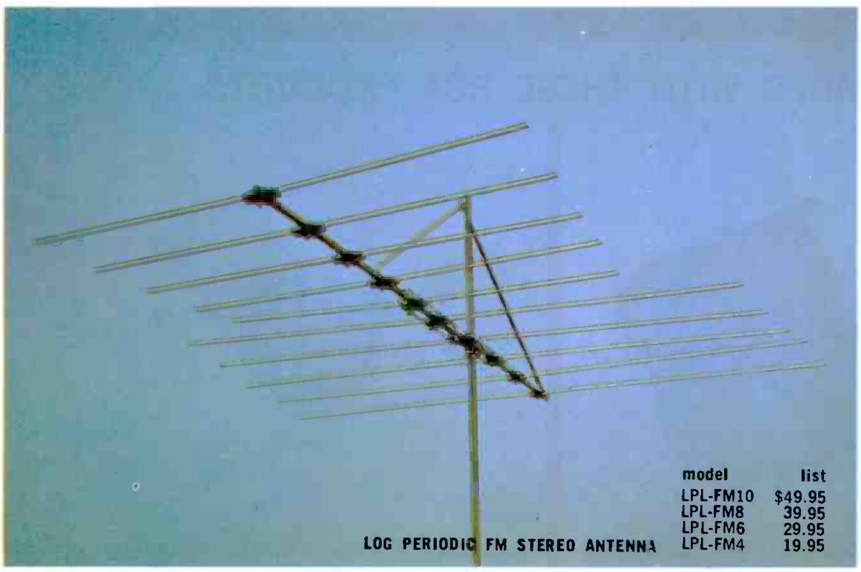
PREFERRED BY MORE N. Y. WORLD'S FAIR PAVILIONS . . . New York World's Fair exhibitors demand flawless color reception. That's why the House of Good Taste, Masonic Pavilion, Formica House, Eastman Kodak Exhibit, New York City Exhibit, House of Japan and other Fair showplaces chose the JFD LPV. This exclusive preference is pre-selling millions of Fairgoers—opening the door for more LPV sales by you.

WHY THE LOG PERIODIC IS THE MOST DRAMATIC BREAK WITH ANTENNA TRADITION SINCE DR. YAGI INVENTED THE YAGI . . . Up until the JFD Log Periodic, it was not possible to devise a truly broadband antenna except by "compromise" design that had to give up vital gain to get wider bandwidth . . . or had to degrade directivity for better impedance. Burdensome parasitics were piled on to try to compensate for gain "suck-outs", ghost-prone polar patterns, and inadequate bandwidth. This pyramided performance complications resulting in signal-sapping standing waves and impedance matches—and yet were only effective at the band edges.

Through the use of the revolutionary new logarithmic periodic formula, the entire frequency range is covered with dipole

Be *All* Set—
Periodic TV & FM Antennas





(Ch. 14-83)...FM/Stereo...VHF/UHF/FM - COLOR & Black/White

groups (cells) of overlapping resonances. These harmonically resonant V-dipoles result in a frequency-independent performance. The LPV's inherently **high gain, sharp directivity, 300 ohm impedance match and flat response are virtually constant across the entire band.**

AND ONLY THE JFD LPV HAS IT! . . . The JFD LPV is the product of the world's largest and newest antenna laboratories. Here, in the JFD Champaign, Illinois R & D Research Center, a team of scientists and engineers, under the direction of Dr. Paul E. Mayes, are revolutionizing the state of the antenna art.

MECHANICALLY SUPERIOR! . . . COMPARE CONSTRUCTION! . . . Life-time stainless-steel take-off terminals that can never corrode, "tank-turret" element brackets, tough heavy-wall Implex A acrylic insulators, twin U-bolts with 6 inch mast grip span; supple, permanently riveted aluminum drive line rod; electrically conductive gold alodizing; plus a host of other exclusive mechanical improvements.

FIGHT CATV WITH THE JFD LPV! Keep CATV out of your area with JFD Log Periodics (such as the 82-channel LPV-VU) which provide viewers with more channels—sharper reception—richer color—plus FM stereo. Don't install inferior antennas that open the door to CATV. Install the best to get the best performance—the LPV!

ADVERTISED IN LOOK, SUNSET . . . COMPARE ADVERTISING AND PROMOTION! . . . A versatile selection of indoor and outdoor sales helps . . . advertisements in LOOK, SUNSET and other national and local consumer publications . . . in newspapers . . . on television . . . sell your best prospects.

Now is the time and your JFD distributor is the place to stock up and step up into big-league LPV Log Periodic profits.

SEE WHY AT THE MOMENT OF TRUTH THE PICTURE IS THE PROOF THE JFD LPV LOG PERIODIC WORKS BEST!

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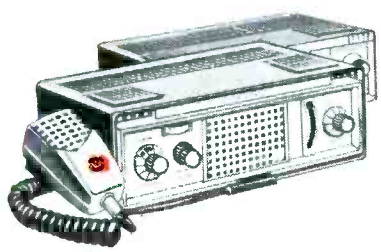
JFD Canada, Ltd., 51 McCormack Street, Toronto, Ontario, Canada

FREE from RCA!

WIN ONE OF BRAND-NEW 1965

Plus over 100 additional prizes awarded in

EACH GRAND PRIZE CHEVY-VAN LOADED WITH THESE RCA PRODUCTS



A.

A pair of new RCA Mark-Nine CB radio units for fastest shop-to-truck communication in your neighborhood.

B.

An RCA Treasure Chest Tube Caddy fully loaded with the fastest selling RCA replacement receiving tube types.

C.

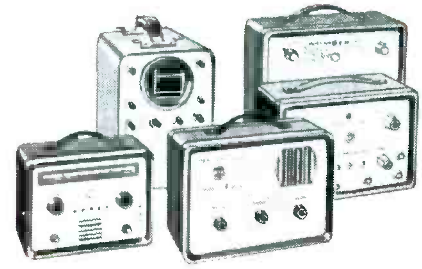
One RCA Colorama picture tube and two popular RCA Silverama black-and-white replacement picture tubes.

D.

A colorful, attractive counter merchandiser fully stocked with RCA transistor radio batteries.

E.

Two complete kits of RCA's "Top-of-the-Line" replacement transistors for entertainment-type equipment.



F. Five RCA popular and versatile test instruments:

RCA WR-64A Color Bar/Dot/ Crosshatch Generator
RCA WO-33A Super-Portable 3" Oscilloscope
RCA WR-69A Television/FM Sweep Generator
RCA WR-99A Crystal-Calibrated Marker Generator
RCA WR-70A RF/IF/VF Marker Adder

THESE NINE CHEVY-VANS!!!

nine separate regions of the United States!

ADDITIONAL PRIZES INCLUDE:

18
SECOND PRIZES:
RCA Victor Color TV Sets

27
THIRD PRIZES:
RCA Victor Black-and-White Portable TV Sets

72
FOURTH PRIZES:
RCA Victor Portable Transistor Radios

RCA's 1965 Regional Sweepstakes is for Radio/TV/Hi-Fi Service Dealers and Technicians EXCLUSIVELY!

NO JINGLES TO WRITE—NOTHING TO GUESS—NOTHING TO BUY! Simply pick up and fill out an entry blank and official rules at your RCA Distributor.

Enter as often as you like. Each entry must be submitted and mailed separately. See your Participating RCA Distributor right away.

This offer not made in states and localities where restricted or prohibited, such as Wisconsin and Florida.

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

RCA **The Most Trusted Name in Electronics**

Bardwell gets the Action-People*. Do you?

"We've found that our Yellow Pages ads reach people at just the right time—when they need service," says Ashby W. Bardwell, President, Bardwell Appliance Service, Inc., Cleveland, Ohio. "During twenty-three years in business, we've noticed that no matter how people first hear our name — from a newspaper ad, word-of-mouth, or from the sticker we leave behind on all jobs — when they need service they look in the Yellow Pages. When they do, they see our ad, recognize our name, and we have a good chance of getting their business. We have a lot of faith in the Yellow Pages . . . that's why we put a major part of our ad budget in there."

Display ad (shown above reduced) runs under REFRIGERATION SERVICE. Call your Yellow Pages man to plan your program. Find him in the Yellow Pages under: ADVERTISING — DIRECTORY & GUIDE.

Advertise for action... Yellow Pages

*The 3 out of 4 busy Americans who shop the Yellow Pages way.

Circle 8 on literature card

The Electronic Scanner

news of the servicing industry

1965 Business Outlook

A recent statement by George S. Dively, chairman of **Harris Intertype Corp.,** points out that current business activity all over the nation, well into its fourth consecutive year of strong growth, continues to be remarkably well balanced. However, the ability of business to continue to achieve these economic gains is likely to be further tested in 1965. Although consumer spending for goods and services is clearly expected to move to new highs, several important factors will have to be overcome. These include the diminishing benefits of the income-tax cut, the dampening effect of world monetary problems with the resulting hike in the Federal Reserve Bank discount rate, the unbalancing effect of demands by labor for wage increases substantially beyond productivity gains, and the anticipated decline in steel demand following the inventory build-up prior to labor negotiations. On the other hand, the continuing acceleration of technological developments, both for consumers and industry, could create stronger market demands and general economic impetus well beyond present levels. The result, for service technicians who run sound business operations, should be definitely greater prosperity. If the economy can satisfactorily bridge 1965, the prospects for greatly increased household formations commencing in 1966 would seem to provide strong support for a dynamic economy in the years ahead.

Three Million Color Tubes

W. Walter Watts, Group Executive Vice President, recently announced production of **RCA's** three-millionth color-television picture tube. The landmark color tube, made at the company's plant in Lancaster, Pa., was a new rectangular 25", 90° tube. A version of the RCA shadow-mask design, the tube is now in commercial production. "Production of RCA's three-millionth color tube is a new milestone in the history of color television," Mr. Watts said. "This event is concrete evidence that the new medium has come of age. By December of this year, we expect that the color-television industry will cross over into the billion-dollar-a-year status," he added. Present estimates place the total industry output of color picture tubes in 1965 at 2,200,000, an increase of 500,000 over the current year. Of that total, RCA plans to make about 1,500,000 color CRT's in the popular 21" round and new 19" and 25" rectangular sizes.

The Hi-Fi Bandwagon

"Hi-fi has become too highbrow." A hi-fi components manufacturer leveled that charge at his own industry, declaring that too much technical mumbo-jumbo has so confused the public that hi-fi sales have not measured up to their potential. Karl Jensen, president of **Jensen Industries,** contends that hi-fi needs to come down out of the clouds, drop its snob appeal, simplify hi-fi and stereo concepts for popular appeal to reach the mass market.

"Instead of selling home entertainment, which is what hi-fi primarily constitutes, we've been confusing and confounding the public with technical verbiage. Instead of talking about what comes out of hi-fi, we've been selling what's in hi-fi—instead of music, we've been talking about the notes. Instead of Beethoven and Brahms, we've been selling woofers and for the Thai metropolitan police frequency and received patrol calls. Two areas for record and tape sales featured American jazz, folk, and classical music. Theater areas demonstrated cameras, slide and movie projectors, and other sight equipment. A complete line of hi-fi components—including speakers, stereophonic tuners and amplifiers, and sound networks—were demonstrated, mainly in soundproofed rooms. Television, both consumer units and closed-circuit systems, rounded out the show.

Overseas Expansion

To meet the increasing demand for communications products and electronic components in foreign markets, **E. F. Johnson Co.** has completed export distributing arrangements with Roburn Agencies, Inc. of New York. As exclusive export distributors, Roburn will handle distribution of Johnson's communications, amateur-radio, and selective-paging equipment as well as their electronic-component line.

CATV Expansion Seen

Community-antenna television systems will, in the not too distant future, operate in "virtually every American city, both small and large," it was predicted by Milton J. Shapp, president and board chairman of **The Jerrold Corp.** Addressing the Federal Communications Bar Association at the National Press Club in Washington, Mr. Shapp asserted that "there is no holding back the growth of CATV," adding that "the evidence is overwhelming that the public wants television service which only cable systems can bring. No segment of the public has yet been harmed by CATV, nor will it be harmed in the future by its continued expansion." He emphasized that the continued development of community-antenna television will have tremendous impact on the broadcast industry, but that the latter "will adjust to these changes and continue to grow."

tweeters. We've been talking in a foreign language, and it's about time we started offering some translations.

"Our own highly diverse inventory indicates the illness which is afflicting the industry. We have created a veritable hi-fi jungle, much of which has become impenetrable to any but electrical engineers and a minority of hi-fi nuts. And yet we are kidding ourselves that we are selling mass entertainment. It is time that the hi-fi industry looks facts in the eye and takes the obvious cure of producing a product that is easy to understand, to listen to, and to enjoy. We need to stop speaking of hi-fi in terms of wild and whacky sounds, of decibels and dynamometry. Let's take hi-fi out of the hands of the engineers and give it back to the public."

Dealer merchandising of hi-fi should de-emphasize technical data and emphasize enjoyment of music listening. Manufacturers should simplify replacement of parts. People nowadays want a hi-fi set for the pleasures of listening, not for gimmicks and gadgets. "When the industry recognizes this and quits the high-brow kick, the industry will find hi-fi sales can make sweet music indeed," concluded Jensen.

Audio-Visual International

Twelve Bangkok firms representing twice that many U.S. manufacturers of audio-visual equipment, did a brisk business at the recent sight-and-sound show in the U.S. Trade Center at Bangkok, Thailand. Nine of the U.S. firms say that estimated sales during the coming year are expected to reach nearly three-quarters of a million dollars as a direct result of the show.

A highlight of the three-week event was a Chevrolet Chevelle equipped with a Motorola radiotelephone, which was set

Microwave Spans U.S.

An unusual coast-to-coast telephone call, the first official cross-country voice communication by **Western Union** microwave, signalled the opening of the company's new $80,000,000 transcontinental microwave system, and its entry into new and broader areas of telecommunications.

Using a special Western Union pushbutton telephone, Walter P. Marshall, president, made the initial call over the microwave radio system to San Francisco from the company's office in New York City. "This new microwave system," said Mr. Marshall, "can handle all types of record and voice communications at high speeds and in large volumes. It is Western Union's first coast-to-coast microwave network and opens the way for many new communication services that will benefit the general public, business, government, and the military."

The network consists of 267 microwave stations spaced 25 to 30 miles apart which, for reasons of national defense, are routed to by-pass critical target areas. It also provides the nation, for the first time, with a second, separate transcontinental network of broadband facilities geared to modern high-speed communications requirements and available for use in any emergency. The new system is capable of handling all forms of electronic communication, including high-speed facsimile, data, telegraph, voice, and Telex services.

Various uses of the microwave system were demonstrated for the press in transmission exchanges between New York and San Francisco, including the first live coast-to-coast microwave transmission of the heartbeats of a mother and her unborn child. The transmission was made directly from Booth Memorial Hospital in Los Angeles to viewers at San Francisco and New York. The two heartbeats were seen at both cities in the form of electronic patterns on a large oscilloscope and also heard over loudspeakers.

An important feature of the microwave system is its dual transmission capacity which assures maximum reliability and continuity of service. Signals travel simultaneously over separate operating frequencies using separate radio equipment.▲

Mr. Shapp poined out that CATV provides the lowest-cost method by which a television-set owner can enjoy "the highest quality reception from all the stations he wishes to receive." Systems now in operation provide up to 12 channels of television, and systems capable of handling at least 20 channels are currently on the drawing board.

Little mention was made in Mr. Shapp's address of the impact of CATV on servicing, although he pointed out that "dealers and servicemen in CATV areas more than make up for the loss of individual antenna sales by increased set sales and services."

ITT Engineer Describes Extremely Senstitive FM

Special frequency-modulation receivers that can detect signals weaker than the threshold level of conventional FM receivers were described by an engineer of an **International Telephone and Telegraph Corp.** subsidiary. Mr. M. Sassler of ITT Federal Laboratories said that the receivers are specially useful for reception of signals from satellites and spacecraft. Such signals, he said, besides being weak, may also have doppler-drift rates of as much as ±250 kc and may be amplitude modulated by a spinning satellite transmitting antenna. They are best detected by using low-noise front-end amplifiers and threshold-extension demodulators. The engineer described a demodulator using a phase-locked feedback loop to narrow the receiver's effective noise bandwidth and thus match the spectrum of the received signal.

"Sell-Service" Progress

EIA says results of an Indianapolis test of a "Sell Service" program (see PF REPORTER, December 1964, page 25) indicate that technicians who asked the question did increase their business. The objective of the program is to persuade service technicians to ask "What else needs fixing?" on service calls.

247 WAYS TO MAKE MORE

From now on, color-TV work is going to bring in a bigger and bigger part of your income. And RCA has EVERYTHING to make color-TV service MORE PROFITABLE for you.

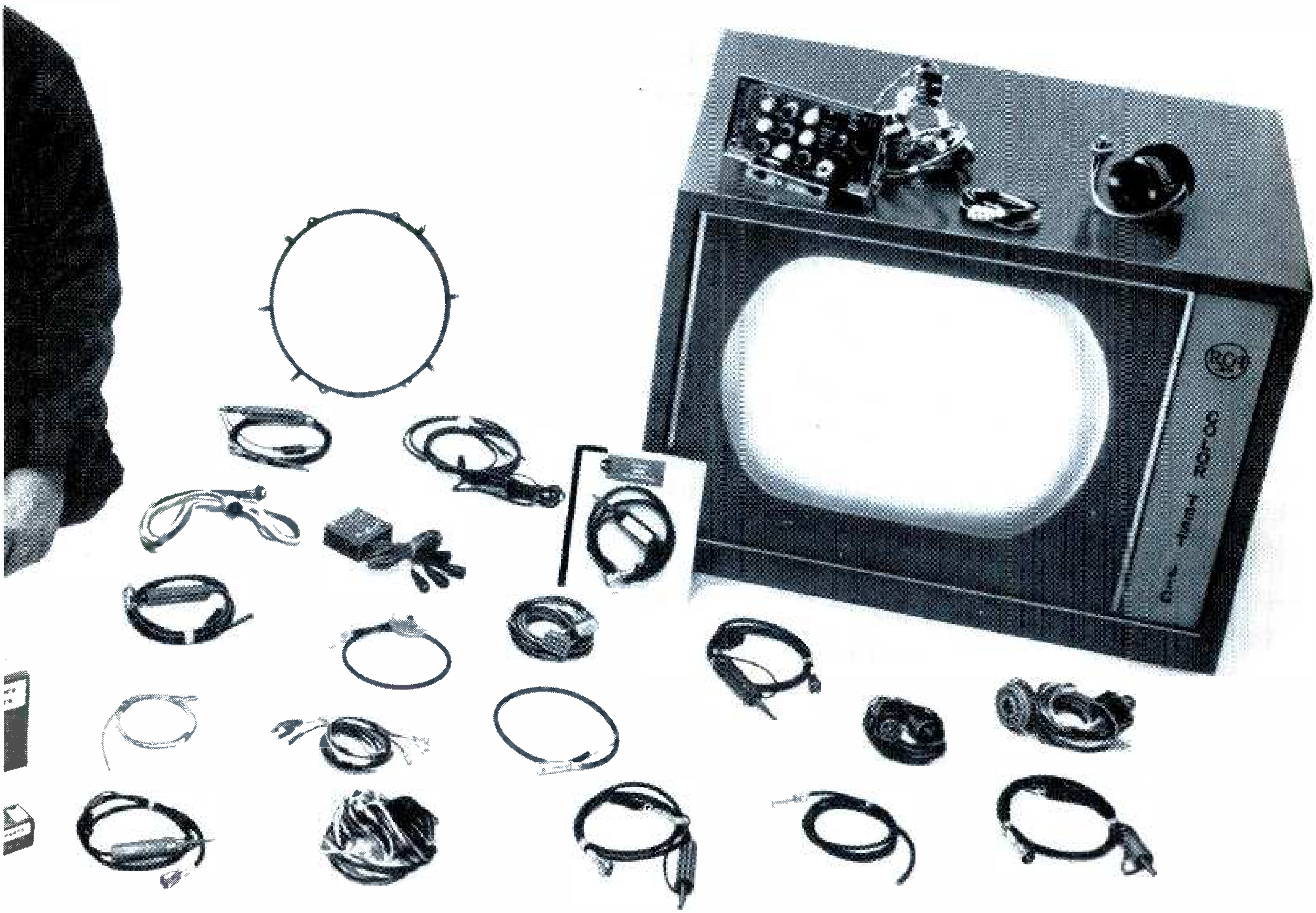
To save you money and manhours.

To increase your efficiency so you can get more jobs out in the same time.

To eliminate those time-wasting extra phone calls and trips to the distributor.

Take the famous RCA Color-TV Test Jig (large unit at right). *It cuts manhours in half* on a color house call. Without it, when you have to pull a set into the shop, it takes two men. With it, it takes just one (you pull the chassis only—leave the color tube and the cabinet). That means MONEY *...extra money for you.*

Take the RCA Color Parts Rack (large unit at left). The rack is FREE when you buy the basic complement of 120 most-needed color service parts. Keeps your color parts neatly organized, all in one place. Simplifies restocking, lets you know what you're short of. No more running out of a vital part just when you need it—which slows down a job.



MONEY IN COLOR-TV SERVICE

That means MONEY... *extra money for you.*

Take the other color service parts arrayed in the photo and listed at right. Degaussing coils, transformers, chokes, yokes, connectors, cables, replacement parts... each with a special function to save you time, to increase the quality and accuracy of your work, to help you cut down on call-backs. That means MONEY... *extra money for you!*

245 specialized color service parts in all. The Rack and the Jig make it 247. And all of them mean MONEY... *extra money for you.*

RCA Parts and Accessories for color-TV service include: *Color Test Jig*—to test all RCA color-TV chassis • *Color Parts Rack*—sturdy, well-organized unit containing complement of 120 most-needed color-service parts • *Degaussing coils*—to demagnetize picture tube and chassis • *Special-purpose extension cables*—to extend kinescope socket, deflection yoke, convergence magnet and kinescope high-voltage leads when chassis is removed from cabinet for servicing • *Special alignment probes*—video detector test blocks, IF test blocks, sound detector test blocks, mixer grid matching pad, tuner IF input head • *High-voltage interlock plug*—to by-pass high-voltage shorting switch • Plus sockets, transformers, fixed and variable capacitors, reactors, resistors, diodes, switches, coils... EVERYTHING to save you time and make more money for you in color-TV service.

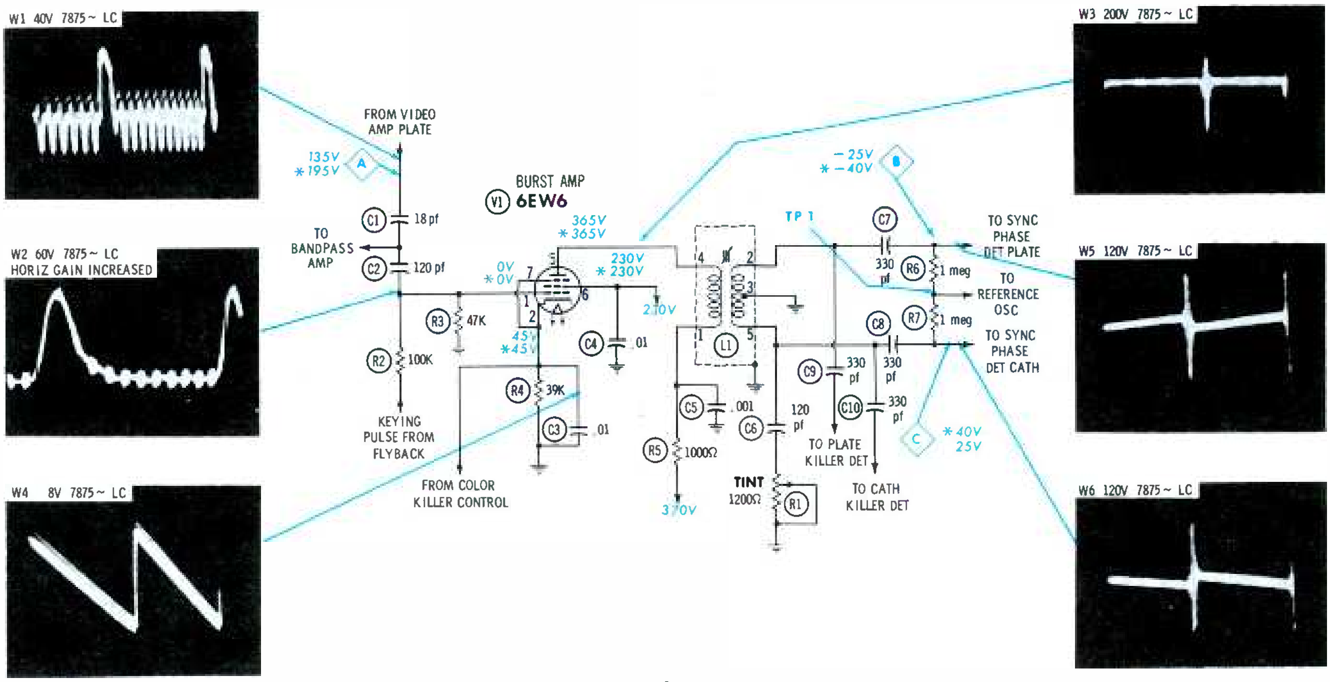
RCA PARTS AND ACCESSORIES, DEPTFORD, N. J.

RCA® **The Most Trusted Name in Electronics**

PF REPORTER Symfact™

Chroma Sync

Burst Amp



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

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

Normal Operation

This burst-amplifier circuit (from Magnavox 45 series) uses pentode 6EW6 to separate burst signal from remainder of incoming chroma information. Composite signal from video stage is applied through C1-C2. Low capacitance of C1 (18 pf) blocks sync pulses and allows only chroma and burst signal to reach C2 and burst-amplifier grid. Positive horizontal pulse from flyback is also applied to grid via R2; bias on V1 is such that it conducts only during uppermost tip of pulse—during horizontal retrace and burst time. Thus, pulses containing only pure burst signal appear at plate. Center-tapped plate transformer (L1) couples burst pulses through C7 to plate and C8 to cathode of chroma-sync phase diodes; signals from each side of secondary are 180° out of phase. Phase-shifting network (C6 and TINT control R1) adjusts phase of burst signal applied to phase detector diodes. When no burst is present in secondary of L1, diodes conduct equally; therefore, no correction voltage is developed at TP1. With color burst, diodes compare burst phase with 3.58-mc oscillator phase. If phase error exists, shift in voltages at C and B develops correction voltage at TP1, which is applied to oscillator to compensate for phase shift. Adjusting L1 also affects phase and amplitude of burst signal applied to phase detector. Adjustment is usually shop job, although minor touchup in field may be necessary to provide proper range of TINT (hue) control. Burst signal is also fed (via C9, C10) to killer detector, operation is similar to sync-phase detector.

Operating Variations

A,B With or without signal, operating controls have virtually no effect on DC voltage. However, signal strength at antenna terminals and setting of fine tuning will vary magnitude of voltages at B and C; may vary from high of 50 volts with strong signal to low of 30 on weak station—normal is 40 volts each.

PIN 1, 2 Grid and cathode voltages remain constant regardless of control settings, either with or without signal.

PIN 5, 6 Screen is connected directly to B+ source; plate is supplied through relatively low-value R5. Voltage remains same, with or without signal and isn't changed by control settings.

WAVEFORMS Amplitude of W1 is dependent upon signal strength at antenna—may vary from 25 to 45 volts p-p. Amplitude of W3, W5, and W6 will vary according to amplitude of burst signal at control grid. Amplitude variations in W3 of 150-200, W5 and W6 of 90-120 volts p-p aren't unusual; content, rather than amplitude, should be primary concern when viewing these waveforms. W2 was taken with scope horizontal gain expanded to show position of burst signal on horizontal pulse (notice it's on extreme tip). Rotating horizontal hold control will change position of burst.

SYMPTOM 1

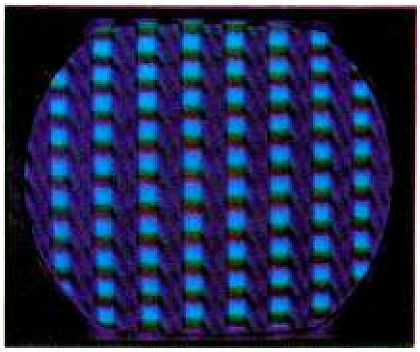
Color Weak or Missing

Color Sync Lost

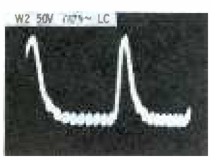
R5 Open

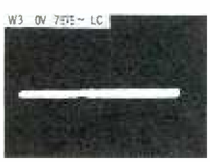
(Plate Supply Resistor—1000 ohms)

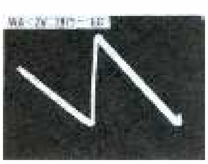
Symptom Analysis



Depending on setting of killer control, complaint may be "no color" or "weak color and loss of color sync." Color-sync or killer stages are best suspects. Logical point to begin checks is burst amplifier—it could cause either symptom.



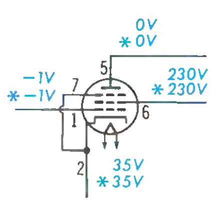




Waveform Analysis

Grid waveform (W2) is reduced slightly in amplitude but shape is normal; therefore, preceding stages are most likely okay. Loss of signal at plate (W3), considering nearly normal signal at cathode (W4), suggests tube just isn't amplifying. Scope readily isolates trouble to burst amplifier, but it will not definitely indicate open resistor. Open primary winding of L1 or break in printed-circuit board would give same scope indication.

Voltage and Component Analysis



Voltage readings quickly isolate trouble to open R5. B+ is normal on supply side of resistor but missing at plate and at junction of R5 and L1. Absence of plate voltage prevents burst amplifier from operating; consequently no burst signal reaches killer phase detector, ultimately resulting in either no color or weak color—depending on setting of color-killer control. In any case, burst isn't holding oscillator in phase; thus, loss of color sync results. A shorted C5 could have burned or opened R5; replace C5, too.

Best Bet: Scope followed by voltage checks.

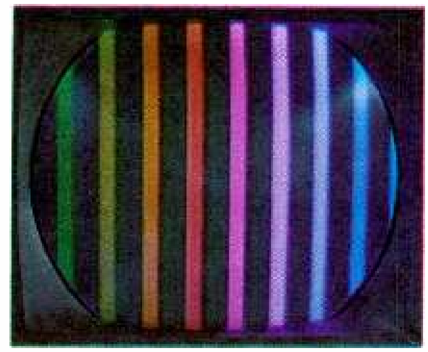
SYMPTOM 2

Color Incorrect

Tint Control is Operative

C3 Shorted

(Cathode Bypass—.01 mfd)

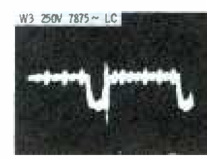


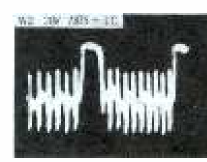
Symptom Analysis

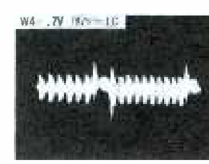
With receiver tuned to station signal, color is quite erratic, flesh tones may appear blue and change to green or red intermittently. Color-sync trouble is evident; burst amp is commonly associated with this type of symptom. However, could be AFC or oscillator.

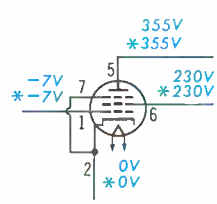
Waveform Analysis

Abnormality of W3 is readily apparent—burst signal has color bars and negative horizontal pulse. Waveform proves trouble is in burst stage. Grid signal (W2) isn't correct either; color bars are present, but horizontal pulse is distorted. Cathode signal (W4) gives best clue—sawtooth is missing; only weak color-bar pattern is present. Scope is useful in isolating trouble to components associated with cathode circuit of burst amplifier.









Voltage and Component Analysis

With or without signal, plate and screen voltages are near normal. Negative 7 volts on pin 1 and complete absence of voltage on cathode (pin 2) offer good clue to trouble in burst stage, and explain why colors are incorrect. Tube is allowed to conduct more than normal due to reduced bias between grid and cathode. Phase shift in burst stage causes 3.58-mc oscillator to shift, causing CW signal applied to demodulators to be in wrong phase. (Open C3 causes slight shift in burst phase but can be compensated for by adjusting tint control.)

Best Bet: Scope and voltage measurements.

SYMPTOM 3

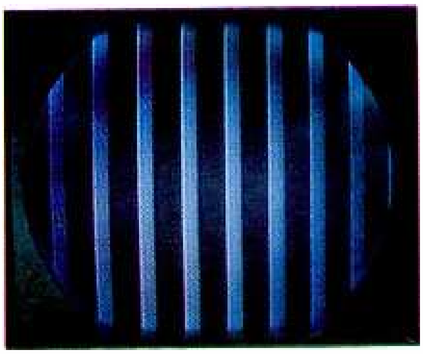
Color Lost

Monochrome Pix Normal

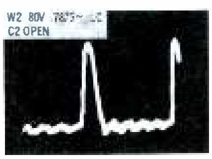
C2 Open

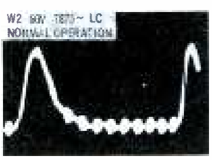
(Grid-Coupling Capacitor—120 pf)

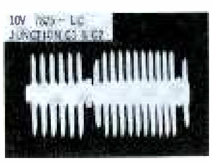
Symptom Analysis



Complete loss of color when tuned to station signal. However, using color-bar generator and overtuning receiver, slight amount of color can be had, but with poor color sync. Loss of burst signal could cause this symptom through action of color killer.



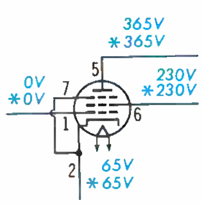




Waveform Analysis

Normal color-bar waveform (not shown) is present at point A. Grid of V1 (W2) has only horizontal pulse — color bars and burst signal are missing (see accompanying normal W2). Junction of C1 and C2 reveals normal color bars and burst signal, therefore C2 must be open or printed board has break. When no color can be obtained, it is wise to check burst-amplifier stage to see if loss of color results because burst is missing.

Voltage and Component Analysis



Only abnormal voltage reading is 65 volts on pin 2; suggests tube is overconducting, most likely from above-normal amplitude of grid signal. With low resistance in plate circuit, overconduction doesn't cause change in plate voltage. Interaction between burst amplifier, 3.58-mc oscillator, AFC, and color killer makes it difficult to pinpoint defective stage immediately when color is lost or out of sync. Missing burst may cause loss of color or absence of sync, depending on signal strength and setting of killer control.

Best Bet: Scope is adequate.

SYMPTOM 4

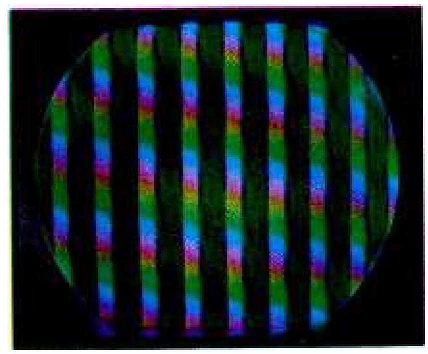
Color Sync Lost

Frequency Error Slight

R2 Increased in Value

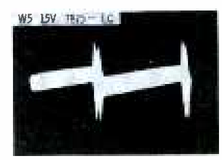
Grid Resistor—100K)

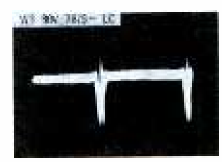
Symptom Analysis

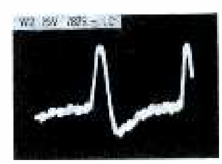


Station signal gives indication of color-sync loss; colors drift across screen and aren't stationary at any setting of controls. Color-bar generator proves symptom truly is loss of color sync; also, small number of horizontal bands indicates frequency error is slight.

Waveform Analysis

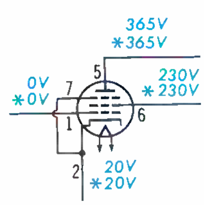






Amplitudes of W6 (not shown) and W5 are greatly reduced; suggests trouble is in burst amplifier, not oscillator or AFC. Abnormally low amplitude of W3 further isolates trouble, indicating L1 and associated components are okay. Horizontal pulse at grid (W2) is only 25 volts p-p (normal is 60)—indicates defect is most likely in R2, R3, or possibly flyback. Decreased amplitude of keying pulse lessens tube conduction.

Voltage and Component Analysis



Low reading (20 volts) at pin 2, with normal reading on all other elements, proves tube conduction is reduced or value of R4 has decreased—resistance measurements prove latter isn't true. Ohmmeter checks from grid to ground are helpful in locating increased value of R2. Normal reading is 33K, as R3 is paralleled by R2 and winding on flyback, but R2 now measures 44K. Improper color sync is result of changed operating characteristics of burst amplifier; burst phase is thus altered, resulting in incorrect AFC voltage to oscillator.

Best Bet: Scope and resistance measurements.

SYMPTOM 5

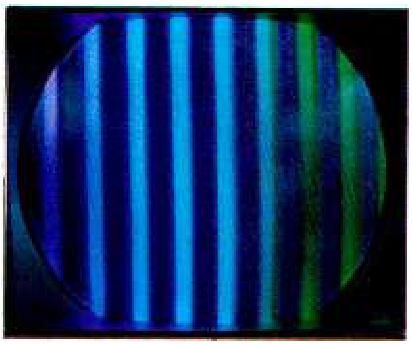
Color Incorrect

Tint Control Inoperative

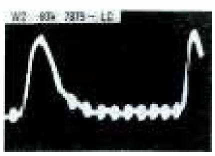
C6 Open

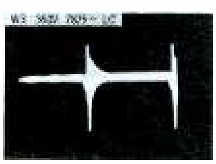
(Tint Coupling Capacitor 120 pf)

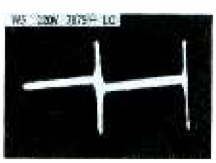
Symptom Analysis



Flesh tones appear purple and cannot be changed by adjusting tint control. Color-bar generator shows 60° to 90° phase shift has occurred. Inability to change hues with tint control suggests making initial checks of control and associated components.



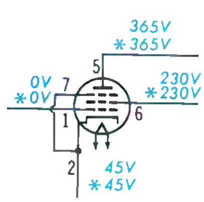




Waveform Analysis

Input to burst amplifier (W2) is normal—burst signal and ten color bars are present. Plate signal of V1 (W3) is increased in amplitude; however, waveform content is as should be. W6 (not shown) and W5 are correct in amplitude; reason for incorrect color must be that phase of burst signal has changed; cannot be determined with scope. Scoping junction of C6 and R1 isolates open circuit, no signal is present —normal burst should be.

Voltage and Component Analysis



Voltage checks are completely useless; all readings are normal with or without signal. With C6 open, tint control cannot change phase of burst signal; therefore, improper color pattern is seen because burst transformer (L1) is aligned with tint control at center of range. Phase of signal applied to chroma-sync phase detector is approximately 60° out of phase if tint control is inoperative and burst transformer is aligned properly. Open capacitor is often difficult to locate with voltage checks or resistance measurements.

Best Bet: Scope and component analysis.

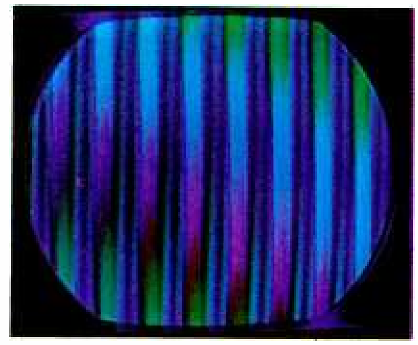
SYMPTOM 6

Color Sync Lost

Frequency Error Slight

R7 Increased in Value

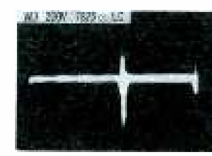
(AFC Balance Resistor—1 meg)

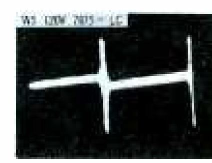


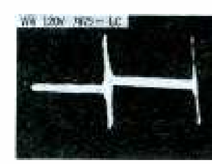
Symptom Analysis

Sync loss when station signal is tuned shows up as red, blue, and green bars in picture. Color-generator pattern also proves loss of color sync is primary concern —also indicates frequency error isn't great. Adjusting tint control changes frequency error.

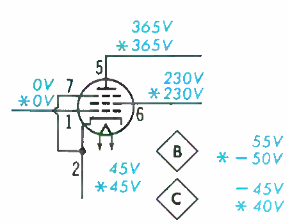
Waveform Analysis







Actually, waveform checks aren't much help in isolating trouble. Signal on both plate and grid of burst amplifier are normal, as is burst signal to chroma-sync phase detector. This is one of these rare instances when scope cannot help isolate defective stage. Fact that burst is normal suggests voltage and/or resistance checks in AFC circuit might prove helpful. Resistor with changed value is generally difficult to locate with scope.



Voltage and Component Analysis

Most valuable clue from waveform analysis is that AFC circuit is likely culprit. DC voltages at B and C are unbalanced—with signal, B reads −50 volts, C measures 40 volts. Same unbalanced condition is evident without signal, throwing further suspicion to change in value of one AFC balance resistor. If either R6, R7, or printed board were open, symptom would be similar, but oscillator frequency error would be much greater—larger correction voltage would be applied to reference-oscillator grid—junction of R6-R7.

Best Bet: VTVM and circuit analysis.

Shop Talk

By Homer L. Davidson

Test Equipment

COMMON TROUBLES ARE EASY TO LOCATE AND CURE

Most radio and TV repair shops don't seem to find time to repair their own test equipment. A good plan would be to repair one instrument per month, or to make up a list of instrument repairs and do them when a slack day occurs. A look at our own test bench shows several test leads and prods are taped up, and should be replaced. The tube tester has a couple of bad sockets and one jack on the VTVM is loose. Even the pilot light is out on the bench power supply. Let's not even wait! Let's take a little time out now and repair some of our test equipment.

The Voltmeter

The VOM and VTVM get the toughest workout in any repair shop. First, take a look at the test leads and replace bent or broken tips and jacks. A new set of test leads may be in order if the old ones have been cut off and repaired until they are short. Look at the meter glass. If it is cracked or broken, take the measurements and get a new one from your local glass cutter. Don't use a piece of cut plastic because static electricity will cause the meter to read incorrectly.

Brush out dirt and clean up the plastic case. Ordinary alcohol will clean and polish that black plastic case till it looks like a new one. If there are any cracked cases use an epoxy cement to put them together again. Worn dials and numbers can be restored with a plastic lettering tool. Check the batteries and replace them, if needed. Spray the selector switch (Fig. 1) with a good contact lubricant.

If any one of the scales fail to work, check the battery or the multiplier resistors. With a weak battery, the meter hand will not zero-adjust correctly. When only one scale is bad, either the multiplier resistor is burned out or a switching contact is bad. These resistors can burn out quickly if voltage too high for the scale is accidentally applied, or if B+ is connected to the ohmmeter scale.

Before replacing a multiplier resistance, have a diagram of the tester handy. These diagrams are generally included in the test instrument manual; if they've become lost, secure one from the manufacturer. Schematics of several popular radio-TV test instruments are included in the Howard W. Sams book *Test Equipment Circuit Manual* (TEC-1).

Let's take a look at the Rx1 scale of a typical VOM, diagramed in Fig. 2. If one of the multiplier resistors has changed value and needs to be replaced, it may be difficult to obtain locally. These odd-value resistors are not often stocked by the radio-TV wholesaler, but must come from the test equipment manufacturer, even though they are not costly. Look at the DC volt-meter range of the same VOM, shown in Fig. 3. These resistors could be located more easily, since they aren't unusual values; in fact, several resistors could be placed in series to obtain the correct resistance.


Fig. 1. Cleaning contacts of a VTVM.

VOM Calibration

A VOM can be calibrated with known voltages. A fresh mercury cell is an excellent source of 1.4 volts. Two of them in series can be used to check the low voltmeter scales. If the reading is off more than 3%, check the multiplier resistor. It is rare that the meter movement is the cause of inaccuracies, but this is possible.

Place several cells in series to check the next higher voltage range. If that range is okay, use a higher-voltage battery or a regulated supply to check the upper ranges. If the voltages in TV and radio sets can be measured within 10%, this is good enough to get by with until you can have the instrument overhauled. One other method of checking is to use a new voltmeter for comparison. Generally, a new meter will be fairly accurate — at least to its rated tolerance.

The AC ranges can be checked against known voltages, such as the 6.3-volt AC filament transformer and the 117-volt AC power line. If the AC voltage scales seem to be more than 10% off, suspect the meter rectifier or a multiplier resistor.

It is also easy to check the ohmmeter range. Take a few 1% carbon resistors that will cover the 1/3 and 2/3 points of each scale. If 1% units aren't available, pick up some 5% types. Add the resistors in series until all scales are checked out. Multiplier resistors are the usual cause of incorrect ohmmeter readings. If only one range is wrong, see if the multiplier resistor has been hot or burned. Weak batteries cause poor zeroing.

The milliammeter scale can best be checked by comparison with a meter known to be accurate. Simply hook the two meters in series with one lead of a battery and some load, such as a small transistor radio. If one of the low-value shunt resistors —such as 11.5 ohm, 2 ohm, or .025

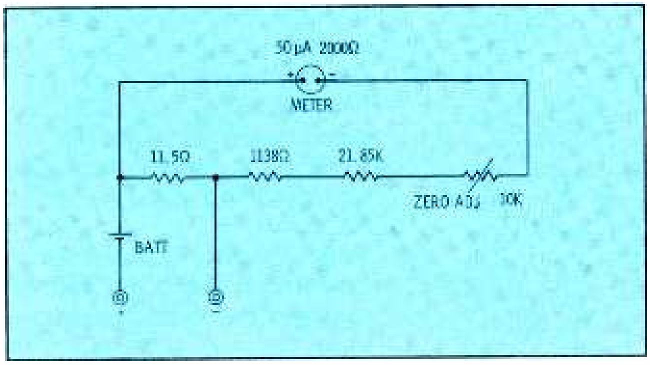


Fig. 2. Simplified diagram of the Rx1 scale.

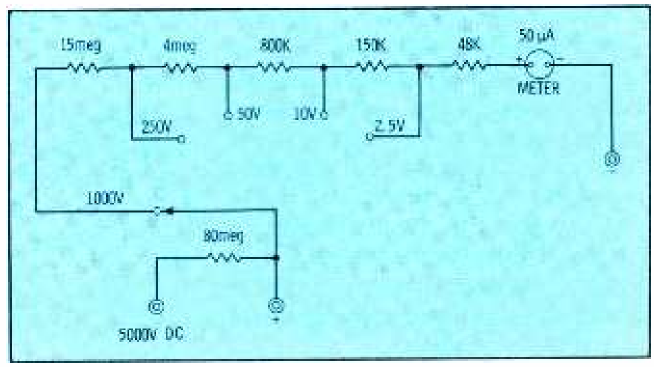


Fig. 3. Multipliers used in voltmeter circuit.

ohm—is defective, it will need to be secured from the meter manufacturer.

Calibration of a VTVM can be checked the same as with a VOM. However, most VTVM's have calibration controls and thus don't require new multipliers merely for correcting inaccuracies. With the batteries and known voltages, the scales can be set with the controls to read correctly.

If the ohmmeter readings should be erratic and you suspect a bad lead, short the two jacks together with a short piece of copper wire. Adjust the pointer for zero and remove the wire jumper. Insert the test leads and, if any value other than zero ohms is noted, install new leads.

The VTVM should have all the tubes checked and any questionable ones replaced with good ones. Clean the switch contacts and check all test leads. Especially check the probe cable and plug. Tighten up all loose jacks or plugs.

If the low ohms range will not register to full scale, replace the small flashlight battery. Make a thorough visual check while the instrument is apart. On one of our units, the zero-adjust knob would not bring the meter pointer to the exact end of the scale. The control was worn at this spot and the needle would either fall in-scale or way off-scale. Instead of fooling around with a control lubricant, we installed a new control.

Tube Tester Repair

The most usual trouble with the tube tester is poor and worn sockets. Socket troubles are often confined to the 7-pin, 9-pin, octal, and 12-pin sockets, because they are used the most. Choose a high-quality tube socket for replacing any of these worn ones. Some of the tube-tester manufacturers place the sockets on a top panel (Fig. 4), and this whole unit can easily be replaced by unscrewing two small screws and unplugging the socket assembly.

If the tube tester doesn't give a reading for a tube being tested, try a new tube. Still no dice? Take a look at the bias fuse, which may be only a dial lamp. If necessary, replace it.

A dirty or worn bias-setting rheostat will cause erratic readings and should be cleaned or replaced. In one tube tester, the bias control was burned out. No one seemed to know how it happened, but the only place to secure one was from the manufacturer. It finally developed that some switches were set wrong and the button held down too long, until the control finally popped.

The rectifier tube should be checked and replaced, if weak, while the tester is open, And, of course, all the switching contacts should be treated with a good switch cleaner. If any section of the function switch doesn't work properly, the switch is bad or there is a loose or broken wire.

Once in a while, a meter hand will stick partly across the scale. Dismount it from the tester, remove it from its case, and look closely at the adjustment spring. Sometimes the pointer base may have jumped out of the meter bearings. If you have poor eyesight and big thumbs, don't try to repair the meter. Send it in to the manufacturer to be repaired. (Sometimes a plastic-covered meter will develop static electricity on the face and the meter may act similarly.)

Watch out for selector knobs that have turned around. A wrong or loose knob could make a costly error. If your tester has a knob that won't stay put, file the set-screw side flat.

Other Instruments

In our shop, we found a lot of other instruments that could use minor corrections. Our B & K Television Analyst Model 1076 has a lot of jacks and test leads that sometimes cause trouble. Dressing them up periodically is important. When troubleshooting the Analyst, remember that this tester is as easily repaired as any TV receiver. Trouble is isolated to a section and then pinpointed and repaired; as an example, take the following case histories.

One of our technicians had repaired a faulty sync section in an Admiral 21" receiver, but couldn't get the set back together that evening. When he came back the next

●*Please turn to page 107*

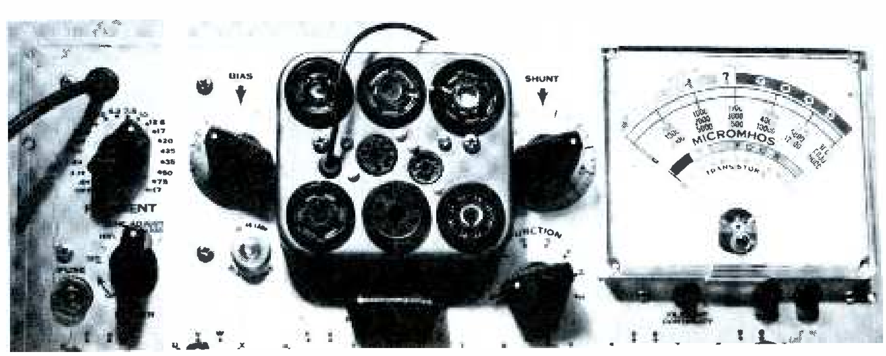


Fig. 4. Separate sockets demount easily by removing two screws.

NEW CRT and Tube TESTERS

By Elis Ladyman

Units Now on the Market Are a Bit Different Than Those Previously Available

The increased use of novars, nuvistors, magnovals, and tubes of other strange base configuration in home entertainment and industrial equipment may have obsoleted your tube tester. The fact that you can't test a few tubes might not worry you, as you can always replace a suspected tube with a new one. This system however, has a couple of drawbacks that can prove expensive to a service technician.

We have all experienced the problems that occur when a new tube used for replacement is bad. (This usually results in a time-consuming search for a nonexistent circuit defect, before we decide to try another tube.) Another problem can arise from the substitution method when tube replacement fails to affect the trouble symptom, because the logical assumption is that the original tube is good and the trouble is caused by an associated circuit defect. Some wasted hours later you find you had a circuit fault *and* a bad tube. A good, up-to-date tube checker is often the answer to efficient troubleshooting. An analysis of *your* tester, to determine whether it is doing an efficient job for you compared to the new testers available, might be in order.

Mutual-Conductance Testers

In practically all home-entertainment devices, tubes function as amplifiers (excepting diodes and rectifiers). Oscillator circuits (RF, horizontal, vertical, etc.) are basically amplifiers with some form of regenerative feedback. A good test of a tube, then, would be to test its ability to amplify, and its ability to amplify is determined by its mutual conductance (Gm). Mutual conductance is defined as the change in plate current caused by a small change in grid voltage.

$$Gm = \frac{Ip}{Eg}$$

where

Ip = change in plate current
Eg = change in signal grid voltage
Gm = mutual conductance.

The measurement of mutual conductance is one of the best tests for determining a tube's merit; however, a simple test for emission is also a very useful check, and it can be performed economically by less complex testers.

Emission Testers

Emission testers indirectly indicate a tube's ability to function as an amplifier. They accomplish this evaluation by checking the cathode's emission capibility; a tube with low emission obviously would not be a good amplifier. Other tests are usually incorporated in emission testers, for example: shorts between elements, heater-to-cathode leakage, presence of gas, contaminated control grids (grid emits current), etc. Since an emission-type checker requires only simple circuitry, it is, as a general rule, less expensive than the more elaborate mutual-conductance testers.

Styles

While most tube testers are designed for the dual role of testing tubes in the field and on the service bench, others are designed for the bench exclusively. Still others perform the dual roll of countertop tester for "do-it-yourself fans," and bench checker for the technician. Another choice for individual preference is the method of operation. Some general styles and configurations are listed below:

1. Roll Chart—A roll chart contains the information necessary to set up test conditions. The roll-chart itself offers an additional choice; it may be flat, upraised, tilted, or positioned anywhere on the chassis, depending on the model and the manufacturer.
2. Set-Up Cards—Indexed set-up cards rather than a roll chart are available on several models. In choosing your new tester, the presentation of reference information should be given some thought. Up-to-date data must be available, therefore storage of the cards and easy modification of the reference material are of primary concern.
3. Multiple Sockets—This type of tester contains prewired, labeled sockets to accomodate many common tubes, and offers minimum setup time. An objection to its use is the difficulty in updating the tester as new tube configurations appear. Many manufacturers now include a blank panel to alleviate this problem.
4. Multiple Sockets and Roll Chart — Combination models offer prewired sockets for fast testing of more common tubes, while covering other tubes through the conventional roll-chart information system; actually two tester types in one.

Fig. 1. CRT Tester has provision for three different G2 voltage levels.

Tube testers are also available in combination with other pieces of test equipment. Tube testers and CRT tester-rejuvenator combinations are common. A tube tester, VOM, and CRT tester-rejevenator was introduced last year. Treated as "window dressing" for many years, the tube tester is gaining more respect from the modern service technician all the time. With approximately 3000 different tubes available to design engineers for use in home entertainment and industrial application, the old substitution system has been replaced by the direct-check method. Ten years ago, when a complete complement of tubes could sit on a handy shelf ready for instant substitution, the drawbacks of the substitution method were far outweighed by the time it saved. In today's shop, a stock of tubes in standby position for substitution would occupy far too much space for practical servicing, and the time formerly saved by substitution is now saved by testing. Modern circuitry incorporating multipurpose tubes almost demands the use of testers to eliminate the tube as a source of trouble.

A partial list of available late-vintage testers is shown in Table 1.

CRT Testers and Rejuvenators

Obsolescence, the same disease that afflicts old receiving-tube testers, has also taken its toll in the ranks of CRT testers. The introduction of new CRT's with an assortment of heater-current ratings, together with differences in tube bases, has made the continued use of the old tester an exasperating experience.

Color CRT's present special problems that should be considered when you plan to purchase a replacement tester. A basic similarity in the symptoms found in most color repair work calls for a good CRT tester. There is a wide variety of trouble symptoms which indicates either circuit defects or CRT defects (or both). Early elimination of the CRT as a suspect serves two very beneficial purposes: First, much time will be saved by keeping the service technician on the right path; and, second, customer goodwill can be enhanced by a quick answer to that old question, "Do you think it's the picture tube?"

Various manufacturers have answered the challenge of these new tubes with an assortment of instruments capable of testing all tubes on the present market, and most have built-in safeguards against obsolescence in the near future. Table 2 lists some of the newest testers available.

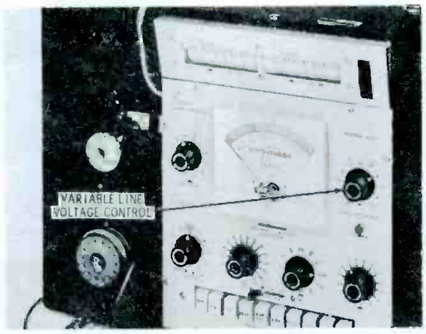


Fig. 2. Line-voltage control insures precisely correct CRT heater voltages.

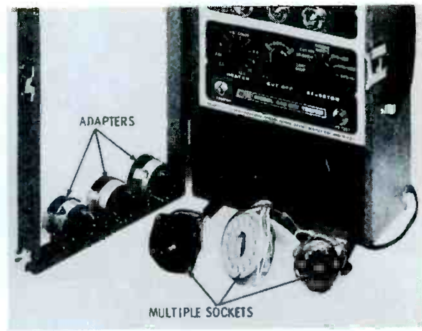


Fig. 3. Multiple-connector cable and separate sockets provide versatility.

Here are just a few of the innovations engineered to aid you in doing more profitable service work:

1. Filament-Voltage Control — An easy means of providing the correct filament voltages to the heaters of the CRT.
2. Gun Switch—The recommended method for checking color CRT's is to test one gun at a time; the gun switch allows you to perform this test, thus providing a means for comparing the guns. This is an important check; should a particular gun become low in emission compared to the other two, serious problems in color-rendition generally result.
3. G2 Voltage Control—To extend the range of testers and provide against obsolescence, a selection of G2 voltages is available on many CR testers. The correct voltage for each type of tube assures a correct evaluation, and proper setup procedures are included with each tester. A typical multivoltage G2 provision is shown on the tester of Fig. 1.
4. Line-Voltage Control — Line-voltage control is important in testing color CRT's. Low line voltage can result in an improper evaluation of the merits of the tube under test. If your tester doesn't have a line-voltage control, you should take care to insure that you have the proper supply voltage when testing. Fig. 2 shows a tester which employs a voltage-control potentiometer.
5. Sockets and Adapters—Most of the testers on the market today include all necessary adapters and convenient storage space.

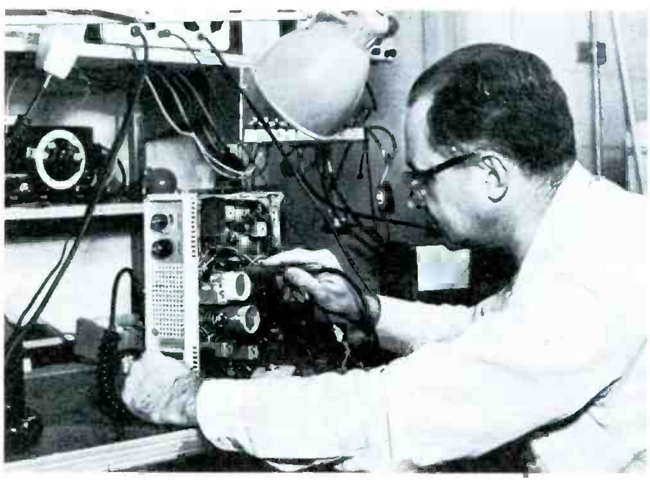
•*Please turn to page 106*

Table 1.

MFG. and MODEL	TESTER TYPE: Mutual Conductance	Emission	Both	TEST SOCKETS AVAILABLE: 7 Pin	9 Pin	Octal	Loktal	Novar	Nuvistor	Compactron	Magnoval	10 Pin	Spare Panel	Transistor	Diode	CRT CK ADAPTER: B-W	Color	Part of Tester	Available as Accessory	STYLE: Portable	Counter	Portable or Counter	SETUP: Multisocket	Index Cards	Roll or Chart
B & K 700	X			X	X	X	X	X	X	X	X	X	X								X		X		
B & K 600		X		X	X	X	X	X	X	X										X					
EICO 667	X			X	X	X	X	X	X	X	X	X		X	X	X	X		X		X	X			X
EICO 628		X		X	X	X	X	X	X	X		X									X	X			X
Hickok 580	X			X	X	X	X	X	X	X	X	X										X			X
Hickok 799	X			X	X	X	X	X	X	X	X	X	X								X	X	X		
Jackson 658A	X			X	X	X	X	X	X	X	X	X									X	X			X
Mercury 1101		X		X	X	X	X	X	X	X	X	X				X						X			X
SECO 107B			X	X	X	X	X	X	X	X	X	X									X		X		
SENCORE TC130		X		X	X	X	X	X	X	X	X	X				X	X	X		X		X		X	
SENCORE TC131		X		X	X	X	X	X	X	X	X	X									X			X	

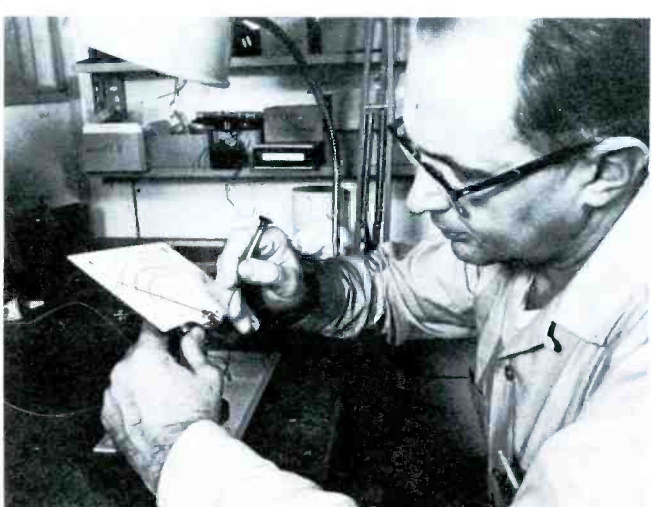
1 At the service counter, Bob Breda receives a customer's instrument for repair. The service order is prepared immediately, work number is assigned, and all particulars on the nature of the malfunction are noted on the repair order.

2 Ojars Staks takes an instrument from the incoming-instrument storage area where other equipment awaits repair. Work-order numbers are checked against the original invoice for service data to speed the specific repair order.



3 Citizens-band transceivers, another service specialization of B & S Electronics, are repaired and serviced at a separate test position which has alignment and calibration equipment for both FM and AM communications gear.

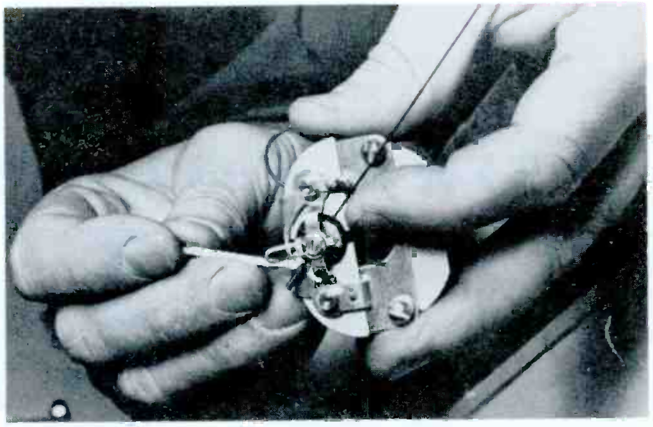
Test Equipment Specialists Meet Two



4 Each general category of instruments has a separate and complete bench area to insure rapid service. One factor in the success of this operation is the willingness of all members to work on any unusual or complex equipment.

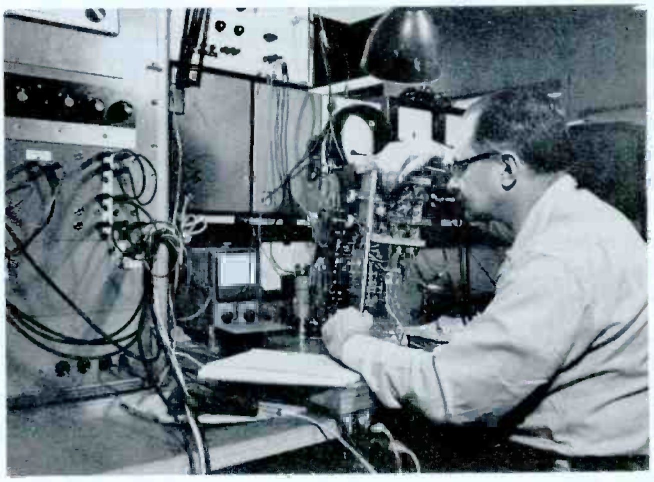
5 An example of the various special services provided is the repair and calibration of meters and meter movements. Burned-out armatures, bent pointers, or broken or missing jewels—all are repaired or replaced as required.

6 An extensive bank of tube testers and checkers enables B & S technicians to evaluate thoroughly all types of tubes and semiconductor devices. This area, as are all others, is separate and self-contained to speed work completion.



7 Staks carefully repositions the armature shaft of a meter in for repair. The need for a delicate and knowledgeable approach to servicing is emphasized by these shop owners. The ability to perform these services brings good income.

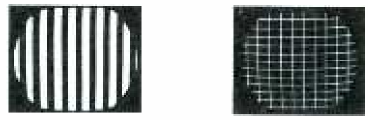
Service and repair of test instruments, medical electronics devices (audiometers), and other specialized equipment is the hard business line taken by Bob Breda and Ojars Staks, who operate B & S Electronics in a western suburb of Chicago. Joining forces in 1957 after independent careers in the radio-TV servicing business, Breda and Staks have carefully guided their efforts away from general servicing toward their present highly specialized and efficient operation. As the official repair station for several major test-equipment manufacturers, B & S Electronics handles several hundred instruments a month with their basic three-man staff. Average handling time from receipt of an instrument to reshipment is 7 to 10 days. Some radio and TV servicing is still done in the shop, but no new consumer business is solicited. Breda and Staks also service bulk quantities of auto radios for local dealers and servicemen who have more than they can handle efficiently. Both men feel their continued success lies in expanding to include additional specialized fields, particularly in industrial and medical electronic equipment.



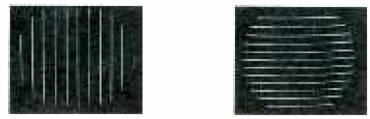
8 Tape recorder from a custom high-fidelity installation is checked out at the audio bench. The panel at left has several circuit modules (audio amps, IF strips, detector, etc.) which can be substituted for the circuits under test.

9 A separate, enclosed booth contains precise audio equipment used to service a line of audiometers. These instruments are used by hearing specialists to perform exacting medical tests, and require regular calibration.

10 A commercial package-shipping service makes several stops a day to deliver and pick up instruments. B & S uses this shipping method, even locally, and has no trucks of its own on the road. All instrument shipments are insured.



USING COLOR GENERATORS



Interpreting keyed-rainbow patterns and waveforms.

By George F. Corne, Jr.

In past issues, we've covered the operation of various color generators: NTSC types producing both single- and multiple-bar displays; rainbow types, usually with a three-color display; and keyed-rainbow types that produce a series of multi-colored bars. Now we'll take a closer look at keyed-rainbow generators, concentrating on a few uses for the color-bar pattern and showing actual screen presentations. We won't be concerned with the additional patterns (dots, vertical and horizontal bars, and crosshatch) used for convergence and linearity adjustments in color receivers. Most generators, of course, supply these signals, too.

Typical Color-Bar Pattern

The majority of generators introduced in the past six or eight months are of the keyed-rainbow type. Ten color bars, varying in hue from yellow-orange through red, blue, and green, are produced on the screen of the color CRT. Each bar represents a change in phase of 30°. The same basic color pattern (Fig. 1), produced by all color generators using the offset-carrier principle, can be very useful in color servicing and can tell us much about the overall condition of the color receiver.

Color and Hue Checks

Color bars with an acceptable degree of saturation are shown in Fig. 1, so we know all circuits handling the video signal—from the front end through the color circuits — are working normally. The colors vary in hue across the screen in the correct sequence: yellow - orange, orange, red, magenta, reddish blue, blue, greenish blue, cyan, bluish green, and green. This preliminary observation assures us that colors will be produced from any normal station signal in proper hue and saturation. (Incidentally, it's a good idea to commit this sequence to memory, although most generators have the pattern visible on the front panel.)

Although each color bar has its own individual hue, it's more advantageous to concentrate on bars having the most significant meanings. The important bars, counting from the left, are the third, fourth, sixth, and tenth. With the hue (tint) control set to the center of its range, the third bar should be brightest red, the sixth brightest blue, and the tenth brightest green. The positions of these three bars represent the phase angles for R-Y, B-Y, and G-Y signals. We mention the fourth bar (magenta) because it is the one technicians use most for a check of hue-control range. Some technicians, however, prefer the eighth bar (cyan).

Rotation of the hue control through its complete range should provide at least a 60° phase change. Since the bars in a keyed pattern are at 30° intervals, this represents a movement the width of one bar to either side of the bar selected as a guide. For example, turning the hue control counterclockwise—using the fourth bar (magenta) as a refer-

Fig. 1. The fourth bar is magenta with hue at center.

Fig. 2. A 30° phase shift will color third bar magenta.

ence—should shift the magenta hue to the third bar (a 30° change), as shown in Fig. 2. Rotating the control fully clockwise should shift the magenta hue to the fifth color bar (a 30° change in the other direction), as in Fig. 3. Thus, the two 30° shifts total the required 60° phase change.

In some receivers, the phase can be shifted more than 60° with the hue control; however, make sure at least a 30° shift can be made in each direction. If the bars don't change color in this manner during rotation of the hue control, it may be necessary to align the color-phasing circuits. If the phase is only slightly off (magenta hue range covers the fourth, fifth, and sixth bars, for example), a small adjustment of the transformer in the burst-amplifier stage will probably be all that's necessary. An article describing a complete phasing-alignment procedure using the keyed pattern appeared in the November 1964 PF REPORTER.

Most generators have some means of controlling the output level for the purpose of verifying a complaint of total loss of color, or to see if the color-sync circuits are functioning properly. If the receiver maintains a normal color display below the generator's 50% point, operation on a station signal will be acceptable. We've shown in Fig. 4 what appears on the screen with a loss of color sync when using the keyed-rainbow pattern. In the example shown, the frequency error is small; with a larger frequency error, more color blobs will appear. On a station signal, however, you'll probably see only three stripes of color — red, green, and blue—usually situated horizontally.

A more positive simulated station check can be made in the following manner: Connect the generator and tune in a normal bar pattern. Then, disconnect the generator leads from the receiver antenna, and place them in close proximity to the set. If a snowy color-bar pattern, as shown in Fig. 5, is produced on the screen and the bars are in sync, you can be sure the receiver will produce a good color picture when tuned to a station.

Scope Checks

We've seen the screen presentations of a keyed-rainbow pattern, useful for checks of performance and controls. Now, let's briefly acquaint ourselves with the oscilloscope waveforms produced by the generator so we can use the generator for signal tracing.

Fig. 6 is a block diagram of typical color circuits, and Fig. 7 the waveforms for these circuits. Note the important check points in these circuits, and the normal signals that should be present at each.

TP-1: You should find the composite generator signal, consisting of the horizontal-sync pulse (large spike) and 11 bars of color information (smaller spikes). A waveform taken here should be approximately 2 volts in amplitude, if fed from the detector output (50 volts if fed from a video amplifier). A correct waveform indicates all circuits up to this point are okay. If W1 is missing or attenuated, the subcarrier isn't passing through the front end, IF's, or (in some receivers) a video stage.

TP-2: Here's the keyed pattern fed to the chroma-bandpass and burst-amplifier stages. Notice that the sync pulse has been eliminated by the small 18-pf coupling capacitor. There are 11 pulses of color; the first pulse appears during horizontal-retrace time and simulates the color-sync pulse (or color burst). Remember, only 10 bars of color reach the grid of the picture tube. All bars should have the same general amplitude—close to 1 volt, if fed directly from the detector (6 volts if from video amplifier).

TP-3: Look for clean color bars 4 to 8 volts in amplitude. In some receivers, as here, 10 bars are present—the burst pulse has been keyed out; in others, when the burst signal is permitted to pass through the bandpass amplifier (it is keyed in a later stage), you'll find 11 bars. The height of all bars should be about the same. If they aren't, gain of the bandpass stage(s) is changing during horizontal scan. The result on the screen would be poor saturation of some color bars. Usually, a defect in the bandpass grid or plate circuit causes unequal gain.

TP-4, -5, -6: The demodulated color-difference signals are shown at these points. Compare these waveforms with the CRT screen presentation for a better understanding. The first five color bars on the screen require that the red gun be on. Notice in W4 that the first five bars apply a positive signal to the red grid; thus, conduction in the red gun follows the signal envelope. The remaining bars — 6 through 10 — don't contain red, and the red signal for those bars is nulled or negative.

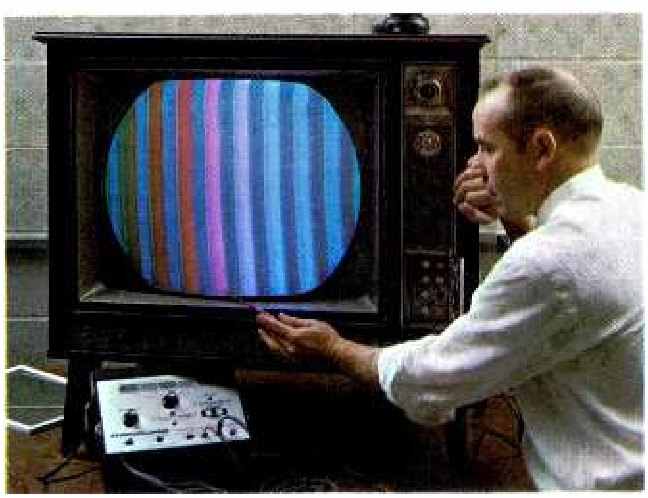


Fig. 3. Fifth bar magenta when the hue is clockwise.

Fig. 4. Loss of color sync with a keyed-rainbow input.

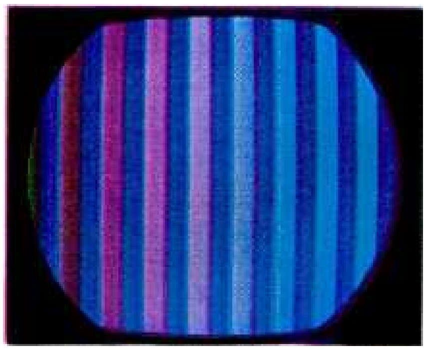


Fig. 5. Simulated station check; color is in sync, but snow is present.

Let's take a closer look, and establish what is present when a bar is nulled on the base line (our zero reference). When the signal at a particular grid is at zero, the gun isn't completely cut off. Rather, zero reference means the gun is conducting only the amount it does when no color signal is present — the amount necessary, when combined with the other two guns, to make a white raster. This operating point is set with the screen and drive controls.

You'll notice the first two bars *do* contain some green, even though the signal on the green grid (W6) is nulled (zero) on the first bar and is slightly below zero on the second bar.

Similarly, in W5 on the blue grid, the blue gun conducts during the fourth through the eighth bars—when blue is needed on the screen. Notice the first, second, third, and tenth bars don't require blue, so the signal on the blue grid during the period of those bars is nulled or negative.

W6 is the color signal at the green grid. Here, the tenth bar is maximum positive, as it should be. Of course, some green is also necessary for the eighth and ninth bars, and to a lesser degree for the first, second, and seventh bars. Although the signal on the green grid is nulled or slightly negative during the latter three bars, the green isn't cut off completely—some green is needed for those color hues, too, and the drive setting controls just how much is available.

When the hue control is rotated, the relative amplitudes of the waveform bars change as the color bars on the screen change hue. For example, on the red grid, magenta is represented by the fourth bar, but it can be shifted to correspond to the third- or fifth-bar position. If a scope is used for phasing adjustments, the significant bars are those nulled at zero (base line); the sixth bar on the red grid, the third and ninth bars on the blue grid, and the first and seventh bars on the green grid.

Summary

The color-CRT photos and scope waveforms presented here represent only the basic servicing procedures using a color generator. Final operational checks on a color receiver include: proper color rendition; control of color saturation; range of hue-control; color-sync action; and a simulated station check. All can be performed in a matter of minutes with a keyed-rainbow generator, if you'll follow the procedures outlined. Concentrating on the important bars in each pattern and waveform makes the performance check fairly easy. Waveforms produced by the color generator can be used also for signal tracing. Locating with your scope the stage responsible for a loss of color, or for weak color, is the *short* route to quicker servicing. Know what signal should appear where, and you'll find color-set troubleshooting far easier in the future. ▲

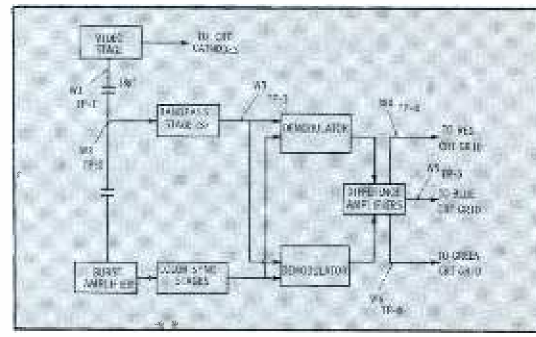
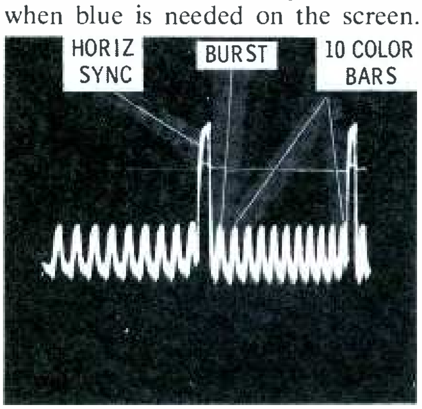
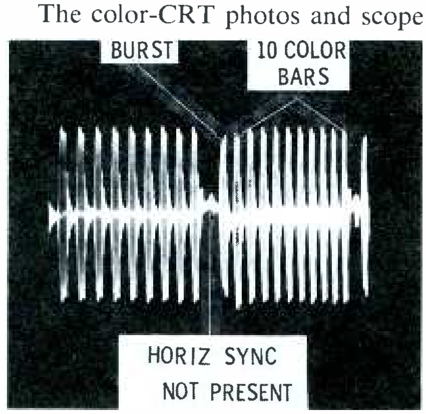


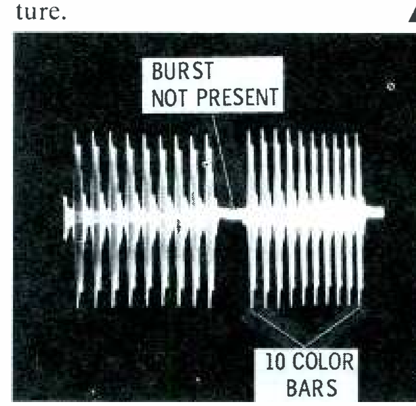
Fig. 6. Block diagram showing test points for tracing signal waveforms.



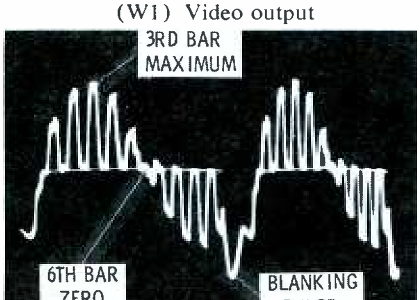
(W1) Video output



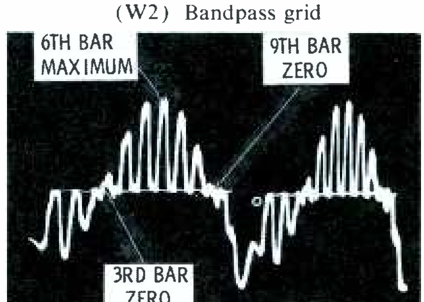
(W2) Bandpass grid



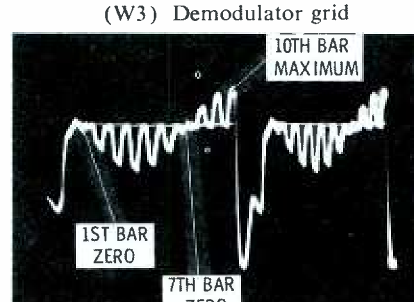
(W3) Demodulator grid



(W4) Red CRT grid



(W5) Blue CRT grid



(W6) Green CRT grid

Fig. 7 Block diagram showing test points for tracing signal waveforms.

Servicing Industrial Electronics
by William H. Lambert

instruments for MICROWAVE Servicing

Far more quickly than most of us realize, electronic servicing is changing from what used to be a fairly simple business to one of rather confusing complexity. For almost 45 years, we have been servicing radios and phonos, and, more recently, we've come to a pretty fair understanding of b-w and color TV sets. The problem is that, no matter how fast we move, the industry seems to move faster; the result is a growing need among servicemen for increased undestanding of more complicated equipment. We need that understanding because daily uses for radar, microwave, marine and aircraft navigational devices, medical electronics, and other fascinating equipment means that we will be called upon to service this more complex circuitry—and, all too probably, before we are ready. This article is offered so you may obtain a better understanding of what instruments are required for servicing at microwave frequencies, and to provide a little food for thought. Perhaps you'll ask yourself if you're moving with the industry or dropping behind.

Line-of-sight microwave transmission finds many applications in today's communications. Typical uses for these radar-related radio waves are multichannel telephone carrier systems, STL (Studio-Transmitter Link) applications, TV transmission systems for CATV relays, and data transmission. In many cases, no distinction is made between equipment for transmission of video and that used for voice and data.

The basic requirement for an RF system in any of the above-mentioned functions would be a bandwidth adequate to pass the highest-frequency information. For video systems, this would normally be anywhere from 4.5 to 8 mc; for data transmission the bandwidth requirement could be as high as 10 mc; for multichannel telephone application the bandwidth requirement seldom exceeds 3.5 mc.

Typical Equipment

In order to describe various test equipment used in servicing microwave links, a description of a basic system and its component parts is necessary. The block diagram shown in Figs. 1 and 2 represent only one particular system and by no means are intended to describe all microwave transmitters and receivers available on the market today.

Transmitter

Fig. 1 shows the block diagram of a typical microwave transmitter. The video or data signal applied to the transmitter is coupled to the modulator where voltage amplifiers boost the signal to approximately 20 volts p-p. The modulator output is capacitively coupled to the repeller of the reflex klystron. Output of the klystron is RF energy which is fed directly to the ferrite isolator, a unidirectional device which passes signals in one direction with approximately ½ db attenuation and rejects signals in the reverse direction by 40 db. The isolator is used to minimize reflections (which cause modulation nonlinearities) due to diplexer, waveguide, and antenna mismatches. From the isolator, energy flows past the crossguide coupler into the diplexer filter. The diplexer filter is a three-section, resonant, post-type device with a bandwidth of approximately 30 mc at the ½ db points. From the filter, RF energy is coupled to the antenna system through a vertical waveguide run. Energy flowing through the crossguide coupler is loosely coupled and fed into a mixer to obtain an AFC-control voltage.

A crystal-controlled reference oscillator, at a frequency between 75 mc and 82 mc, generates a carrier which is then multiplied in two stages to a frequency 100 mc removed from the output carrier generated by the reflex klystron. The output of the second multiplier is fed into the above mentioned mixer. Mixer output is an RF voltage in the vicinity of 100 mc. This energy is fed into an IF-and-limiter chassis, the output of which is of constant amplitude. The IF signal fre-

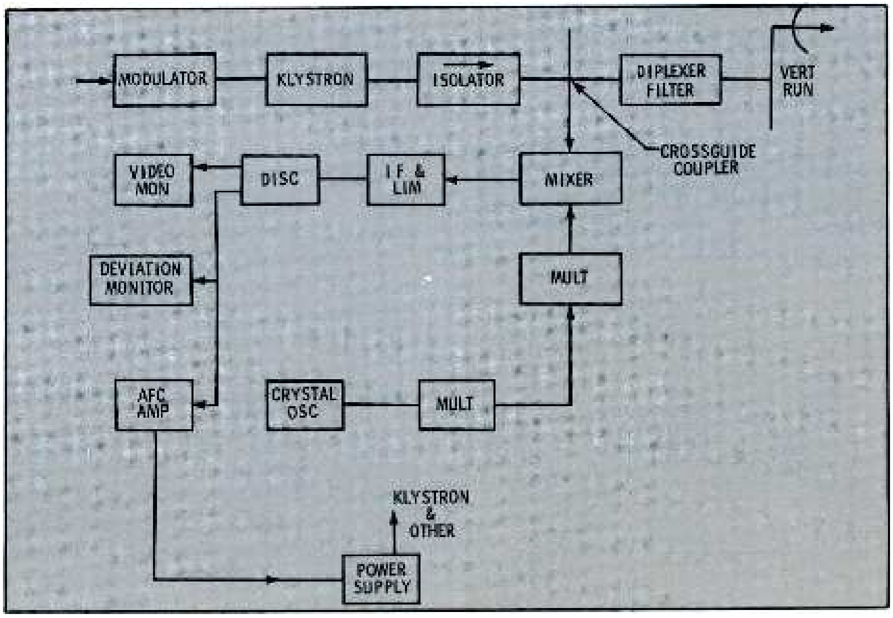


Fig. 1. Taken unit by unit, a typical microwave transmitter is simple.

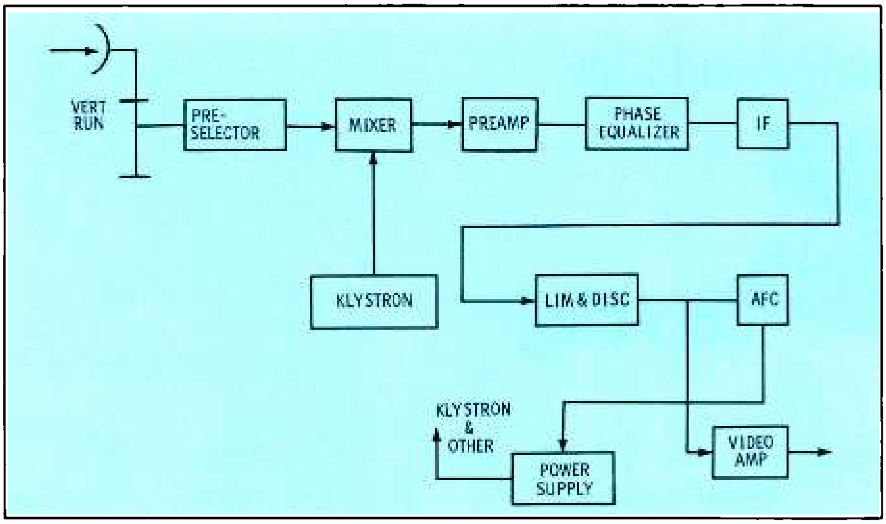


Fig. 2. The signal path through the microwave receiver is easily traced.

quency is directly related to the output frequency of the reflex klystron. That is to say, if the klystron frequency increases by 1 mc, the frequency of the IF output also increases 1 mc; the converse is also true. Output of the IF is fed to the discriminator chassis where frequency shifts are converted to voltage variations.

Three outputs are taken from the discriminator. One is fed to a video monitor, another is applied to the deviation monitor for measuring the peak-to-peak deviation of the transmitter carrier, and the other (a filtered component of the video) is DC coupled to a chopper-stabilized AFC amplifier. Output of the AFC amplifier is DC-connected through the power supply to the repeller of the klystron, thereby completing a closed-loop frequency-control system. A single power supply supplies all system components, including the reflex klystron. A front-panel meter is provided to monitor all tubes, power-supply voltages, RF power output, and peak-to-peak deviation.

Receiver

Fig. 2 shows the block diagram of a typical microwave receiver. RF energy from the receiving antenna is coupled to a five-section post-type preselector, the output of which is matched to a single-ended mixer. One milliwatt of energy from the local oscillator's reflex klystron is also coupled into the mixer.

Mixer output is 75-mc energy which is fed to a low-noise preamplifier. From the preamp, the signal is coupled into a bridged-T phase equalizer. This equalizer compensates for phase distortions injected by the preamp, IF, and waveguide sections. From the phase equalizer, the signal passes to the IF section where amplified AGC maintains a constant output level regardless of varying RF-input levels. IF chassis output is fed to the limiter and discriminator chassis, where amplitude variations are removed by the limiter. The output of the discriminator is low-pass filtered and connected to an AFC amplifier. Output of the differential-AFC amplifier is DC-connected, through the power supply, to the repeller of the local-oscillator klystron, thereby completing the closed loop for the receiver's automatic frequency control.

Video signals from the discriminator are connected to a video amplifier which increases their level to 1.5 volts, a level suitable for drop-cable purposes. (A drop cable is used in CATV systems to feed each individual home.)

A front-panel meter monitors all tubes, power-supply voltages, and the amplified-AGC buss; the latter is used to calibrate receiver carrier levels.

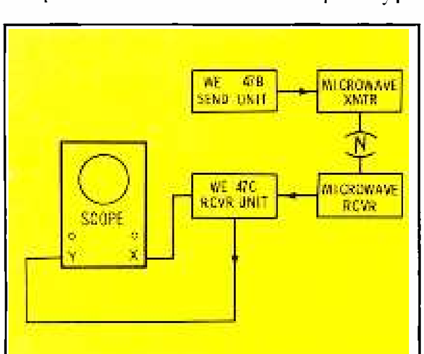


Fig. 3. Test setup check ΔG and Δθ.

Test Equipment and Techniques

The test equipment and techniques described here are by no means complete, but should provide a good familiarity with typical equipment. Other manufacturers of microwave transmission and test equipment may employ other methods for measuring the various parameters of microwave links.

Differential Gain and Phase

Two parameters of prime importance in video transmission are differential gain and differential phase. Simply stated, differential gain is the undesired amplitude modulation of an RF carrier of one frequency, in the presence of a second carrier of a different frequency, due to gain variations in parts of the system. (The biggest offenders in any microwave link are the transmitter klystron and the receiver discriminator.) Differential phase, similarly, is undesired phase modulation of one tone in the presence of a second tone due to phase distortions introduced by the system. Most phase nonlinearities in a microwave link occur in the IF system of the receiver.

Two test sets commonly used to measure differential gain and phase are the Western Electric 47A transmission-measuring system, and the Telechrome 3508 (for differential gain only). The block diagram of the WE 47A test setup is shown in Fig. 3.

Output of the 47B sending unit is adjusted for a 1 volt p-p composite-video output using a ratio of 4 to 1 between the 15,750-kc and 3.58-mc tones. Transmitter deviation is adjusted to 10 mc p-p with the pre-and de-emphasis networks out of the circuit. Receiver output is connected to the 47C receiving unit, and the CAL-TEST switch placed in the GAIN position. CAL 1 coarse- and fine-tuning controls are then adjusted for a 20-ua meter reading. CAL 2, 3, and 4 are adjusted for 0-ua meter readings. With the scope calibrated for a 5-cm display, the results observed are differential gain (.2 db/cm) and differential phase (10°/cm) with the CAL TEST switch in the appropriate position.

Adjustments for differential gain are made by touching up the discriminator tuning. Adjustments for differential phase are made in the IF tuning. Some microwave receivers incorporate a phase equalizer in the IF section of the receiver, with which compensation for phase distortions in the basic IF stages and preamp may conveni-

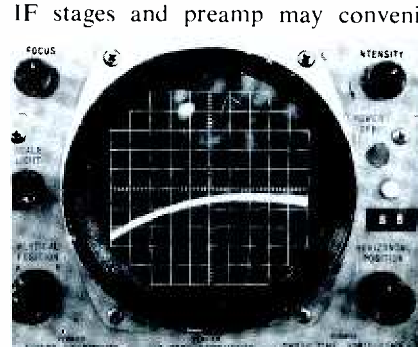


Fig. 4. Scope (calibrated to .2 db/cm) shows the differential gain of .5 db.

ently be made.

Once the link has been adjusted (remember, no pre- or de-emphasis with 10 mc p-p deviation), a 12-db pre-emphasis network is inserted at the input of the microwave terminal. Transmitter level and gain control are left untouched. A matched de-emphasis network is inserted at the output of the receiver, and the level (from receiver) is re-adjusted to 1 volt p-p. The 47C is recalibrated, and differential-gain and differential-phase measurements are once again performed. Typical results are shown in Fig. 4 (.5 db) and Fig. 5 (1.5°).

Differential-gain measurement by the use of the Telechrome 3508 is accomplished by using a stairstep waveform with super-imposed burst signal. A block diagram of the test setup is shown in Fig. 6. Fig. 7 shows the stairstep (10 seteps) with the 3.58-mc burst superimposed. At the receiver output, a 1-mc high-pass filter is used to remove the stairstep, leaving the 3.58-mc burst intact. The amplitude difference in db, from the smallest to largest burst, is the differential gain of the system. Fig. 8 shows the output of the 1-mc high-pass filter. A tapering from left to right can be observed; the measured differential gain (ΔG) is 1 db.

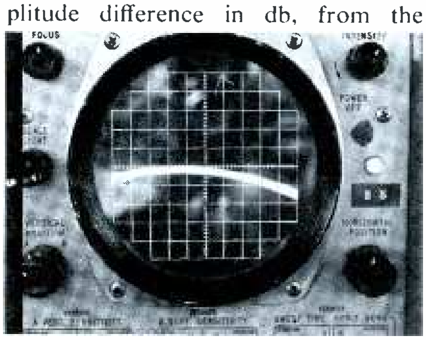


Fig. 5. Scope (calibrated to 1°/cm) shows the differential phase of 1.5°.

Noise-power Ratio

An important parameter of any data- or message-handling system is the noise-power ratio of the link. This ratio is a measure of the degradation of a single channel due to the proximity of other channels in the same microwave system. The most commonly accepted method of measuring NPR is with a white-noise generator, band-stop filter unit, and tuned-receiver system. A typical test set for making this check consists of the Marconi TF 1226B noise generator, TM 5774 band-stop filter unit, and the TF 1225A noise receiver shown in Fig. 9. The block diagram for a typical test setup is shown in Fig. 10.

Assuming a 600-channel link, using single-sideband suppressed-carrier multiplex with a transmitter input level of -35 dbm per channel, the test is performed as follows: A 2538-kc low-pass filter (standard frequency) is inserted in the white-noise generator, and the output level set at $+11$ dbm. 35 db of attenuation is introduced in the band-stop filter unit using a calibrated, built-in attenuator. The signal level into the microwave transmitter is then representative of a single-channel test tone of -35 dbm. Receiver output is connected to the noise recevier, and the noise-power-ratio attenuator set to 20 db; a sensitivity control is adjusted for any convenient meter reading. The band-stop filter associated with the receiver channel under test is then inserted to absorb the noise signal in that narrow slot or band of frequencies, and the noise-power-ratio attenuator is adjusted to equal the reference-meter reading noted in the initial setup; the difference in required attenuation between the initial reading and the new reading is the NPR for that particular slot.

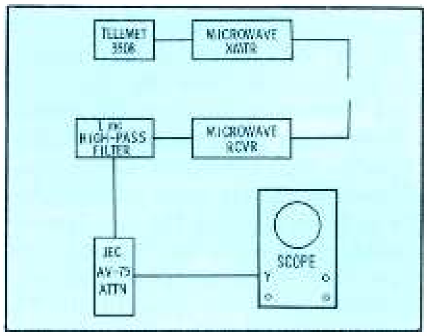


Fig. 6. Equipment setup for checking Δ G using combination test set.

Four commonly measured slots in a 600-channel system are 70 kc, 534 kc, 1000 kc, and 2438 kc. System specifications generally call out a minimum NPR for the worst channel.

Combination Test Set

A useful piece of test equipment for calibrating receiver AGC, checking AFC, and determining discriminator sensitivity is the 623B test set built by the Dymec division of Hewlett-Packard. After the test set has been allowed to warm-up and has been calibrated, its output is connected through a 30-db crossguide coupler to the receiver input. With the test set attenuator at zero, the receiver input level is -60 dbw. If the amplified AGC buss of the receiver under test has been properly zeroed, it is now possible to run a plot of AGC metering vs. received carrier level. The calibration is generally taken in 5-db steps by varying the test-set attenuator and reading the receiver's front-panel meter. In doing this, a calibrated front-panel meter reading is obtained (known input power to the receiver) such that, when the antenna is reconnected to the receiver, a fairly accurate measurement can be made of the receiver's input-power level. Where an amplified AGC buss is not used, meter readings on each succeeding limiter are observed.

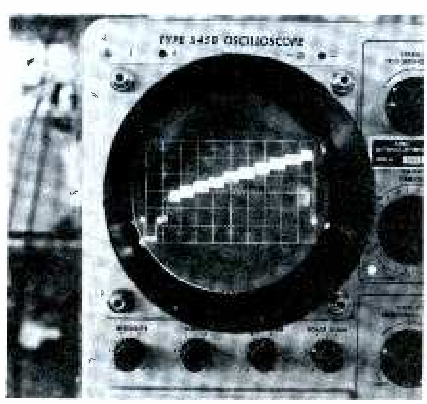


Fig. 7. Stairstep pattern with super-imposed 3.58-mc color-burst signal.

The procedure for measuring discriminator sensitivity is as follows: With the test set in its calibrate position and attenuation at zero, connect the scope to the crystal-output terminal. Adjust the deviation until a carrier notch appears at the center of the mode pattern. The test set's frequency micrometer is read with the absorption marker at each end of the mode display and the difference noted (this is the peak-to-peak deviation). The test-set output is then fed into the receiver through the 30-db crossguide coupler. The scope is connected to the discriminator test point, and the peak-to-peak voltage is recorded. The resulting voltage, divided by the set deviation above, is the discriminator sensitivity in volts/mc.

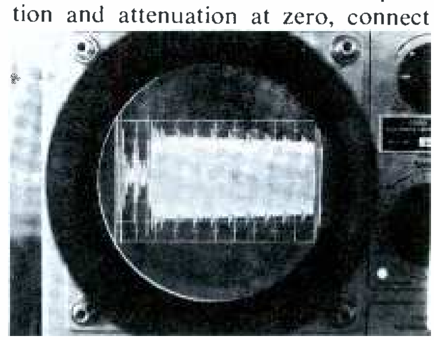


Fig. 8. Output from 1-mc high-pass filter shows differential gain of 1 db.

To measure a microwave transmitter's power output, transmitter output is fed through a 30-db coupler to the test-set RF input. The CALIBRATED-OPERATE switch is left in the OPERATE position. Power output is read directly in dbm, and 30 db is added to the above reading to obtain the transmitter power output in dbm. An alternate method is to read the test-set meter directly in dbw, regardless of the fact that the meter is in reality calibrated in dbm. The direct conversion is made possible by the use of the 30-db coupler.

Baseband Video Response

There are three methods whereby the baseband video response of a microwave link may be checked: The point-by-point method using a signal generator and a VTVM—this is tedious and time consuming, but yields satisfactory results; a faster method utilizes a multiburst signal provided by a combination-test-signal generator.

The first step in checking the system's baseband response using this type of equipment is to connect the burst generator directly to the scope used to observe the system output. Scope response must be flat to at least 5 mc, with the burst frequencies adjusted for equal amplitude. The generator is then connected to the input of the link and the scope connected to the link output (see Fig. 8); remove 1-mc high-pass filter for this test. Care must be taken to terminate the burst generator and scope properly. If a 75-ohm variable attenuator is inserted between the receiver output and the scope input, it is possible to determine the amplitude variation directly in db. This is done by noting the db change required in the attenuator to vary the

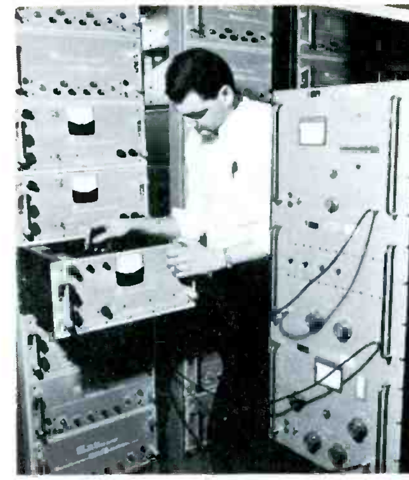


Fig. 9. Technician performing white-noise test for noise-power-ratio test.

amplitude of the greatest burst level to that of the smallest burst level.

The limitations here are the requirement of a scope with a flat frequency response to at least 5 mc, and the use of only six individual frequencies (.5, 1.5, 2, 3, 3.6, and 4.2 mc). If pre- and de-emphasis networks are incorporated into the link under test, care must be taken not to overdeviate the klystron with the burst signals. Excessive deviation is possible since the use of pre- and de-emphasis is based on the fact that full-amplitude high-frequency components do not exist under normal-signal conditions as they do when using multiburst signals. The results of a multiburst test are shown in Fig. 11.

The third method of checking baseband frequency response involves the use of a video-sweep generator, an external detector, and an oscilloscope. In this test, the scope requirement is minimal: a frequency response of 200 or 300 kc is adequate. Here, again, the first step is to connect the sweep output to the detector and check the basic linearity of the sweep-detector combination. This measurement is made as shown in Fig. 12. To measure the overall video response, connect the output of the AV-75 to the transmitter input and the D-86 detector RF in connection to the receiver output.

The scope's horizontal drive needs to be generated at the receiver re-

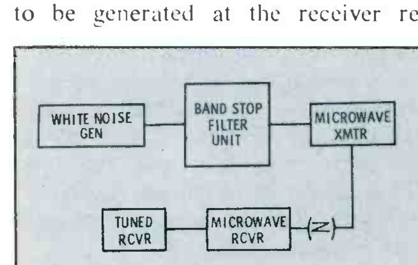


Fig. 10. An equipment setup for the white-noise power-ratio determination.

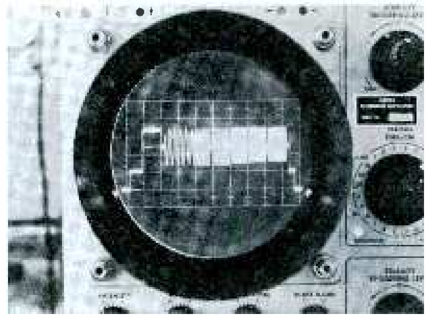


Fig. 11. Scope shows six-frequency multiburst test of baseband response.

gardless of the type (Jerrold 900A, Jerrold 1015, Telonic SM2000, Kay 110 A, etc.) of sweep unit that is used. For some sweeps a sine wave is required, while others require a sawtooth, and still others require a pyramidal-shaped wave. The requirement for generating a separate horizontal drive is the one limitation inherent in this measuring technique.

A typical frequency-response curve is shown in Fig. 13. The amplitude variation is measured by inserting 1 db of attenuation using attenuator "B" and calibrating the scope display at a convenient setting (generally 1 db/cm). With attenuator "B" reset to zero, the variation in system amplitude is then read directly from the scope. Attenuator "A" is used to adjust the level of video fed to the microwave transmitter.

Field-Strength Meter

The Jerrold 704B field strength meter is continuously tunable from 54 mc to 220 mc with a 3 db bandwidth of .6 mc and a dynamic range of 100 uv to 3 volts. The following checks and measurements on a microwave link can be performed with the 704B:

- Measurement of peak-to-peak deviation
- AFC operation
- IF output level adjustment
- Antenna peaking

The peak-to-peak deviation of a transmitter is checked as follows: Connect the 704B to the output of the transmitter IF chassis and note the rest frequency of the IF carrier (on a properly adjusted system this should be 100 mc). Insert a 15-kc square wave into the modulator (1 volt p-p) and adjust gain control half way. Retune the 704B until two distinct peaks are noted, one each side of 100 mc. The frequency difference between the two readings is the peak-

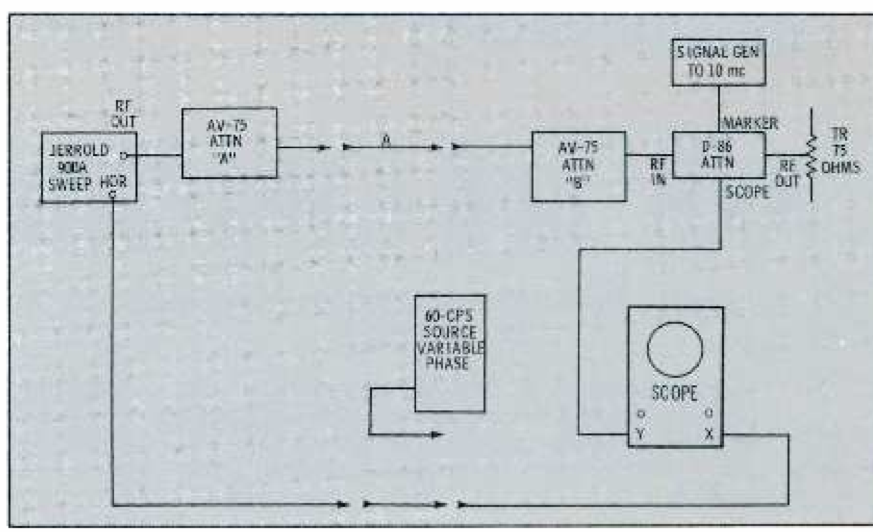


Fig. 12. Test setup for determining bandpass characteristic with sweep gen.

to-peak deviation of the transmitter. Another approach is to set the field-strength meter to a given frequency (say 103 mc), and adjust the gain control until a peak is noted. The peak below 100 mc should now be found at 97 which indicates a p-p deviation of 6 mc.

The same test may be performed by using a sine wave, with the exception that sharp, distinct peaks will not be noted, but rather two peaks separated by a shallow valley. If an attempt is made to measure deviation during transmission of video which is constantly varying in level, the measurement becomes more difficult.

AFC operation of a transmitter or receiver may be checked in the following manner: Note the undeviated rest frequency of the IF carrier; turn the AFC off and introduce some error by manually varying the repeller voltage. (A 10-volt change is adequate for this test.) Turn the AFC on and observe that no retuning of the 704B is necessary to obtain the same reading that was observed before the AFC was turned off (before the error was introduced). This is by no means a rigorous test and will not show the transmitter to be on frequency within the tolerance of ±.005%; it will demonstate only that the AFC circuitry is functioning properly.

As a tuned voltmeter, the 704B is used to adjust the output level of the receiver's IF stages to a level of .7 volt rms with an undeviated carrier. If the link is carrying video traffic, the IF-output level is adjusted to .55 volt rms (2 db lower than .7 volt rms). The above mentioned check on deviation and AFC action can be made in the link receiver if the transmitter AFC system does not employ an IF chassis.

The 704B tuned to the IF carrier frequency serves as a useful instrument for the final peaking of the antenna system. The procedure here is to insert a 6 db, 75-ohm resistive splitter between the waveguide mixer output and the preamplifier input. The third terminal of the splitter is connected to the field-strength meter. The 704B reading should be in the vicinity of .5 mv rms for a received carrier level of −65 dbw. Because the 704B is a linear device, any improvement in antenna alignment will be clearly noticeable and not reduced in magnitude as is the case with the logarithmic-like characteristics of the amplified AGC buss.

On systems where the connection from the mixer to the preamp is not available at a 75-ohm impedance level, similar results can be obtained if the splitter and 704B can be connected between the preamp and main IF. Best results will be obtained if the AGC buss does not include the preamplifier.

Much of the information presented in this article is of a fairly high technical level, and many terms used are probably unfamiliar to service technicians for whom microwave equipment is a new experience. In order to avoid constant editorial interruptions for the purpose of explaining terms, however, they have been left in context with the expectation that many general meanings may be deduced from their repeated use in familiar setups. Remember that whether or not you decide to enter the field of microwave servicing, you owe it to your profession, and to yourself, to upgrade constantly your knowledge of electronics. ▲

Fig. 13 Video-bandpass response marker is at 8 cm. lower trace 1 db dn.

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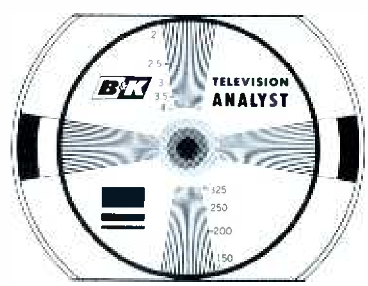

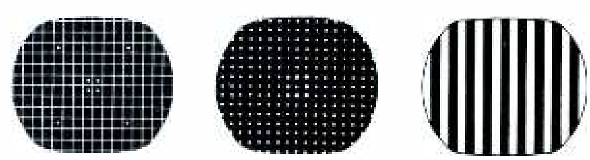

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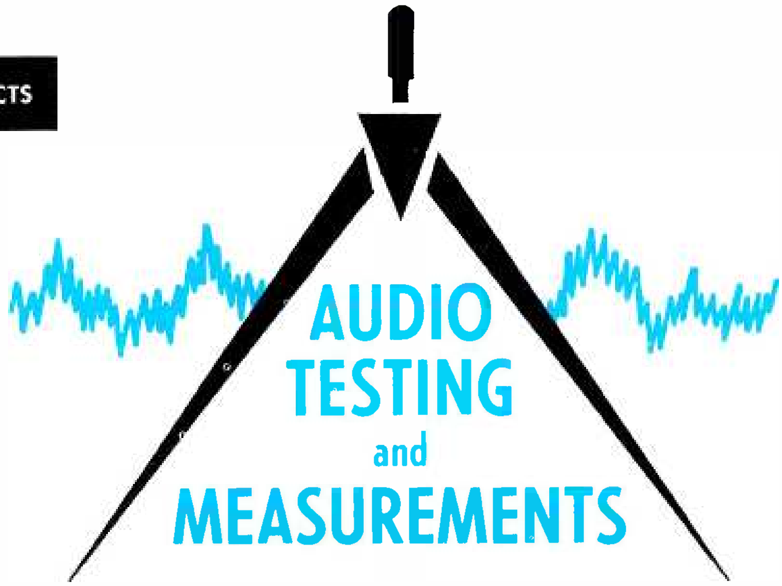

AUDIO TESTING and MEASUREMENTS

By George M. Frese

A friend of mine recently purchased a hi-fi kit. When he completed the assembly and turned it on, he was quite pleased with the sounds he heard. His enthusiasm led him to ask me over to hear his new system. As we both listened, we agreed it sounded fine.

Then I suggested it might be fun to put the system through performance tests to see how such a good-sounding system would measure up. To our surprise, there was a 50-kc oscillation that was producing 4% harmonic distortion and −25 db of extraneous hiss noise, besides reducing the output power.

The 50-kc oscillation was easily cured by rerouting some wiring, which reduced the harmonic distortion to .3% and the extraneous noise to −60 db, and considerably increased the output capability. Once again we put music through the system, and were astonished at how marvelous it sounded. By comparison, the original sound we had thought to be so fine was actually not very good at all. We had proved definitely that a listening test is not an adequate check for a high-quality audio system. This article will deal with testing and measuring in audio systems, for the purpose of evaluating them and deciding what improvements can be made.

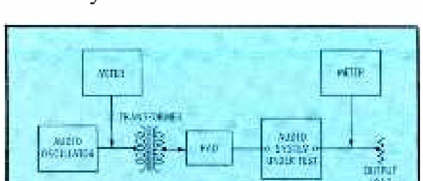

Fig. 1. Typical test setup for measuring frequency response of audio system.

Characteristics to be Considered

To be sure that an audio system is functioning properly, we need to evaluate several of its performance characteristics. Characteristics that affect the ear are frequency response distortion due to amplitude nonlinearity, extraneous noises, and sometimes the operating power output.

There are other characteristics important to the installation and operation of an amplifier, but they do not directly affect listening. For example, it may be of importance that the input impedance is 250 ohms, but the exact value of this impedance does not seriously affect the quality of the sound. Other such noncritical characteristics include power consumption, output impedance, output power capacity, overall gain, and parts ratings.

Frequency Response

Frequency response is a measure of how well an amplifier passes all frequencies fed into it. Frequency response is measured in relative db, using 1000 cps as the reference or 0-db frequency.

How does it affect listening? As an example, if the low-frequency register seems weak to the ear, it might be that 100 cps is −6 db; or, if the music sounds too shrill, perhaps 5000 cps is +6 db. It is generally considered that an overall broad, flat response produces the most natural sound reproduction—that is, a system which passes all frequencies equally. A perfectly flat response from 20 to 20,000 cps is broad enough for most audio requirements.

There are instances where a broad, flat response is not desirable. For high-quality broadcasting, an *overall* flat response is desirable; but systems of pre-emphasis and de-emphasis are often used in intermediate steps of the transmission system. For example, a disc recording is recorded with the high frequencies accentuated (emphasized) and the low frequencies attenuated (de-emphasized). Then on playback, the preamplifier boosts bass and attenuates high-frequency response so the overall sound becomes flat in frequency response. This same general process is used in FM and broadcasting in the aural part of TV. Therefore the audio section of an FM or TV receiver will have high-frequency de-emphasis in order for the overall sound to be reproduced with fidelity. These factors are mentioned because if there is pre-emphasis or de-emphasis in the system, it must be taken into account in testing.

The equipment needed for response measurements is as follows: Audio oscillator that is variable over the spectrum, associated pads, matching transformer, and audio voltmeter (see block diagram in Fig. 1). Set the oscillator frequency to 1000 cps and adjust the oscillator so that the signal level into the audio system is approximately the same as during normal operation. Whatever the output meter reads can be considered as zero db. Then shift the oscillator frequency to the next test frequency, adjust the oscillator output for the same input level as was used at 1000 cps, and record the output reading in db above or below the 1000-cps reference. You will get a good idea of the response of the system by checking the following frequencies: 30, 100, 1000, 5000, and 15,000 cps. You can check any other frequencies that appear from these tests to be in need of study.

There are other signal sources, such as tone records or tone tapes,

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a sweep tone generator, and sweep records or tapes; however, the method described here is simple and straightforward.

Should the response appear to be incorrect, the oscillator output lead can be moved a stage at a time, keeping its output level appropriate, or the output meter can be moved backward a stage at a time. (The best type of meter for this purpose is an audio harmonic-distortion meter, used on the NOISE position.) By this method of stage-by-stage isolation, the exact section producing improper response can be located, and correction can be made.

Amplitude Distortion

The word *distortion* refers to sounds that are not reproduced exactly like the original. They can be caused by amplifier nonlinearities, by poor frequency response, or by phase shift. Because it is most common, distortion caused by nonlinearity is what we'll discuss here. Amplitude distortion is the instantaneous deviation from the original input shape, as depicted in Fig. 2. If there are serious nonlinearities in the amplifying system (all systems have some), two types of distortion will result—harmonic distortion and intermodulation distortion.

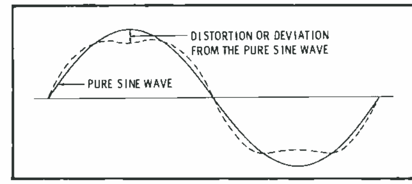

Fig. 2. Example of amplitude distortion.

Harmonic distortion can be explained as follows: Suppose a pure sinusoidal tone (say 400 cps) is fed into the system. If there is any harmonic distortion in the system, the output will contain additional frequencies of various amplitudes, depending upon the type and amount of nonlinearity. The frequencies newly generated by the distortion process will be whole-number multiples of the fundamental—such as 800, 1200, 1600, 2000. . . . n cps.

Intermodulation distortion is explained as follows: Two pure frequencies are fed into the system (say 400 and 1000 cps). In a nonlinear system, the output will now also contain new frequencies equal to the sum and the difference of the two input frequencies, or 1400 and 600 cps. Thus, for first-order distortion products, we have 800, 1200, 1600, 2000. . . . n; 2000, 3000, 4000, 5000. . . . n; and 1400 and 600 cps. Third-order intermodulation products might be 1200 + 2000 = 3200 cps, etc. This sort of distortion produces many combinations in the third order, but there is no need to be concerned about them — if second-order products are 10%, the third order will be only 1%. Second-order products will be so undesirable, the smaller third order will go unnoticed.

There are many ways intermodulation distortion can be measured. For example, we might feed in 700- and 1000-cps tones, cancel 700 and 1000 cps from the output, and tune a measuring instrument to 1700 cps, 300 cps, or both. The rms amplitudes of 1700 and 300 cps can be presented as a percentage of the rms value of the original 700- and 1000-cps signals.

A simpler method is to measure harmonic distortion. This requires an audio oscillator connected into the system and a harmonic-distortion meter bridge across the output (see Fig. 3). In the meter, the

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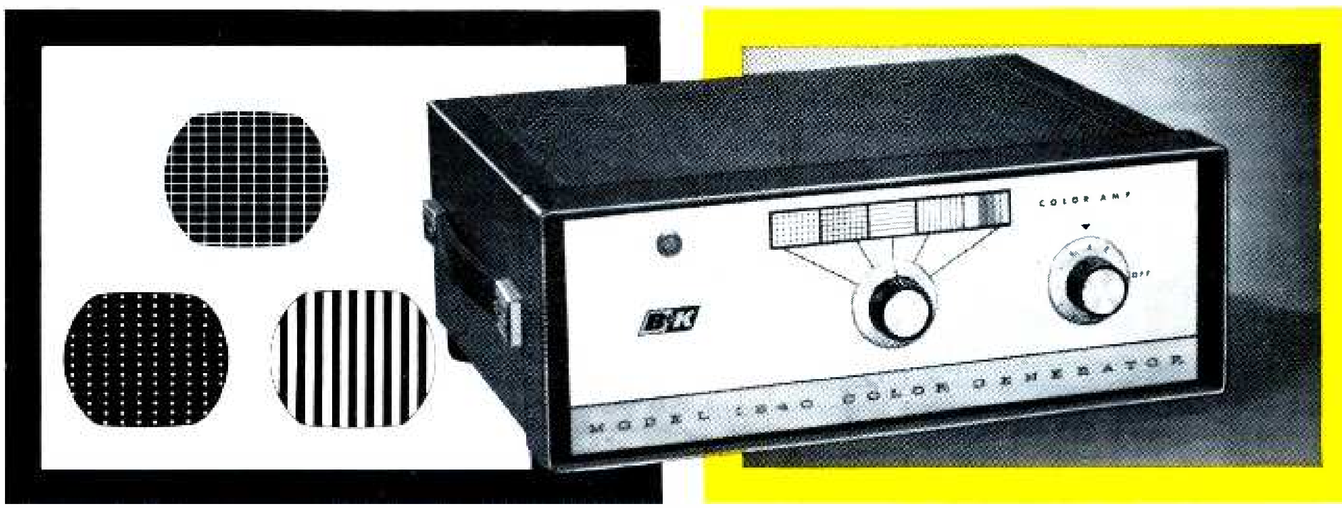

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fundamental frequency is cancelled out completely in a bridge circuit, leaving the meter to read the rms value of unwanted harmonic energy that has been developed.

When the harmonic reading is obtained, the input oscillator is shut off. The remaining reading is not distortion, but is extraneous noise generated within the amplifier. An oscilloscope connected to the output of the distortion meter will help analyze the type of distortion or extraneous noise present in the system.

If harmonic distortion is below 3% to 5%, you need not be too concerned for intermodulation distortion will usually be quite low, as you can see in the chart of typical values in Fig. 4. An excellent audio system can be below 1% distortion and it is even practical to find distortion in ordinary audio amplifiers as low as .25%.

Extraneous Noise

Extraneous noise has already been discussed partially along with amplitude distortion. Noise is generally considered to include all signals in the output that were not part of the input signal.

It is measured by inserting an input signal of 1000 cps, then setting the gain of the system so the output is normal. The noise meter is adjusted to read 100%. Turn off the input signal, turn up the noise-meter multipliers until a reading is obtained. The reading can be either in % of 100 or in db below 100%; the db reading is more common. A hi-fi system should read at least −60 db of noise whereas −45 db is acceptable for some purposes.

A scope will show what type of noise is present. Three types of noise are common, and a fourth is possible. Hum (60-cps) is the most common, and can be injected into the system in so many ways it would require another article the length of this one to deal with the subject. The cause of 120-cps power-supply hum is a little more definite; it is usually caused by inadequate or defective power supply filters, but can sometimes be traced to magnetic coupling between audio and full-wave power transformers. Thermal hiss is next in probability of occurrence; the common cause of thermal noise is within a tube, but it could be caused by a bad resistor or leaky capacitor.

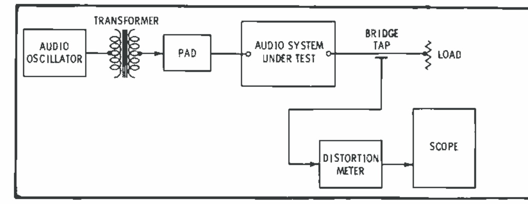

Fig. 3. Typical test setup for measuring distortion; checks noises, too.

Too weak an input signal for some tube might be the cause—such as a low-level pickup feeding a high-loss equalizer before any amplification takes place.

Power Output

Any audio amplifier has a rated amount of power it is expected to deliver undistorted. Then there is a higher rating of power that is required only occasionally or is built into the system as a reserve. Much can be learned about the condition of an amplifying system by measuring its output capability at its rated distortion.

Power measurements are relatively simple to make. There are audio output power meters available that read audio power directly. Usually, however, an AC voltmeter such as the AC range of a service-type VOM or VTVM is adequate, provided only one frequency (1000 cps, preferably) is involved; a resistor of the correct output impedance and wattage rating is connected across the output, and power computed from the formula $P = E^2/R$.

Output power is increased until the distortion reaches its rating. The rms voltage is read on the meter and power determined by the formula. That power is the capability of the system.

Input and Output Impedance

Usually the input and output im-

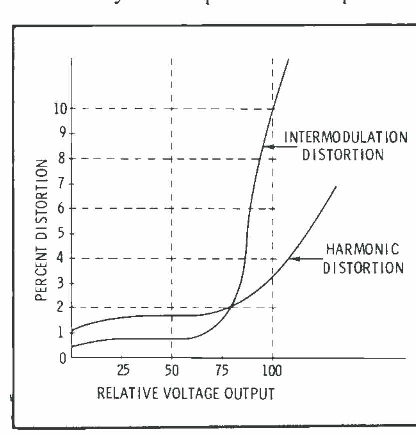

Fig. 4. IM vs H curve for push-pull amp.

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Circle 23 on literature card

pedances of a system are given in the instruction manual and there is no need to measure them. The output impedance is important because, when a load of that value is connected to the amplifier, full power output will be delivered into that load with a minimum of distortion.

A law of generators and loads says that maximum power is transferred when the external load impedance equals the internal source impedence so that one half of the power is dissipated in the load and one half dissipated in the generator's impedance. When distortion becomes a factor this may be not quite true. Some amplifiers operate into a load resistance actually twice the internal resistance for truly best performance. It becomes apparent then that the output load impedance can be a variable, but usually does not require measurement. If you wish to measure the optimum output impedance, use the method shown on page 72 of this issue.

Seldom will you find it necessary to measure input impedance; however, if you should, you may or may not find it to be the rated impedance. The rated impedance depends upon the purpose of the input. For example, the input may be rated at 250 ohms for minimum noise figure when used with a transducer, and the actual measured input impedance may be several times that value. Or, the input may be for bridging 250 ohms, in which case the input impedance may be up to one hundred times the bridged impedance. Or, the input may be actually 250 ohms, in which case it will reflect a true 250 ohms to the generator oscillator.

Gain

The overall gain of a system is usually measured in db of the output over the input. The db unit used here is always power, not voltage or current. If you are measuring gain of a high-impedance stage, it may be measured in how many times the voltage output is multiplied over the input. If input impedance is different from the output impedance, this will have to be taken into account when measuring overall gain in db.

As mentioned in the earlier discussion, the source may not actually *you get* **PRODUCT PLUS** *from your Sylvania Distributor*

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have to match the input impedance for maximum power transfer. In this case, the input power is assumed to be whatever is generated by the source, assuming the source is terminated by a matched impedance. Since the actual input impedance may be ten times the transducer impedance, a power measurement is impractical and meaningless, since power must involve R ($P=E^2/R$ or $P=I^2R$). In this case, we measure input power by assuming a phantom R of the specified impedance.

Miscellaneous Characteristics

Thus far we have covered the more important characteristics of audio systems. There are several other characteristics of reproduced audio waves, but to measure them is of doubtful value. They are phase shift versus frequency, transit time response, and wave symmetry.

Since the early days of audio, it has been generally accepted that audio *phase shift* has little effect on the listener's ear—that is, the phase of harmonics with respect to the fundamental is of little importance. However, phase shift can cause a change in wave characteristics so

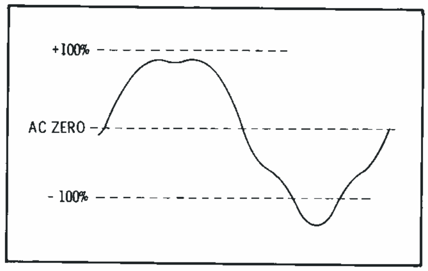

Fig. 5. Asymmetrical audio waveform.

that the wave may be either flattened or peaked (see Fig. 5). The amplifier may distort on the peaked wave but not on the flat wave—an effect of phase shift.

Also, with the coming of stereo, phase shift has more importance. Two audio channels must have identical phase response characteristics if we hope to reproduce stereo properly. However, if the amplifiers are identical and the response and distortion measurements are the same, there is little likelihood that phase response will differ.

Transit time is sometimes measured by using square waves, but actual frequency-response measurements are more meaningful. If the system has some sort of automatic-gain-control device, the reaction time of the gain-control circuits may be of some importance. The best way to test this characteristic is to use a 3000-cps square wave connected through a telegraph key. Key the signal at various rates and observe the waveform on a wideband scope set for slow sweep. Reasonably square or rectangular envelopes should be reproduced.

By symmetry of response we mean the amplitude difference between negative half-cycles and positive half-cycles. This is relatively unimportant unless you are dealing with audio systems in association with modulating RF. Usually an asymmetrical response will show up as distortion, and we need not go into symmetry details to trace the fault and make the correction.

Conclusion

The most important measurements for testing audio are: frequency response, distortion, and noise. The equipment needed is relatively simple, an audio oscillator, and a distortion meter, with associated pads, transformers, and cords. An oscilloscope is a good aid in observing most characteristics. ▲

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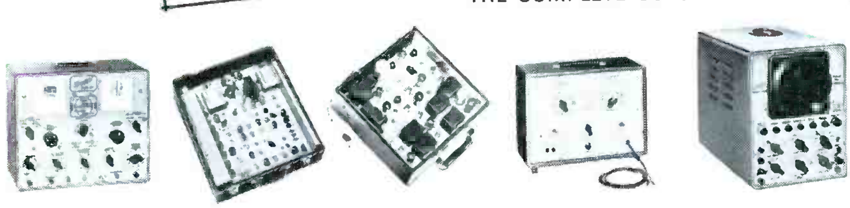

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Circle 28 on literature card

GUIDE TO ACCESSORY PROBES

An accessory probe could be described as an aid to increase the versatility of your VTVM or scope. While each manufacturer usually designs a probe especially for his own test equipment, in many cases this same probe is suitable for other manufacturer's equipment as well.

The accompanying charts show the manufacturer's probe number and the model number of the instrument for which it was designed. The notation of "Misc." means this same probe is usable with, or may easily be adapted to, other similar equipment. Using these charts, it should be easy to choose the type of probe you need for your particular scope or VTVM.

The high-voltage probe permits measurement of DC or AC voltages up to 30 kv (and sometimes even higher). (When choosing a high-voltage probe, remember that some types may require a multiplier resistor and cable connector specifically matched to your meter.)

One of the commonest uses for an H-V probe is the measurement of CRT anode voltage in television receivers. Using a high-voltage probe will readily determine if lower-than-specified high voltage is responsible for a particular trouble.

The RF probe contains a demodulator and will extend the upper frequency to which RF-voltage measurements can be made—usually to 200 mc or above. It contains a crystal diode, which serves as a rectifier, and an RF filter. The probe develops a DC output voltage proportional to the peak value of the input waveform. When using an RF probe, remember that the meter indicates demodulated voltage; therefore, the function switch of the meter should be set to its DC position.

The demodulator probe used with scopes is similar in construction to the VTVM RF probe. It also contains a crystal diode and an RF filter network, which separate modulation from the RF carrier; thus, only the modulation signal is applied to oscilloscope input.

The scope demodulator probe can be a most useful aid in signal-tracing RF or IF signals in radio or television. It is also quite handy in alignment when it is preferable to view response curves of individual stages.

The low-capacitance probe used with scopes has a high-impedance network in series with the probe tip to permit viewing waveforms in circuits that would be loaded down by a direct probe. The high input resistance of this probe attenuates the signal; therefore, when making peak-to-peak voltage measurements be sure to consider the attenuation factor (usually 10) of the probe.

VTVM High Voltage Probes

Manufacturer	Instrument Model No.	Probe No.
B & K	375	PR-39
EICO	222, 232, 249, and misc	HVP-2
Heath	IM-10, 11, 13, 21, 32, and misc	336
Hickok	203, 209	PR30
	209B	PR30A
	435A, 450	PR25
	455A	PR4-6KV
	455A	PR4-30KV
	470A	PR-50KV
Precision	120, 120M	TV-2B
	110	TV-5B
	48	HV-48
RCA	WV-77A, 77B, 77C, 87A, 87B, 97A, 98A, 98B, 98C, 65A, 75A, 95A, 165, 165A, 195A, and misc	WG-289
	WV-38A and misc	WG-297
Simpson	221	0009
	260 Series 2	0007 (25kv)
	260 Series 2	0179 (50kv)
	260 Series 3	0247 (25kv)
	260 Series 3	0248 (50kv)
	262	0172 (16kv)
	262	0180 (40kv)
	269	0173 (16kv)
	269	0181 (40kv)
	303	0074 (30kv)
	311	0732
Triplett	850	79-196
	630, 630A, 631	T-79-70 (30kv DC)
		T-79-71 (30kv AC)
		7-79-152 (60kv AC)
	630-PL, 630-APL,	T-79-83 (10kv DC)
	630-PLK, 630-L	T-79-130 (25kv DC)
		T-79-166 (25kv AC)
		T-79-152 (30kv DC)
	630-NA, 630-NA-Rm, 800	T-79-71 (30kv AC)
		T-79-152 (60kv AC)
		T-79-230 (6kv AC)
	630-NS	T-79-229 (6kv DC)
		T-79-152 (30kv AC)

VTVM RF Probes

Manufacturer	Instrument Model No.	Probe No.
B & K	375	PR-38
EICO	222, 232, 249, and misc	PRF-11
Heath	IM-10, 11, 13, 21, 32, and misc	309C
Mercury	Misc	MP-1
RCA	WV-77A, 77B, 77C, 87A, 87B, 97A, 98A, 98B, 98C, and misc	WG-264 (use with WG-218)
	WV-77A, 77B, 77C, 87B, 98A, 98B, 98C, and misc	WG-301A (use with WG-299D)
	WV-77E and misc	WG-351A
Simpson	303	0073
	311	0731
	479, 480	0185
Triplett	631	T-79-145
	850	T-79-215

Oscilloscope Demodulator Probes

Manufacturer	Instrument Model No.	Probe No.
EICO	427, 430, and misc	PSD
Heath	IO-11, 12, and misc	337-C
Hickok	Misc	34
	675	35
Jackson	CRO-2, 3, and misc	DEM-P
Mercury	Misc	MP-1
Precision	Misc	SP-5
RCA	WO-91A and misc	WG-302A (use with WG-302A or 300B)
SENCORE	PS120, PS127	39G3
Simpson	458, 466, and misc	739

Oscilloscope Low Capacitance Probes

Manufacturer	Instrument Model No.	Probe No.
EICO	427, 430, and misc	PLC
Heath	IO-11, 12, and misc	PK-1
Hickok	675 and misc	TVP-1
Jackson	CRO-2, 3, and misc	LC10-IP
Mercury	Misc	MP-1
Precision	Misc	SP-5
RCA	WO-91A and misc	WG-300A or WG-300B
SENCORE	PS120	39G2
Simpson	458	739

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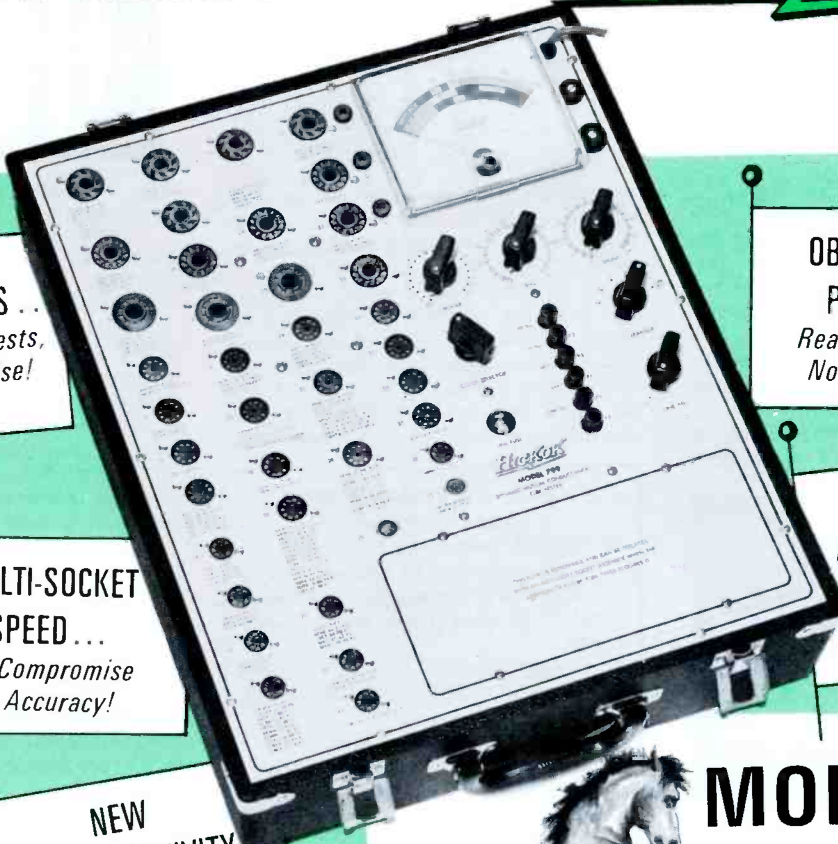

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Circle 29 on literature card

Notes on Test Equipment

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

by Allen B. Smith

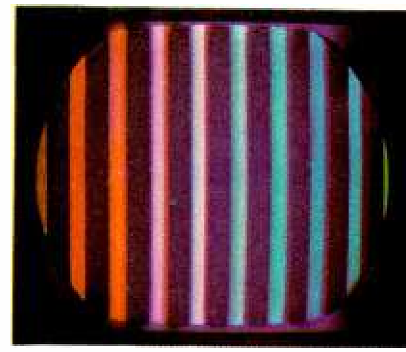

Fig. 3. Color bars on correctly adjusted TV run from yellow to green.

Behind the Color Bars

Growing interest in color television has prompted many servicemen, who previously had not done much color servicing, to re-examine that avenue to increased service business. A primary tool for color servicing of any kind is the dot-bar generator used for convergence, linearity, tint (hue), and chroma adjustments. These generators vary widely in size, types of display, and, of course, cost.

Fig. 1. This small color-bar generator uses crystal oscillators for stability.

The Model 1240 Color Generator (Fig. 1), made by B & K Division of Dynascan, uses crystal oscillators to initiate the pattern and color-reference signals. This approach insures stable base signals from which all functions are generated.

Fig. 2 shows a block diagram of the Model 1240 and makes apparent the manner in which the basic 189-kc crystal-controlled signal is split into various submultiple frequencies which generate sync, line, and bar information. The output of the 189-kc crystal oscillator is fed to a six-times multivibrator divider and to the pattern-selector switch. When vertical lines are selected, the switch is indexed to feed the 189-kc signal through two video amplifiers to the modulator stage where it is mixed with the RF-output signal and applied to the set. During the time of each 15.75-kc horizontal-sweep line, the 189-kc signal brightens the trace at ten equally spaced points (actually 12, but two are lost during retrace and blanking time). The cumulative effect in a TV raster of these ten bright points on each horizontal scanning line is a series of ten vertical lines.

B & K Model 1240 Specifications

RF Output Frequency:
Factory adjusted to channel 4, but tunable to either channel 3 or channel 5 by tuning the RF-oscillator coil.

RF Output Level:
In excess of 5000 uv on channel 3, 4, or 5.

Method of Bar Generation:
Offset subcarrier principle; subcarrier is 15,750 cps below color-TV reference-oscillator frequency of 3.579545 mc.

Patterns Available:
Keyed rainbow, vertical lines, horizontal lines, crosshatch, and dot patterns.

Power Required:
105-125 volts, 50-60 cps AC

Size (HWD):
4⅝" x 12¼" x 10¼"

Weight:
9 lb.

Price:
$134.95.

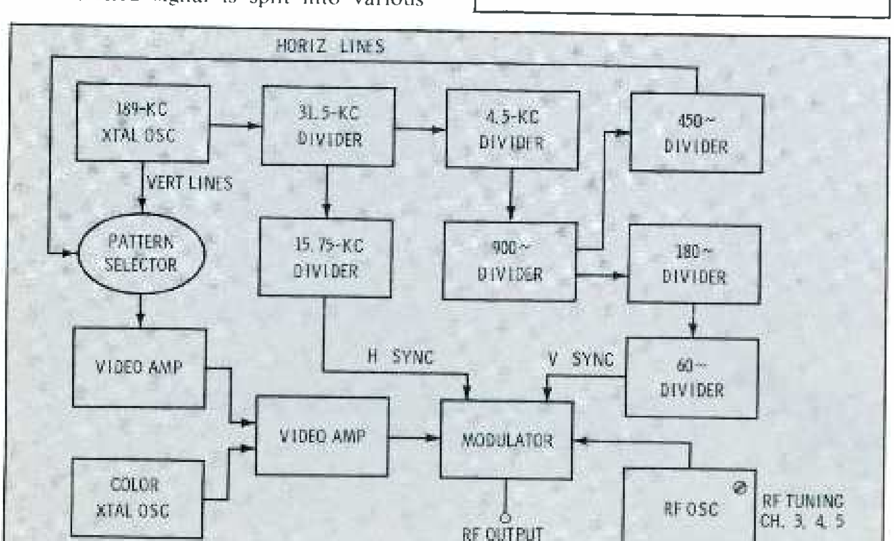

Fig. 2. Triggered multivibrators divide basic signals, provide varied outputs.

Horizontal lines are derived from the same crystal-controlled signal after it is divided a total of 420 times by passage through the string of four dividers ending with a horizontal-line frequency of 450 cps. The 450-cps signal is fed to the pattern-selector switch, then through the two video amplifiers (alone for horizontal lines, or combined with the vertical lines for crosshatch or dot patterns) to the modulator. During the 30-cps vertical-sweep period, the 450-cps signal generates 15 horizontal lines, 14 of which actually appear on the screen. The use of a 450-cps signal in alternate fields provides a horizontal line only one scanning line thick. To provide a grid of dots for convergence, a diode is used to clip the crosshatch lines except at the points of intersection.

In the COLOR position of the pattern-selector switch, the 3.563795-mc color-bar oscillator is activated, and its output is fed through the second video amplifier (see again Fig. 2). Gating action takes place in that amplifier stage, and the gated 3.563795-mc signal then goes to the modulator where it is impressed upon the RF signal.

The color bars are generated in the TV set by the action of the gated 3.563795-mc signal and the set's 3.579545-mc chroma-reference oscillator. The frequency difference between the set's oscillator and the generator signal produces a beat signal that varies in phase from 0° to 360° during the time of one horizontal scanning period in which the red, blue, and green guns trace one raster line. Since color is the result of phase relationships, the color demodulators provide a series of 12 bars (10 of which appear on the screen) varying in color from yellow, red, and blue to green, across the face of the CRT. Fig. 3 shows the 10 color bars on a correctly adjusted color set.

Horizontal and vertical sync pulses insure a fully synchronized display pattern, even under difficult conditions. The horizontal sync pulses are derived from the 189-kc oscillator after division (by six in the 31.5-kc divider and by two in the 15.75-kc divider) to the horizontal-sweep frequency. The 15.75-kc pulse chain is shaped in the output circuit of

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4	4K5	.55	3.2	2.90
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5	5K5	.55	3.2	3.25
5	5K7	.68	3.2	3.85
5¼	525K7	.68	3.2	4.35
6	6K7	.68	3.2	4.35
7	7W3	1.00	3.2	6.55
8	8W3	1.00	3.2	5.85
10	10J10	1.73	3.2	9.00
12	12J10	1.73	3.2	10.50

Nominal Size	Model No.	Magnet* Wt. Oz.	Imp. Ohms	List Price
3x5	3X5K5	.55	3.2	$4.10
4x6	4X6K7	.68	3.2	4.80
4x8	4X8W3	1.00	3.2	6.00
4x8	4X8W9	1.00	8-10	6.00
4x10	4X10W3	1.00	3.2	6.50
4x10	4X10W9	1.00	8-10	6.50
5x7	5X7W3	1.00	3.2	5.35
5x7	5X7W9	1.00	8-10	5.35
5x7	5X7V3	1.47	3.2	5.40
5x7	5X7V9	1.47	8-10	5.40
6x9	6X9W3	1.00	3.2	5.95
6x9	6X9W9	1.00	8-10	5.95
6x9	6X9V3	1.47	3.2	6.40
6x9	6X9V9	1.47	8-10	6.40

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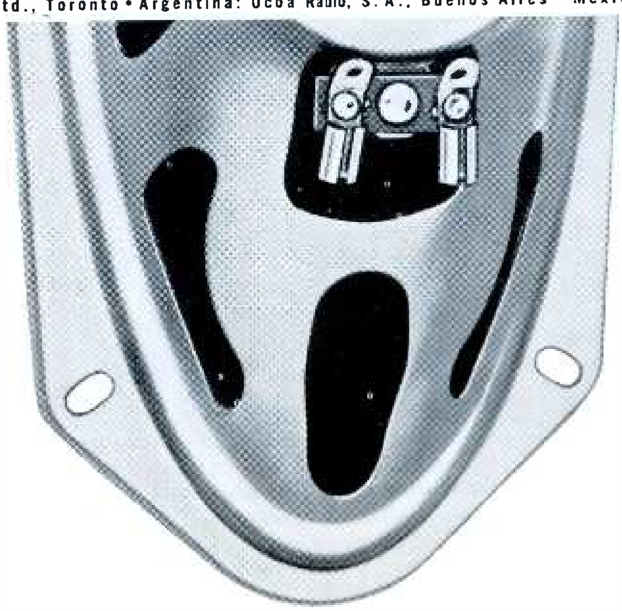

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Circle 30 on literature card

the latter divider and applied to the modulator. Vertical sync pulses are provided, in a similar manner, from the 60-cps divider at the end of a long divider chain (see Fig. 2 again). The vertical pulses receive some shaping in the output of the final (60-cps) divider.

For further information, circle 135 on literature card

Three-Gun Analysis

It is sometimes said the simplest tools require the most comprehensive explanation for correct usage. In the case of the RCA Model WT-115A Color CRT Tester (Fig. 4), that may be pretty close to the truth. Electrically, the WT-115A is a simple test set consisting of a power supply to provide test voltages, a switching network to apply voltages to the CRT tube elements as needed, and a sensitive long-scale meter for readout.

This tester will perform three basic tests to a color CRT, all of which are necessary to evaluate the tube properly. The single socket will accommodate most color tubes—including types 21AXP22, 21CYP22, 21CPP22A, 21FBP22, and 21FJP22—for testing emission quality of each gun, interelectrode leakage, or shorted elements. The meter has two separate scales, one for emission quality, and the other for interelectrode leakage. "Shorts" are indicated by a neon indicator lamp on the panel located immediately above the cut-off-adjustment potentiometer. The same lamp is also used to protect the meter movement from overload damage.

The front panel of the tester is divided into two approximate areas; the upper part displays the meter, and the lower contains all operating controls and indicators. Power is applied by turning the LINE ADJ knob clockwise from its POWER OFF position. The FUNCTION switch, when in the LINE ADJ position, allows you to index the meter needle to a mark about two-thirds of the way across the longest scale, thus compensating for line-voltage variations. The same switch selects R, B, or G guns for test. The CUTOFF ADJ control has two positions, one a detented position marked OFF FOR LEAKAGE TESTS, and another anywhere along a 260° arc to set the proper cutoff point when checking emission. A pushbutton switch is provided for measuring the quality of the three guns. A red neon indicator lamp shows when power is on, and, as mentioned previously, a yellow neon indicator glows when a short exists on any interelectrode path. The unit is housed in a standard RCA gray case and has a gray vinyl carrying case for protection.

Fig. 4. Color-CRT tester employs two time-based checks for emission quality.

Testing a color CRT requires a fairly involved procedure for accurate results. A handy reference card inside the carrying case has detailed, step-by-step directions; however, the technician must familiarize himself with the test method, because a useful evaluation can be made only if the correct sequence of operations is followed within the time specified.

Leakage test: This is the simplest check and requires only applying power, setting the line adjustment to the mark, turning off the cutoff switch, and switching FUNCTION control through positions R, B, and G. If the pointer moves out of the short yellow scale, the tube has excessive leakage. During this test, the presence of any interelement short will cause the yellow neon indicator to remain lighted.

Emission-quality tests: Two minutes after applying power to the CRT under test (leakage and shorts tests are performed during that period) examine the emission figure for each of the three guns in sequence using the following method:

1. Note position of pointer on yellow scale, CUTOFF ADJ fully counterclockwise; then advance control clockwise until pointer rises two scale divisions.
2. Press PUSH FOR QUALITY TEST pushbutton. Note (and record for reference) reading for each of the three guns.

At this point, wait until four minutes from initial turn on have passed and repeat the above steps for each gun, taking no longer than one minute (once familiar with the procedure, it can be done in about 30 seconds). Once again, record each of the three readings.

Final comparison: To fall within acceptable limits, all readings must be within the green-scale area; the four-minute reading of any gun must be no greater than 1.5 times that of any other gun; furthermore, all readings taken after two minutes must be within 75% of the reading obtained for the same gun at four minutes. A chart (see Fig. 5) is

RCA Model WT-115A Specifications

Function:
Tests most color CRT's (one socket only).

Tests Performed:
Fmission quality of three guns, interelectrode leakage, and shorted elements.

Shorts Indicator:
Neon lamp (also protects meter from overload).

Power Required:
108 to 132 volts AC, 50-60 cps, approximately 25 watts.

Size (HWD) With Case:
10" x 6" x 5".

Weight:
5 lbs.

Price:
$89.50.

For further information, circle 136 on literature card

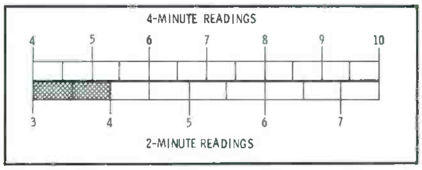


Fig. 5. Comparative readings taken at 2 and 4 min. establish CRT condition.

given to make the percentage calculation easier.

Our WT-115A was used in the field to check several color CRT's where low brightness seemed to indicate low emission. Assured by a quick check that the tubes were okay, the technician searched further and found simple adjustment problems. The tester was also used to determine that a showroom display set had a bad CRT, even though it had only a few operating hours. A little familiarity with the testing procedure will eliminate any difficulty in performing rapid tests.

For further information, circle 136 on literature card.

Lab-type Transistor Analyzer

Tremendous progress has been made toward increasing transistor reliability while reducing significantly the unit price of that remarkable solid-state device used so widely today in electronic equipment. There remains, however, a need for acceptible procedures and test equipment to evaluate the condition of transistors and other semiconductor devices.

The problem is not one that suggests an easy or inexpensive solution. Semiconductors in a confusing variety of case and lead configurations require versatile, therefore complex, analyzers. And, the many separate parameters needed to describe the function of each transistor only compound the confusion. In designing a transistor tester or analyzer, an engineer must decide whether to make it check just a few essential parameters or to broaden the analysis to include a greater number of functions, thereby increasing the complexity of the analyzer. Obviously, the second course can be expensive, especially if the analyzer must accommodate the wide variety of modern solid-state devices.

The Triplett Model 3490-A Transistor Analyzer shown in Fig. 6 represents one effort to provide a test set that will test a comprehensive list of specifications for a truly bewildering number of semiconductor devices.

This analyzer employs a unique connector arrangement to accept semiconductors of various configurations. It consists of a heavy copper plate that performs the dual function of collector fitting and heat sink. The plate is, of course, insulated from the chassis. Base, emitter, and B_2 (for tetrodes) fittings are also mounted to the plate on insulated feedthrough binding posts. Mounting hardware of various types (included with the instrument) allows heavy-case power transistors to be mounted securely to two heavy, brass posts mounted directly

Fig. 6. Lab-style analyzer that can be used to advantage in any service shop.

to the plate. Two standard four-pin transistor sockets are also provided for small-case units with standardized lead configurations.

Reference voltages applied to these various fittings come from three independent power supplies; the level of each is controlled by a separate panel-mounted control. The COLLECTOR control varies the angular position of a variable transformer in the primary circuit of the collector supply; the INPUT control is a heavy-duty vitreous potentiometer which adjusts the secondary AC voltage to the input supply; the TETRODE VOLTS potentiometer varies the level of the tetrode supply for testing double-base (tetrode) transistors.

Two dual-scale and one multiscale 4" x 4½" rectangular meters are provided

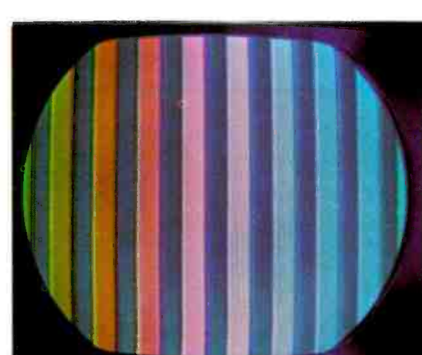
COLOR COUNTERMEASURES

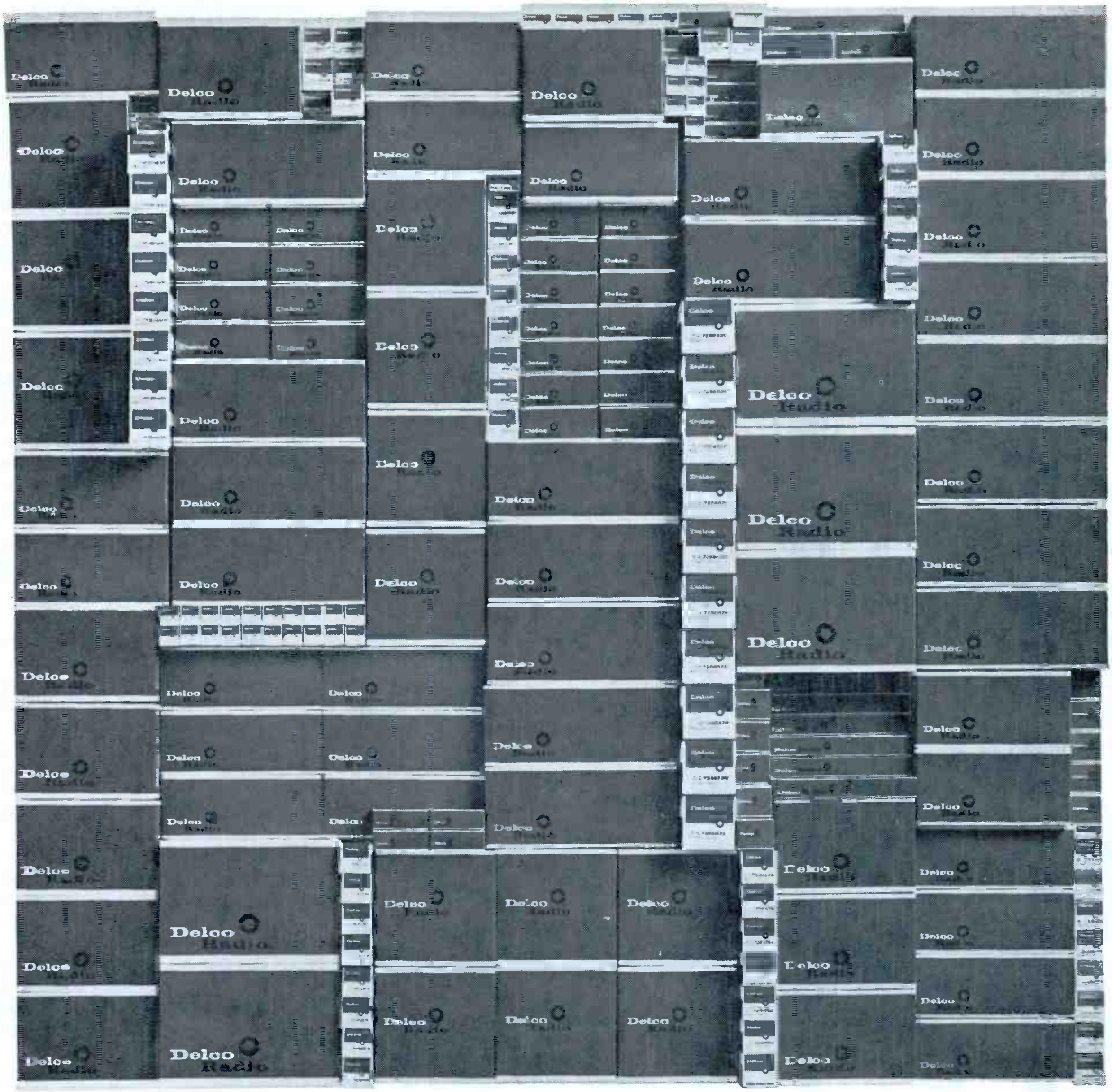
Symptoms and service tips from actual shop experience

Chassis: All color receivers.

Symptoms: Precautionary measures to prevent damage to picture tube.

Tips: Shown below is a fairly bright color-bar pattern on the screen of a color tube. It is repeated continuously on the face of the tube—that is, the color bars appear at the same location each time the screen is scanned. If you're testing a color receiver—especially if you're "cooking" it after repair—and the brightness control happens to be set to a high level, it's entirely possible for the phosphors on the tube to become burned between the bars. The result on the face of the tube might be permanent. This is especially true if the set is operated for **several hours** at high brightness. It's far better to cook out a receiver with a station tuned in. If a defect in the color circuits was repaired, make a test with the color generator from time to time, but not on a continuous basis.





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San Francisco..Landscape 6-8221
Seattle..........Parkway 2-4477
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Washington, D.C..Juniper 8-7494

Circle 34 on literature card

for continuously monitoring several conditions: INPUT CURRENT; INPUT VOLTS, COLLECTOR VOLTS, or REACH THRU; and COLLECTOR CURRENT. Each meter has an associated range switch providing ranges as noted in the specifications chart. Secondary controls provide versatility for determining many other useful parameters.

To avoid overload or breakdown of the transistor under analysis, and to prevent damage to the instrument itself, several switched circuits are protectively interlocked. On each position of the INPUT switch, for example, the load presented to the input supply is changed to provide a constant-current input regardless of emitter or base resistance. Further, when the INPUT VOLTS lever is set to its REACH THRU position, the input (emitter) circuit of the unit under examination is opened, regardless of the setting of the INPUT switch. Similarly, when the I_{CO} lever is moved from the RET position, the input circuit is opened regardless of the position of the COLLECTOR switch. This action puts the I_{CO} meter into the collector circuit without damage, even if the transistor under test has just been operating at 15 amps of collector current. The switch opens the emitter or base circuit before the sensitive microammeter is put into the collector circuit; the sequence is reversed (meter disconnected before the input circuit is completed) when the lever is returned to RET position.

Since momentary overloads can damage or completely destroy a semiconductor device, several warning lights are used to indicate dangerous conditions. To the right of the INPUT CURRENT meter is a yellow warning light which glows when the INPUT control is set to any position but off (completely counterclockwise). When the yellow indicator glows, power is being applied to the input circuit of the transistor under test. To the left of the COLLECTOR CURRENT meter is a second yellow indicator which lights when the collector circuit is activated. The lamp extinguishes when the COLLECTOR variac is turned completely counterclockwise. To avoid transient surges when connections are changed or when control-switch positions are altered, these lamps should both be dark before adjustments are made. Lighted indicators also show that power is on and that you should avoid contact with the various exposed terminals on the mounting plate.

The third warning light is red and is located to the right of the COLLECTOR VOLTS range switch. This REDUCE POWER indicator is connected to an interlock circuit between the collector-current and collector-voltage switches. When the current switch is set to any range over 300 ma and, at the same time, the voltage switch is set to any range between 30 and 120 volts, the lamp lights. A lighted indicator warns of overload in the collector transformer and variac and warns that one switch, or both, must be indexed to a lower range to extinguish the lamp.

Comprehensive instructions for testing transistors and other solid-state devices are given in the accompanying manual. Each test begins by collecting the transistor's basic characteristics from any of several available data books (one comprehensive reference is included with the analyzer). The unit to be tested is then inserted into one of the two sockets or attached via the mounting plate and accessory clamps. The various switches on the 3490A are set to maximum values as noted in the specification data. The procedure for testing each parameter varies, but each is covered by complete instructions.

The Triplett 3490A is not a simple "yes or no" tester, nor is it simple to operate. The instructions must be read thoroughly to obtain an understanding of the analyzer's use, and reference will undoubtedly be made regularly to the book. A service technician who must work with industrial and other precise solid-state devices, as well as those in increasingly complex entertainment equipment, will find heavy use for this transistor analyzer. ▲

Triplett Model 3490-A Specifications

Transistor Types Tested:
Most large- and small-signal and power types; also tetrode types, diodes, rectifiers (germanium, silicon, and selenium), and SCR's.

Transistor Tests:
Collector-junction leakage current —I_{CO}, I_{CEO}, I_{CES}, I_{CER}, I_{CBR}; alpha (h_{FB}); DC beta (h_{FE}); AC beta (h_{FE}); V_{CE}Sat; R_{SAT}; reach thru (punch-through).

Rectifier and Diode Tests:
Forward voltage drop, forward leakage current, reverse leakage current.

SCR Tests:
Reverse leakage (I_R), forward leakage (I_S), gate-firing current (I_{gt}).

Full-scale Collector-current Ranges:
1 ma to 30 amps in 11 overlapping ranges.

Full-scale Collector-voltage Ranges:
3 to 120 volts DC in 7 overlapping ranges.

Indicator Lights:
Power ON, INPUT ON, COLL ON, REDUCE POWER.

Weight:
28 lbs.

Size (HWD):
8¼" x 18¾" x 15½".

Power Source:
105-125 volts AC, 60 cps, approximately 200 watts, maximum.

Price:
$399.95.

For further information, circle 137 on literature card.

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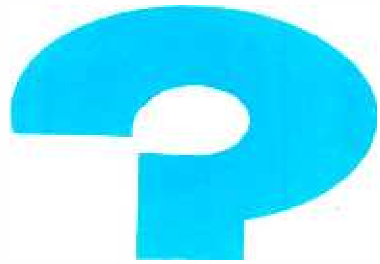
The latest test instruments being analyzed for future "Notes" columns:

Lectrotech Model V7 Color Vectorscope
SENCORE Model PS127 Oscilloscope
Sprague Model TO-6 Capacitor Analzer
Jackson Model 825 CRT Tester



How Many USES for a VOM

Old and new procedures for applying this familiar instrument.

Every technician knows the obvious uses for a VOM—measuring voltage, resistance, and current. This it can do in various ranges and with varying degrees of accuracy, depending upon the VOM being used.

Often unnoticed is the fact that this instrument is about as versatile as any you will find on your servicing bench. With a little imagination and understanding, you can put it to use for literally dozens of tasks not ordinarily expected of a VOM.

In this article, we are going to describe several unusual tests you can perform with an ordinary 20,000 ohms-per-volt VOM. Some of these tests will require accessory components, but in no case are these components unusual or difficult to obtain. By using your imagination, you can extend the methods disclosed in these examples to hundreds of new uses for your versatile VOM. (It is also worth noting that most of the tests requiring voltage or resistance measurements can be undertaken with a VTVM.)

Resistance Checks

Resistance of Meter Movement

Use a dry cell and two potentiometers (see Fig. 1). R2 must have a value greater than the internal resistance of the meter, and R1 must limit the current to full-scale value; otherwise, the meter movement may be damaged. Thus, if a 10-ua movement is under test, R1 must have a value of at least 150,000 ohms. Make connections as shown, leaving R2 disconnected.

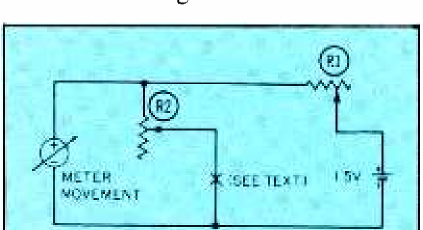


Fig. 1. Method used to determine the internal resistance of meter movement.

Adjust R1 for full-scale reading on the meter movement. Then connect R2 into the circuit and adjust

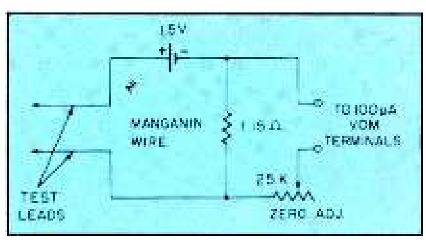


Fig. 2. Circuit for a low-ohms probe.

it for half-scale indication on the meter movement.

Disconnect R2 and measure its resistance with an ohmmeter or a resistance bridge. The resistance of R2 is equal to the internal resistance of the meter movement.

Fractional Resistance

Construct a low-ohms probe (see Fig. 2). Plug into VOM. Connect probe leads across component or circuit under test.

Use the external zero-set adjustment, as for usual ohmmeter function. VOM is operated, however, on its microampere range. (Internal battery of VOM is not used with low-ohms probe, because heavy current is drawn by low-resistance measurements with a series ohmmeter.) Ohmmeter scale reading is multiplied by .1.

Editor's Note: Material for this article was taken from the Howard W. Sams books "101 Ways to Use Your VOM and VTVM" and "101 More Ways to Use Your VOM and VTVM" by Robert G. Middleton.

The configuration for a low-ohms probe or box, used with a VOM having a 100-microampere current range with an input resistance of 2500 ohms (full-scale voltage drop of 250 millivolts) and 12 ohms center-scale indication, is given in Fig. 2. Note that the circuit, including the 1.15-ohm Manganin-wire resistor and test leads, must have very low resistance. Use bus leads from Manganin-wire resistor, heavy ultraflex armature wire for the test leads, and heavy copper clips to terminate the test leads. Manganin wire is used for the resistance to maintain a constant value of 1.15 ohms whether hot or cold. Battery can be any 1.5-volt type with very low internal resistance and high current capability.

Interelectrode Leakage in CRT

Disconnect high-voltage cable from the picture tube. Short high-voltage terminal of tube to chassis. Connect ohmmeter between terminals of tube to be tested. Socket must be removed from tube and temporary heater connections made with test

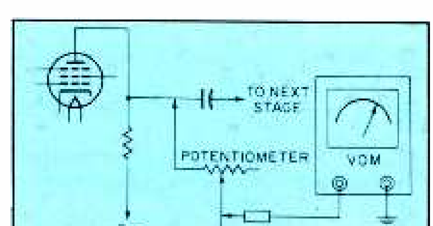


Fig. 3. Test setup to measure circuit.

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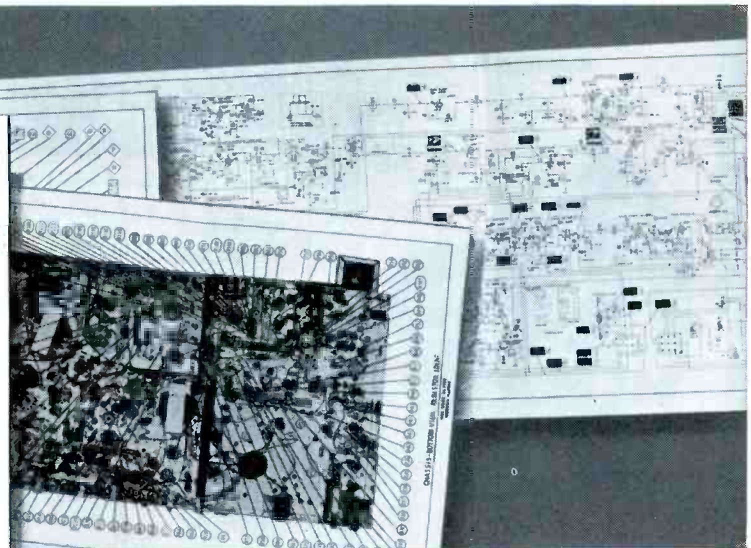

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Photofact Set	Brand	Photofact Set	Brand
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259	Westinghouse	643	Andrea
262	Arvin	644	Westinghouse
265	Stromberg-Carlson	650	DuMont
283	Motorola	653	Magnavox
293	CBS-Columbia	655	Silvertone
299	Sparton	658	Sylvania
300	RCA Victor	660	Bradford
305	Hoffman	663	Zenith
314	RCA Victor	665	Curtis Mathes
320	Sentinel	670	Coronado
323	Magnavox	673	RCA Victor
324	Airline	678	General Electric
327	Capehart	680	Airline
344	Sentinel	683	Philco
346	Philco	685	Packard-Bell
353	RCA Victor	688	Zenith
357	Westinghouse	690	Westinghouse
358	RCA Victor	693	Sylvania
371	Motorola	695	Motorola
378	Raytheon	698	Philco
382	Truetone	700	Airline
383	Admiral	703	Admiral
385	Hoffman	705	Zenith
386	Packard-Bell	708	Magnavox
388	Silvertone	710	Magnavox
399	RCA Victor	713	Silvertone
412	Emerson	715	Setchell-Carlson
433	RCA Victor	716	Truetone
437	Westinghouse	717	Penncrest
459	RCA Victor	719	Emerson
495	Admiral	721	Motorola
517	RCA Victor	722	Zenith
540	Admiral	724	DuMont
546	Packard-Bell	726	Coronado
565	General Electric	727	Muntz
576	DuMont	729	General Electric
584	Silvertone	731	Olympic
588	Magnavox	732	Electrohome
592	Emerson	734	Andrea
596	Olympic	736	RCA Victor
599	Zenith	737	Catalina
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* An average of 3 Color TV chassis now covered monthly in current PHOTOFACT

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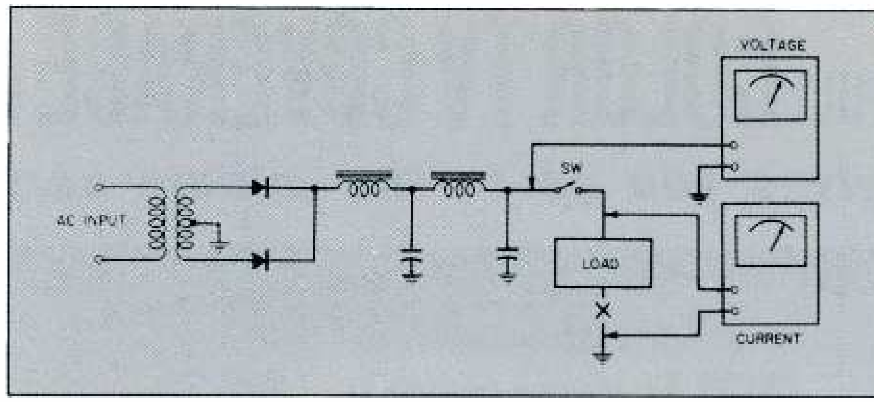


Fig. 4. Method used to determine the internal resistance of a power supply.

leads.

Set ohmmeter on its highest resistance range. Check for leakage resistance from cathode to control grid, second grid, focusing anode (if present), and second anode. Repeat test from control grid to second grid, focusing anode (if present), and second anode. Make final check from focusing anode to second anode.

Any reading other than infinite resistance is cause for rejection or questioning the usability of the CRT.

A hot check is more reliable than a cold resistance test. Observe that the positive ohmmeter lead must be connected to the cathode of the picture tube when making hot resistance tests. Otherwise, the ohmmeter battery will cause a small beam current to flow and indicate falsely the presence of leakage resistance.

Internal Resistance of Circuit

Connect potentiometer in series with VOM test lead. Apply arrangement to circuit under test, as shown in Fig. 3.

With potentiometer set to zero resistance, read voltage value on DC scale of VOM. Then increase potentiometer resistance until voltage reading is reduced to one-half. Disconnect potentiometer and measure its resistance.

Internal resistance of circuit is equal to resistance of potentiometer minus input resistance of VOM. For example, if you are operating on the 30-volt range of 20,000 ohms-per-volt VOM, its input resistance will be 600,000 ohms. If you measure at the plate of an amplifier and find that a potentiometer resistance of 800,000 ohms is required to reduce the voltage reading to one-half, the internal resistance of the plate circuit will be 200,000 ohms.

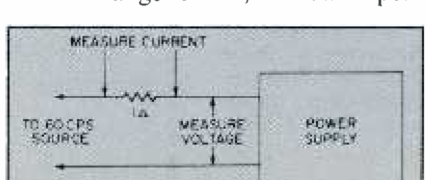


Fig. 5. Test setup for AC impedance.

Internal Resistance of Power Supply

Connect equipment as shown in Fig. 4. The same VOM can be used to make both measurements.

Measure no-load output voltage from power supply. Next measure output voltage with load connected. Measure also current through load.

The internal resistance of the power supply is determined by Ohm's law. Divide the difference between the two voltage values by the current flow; that is:

$$R = \frac{E\ \text{no load} - E\ \text{full load}}{\text{current in amperes}}$$

For example, if 300 volts under no load and 250 volts under a load of 100 ma are measured, the internal resistance of the power supply is 50/.1, or 500 ohms.

AC Impedance of Circuit

Use a 1-ohm resistor. Connect resistor in series with line, as shown in Fig. 5.

Measure voltage drop across resistor and calculate current flow. Then measure total voltage applied to circuit.

Voltage value divided into current value gives input impedance of the circuit. This impedance value is for test frequency only. At other frequencies, other impedance values will be found.

Capacitances

Measure via Time Constant

You'll need a battery and a watch with a second hand. First connect battery to capacitor, then connect

capacitor to VOM as shown in Fig. 6 (or use SPDT switch). Observe the time required for the reading to fall to 36.8% of its initial value.

If the reading takes X seconds to fall to 36.8% of the battery voltage, we find the capacitance value by dividing X by R_{in}, the input resistance of the VOM. For example, suppose we have a 100-volt battery. If the VOM is set to the 100-volt range, R_{in} is 2 megohms. If the reading takes 80 seconds to fall to 36.8 volts, the capacitor has a value of 40 mfd. Or, if we have a 10-volt battery and operate the VOM on the 10-volt range, the input resistance is 200,000 ohms. If the reading takes 8 seconds to fall to 3.68 volts, the capacitance value is 40 mfd. This test is accurate only for capacitors having high insulation resistance.

Measure .001 to 1 mfd

Use a 2960-ohm resistor and a 231-ohm resistor. Connect resistor and capacitor in series across AC

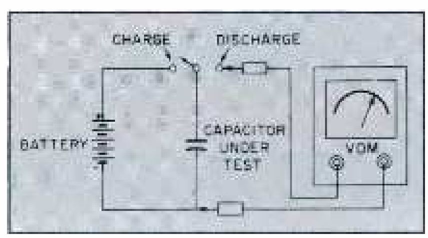


Fig. 6. Test setup measures capacitance.

line. Connect VOM across resistor. Energize capacitor and resistor from a 115-volt, 60-cps power outlet.

Note reading on AC scale and determine capacitance value by referring to Table 1. The tabulation is for AC voltmeters having a sensitivity of 1000 ohms-per-volt and operated on the 10-volt range only. For VOM's with other AC voltage sensitivities or for operation on other ranges, make a new tabulation. Use close-tolerance capacitors while making the new tabulation.

Inductances

Measure Inductance and Reactance

Precision 1-ohm resistor and audio oscillator are needed. Connect resistor and coil in series across audio-oscillator output. Connect AC voltmeter in turn across audio- oscillator output, across resistor, and across coil.

Observe AC voltage readings in all three tests. Operate audio oscillator at a frequency of X cps.

Represent the voltages as line

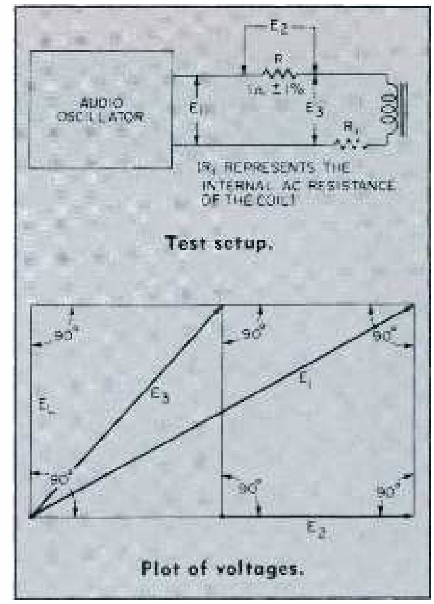


Fig. 7. Test setup, plot of voltages.

lengths. Combine into a rectangle, as shown in the diagram of Fig. 7. The length for E_L is the voltage across the inductive reactance. We can calculate the inductive reactance in ohms by dividing E_L by E_2. We calculate the inductance in henries by dividing E_L by 6.28f E_2.

Signal Tracing

Half-Wave Probe

The configuration in Fig. 8 is for a half-wave signal-tracing probe and can be used with either VOM or

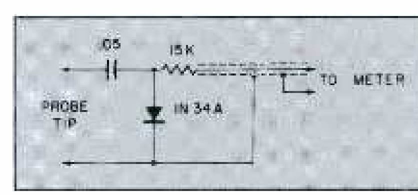


Fig. 8. A half-wave signal-tracing probe for use with VOM or VTVM.

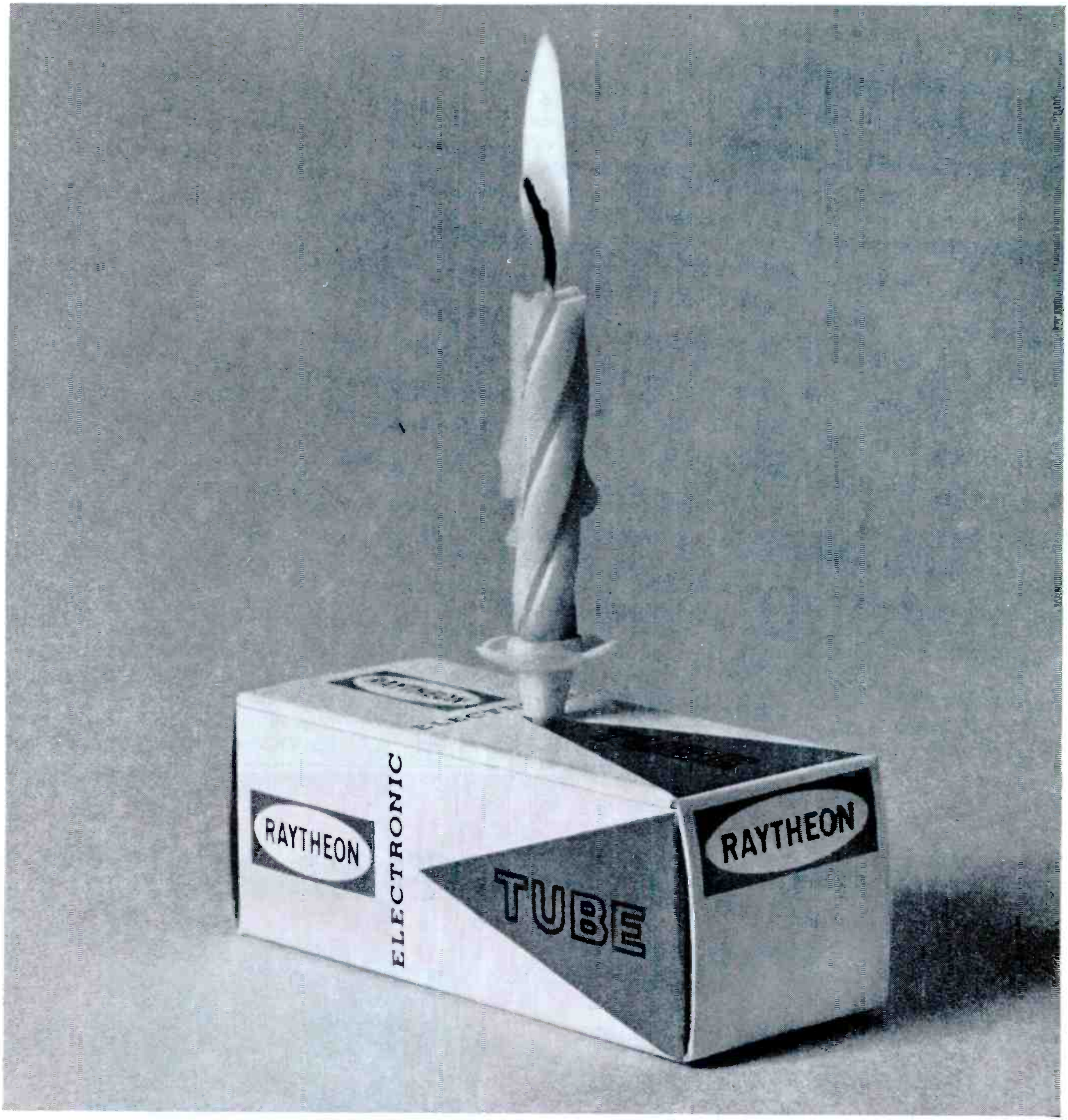
VTVM. Probe is not intended for highly accurate voltage measurements, only for general signal-level checks.

Peak-to-Peak Probe

You can use a peak-to-peak rectifier probe to measure peak-to-peak voltages of complex waveforms (Fig. 9). Note that any probe using semiconductor diodes has a limited voltage range; therefore, input signals should not exceed about 75 volts peak-to-peak because the diodes may be damaged.

To Signal-Trace the Sync Section of a TV Receiver

Use a signal-tracing probe. Connect probe cable to VOM. Apply probe between circuit terminal under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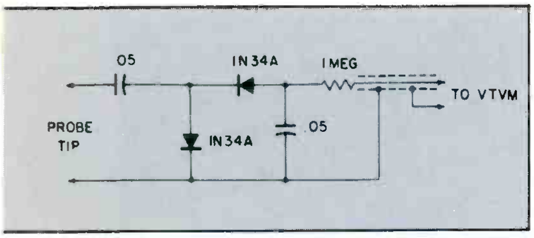

Fig. 9. A peak-to-peak signal-tracer.

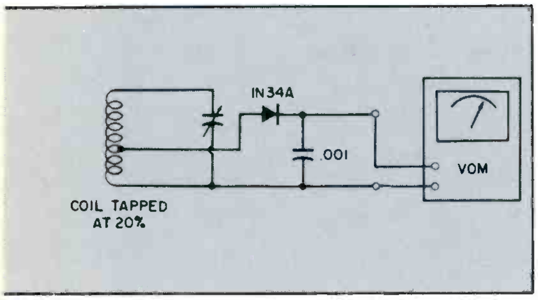

Fig. 10. An RF meter configuration.

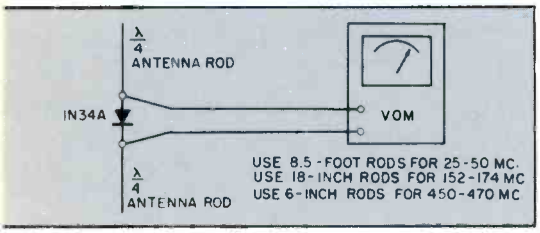

Fig. 11. Simple field-strength meter for checking a mobile transmitter.

test and chassis ground.

Operate VOM in its DC-voltage position. Tune in a TV station (or use a pattern generator). Note the reading on the DC scale.

If full-wave probe is used, peak-to-peak voltage values can be compared with data in the receiver service literature. If half-wave probe is used, lesser voltage values will be indicated, and circuit loading will be substantial.

Miscellaneous

RF Meter

Use a tuning capacitor, tapped coil, germanium diode, and a .001-mfd fixed capacitor. Connect equipment as shown in Fig. 10.

Select a coil (plug-in coils can be utilized) that covers the desired frequency range. Calibrate the tuning capacitor by link-coupling a signal generator to the coil. If a frosted plastic dial is used on the tuning capacitor, frequency calibrations can be marked on it.

The RF meter is useful to check for RF leaks in dielectric-heating equipment, to neutralize amplifier stages in transmitters, to check local-oscillator frequencies, etc.

Field-Strength Meter

Make a simple dipole antenna and use a crystal diode. Connect equipment as shown (Fig. 11).

Place the dipole at a predetermined distance from the transmitting antenna, with the dipole in the same plane.

Turn the transmitter on and observe meter reading.

This arrangement gives a relative field-strength indication, which will be valid only with respect to a reference reading that corresponds to normal field strength.

S-Meter

You'll need a triode, some resistors, and a potentiometer. Connect equipment as shown in Fig. 12. The meter posts are mounted on the front panel of the receiver, so that the VOM can be connected whenever desired.

First unplug the DC-amplifier tube. Connect the VOM test leads to the meter posts and set the VOM to its DC-voltage function and 15-volt range (or approximate range). Try different values of R and select the value that produces a full-scale reading on the meter. Next, plug in the DC-amplifier triode, and short

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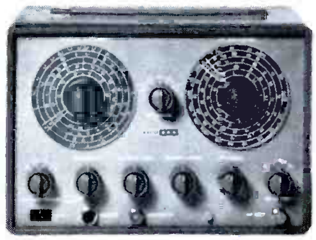

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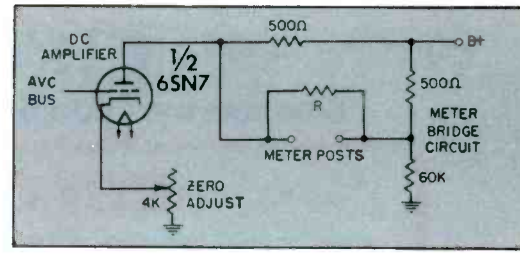

Fig. 12. Connecting arrangement for utilizing the VOM as an S meter.

its grid to ground. Adjust the cathode resistor for zero reading on the VOM. Finally, remove the short from grid to ground.

The DC amplifier inverts the AVC voltage applied to the grid so an increase in negative AVC voltage causes an increase in positive plate voltage and steps up the grid voltage for increased sensitivity. The VOM deflection is approximately linear with respect to signal strength, up to the cutoff point of the DC-amplifier tube.

Tachometer

Obtain the components illustrated in Fig. 13. (A scope is needed for calibration.) Connect them as shown.

To calibrate the meter, the scale is converted to rpm. Use 5400 rpm for full-scale deflection. (An overlay scale can be drawn, if desired.) Divide the scale equally into divisions of 900, 1800, 2700, 3600, 4500, and 5400. Set the horizontal-sweep rate of a scope to lock in a 60-cps signal applied to the vertical input. The scope then sweeps 3600 times a minute. Connect the scope's vertical input and the tachometer input to the 6- or 12-volt ignition supply voltage where it connects to the distributor, and start the engine. At little more than idling speed, one pip will appear on the screen; this is a speed of 900 rpm. Increase engine speed to display two pips, or 1800 rpm, and adjust R2 for an 1800-rpm scale reading on the VOM. The neon lamp should glow steadily at speeds over 1500 rpm; if it flickers at higher speeds, change R1 to a lower value. Use the scope to check the meter reading at 900 and 2700 rpm (one and three pips). If the readings are high, increase C1 and readjust R2 at 1800 rpm. If readings are low at 900 and 2700 rpm, reduce C1 and recalibrate.

The calibration procedure described is for an eight-cylinder engine. If the electrical system of the

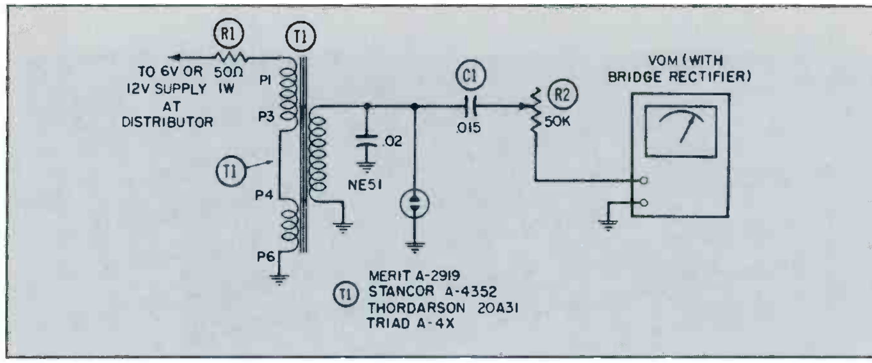

Fig. 13. VOM can be used as electric tachometer.

engine used for calibrating the meter is correctly tuned, the tachometer can be used to check any eight-cylinder engine which is also correctly tuned.

Phase Angle Between AC Voltages

An audio oscillator will be needed. Connect VOM to measure each phase voltage by itself, and then to measure the sum of the phase voltages, as in Fig. 14. The amplifier must be energized.

Represent each voltage by a line length, and combine the lines into a triangle, as shown. The angles of the triangle show the phase angles between the voltages. Note carefully that the phase angle θ between V_1 and V_2 is customarily specified by the projection of the line for V_1, as shown. In other words, the phase angle is greater than 90° but less than 180°. The phase angle between V_1 and V_2 changes with frequency, and changes faster at very low and at very high frequencies. This consideration is of great importance when troubleshooting negative-feedback amplifiers. Ideally, the feedback circuits should operate to apply a voltage from the output to the input of the amplifier which is exactly 180° out of phase at any frequency within the response limits of the amplifier.

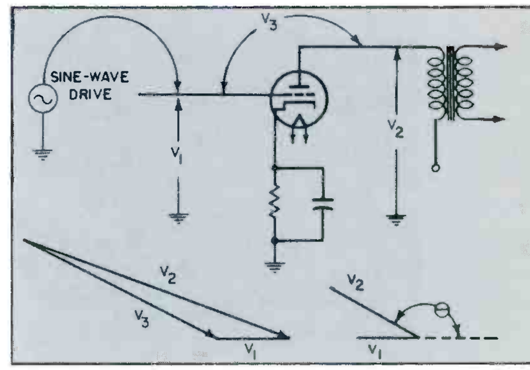

Fig. 14. Test setup for finding the phase angle between two AC voltages.

Conclusion

From these examples, you should be able to develop even more uses for your VOM. The accuracy of results you get from these tests will be determined primarily by the accuracy of the VOM and your care in making the tests. As we pointed out at the beginning, the VOM is probably the most versatile single instrument you have in your shop, if it is properly used. ▲

Capacitor Value (Mfd)	Approximate Reading (AC Volts)	Capacitor Value (Mfd)	Approximate Reading (AC Volts)	Capacitor Value (Mfd)	Approximate Reading (AC Volts)
.001	0.6	.01	1	.1	1
.002	1.1	.02	2	.2	2
.003	1.5	.03	3	.3	3
.004	1.9	.04	4	.4	4
.005	2.5	.05	5	.5	5
.006	3.0	.06	6	.6	6
.007	3.6	.07	7	.7	7
.008	4.0	.08	8	.8	8
.009	4.4	.09	9	.9	9
.01	4.8	.1	10	1.0	10
R = ∞		R = 2,960 Ω		R = 231 Ω	

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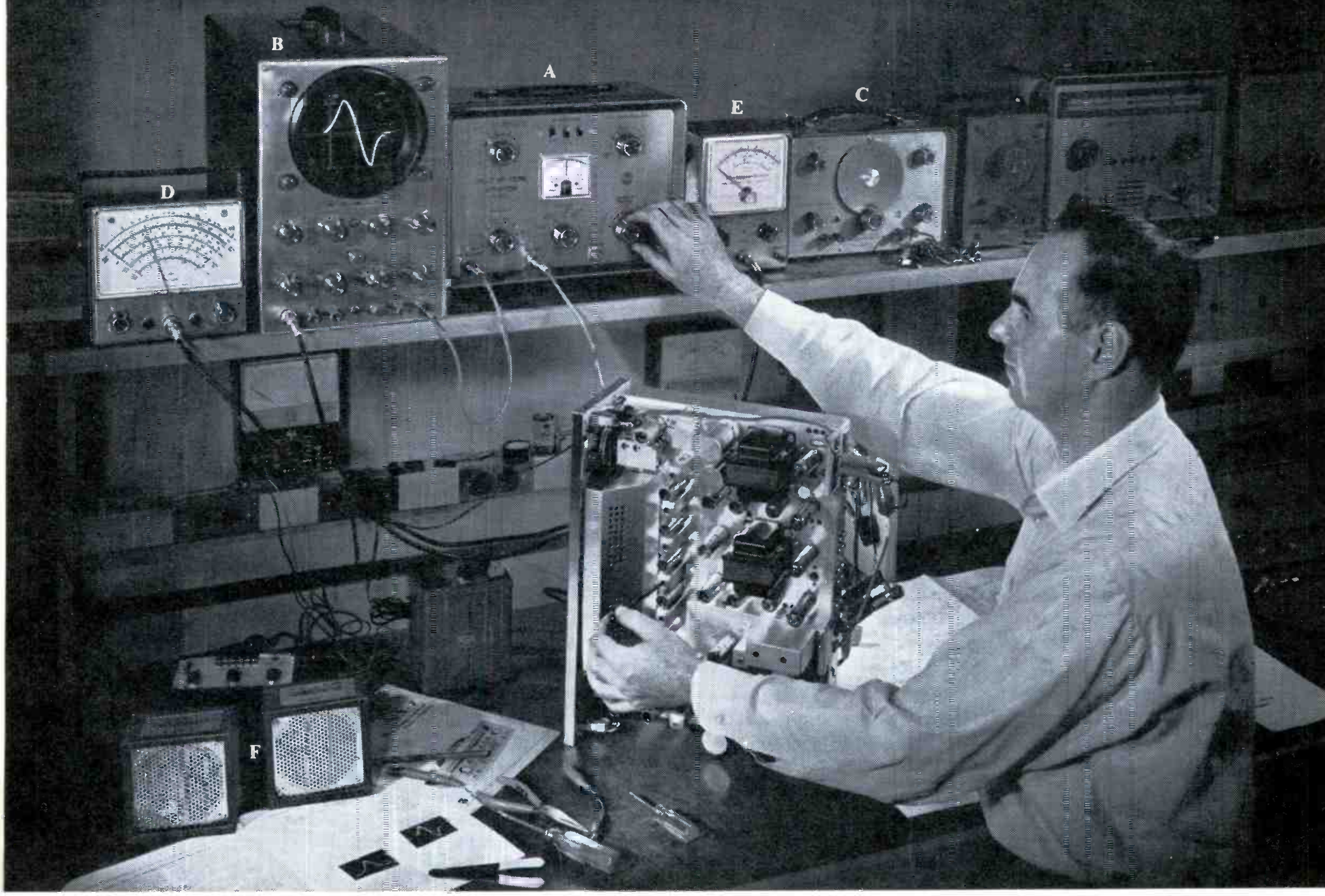

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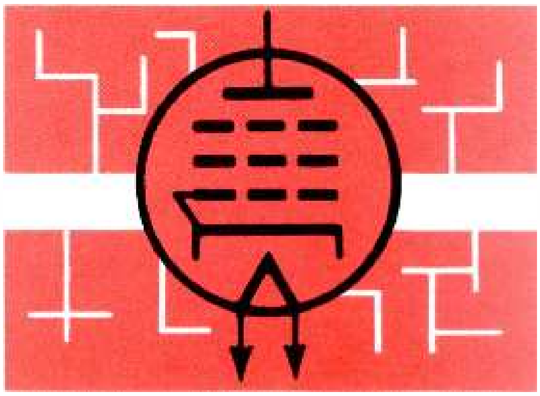
TUBES as voltage dividers



At one point in a previous article ("How Voltage Dividers Work"—February 1965, page 52), we discussed why it is necessary to consider a *phantom resistance* (load) when calculating values and power ratings of resistors for a power-supply voltage divider. Now, we'll consider the phantom resistance in its true form. Instead of being a dotted-line resistor on a schematic, with an assumed value, the phantom resistance we're going to describe is a vacuum tube and its associated circuit. The total phantom resistance is often comprised of more than one tube, of course, but for simplicity we'll concern ourselves with just one.

In this article, we'll explain how a tube is actually part of a voltage divider. We'll show you how your troubleshooting time can be shortened if you'll approach a circuit with this fact in mind. Basic voltage-divider theory, applied to vacuum tubes, provides a quick way to evaluate circuit operation.

Tube As Variable Resistance

First, let's explore what makes a tube a variable resistance. Next, let's hook this variable resistance into an R-C coupled amplifier circuit and see how our divider theory holds up in an actual circuit.

A triode is a good example for showing a tube as a variable resistance (Fig. 1). The control grid can be compared to the wiper contact of a potentiometer. When the grid is more negative with respect to the cathode, fewer electrons are able to reach the plate, raising the plate-cathode resistance. The exact opposite is true when grid voltage is less negative (more positive) with respect to the cathode; the effective plate resistance is lower. Changing the bias of the tube to a more negative potential and moving the wiper arm toward a maximum-resistance position both produce the same effect; resistance increases between points A and B.

If we apply B+ to either of the circuits in Fig. 1, we'll find that voltage at point A changes with either a change in bias (1A) or a change in resistance (1B). Why? Same old story: Because of the Ohm's-law relationship, a resistance increase causes a voltage-drop increase, also. Change the tube bias in a less negative direction (1A) and you'll get the same result on voltage at point A as if the wiper arm (1B) had been moved toward minimum resistance—the voltage lowers. A so-called tapped voltage at point A in the obvious voltage divider of Fig. 1B corresponds to plate voltage in the voltage divider of Fig. 1A. Moving the wiper arm toward a maximum-resistance position and raising the bias of the tube to a more negative potential both produce the same effect upon voltage at point A in each circuit—it increases.

In our look at a triode as a variable resistance, we must cover more than just bias. Let's delve into the three main types of bias used on triodes. One is *fixed* bias, usually produced by a battery. If the battery output were to decrease, the resistance of the tube would also be reduced. There is *grid-leak* bias, which depends upon the charge a capacitor develops when a signal is

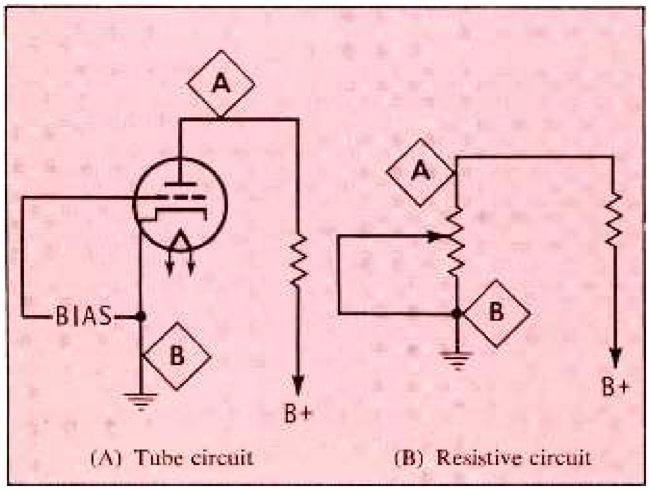


Fig. 1. Grid bias determines effective plate resistance.

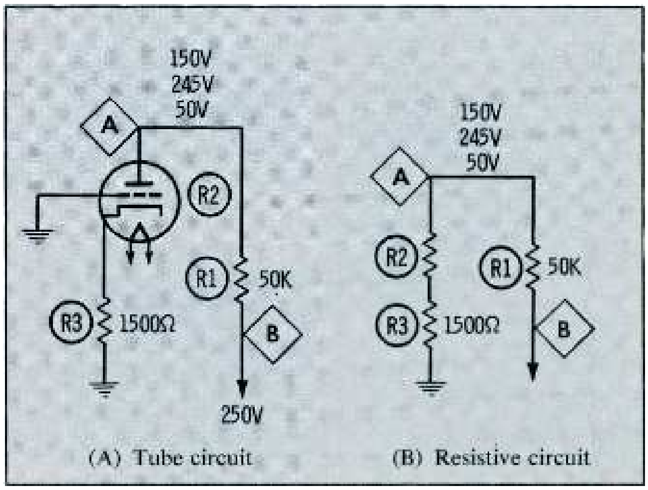
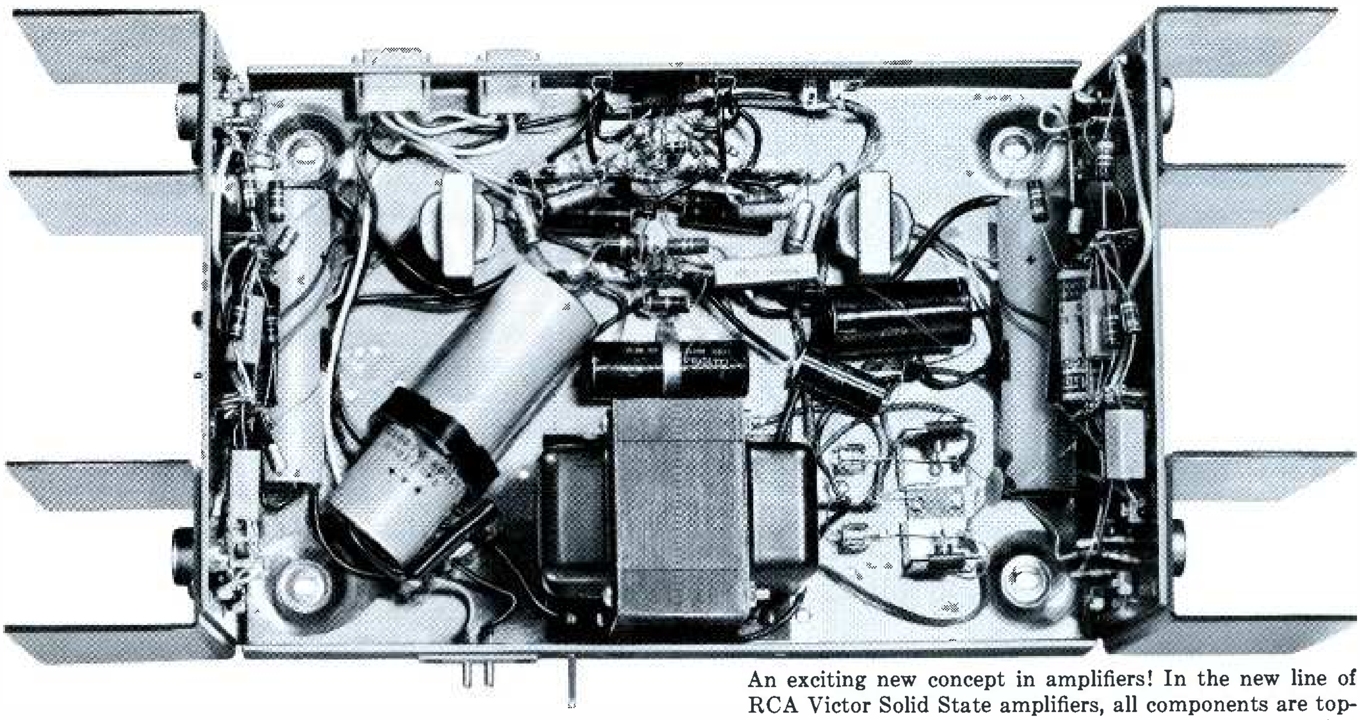


Fig. 2. Cathode resistor for bias is part of divider.



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applied and the subsequent draining of that charge through a grid-leak resistor. The amount of bias developed in this method is dependent on the input signal, but affects the tube resistance much the same as fixed bias.

The most common method of biasing a triode is *cathode* bias. This term is derived from the use of the cathode resistor to obtain bias for the tube. The voltage applied to the control grid is developed across a resistor in the cathode circuit. The value of this resistor sets the value of bias.

Again considering the triode as a variable resistance, we can see how cathode bias can radically affect the plate resistance of the tube. If the resistance of a cathode-biased triode changes, the first component to suspect is this cathode-biasing resistor.

In A Live Circuit

Now that we've explained the changing resistance of a triode, we should consider the importance of the voltage changes that take place as a result.

In Fig. 2A, we've drawn a triode and its associated components to illustrate how a tube circuit resembles a voltage divider. To compare this vacuum-tube circuit with a voltage divider, an equivalent resistive circuit has been included (Fig. 2B). Notice the three voltage values at each circuit point marked A. One of these—150 volts—is the normal plate voltage measured from A to ground. The other two are examples of incorrect voltages that might be measured if this circuit were to become inoperative. Using the three conditions of normal, high, and low plate voltage, we'll explain how the triode circuit works exactly like a divider.

Each circuit in Fig. 2 is a series resistive divider. R1 in the equivalent circuit represents the plate supply resistor of the tube; the tube itself is represented by R2; R3 is equivalent to the cathode bias resistor.

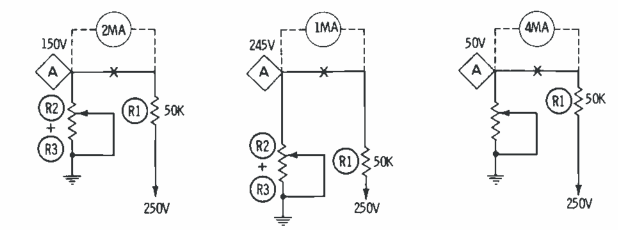
Across our equivalent circuit in Fig. 2B, 250 volts is applied, measured between point B and ground. We would call this the B+ supply in an actual tube circuit. The 150 volts on the plate is developed across the combined resistances R2 (tube) and R3 (cathode resistor), and is dropped from B+ through R1. Since the value of R3 is so insignificant in comparison to R2, and is used only to create a small bias voltage for the tube, we'll consider R2 and R3 as one total resistance.

Normal Voltage

In our circuit, normal voltage at A is 150. This value is needed to figure the voltage dropped across R1 (plate resistor). By subtracting 150 volts (point A) from the total potential (point B) applied across this entire divider (R1-R2-R3), we derive an answer of 100 volts.

Now, using Ohm's law, we can compute the current flowing in this circuit. Dividing 100 volts by 50K gives us an answer of 2 ma—the normal current flow. Since the current in a series resistive circuit (which we have here) is the same through all the resistances, let's compute the total effective resistance of R2-R3. Dividing 150 volts by 2 ma, we find this to be 75K.

Stop and think. Have we done any computation that doesn't apply to both circuits in Fig. 2? The answer, of course, is "No." What we have done is find the normal current value and the effective triode plate re-



(A) Normal (B) High (C) Low

Fig. 3. Voltage drops in equivalent circuits tell story.

sistance using voltage-divider theory. Now, we're ready to tackle *abnormal* indications.

Above Normal

To find 245 volts at point A would not be an unusual trouble symptom. Let's try our wings a bit and check this out by using divider theory. Fig. 3 shows three circuits equivalent to our triode circuit. In these, R2 and R3 have been combined in the form of a variable resistor.

Let's find out why the plate voltage measures 245 volts from point A to ground. Remembering that this is a series circuit, we subtract 245 volts from 250 (the supply voltage) and find the potential dropped across R1 is only 5 volts. Dividing 5 volts by 50K, using Ohm's law again tells us that only .1 ma is flowing in this circuit.

Having found the value of current, we can now divide .1 ma into 245 volts and see that tube resistance (R2-R3) is 2.45 meg—an extremely high value, suggesting a completely inoperative tube. All this computing was done on an equivalent circuit, but can you find anywhere it differs from our triode circuit? "No" is again the obvious answer.

Below Normal

In the instance represented by Fig. 3C, 50 volts is measured at the plate of the triode. By again subtracting 50 volts from the 250 applied across the entire series voltage divider—including the tube—we derive the voltage dropped across plate resistor R1; it is 200 volts. We have now only to divide 200 volts by 50K and we'll calculate a current value of 4 ma, to see that current has doubled.

Remember that, with the normal 150 volts at the plate, the current was 2 ma? Obviously, with only 50 volts developed across the triode and cathode resistor (R2-R3), the resistance of these two has somehow decreased. By dividing 50 volts by 4 ma, we find their value to be 12.5K—a far cry from the normal 75K when the tube circuit is operating properly.

Do you see any part of the triode circuit (keeping in mind that the tube and cathode resistor were considered as one) that differs from the divider? Once more, the answer is "No." Now, we're ready to proceed a step further.

Using Divider Theory

If we were to check the plate voltage of an inoperative triode stage and find it increased beyond normal limits, it would indicate (if we were thinking in voltage-divider theory) that the resistance of the tube had increased and was developing more than its share of the total voltage. This could be the result of an increase in bias from some cause, an open cathode resistance, or an open heater that causes nonconduction in the tube.

If we were to measure about the same voltage on the cathode pin as we did on the plate, an open cathode resistor would be the likely culprit. Normal reading at the cathode should be only the drop across the cathode resistor. However, in the case of an open resistor, the VTVM internal resistance would complete the cathode circuit; its resistance is so large (11 meg) in comparison to that of the tube (75K) that practically all the voltage would be developed across the VTVM. Sound strange? Let's look at the equivalent circuit (Fig. 4), keeping in mind voltage-divider theory, and find an explanation for this behavior.

Plate voltage in Fig. 4 measures 245 volts. When we measure from the tube cathode to ground, we measure 245 volts, also. The reason for this is a matter of resistance-value ratios in what amounts to a voltage-divider network formed by V1 and the internal resistance of the meter. The VTVM substitutes for the cathode resistor and is in series with V1. The plate resistor appears inconsequential due to the extremely small current flowing in it—so small it drops only 5 volts.

The high ratio of resistance is evident; the VTVM is by far the larger of the two. From divider theory, we know that the larger voltage should be developed across the larger resistance; hence the appearance of 245 volts at the cathode of V1. With some tube types, this value might be slightly less than the plate voltage. The particular voltmeter, the tube itself, and any component variations—all might affect the reading, but not more than a few volts.

When we speak of the voltmeter affecting the cathode readings, we might consider for a moment a 20,000 ohms-per-volt VOM. This instrument would change the resistance ratio of the "divider," and thus the voltage measured at the cathode pin would be 10 to 20 volts less than with a VTVM of 11-meg input resistance.

Getting back to our analyzing of the abnormal voltages, we can

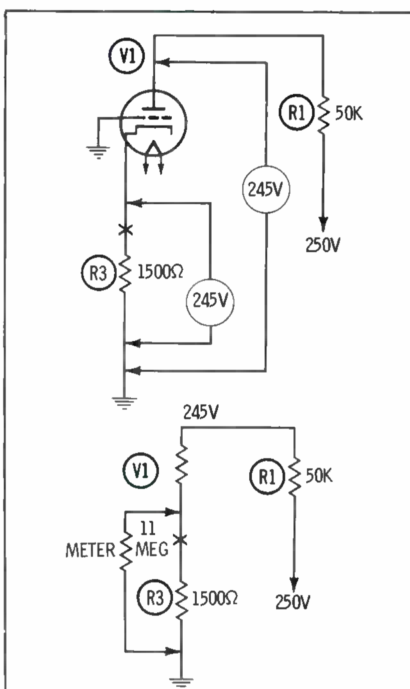


Fig. 4. If R3 opens, unusual voltage will be present on cathode of V1.

easily see how an abnormal *decrease* in plate voltage could also be checked out by divider theory. The cause could be (1) too much tube current, thus dropping more voltage than normal across the plate supply resistor and developing less across the tube because of its lower resistance; (2) too-high a value of plate supply resistor, thus dropping more voltage than normal even though current hardly changes; or (3) reduced supply voltage, which is easily measured and can then be checked at its source.

Thus, you see, DC divider theory can be an important clue to deciding in which direction to "chase" that elusive defect that is changing tube voltages from their normal values.

In the interest of quicker servicing, we have tried to make you alert to voltage dividers. We've explored and uncovered dividers that aren't always readily evident in appearance. Most of all, we've brought you to the realization that learning to recognize the simplified form of something complex is an asset when you seek a reason why some circuit doesn't work at it should.

An old saying among electronics men states: "The trouble's in there, all you have to do is find it!" That may have been the case a few years ago, but today it must be rephrased to state: "The trouble's in there, all you have to do is find it—fast!" Think dividers—and you will. ▲

BOOK REVIEW

Servicing Garage-Door Openers (GDO-1); Jack Darr; Howard W. Sams & Co., Inc., Indianapolis, Indiana; 128 pages $2.95.

A recent publication from a well-known service specialist, this book offers yet another opportunity for technicians. Running the full course from a general description of garage-door equipment and installation methods to specific servicing procedures, author Darr charts a path to full understanding of the timesaving devices that are becoming more and more popular.

Chapter 1 introduces the novice to various drive systems, motors, radio-control units, and track assemblies. Chapters 2 and 3 describe basic theory of both transmitting and receiving equipment for GDO's, giving several typical schematics with circuit explanations. Special circuits (tone filters, very-low frequency transmitters, stagger-tuned and sharply tuned IF's, and mobile supplies) are described in detail and supported by many illustrations. The fourth chapter is devoted to installation of track assemblies, antennas, receivers, transmitters, and drive systems. Several short-cut tuning methods and other hints provide additional information for the serviceman or installer.

Servicing data covering test equipment, transistorized circuits, tuning, tone-coding adjustments for transmitting and receiving equipment is given in chapters 5 and 6. Concise instructions for alignment, showing test-equipment setups and special circuits, enable the service technician to effect speedy repairs and adjustments.

Typical of many books on special electronic equipment, "Servicing Garage-Door Openers" is instructive and interesting, and it provides new areas for specialization for service technicians.

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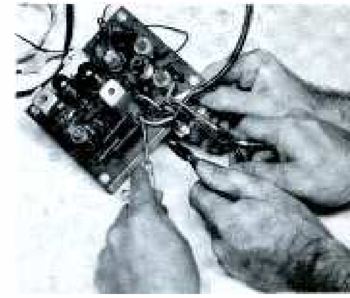


Special purpose types can save you time and money.

By Cyrus W. Moody

For many years, electronic-service technicians were able to perform their work using only a simple assortment of basic hand hools. Diagonal cutting pliers, either large, medium, or small; a pair of long-nose pliers, either the stubby or the extra-long type; a pair of electrician's pliers with side-cutting blades; a few screwdrivers for both slotted-head and Phillips-head screws; about six different sizes of nutdrivers or socket wrenches; a few alignment tools; and a soldering iron were all the average technician needed to do his repair work. However, with the advent of printed-circuit-chassis layouts (together with increasing use of transistors and other miniaturized components), a need arose for newer, more specialized tools and for improvements in basic standard types. Today, commercial tool manufacturers offer a variety of both standard and special-purpose tool types. With the varied electronic equipment today's technicians are required to service, it is important that all technicians keep themselves up-to-date on all aspects of their profession, including the hand tools with which they must work. Since tool design changes rapidly, this article will describe some of the more important changes made in standard tools, and some of the more useful and interesting new tools.

Variation and Improvements

Many of the newer tools available today are simply improvements or refinements of older types. The wire-cutting plier, for example, formerly was available in just three different types—side cut, diagonal cut, and end cut—in a limited number of sizes. Today, this basic tool has many shapes and cutting angles in a much greater range of sizes. This is particularly true of the very small cutters developed for working on miniaturized chassis and components. Several examples are shown in Fig. 1. The small, end-cutting plier shown in Fig. 2 has become extremely useful for close lead trimming in tight areas where ordinary pliers would not reach. Fig. 3 shows a pair of diagonal-cutting pliers which have steel springs placed between the jaws to grasp and hold the clipped ends of wire or component leads. This plier is very useful, when complex circuitry is being wired, to prevent the clipped leads from falling into the chassis.

Another example of a wire-gripping cutter is shown in Fig. 4. This is a needle-nose cutter for reaching into confined spaces; it shears the wire rather than clips it. The shear-cutting principle eliminates the jarring snap common to the clipping type, thus eliminating any

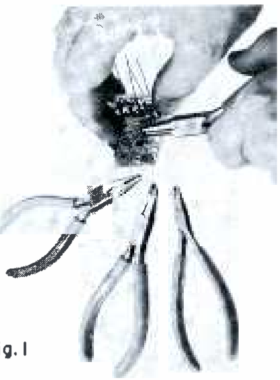


Fig. I

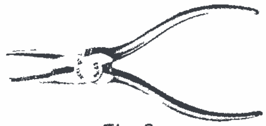


Fig. 2

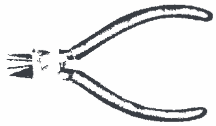


Fig. 3

mechanical shock which could damage delicate parts. As the wire is being cut, the jaws of this tool grip the cut end of the wire for instant removal. This plier, as do many others made especially for precision electronic work, has pinned jaws to keep the jaws and cutter blades in precise alignment. It is also equipped with a spring which opens the jaws when hand pressure is relaxed.

The diagonal cutter shown in Fig. 5 was designed especially for working on printed-circuit boards. This tool trims the lead ends of newly installed components then crimps the lead against the board to prevent the component from falling out prior to soldering. Both actions are performed in one operation.

Among the many long-nose or needle-nose pliers, special shapes and sizes, especially designed for the electronics industry, are now available. Many are mechined with rounded edges to prevent nicking or scarring wires and component leads during service work on crowded boards or chassis. The pliers shown in Fig. 6 illustrate one approach. Such factors are important for technicians to consider when working on delicate electronics instruments, because wires become weakened when nicked and can cause future servicing headaches.

The pinned-jaw needle-nose plier shown at the top of Fig. 6 is a particularly valuable tool in this era of miniaturization, because it assures perfect jaw alignment when gripping extremely small parts and wires. Any technician doing a large volume of work on equipment of this nature, such as small transistor radios, would benefit himself considerably by investing in tools of this type. Another very useful tool for work in modern electronic equipment is the curved needle nose plier shown in Fig. 7. This tool is handy when a technician is working in confined areas.

Screwdrivers have also undergone considerable change and improvement in recent years. Although the

Fig. 4

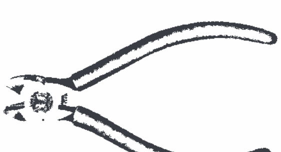


Fig. 5

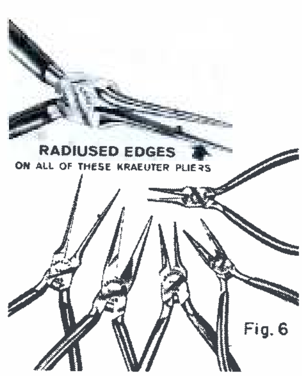


Fig. 6

Fig. 7

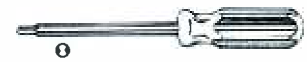


Fig. 8

Fig. 9

Fig. 10

slotted-head and Phillips-head screws are still the most popular, an increasing number of special types are being used, thus necessitating special drivers to fit these screws. One outstanding example of this is the clutch-head screw, requiring the driver shown in Fig. 8. There are approximately six different sizes of these screws in use.

Another special type requiring mention is the Reed-and-Prince screw which, although resembling the Phillips-head type, is somewhat different, as can be seen in Fig. 9. It requires a special driver. There are approximately four most-often-used sizes of this screw.

Screwdrivers featuring screw-holding or gripping devices are not by any means new, but today's complex chassis and cabinet arrangements require some kind of gripper to perform reassembly work quickly. Two examples are shown in Figs. 10 and 11. The more conventional spring-grip type is shown in Fig. 10, while a somewhat different type featuring two, half-round blades made of spring steel is illustrated in Fig. 11. In this latter type, the two blades, welded flat sides together, are molded into a plastic handle and enclosed by a sliding metal tube. At the bit end, the blades flare outward in a "V" shape when the metal tube is pulled back. As the tube is pushed forward, the blades are forced together until they form one single blade that fits snugly into the screw slot. Pressure from the tube is then released, and the blades, being made of spring steel, exert a firm outward pressure against the slot edges, holding the screw securely.

In addition to the standard one-piece screwdriver, most tool manufacturers today offer a variety of multi-purpose kits using one or two handles into which several different blades can be inserted. These kits are

Fig. 11

Fig. 12

Fig 13

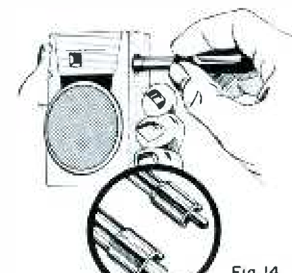


Fig 14

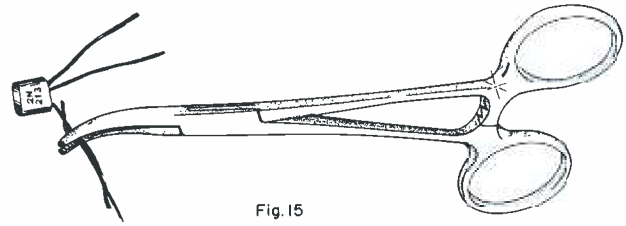


Fig. 15

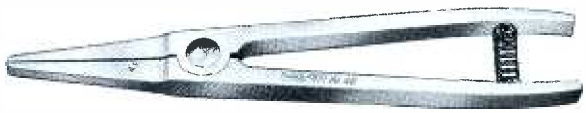


Fig. 16

available with a wide variety of screwdriver blades and nutdrivers—and, in larger sets, additional tools such as reamers. Some examples of this tool are shown in Fig. 12.

A new combination nutdriver or socket wrench is shown in Fig. 13. This tool contains four built-in hexagonal sockets in one unit and will fit as many as seven different-size hex-head screws or nuts, thus enabling the technician to work on various sizes without having to fumble for the proper tool. Operation of the wrench is automatic; the technician simply presses the wrench against the screw or nut and turns it. The tool automatically engages any screw or nut within its size range.

Tools For Special Uses

Many of the tools available today are designed for limited, special uses. Despite their infrequent use, many of these tools are invaluable aids to technicians because of the time (and additional profits) gained by using them. An example is the spannernut wrench shown in Fig. 14. Two sizes of this tool are currently available. Technicians specializing in servicing small transistor radios find this tool virtually indispensable for removing the spanner nuts on the external-antenna and earphone jacks.

Another special tool being used more and more often by technicians who service miniaturized equipment is the clamp or "seizer" shown in Fig. 15. As can be seen, this tool is used primarily for holding wires together for soldering, but it also acts as a heat sink to protect delicate components such as transistors and diodes from heat damage. It can also be used to retrieve small parts from hard-to-reach places!

Another example of a heat sink and clamp-type tool is shown in Fig. 16. This tool works mechanically opposite to the seizer of Fig. 15. When the handles are squeezed, the jaws open; a spring between the handles closes the jaws when hand pressure is released.

Wire-stripping tools have been available for many years and although most technicians are familiar with them, many still prefer to strip hookup wire with a pair of "dikes" (diagonal cutters). This method sometimes seems faster than taking time to adjust the stripping tool to fit a certain wire size. Several manufacturers have recently introduced improved versions of their stripping tools, however, making them a little more useful. An example is the stripper shown in Fig. 17 which has an eight-stop gauge permitting instant adjustment to the correct wire size. A somewhat different type is shown in Fig. 18; this one has a graduated stop for quick ad-

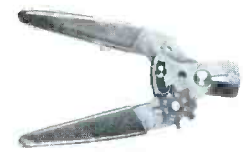


Fig. 17

Fig. 18

justment to proper wire size.

Yet another stripping tool, which is also designed for other uses, is shown in Fig. 19. The wire-stripping feature of the tool is accomplished with six stripping holes varying in size from No. 101 to No. 22-gauge wire. The tool can also be used for crimping insulated or noninsulated terminals, and for cutting wire. In addition, recently improved versions also contain a bolt-slicer. Bolt slicing is accomplished, as shown in Fig. 19, by screwing the bolt into the proper size threaded hole (six different sizes are provided) to the desired length, and then applying hand pressure.

Many manufacturers, in addition to offering special-purpose wire strippers, will also provide (on order) standard wire-cutting pliers having one, two, or three various-sized skinning holes between the cutting blades; an example is shown in Fig. 20.

Repair work on small transistor radios and other miniaturized equipment can be speeded up considerably with tools such as the tweezers shown in Fig. 21. These are available in many different jaw shapes, including one with angularly offset jaws. This tool facilitates the handling of small components in hard-to-reach places.

Summary

This article has covered only a few of the standard and special hand tools available today, the use of which could result in saving time and money. The subject matter has been limited only to commercially available tools. PF REPORTER invites any of you knowing of special shop-built time-saving tools or techniques, however insignificant they may appear, to write the editors describing the tool, its purpose, and how it was fashioned, and sending a photo of the tool. Any such device considered unusual and interesting will be given coverage in future issues for the benefit of all readers. ▲

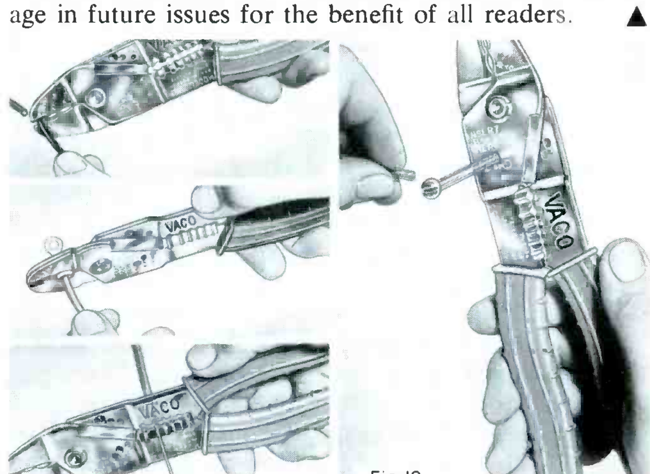


Fig. 19

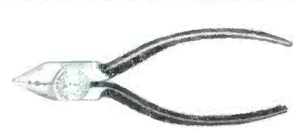
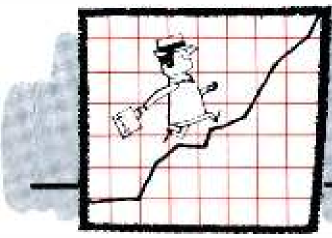


Fig. 20

Fig. 21



trade Old TE for New

By Ed Torrell

The cost of living is rising. And, so are the costs of doing business. One of the most significant—and important — expenditures that accrue to the radio-television-electronics service technician is the expense connected with test equipment.

The cost is great enough to the serviceman who is just getting into business, but often surprising is the expense of keeping test equipment up-to-date and modern. A few years ago, any technician worth his salt could get by with a VTVM (or VOM), a signal generator, and a tube tester.

Then came television, and a lot of new tubes and components. The tube tester no longer checked the new types. The old radio signal generator would no longer do the job; more frequencies, greater accuracy, and increased stability were necessary in the signal generator for TV work. The need for an oscilloscope became obvious. For the really competent, a sweep generator became a necessary item. Through those years, dozens more time-savers have been developed: sweep-circuit analyzers, video, dot, and linearity generators, flying-spot-scanner video generators, components testers of both the quick-check and sophisticated variety. The range of test equipment was becoming complex, difficult to choose from, and expensive.

More recently, color television, stereo FM, stereo hi-fi, CB, and many other devices have been added to the types of equipment the consumer-electronics servicing specialist is called on to service. No longer is it possible to service "by guess and by gosh." The technician either procures the instruments he needs to do a good job, or relegates himself to the class of technicians thought of generally as mechanics. A few, not concerned with time, profits, or customer satisfaction, continue to get along without "complicated test equipment." Those who are concerned with their ability and image, however, have found some way to obtain the equipment they need.

Obsolescence

The initial cost of equipping a service shop is considerable. With the field of electronics advancing so rapidly, however, buying equipment at the start is only a small part of the total problem. Equipment must be kept up-to-date, and there seems to be a continually arising need for equipment to generate new signals, perform new functions, or otherwise make the serviceman's job possible.

For example, new tube types are being developed almost faster than the serviceman can learn of them. Changes are therefore necessary in tube-tester roll charts, and sometimes in the testers themselves. New circuits in color sets seem more and more to demand modern equipment to keep them in working order. As viewing standards rise, a serviceman must have equipment to do each job really well—especially jobs such as alignment, demodulator adjustment, etc. Stereo FM demands that conscientious service technicians must have adequate signal-generating and test equipment.

Improved test equipment itself plays a part in this constant obsolescence of older units. In the field of oscilloscopes, the time was when an oscilloscope that would pass 100 kc without distortion was fine. TV waveforms suddenly made it necessary that the scope's vertical amplifier handle frequencies at least in the order of a megacycle or so. And now, with color, it is necessary that any serious color technician have a scope capable of passing at least 3.58 mc without attenuating.

Without going further, it is easy to see that obsolescence in your test equipment lineup does not always develop from just the fact that your instruments are chronologically old. New developments make older instruments obsolete. Improved performance standards among the equipments that must be serviced demand better specifications in the test equipment that will be used to service them. The serviceman who doesn't take this obsolescence factor into consideration is doomed to a back-alley operation, and is doomed eventually to obsolescence himself simply because he will not be qualified or equipped to work on the equipment his customers will be bringing to him.

An Upgrading Program

The forward - thinking and successful service - business operator must plan ahead to prevent the obsolescence we've described. It should be obvious that, if a regular upgrading program isn't followed, it would be easy to fall into the doldrum of ignoring developments in the field and in test equipment.

A specific, well-planned program of test equipment upgrading will pay untold dividends for the practical service technician. This can take several forms. The two most appropriate programs seem to be either a periodic modernization of existing instruments (in addition to normal preventive maintenance and calibration procedures) or periodic purchase of new instruments to replace those that have become outmoded.

Periodic modernization can be considerably less expensive than purchasing new instruments, but cannot always really get the job done. For example, there is no way to make a color-bar generator out of a signal generator. True—special modifications to a square-wave generator and a signal generator can combine the two to give you some sort of color-bar presentation; or a minor modification might convert a signal generator to a simple rainbow generator for color. But none of these expedients will take the place of a good color-bar generator —one that is compact, stable, and accurate beyond any jury-rigged or haywired servicing makeshift.

On the other hand, a really good-quality older scope can sometimes be modernized enough to make it usable for color work (see "Modernizing Your Scope" on page 1 of this issue). Modernization of this nature must be carried out in strictly *spare* time, or it quickly ceases to pay. Frequently the same amount of time, spent servicing sets, could easily pay for a more modern scope. Modernize if it is appropriate, but don't fight it—when an instrument has "had it," get rid of it and buy something more appropriate for the professional kind of servicing you do.

But periodic purchase of new equipment brings up another problem—where is the money going to come from? There is only one surefire means of having money available for new and more modern test equipment when you need it for them. This is a device called the *depreciation account*.

Your tax attorney—or you, if you prepare your own tax forms—no doubt deducts a certain amount of money each year for depreciation of test equipment and other capital goods. In many small businesses, however, this is handled only as a bookkeeping transaction and little of the money is ever actually used to replace instruments (the true reason for the depreciation allowance). Human nature being what it is, it is very easy for this money to be spent for something else; but, when it is spent for something else, it actually represents an erosion into your capital, because this money should have been set aside for eventual replacement of the test equipment or other capital equipment that is being depreciated. Don't forget—it really *is* depreciating (especially in the case of test equipment) because it is going through stages of technological obsolescence as well as just aging. With proper maintenance, the effects of age can be minimized or almost eliminated, but nothing whatever can be done about technical obsolescence.

Consequently, you must guard against letting this erosion affect your financial position. If necessary, put the money you allow for depreciation into a separate savings account. This system has been used successfully by several service businessmen, and is very effective. In fact, as the money accumulates in the savings account, it draws interest—extra dollars that can be applied toward the purchase of equipment.

For example, suppose you have $6000 worth of test equipment which you are depreciating on a straightline basis at the rate of $1200 per year. This means you should each month deposit $100 into your special depreciation savings account. At the end of the first six months, assuming your bank pays 3% interest, you will have a total of $609. At the end of twelve months, you'll have over $1227, interest and all. Thus, if you were to use this money to replace old test equipment at the end of each year, you would have an extra $27 to spend.

The important thing, though, is that you actually have the $1200 you've laid aside to improve your test equipment setup. Without your special savings account, you might have spent the money for something else and thus actually have chopped away at your capital structure.

Another means of obtaining money for new test equipment, or at least *some* extra money, is to find a way to sell older units. Don't just put them on a shelf and let them collect dust, because there they will do no one any good. Consider selling some of your obsolete instruments to experimenters or to students who are not yet ready for the more sophisticated instruments you need in your professional servicing business. Keep in mind that the few dollars you get for an old instrument are worth a lot more than the

Table 1.				
	40%	30%	30%	
New Price	1 yr.	2 yr.	3 yr.	Beyond
$ 50	$ 30	$20	$15	$10 or less
100	60	45	30	25 or less
200	120	90	60	50 or less

dust and corrosion it will collect on a shelf or in a basement. You *know* you'll never use it again—turn it into cash.

Trade-In vs Modernization

There are several factors that must be considered when you are trying to decide whether to buy new equipment or modernizing your old gear. What factors are involved in modernizing the unit? How much time will it take? What will be the cost for additional parts? How will the unit perform afterward as compared with a newer version of the unit that you could purchase? All these questions have to be answered in making a decision between modernizing or replacing an instrument.

The factor of *time* is probably greatest in the busy shop. If you have a lot of time that is not spent servicing for customers, it is quite easy to justify spending the time to modernize old test equipment. In fact, this could be a very profitable way to spend time otherwise wasted. On the other hand, if you could be taking in $5 to $7 an hour repairing equipment for your customer, you are losing that amount every hour you spend monkeying with some piece of obsolete test equipment. If your time is fully occupied with servicing, you'd be much better off, and quite a few dollars ahead, to buy a new unit and get rid of the old one.

Another significant factor is the *expense* involved in modernizing a particular instrument, which must be considered against the extra dollars that will be earned by the instrument when it's modernized. Expenses for modernizing consist primarily of the cost of parts. Some such projects are quite elaborate, and require such expenditures that a new instrument would cost less. A careful calculation of parts costs should be made before any extensive modernization is undertaken. You might find that the same number of dollars, added to whatever you might sell the old unit for, might go a long way toward purchasing a new one. Add to this the time factor we've already discussed, and you might have the price of a new instrument almost before you started. Obviously, if expenses are so high, the answer would be to buy a new unit.

Also of considerable importance is the *performance* of the unit after it has been modernized. Can it be modernized capably enough that it will perform as well when completed as a similar instrument purchased new? Do you have the facilities for calibrating it correctly? Modification of many units requires considerable care and understanding of the instrument. Be very sure you're qualified to undertake these steps, or have adequate instructions for doing so, before you become involved in such a procedure. You might wind up with a unit that was worse off for being "modernized."

One of the strongest arguments for new equipment, as opposed to modernizing old, is that new equipment has many new features that can't be added to the older units. For example, an older video dot-bar generator probably doesn't have color bars. Your older color-bar generator may not have color-gun killers. You may want a keyed-rainbow pattern in place of an NTSC pattern, or vice versa. A particular video generator may incorporate a flyback tester. A modern VTVM may have features that don't exist in older units. All of these and many other factors must be evaluated when you're considering the pros and cons of modernization versus trade-in.

Trade-In Plans

As we mentioned earlier, one method of financing modern equipment is to sell off some of your older units. On the other hand, you may not have a ready buyer for such units.

One method of selling your instruments would be to place a 3" x 5" card ad on the bulletin board at your local distributor. Most distributors have some means of putting information such as this before other dealers who frequent the store. You might take an ad in your local association newspaper or newsletter; such ads are generally seen by most of the service people in the area—at least those who are affiliated with the association.

Other distributors will frequently sell your used equipment on a commission basis. One we know has a 10% fee. His plan operates as follows: If you have an old piece of test equipment you want to trade for a new one, he will simply sell you the new one and put your old one on his shelf. You set the price, and if and when it sells he keeps 10% handling charge and credits the rest to your account. If, at any time before he sells it, you have an opportunity to sell it yourself, you can take it from his shelf and you owe him nothing. Such an arrangement is quite a service for technicians who wish to get rid of unneeded test gear.

Some distributors offer a reasonable trade-in allowance on old or used test equipment. However, keep in mind that test equipment values depreciate rather rapidly, and you shouldn't expect to obtain any great

amount of dollars for old instruments. First of all, your distributor will probably mark it up a few per cent in order to make a fair profit for having handled the unit. Generally, he will decide what he can sell your instrument for, and then offer you about 20% less. Even that is a mighty small margin of profit.

The chart in Table 1 gives you some indication of probable trade-in values for your test equipment. The figures in this chart are based roughly on 40% reduction in value the first year and 30% reduction for the second and third. Beyond that the value will depend very much on whether the unit is actually obsolete or whether it is just well used.

Items of test equipment that cost over $150 new sometimes don't depreciate as rapidly as those in the chart. Again, however, this depends very much on the instrument itself—whether or not it is actually obsolete, and what condition it is in at the time of sale.

One thing you must keep in mind: With technological advances taking place as rapidly as they are, test equipment is going to become obsolete more rapidly than ever before. For this reason you'll want to be very certain that new equipment you choose is as obsolescence-proof as it is possible to make it. No test equipment manufacturer can bat 1.000 in this particular category, but careful engineering can go a long way toward preventing the instrument from becoming prematurely obsolete.

Dealing With Your Distributor

When you get ready to purchase new test equipment, decide what functions you need for your particular servicing operation and allocate your test-equipment money accordingly. Buy the very best equipment you can afford, and no more. Read the ads, search the catalogs, write for spec sheets, talk to your distributor (and read the regular analyses of test equipment you find in PF REPORTER) all of these steps will acquaint you with features that you'll buy.

Once having decided, take your money in hand and go see your distributor. Talk to him about your particular servicing situation. If you need more equipment than you have money for, talk to him about that, too. Perhaps you might even want to talk that situation over with your banker.

Conclusion

Test equipment is a costly but necessary investment. To have the test equipment you need, and so you won't have to put up with obsolete or outmoded instruments, prepare a regular plan for updating, upgrading, improving, and modernizing your lineup of test equipment. The money for it will be available if you manage properly.

Once you've decided to obtain new equipment, take your money in hand (or get some if you haven't any) and go shopping for the best instruments you can find that will do the kind of job that you as a competent serviceman want your customers to have. Trade off that old equipment, and replace it with new; a well-equipped service shop is a reasonably sure sign of a conscientious and generally prosperous service-shop manager. ▲

Learning about TRIGGERED-SWEEP Scopes

Facts to acquaint you with the advanced version of the modern oscilloscope.

By M. R. Gordon

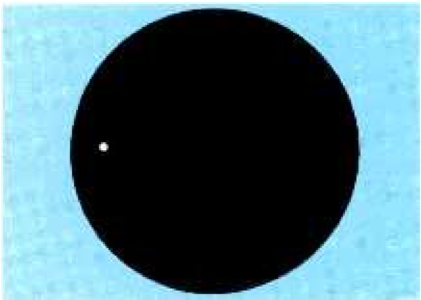
It's doubtful that any competent technician who takes his servicing ability seriously would try any longer to get by without an oscilloscope. Most have long ago become familiar with this important servicing tool; indeed, with color TV, multiplex FM, and stereo hi-fi to contend with, it is nigh impossible to get through a single workday without having to fire up the scope to examine one waveform or another.

The reason for this acceptance of the scope is the realization that electronics equipment has become more complex. Complicated signal systems can be studied only with the help of a good wideband oscilloscope.

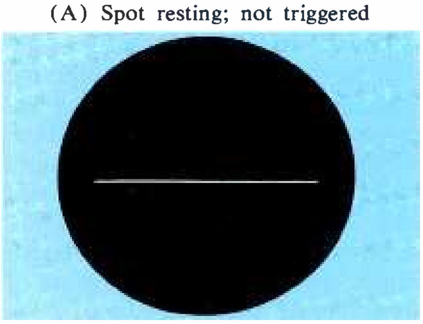
But time marches on! Equipment that today can be serviced very adequately with a scope, VTVM, and some special generators, are already being replaced section by section on the drawing boards by modular units that are "grown" as integrated components (see PF REPORTER May and September 1963). An entire audio section can be grown on a slab of semiconductor material no larger than the head of a tack.

What kind of servicing techniques will be required for these sets of the future? In many respects, techniques similar to those used with present-day equipment. The main difference will be in the more exacting criteria, and servicemen will need the ability to analyze waveforms more closely and completely. Circuit measurements that can be ignored nowadays in practical servicing will become of paramount importance in sets where you can't take a component loose for testing because it is just part of a unit that is smaller than the present-day component itself.

Your oscilloscope is going to play an important role in servicing these more sophisticated circuits, but not the old standby unit that serves you in such good stead these days. Instead, competent servicers of modular sets will be calling on a more sophisticated piece of waveform-analyzing equipment — the triggered-sweep scope. Therefore, if you're going to be one of those who services the electronic units of the future, you'll be needing to get acquainted with this advanced version of the modern oscilloscope. (Thousands of them are already in use in many facets of the electronics industry, so they are nothing really new or unusual, but the average TV serviceman has had little encounter with this particular type of scope.) This article will introduce you to the concept of triggered-sweep scopes and familiarize you with how they operate and how to set one up. They're not so very different from ordinary scopes in many respects, so you'll find them not difficult at all to understand.



(A) Spot resting; not triggered



(B) Scope triggered

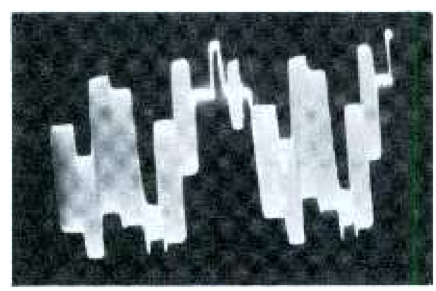
Fig. 1. Trigger control of a CRT beam.

Why Triggered Sweep?

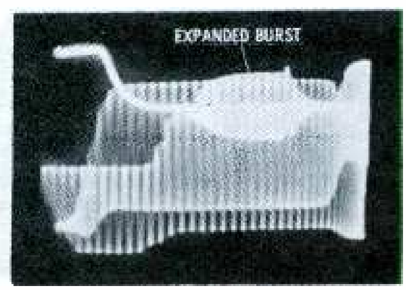
What is a triggered-sweep scope? In its simplest form, it is a conventional scope with the sweep oscillator biased beyond cutoff. No horizontal deflection occurs until a sync (trigger) signal rises sufficiently in amplitude to bring the sweep oscillator out of cutoff. Then, the beam is deflected once by a single sawtooth cycle. The beam then rests until the sync signal rises once again to the triggering level. This characteristic is illustrated in Fig. 1.

This triggering might seem to be a minor feature, but it actually has considerable utility. An example in Fig. 2A shows an NTSC color-bar waveform displayed at a 7875 cps sweep rate; the color burst is highly compressed. If we speed up the horizontal deflection rate, we can expand the burst as seen in Fig. 2B. However, the burst display is overlapped twice by bar signals. On the other hand, consider the display obtained with a triggered sweep (Fig. 3). If the sweep oscillator is triggered by the horizontal sync pulse, a full-screen burst display can be obtained.

Why is there no overlap in Fig. 3? It is because the beam deflects only once for each horizontal sync pulse, regardless of sweep speed. Since sweep speed can be set at any value, we choose a speed which fills the screen horizontally with only the burst display. Unlike in a conventional scope, sync lock is unaffected by changing the scope's horizontal sweep speed. In other words, the horizontal deflection controls are in-



(A) 7875-cps sweep



(B) Sweep speeded up

Fig. 2. Version of NTSC bar signal.

dependent of the sync triggering controls. If desired, you can speed up the horizontal sweep until one cycle of the burst spreads across the full screen; sync action is absolutely unaffected.

When the retrace blanking voltage is disabled in an ordinary scope, expanded waveform detail is visible on the retrace as well as on the main trace—as seen in Fig. 4. This is

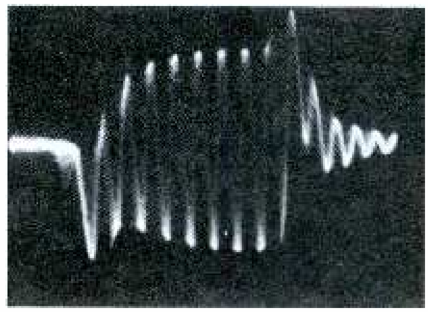


Fig. 3. Color subcarrier sample as viewed on a triggered-sweep scope.

because the retrace is always more rapid than the main trace. This is not a very practical method of analyzing waveform detail, however, principally because the retrace is so dim. Moreover, it is difficult to adjust the sync controls in an ordinary scope to bring the desired portion of the waveform into a viewable position on the retrace. However, this primitive type of waveform expansion serves as an introduction to the way it's done with triggered-sweep scopes.

Brightness Considerations

When a small portion of a waveform is greatly expanded by increasing the sweep frequency (speed), the beam travels much faster on the screen. Consequently, the waveform appears comparatively dim, as it does in Fig. 3. This brightness reduction is inevitable in simpler triggered-sweep scopes — the high-voltage power supply operates at 1 to 1.5 kv. Even when the brightness control is advanced to maximum, the pattern cannot be made

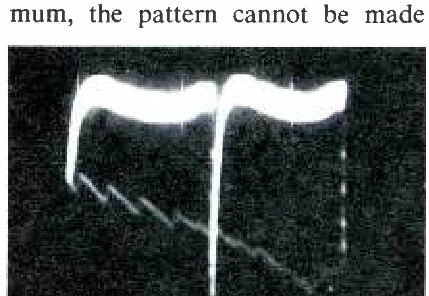


Fig. 4. A signal shown during retrace.

clearly visible.

If the accelerating voltage were doubled in the ordinary scope used for Fig. 4, the retrace display would be more visible. On the other hand, we would still have the problem of getting the desired portion of the waveform to fall exactly at the retrace interval. This is a very touchy and sometimes impossible adjustment with the sync circuits in most service scopes. Note also that the section of waveform displayed on the retrace is reversed from left to right.

Waveform Detail

From this introduction, it is evident that ordinary service scopes are often limited in analysis of complex waveforms. Detail may be so highly compressed that it appears only as a blur. On the other hand, high-speed details may be completely invisible.

Consider square-wave testing. This important area of analysis has been all but ignored in service work —simply because ordinary scopes

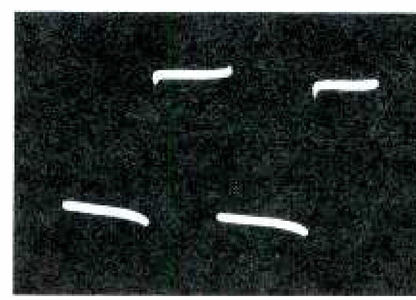


Fig. 5. Rise time of this square wave can't be measured with ordinary scope.

cannot give an adequate presentation of the waveform. For example, a most informative part of a square wave (shown in Fig. 5) is the rise time. However, it is impossible to measure this rise time with any reasonable accuracy on an ordinary scope.

The rise is so fast as to be almost invisible. Of course, if the CRT voltage were doubled or tripled, the rise would be plainly visible, but it would still be impossible to expand the leading edge sufficiently for an accurate measurement of its duration. Furthermore, the top and bottom excursions of the waveform would then be so bright that the CRT screen would probably be damaged. Hence, another important feature of an elaborate triggered-sweep scope is automatic intensity control to prevent screen burning.

Time Base

The time base of an oscilloscope is determined by the frequency of sweep, or the sweep speed. The term *time base* is used to refer to the time required for completion of one sweep across the CRT face. Depending upon the sweep waveshape, this time base is the first portion of the time required for one complete sweep cycle (the second portion is the sweep retrace). The time required for the completion of one cycle is also called the *period* of one cycle, expressed by the relationship: $T = 1/f$, where T = time and f = frequency.

In a service-type scope (Fig. 6), the horizontal deflection rate is known only approximately. To measure rise time, however, we must know the horizontal sweep speed. For this reason, most triggered-sweep scopes (Fig. 7) have sweeps accurately calibrated in milliseconds and microseconds. The sweep-time control is thus marked in milliseconds per centimeter (msec/cm) and microseconds per centimeter (μsec/cm). The rise time of a square wave can be measured directly from the CRT graticule, as shown in Fig. 8.

Fig. 6. Sweep-frequency controls for the ordinary service-type oscilloscope.

Sweep times are completely independent of the sync and trigger-level control settings.

Rise time is measured from the 10% to the 90% point on the leading edge of a square wave. This practice eliminates consideration of end effects, which vary considerably and are not primarily a function of rise (or fall) time. Nevertheless, as

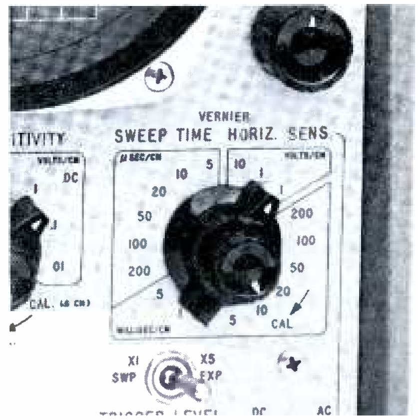


Fig. 7. Calibrated sweep dials on scope.

you might suspect, end effects have great significance of their own in square-wave analysis.

Imagine that the graticule divisions in Fig. 8 are ruled 1 cm apart, and that the rise of the square wave occupies 2 divisions. It is evident that if the sweeptime control is set for 5 μsec/cm, the rise time is 10 μsec. This is a slow rise time, which would be encountered more often in audio or industrial-electronic equipment than in TV circuits. When comparatively fast rise times are to be measured, it is convenient to use the sweep expander usually provided in triggered-sweep scopes.

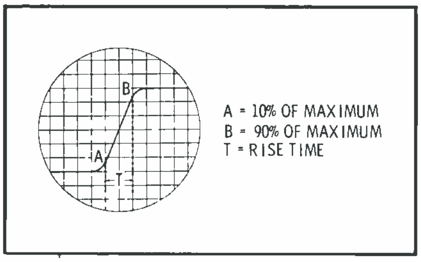


Fig. 8. Measurement of slope rise time.

Vertical-Amplifier Bandwidth

There is a general correlation between the vertical-amplifier frequency response and the maximum sweep speed that is provided in triggered scopes. The fastest rise that can be displayed through the vertical amplifier is determined by the high-frequency limit. Hence, the maximum sweep speed need be only adequate to measure the fastest rise that can be displayed.

The rise time of a vertical amplifier is equal to one-third of the period at the high-frequency limit (where frequency response is down 3 db). For example, if the vertical amplifier has a high-frequency limit of 15 mc, the corresponding period is 1/15 μsec, and the rise time of the amplifier will be approximately 1/45 μsec, or 22 nanoseconds (nsec). Typical small scopes with triggered sweeps have a vertical-amplifier response up to about 15 mc.

Triggered-Sweep Circuits

Scopes with recurrent sweeps use free-running multivibrators, while scopes with triggered sweeps utilize one-shot multivibrators. The multivibrator must be triggered for each cycle of output excursion. As shown in Fig. 9, the circuit consists essentially of a two-stage RC amplifier with one tube cut off and the other conducting. This balanced condition is established by biasing.

A positive trigger pulse causes V1 to conduct, which will result in a large positive-pulse output from the plate of the second tube. The length of the positive output pulse at the plate of V2 is controlled by the time constant of R2-C2. If larger values of R2 and C2 are used, the length of the output pulse is increased. One output pulse is produced for each input trigger pulse.

Trigger Polarity and Slope

It is evident that the one-shot multivibrator can be fired only by positive triggers. In practical use, only a negative trigger pulse or waveform might be available, so a polarity switch is provided. The trigger pulse is passed through a phase inverter, so the positive trigger excursion can be chosen no matter which polarity the input signal takes. In most situations, the trigger waveform has both a positive *and* a negative excursion. Hence, the multivibrator can be triggered on either excursion, by setting the polarity switch.

Let us take the example of a sine wave. If we choose to trigger on the negative slope of the wave, the waveform starts on the CRT screen at some point in the negative half-cycle. On the other hand, if we choose to trigger on the positive

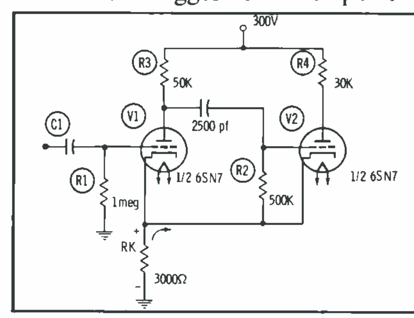


Fig. 9. One-shot multivibrator circuit.

slope, the waveform starts on the CRT screen at some point in the positive half-cycle. Furthermore, the exact point at which the sweep circuit fires will be determined by the amplitude or level of the trigger. Hence, we can select the precise portion of the waveform we wish to display by adjusting the trigger polarity and level controls.

Conclusion

This article provides some general knowledge of how a triggered scope works, how it is set up and adjusted, and how to convert frequency settings to time-base settings. This knowledge is basic to any thorough analysis of critical waveforms.

In the months to come, other articles will take up practical applications of triggered-sweep scopes. These features will review the detailed analysis of rise time, fall time, cornering, overshoot, undershoot, symmetry, ringing, tilt, and curvature. These waveform details will be tied in with normal and defective components of three-terminal networks commonly encountered in TV chassis and other electronic devices. ▲

PFR

Bench Report

Self-Soldered Connector

Every once in a while, someone comes up with a simple device so clever and useful that we all wonder why it hasn't been done before. Easily in that category is the spiral soldering aid developed by **Sprague Products Company,** a division of the Sprague Electric Company. Called *Quigs,* the connectors are formed from multicore wire into a tight spiral about 3/8″ long and 3/32″ in diameter. The coiled wire has a central core of strong, copper-covered steel wire, a second layer of soldering flux, and a final outer jacket of solder. Although the concept is simple, we understand it has taken almost five years to perfect the mass production of these little gems.

Using *Quigs* is simplicity itself; and—since you don't have to get both hands and a soldering iron into the working area—tiny, crowded vector sockets or printed-circuit boards are as easy as standard chassis to work on. The pictures show clearly

how to use a *Quig*: First snip out the defective component, leaving a short stub of the lead; slip a *Quig* over the stub and place one lead of the new component into the other end of the *Quig;* touch a hot soldering pencil or iron to the *Quig,* and you have a perfectly soldered connection. No burned fingers, cooked wiring, or fractured P-C boards.

We found that these little devices can be used for connecting leads with diameters as large as that on a standard 2-watt composition resistor—and that takes in a lot of components.

For the time being, at least, these handy pigtails are available only as a premium with the purchase of standard packages of Sprague type TVA Atom electrolytic capacitors. We expect they will become more widely available as soon as the manufacturers are able to increase production, packaging, or distribution efforts to include them with other product lines, or offer them independently as a separate product. ▲

The Troubleshooter

answers your servicing problems

These "Blooming" Troubles

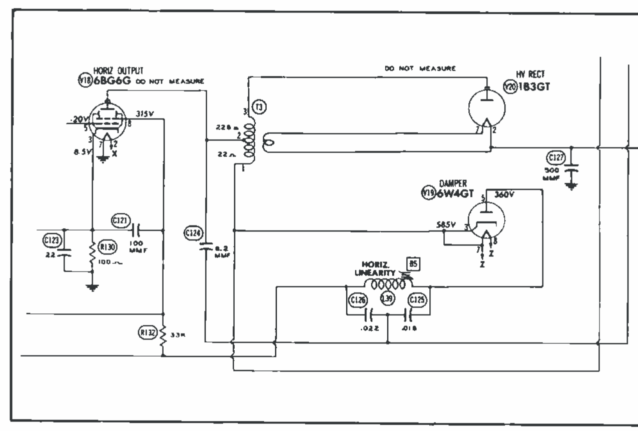
I am having blooming troubles with an RCA Chassis KCS47E. When the brightness control is advanced toward maximum, the pictures blooms, the CRT loses focus, and sometimes the raster completely disappears. High voltage is only 5 kv. I have replaced all tubes in the horizontal and high-voltage sections, along with the yoke; however, the trouble hasn't been corrected. Please, can you help me with my blooming trouble?

LEONARD B. IZZO

Clark, N. J.

Your description of the symptoms in your RCA Chassis KCS47E (covered in PHOTOFACT *Folder 160-10) seems to indicate trouble in the horizontal-output section.*

Check capacitor C127 by disconnecting it from the chassis. With the capacitor disconnected, turn the set on and measure the high voltage: if it returns to normal, replace C127—if not, reconnect the capacitor. Next, perform the horizontal-sweep circuit adjustments as outlined in PHOTOFACT. *If this doesn't help, the flyback transformer (T3) is a prime suspect. The transformer may be faulty, even though the DC resistance checks are normal.*



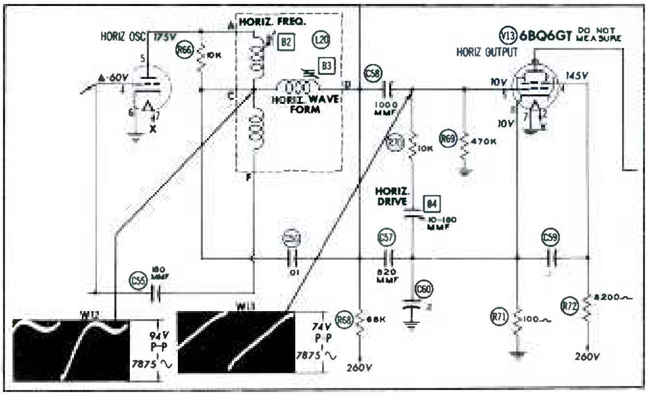
Red-Hot Output

I have a Muntz TV Model 2158A to repair. The trouble is no high voltage; also, the horizontal-output tube plates get cherry red. Sound is normal, but I have been unable to restore high voltage. Any assistance you can offer will be greatly appreciated.

STANLEY BARYCKI

Philadelphia, Pa.

The trouble in your Muntz receiver (covered in PHOTOFACT *Folder 163-8) is most likely in the horizontal-oscillator section. Check the drive voltage on pin 5 of V13; it should be negative 10 volts. Also, using your scope, be sure and check for W13; it is probably missing or very low in amplitude. An abnormal W13 would indicate possible trouble in the horizontal-oscillator circuit. If the drive signal is okay, check the screen and cathode voltages on the output tube, looking for possible voltage clues at either point. Incidentally, any time the horizontal oscillator is* *dead, you'll find the output tube draws excessive current—indicated by the cherry-colored plates. This increased current in the output stage is caused by the absence or reduction in grid bias.*



Electric Fence on TV

I am taking advantage of your troubleshooter column to submit a problem that has been difficult to correct.

We have a CATV system here in town, and about half a mile from our headend site we have constant interference from electric-fence chargers. They cause a constant pulse streak in our weaker channels. The interference varies with the signal-to-noise ratio. Are there any effective methods to use in eliminating this type interference?

We constantly check these fence lines for arcing and for any weeds that might create an arcing condition, but still seem to have this radiation problem from these fence units. Up to this time, we have been unable to eliminate this interference completely. I would be most grateful for any information you can give me in regard to this problem.

AUGUST AUBERT

Connell, Wash.

Have you tried a small amount of resistive suppression in the HT side of the fence chargers that are causing the interference? This is a pulse-train type of "signal," almost identical to the spark pulse of auto ignition systems, and we have had pretty good results around here, with similar problems, by using suppressor resistors. If you can find any of the old "inductive suppressors" of the spark-plug type, they seem to do a bit better. Normally, while this does reduce the peak voltage of the pulse, and does reduce its duration somewhat, it doesn't seem to interfere with its use as a fencer. Don't use over 10,000 ohms if the resistive types are used.

One other method has helped—the use of LC filtering across the input AC line, to keep the pulses from getting a "backfeed" into the AC supply lines and being radiated from there. Wind up a couple of air-cored RF chokes (say about 15-20 turns of No. 14 wire) and connect a pair of .05-mfd capacitors across the input, and .005 mfd's across the output, with all of the free ends tied together to a common ground. This can usually be placed inside the fencer cabinet. Ground the cabinet well.

Finally, and this is admittedly a little wild, but might work: Try making a parallel-resonant circuit at the affected channel video frequency with an air-core coil and a ceramic trimmer, and hooking this in series with the hot lead from the "charger" to the fence. Since this is a pulse, with the customary Gaussian distribution of frequency components, by putting a very high impedance at this one frequency in series with the "antenna" (fence) perhaps we can cut down on radiation at this frequency. No guarantees, of course, but it could work. ▲

CRT Tube Testers

(Continued from page 35)

Some manufacturers use a cable with various sockets and/or adapters connected along the cable. Others employ separate adapters, each with its own storage spot. The instrument shown in Fig. 3 uses both a multisocket cable and separate adapters. Anyone who has hunted through a tube caddy only to discover that the needed adapter was left at the shop will appreciate the storage compartments in most newer testers.

6. Automatically Controlled Rejuvenation — Takes the guesswork out of "shooting" cathodes. Just push the button, and rejuvenation takes place automatically for those cases in which such an approach may restore the weakened gun. Automatic control eliminates the possibility of ruining a tube by incorrect operation.

Conclusion

Should you decide you are in the market for either a receiving-tube tester or CRT tester-rejuvenator, you will be offered a wide variety of styles, carrying cases, etc. In the final analysis, it will be largely a matter of personal preference which instrument you choose. Fix in your mind the things you want your tester to do, how you want your setup information to be stored, and how you want it to look; chances are, your local distributor can supply it. ▲

Table 2.

	Data Storage		Setup Features			Adapters		CRT Repair		Misc Features			
MFG. and MODEL	Roll	Chart Indexed	Variable Line Voltage	Lo, Lo, Hi Selection G2 Voltage	Variable Filament Voltage	Separate, With Storage Space	Combined With Cables	Automatic	Manual	Individual Gun Test For Color CRT	Variable G2 Voltage	Checks B-W	Checks Color
B & K 445		X		X	X	X			X	X		X	X
GC 36-616		X					X		X	X		X	X
Jackson 825	X		X		X	X		X		X	X	X	X
Mercury 301*		X			X		X		X	X		X	X
RCA WT-115A		X	X				◆			X			X
SENCORE CR128		X		X	X		X	X		X		X	X
SENCORE CR133		X	X		X		X	X		X	X	X	X

* Combination tester, receiving tubes and CRTs; filament voltage available 2, 6, 8 volts
◆Color adapter only

Repair Test Equipment

(Continued from page 33)

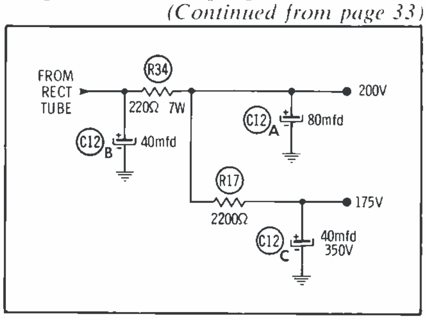


Fig. 5. Supply filter caused poor sync.

morning, the sync was okay for only a few minutes and then it was gone. The test pattern became erratic and fell out of horizontal sync. Even the vertical started to roll, and the picture could be held only with the video control of the Analyst full on. A lot of time was wasted finding that the TV receiver was the same as the night before—the Analyst was at fault!

At first, the RF lead was suspected, but it checked okay. The tubes in the sync section were tested, but we couldn't be that lucky. The trouble was finally traced to a 40-mfd electrolytic capacitor in the 175-volt line (Fig. 5); when a new one was paralleled, the picture plopped into sync. Since the bad capacitor was part of a dual-section filter, the entire unit was replaced—see Fig. 6.

The sync-level control R121 (refer to manufacturer's schematic) had to be adjusted after the filter was replaced. Here's the procedure: Connect an oscilloscope to pin 2 of RF modulator V4A. Be sure the video gain control is turned down. Adjust R121 for .35 volt peak to peak of sync signal. The sync-level calibration control determines amplitude of the sync output. With an oscilloscope connected to the sync-output jack and the sync-level control set to either −50 or +50, adjust resistor R215 for 50 volts peak-to-peak of sync information on the oscilloscope. Be sure the vertical

Fig. 6. Entire filter can was replaced.

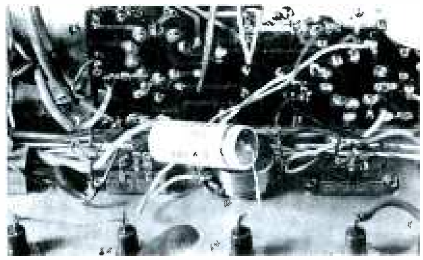


Fig. 7. Coupling cap had jarred loose.

size, vertical linearity, horizontal size, and horizontal drive controls are adjusted to give the best possible test pattern. Calibrate them early some morning by picking up a station test pattern on a TV receiver and adjusting the receiver for a round circle; then feed in the Analyst pattern and adjust its controls for a round circle.

Besides a few tubes from time to time, the only other trouble ever encountered with the Analyst was another intermittent sync problem. This was pinned down to the area of the sync jack; when it was wiggled up and down, sync would disappear. When we opened the bottom cover, the trouble was obvious—a small coupling capacitor (Fig. 7) with a long lead had come loose. Lifting the lead up and soldering it in place cleared up the trouble.

The cathode-ray-tube tester generally develops a frayed cable or bad socket. In a color-CRT tester, if the red gun is bad and the green and blue are good, check the switch connections or the wiring leading to it. If there is some slight movement of the meter, check the rectifier and the B+ voltages. Least likely to cause trouble is the meter itself.

The dot-bar generator is a delicate instrument for color servicing. If you obtain no color or intermittent color, check the 3.56-mc crystal. The crystal usually plugs into a socket on top of the chassis (Fig. 8); if the socket contacts become loose, you'll have intermittent color. In our Hickok 660, the dots would stand still for awhile and then bounce. You could sometimes stop it with the vertical hold control, but then it would roll vertically. We finally found a bad OA2 regulator tube (which is located under the chassis).

After a few years of aging, the video-gain control on our 660 must be turned wide open, as well as the attenuation control. If wavy bars appear diagonally across the dot pattern, adjust the *video clip* level until they disappear. It is best to have a diagram and manual handy before digging into one of these delicte instruments. Don't mess with critical factory adjustments — send the unit back for service if it's that fouled up.

The scope is a complex instrument, but by considering it in horizontal, vertical, sweep, sync, and power-supply sections, it won't be too difficult to troubleshoot. First check all tubes in the suspected section, and then make voltage checks.

In one of our 5" scopes, there was no vertical gain at all. The tubes were checked in the vertical section, and one 6V6 replaced, but still we got no vertical amplification. Voltage checks did the job — one of the 6V6's had no plate voltage. Tracing back to the B+ voltage we found one of the peaking coils (Fig. 9) had been chewed by a mouse who had entered through the cooling slots. He had even tasted a few coupling capacitors and paper electrolytics.

By checking cables, jacks, tubes, and making voltage checks, you can repair most of your own test equipment. Be sure you take the time, for it'll save time in the long run. ▲

Fig. 8. Note "clip level" pot, crystal.

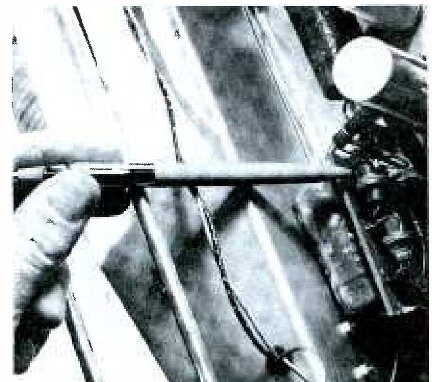


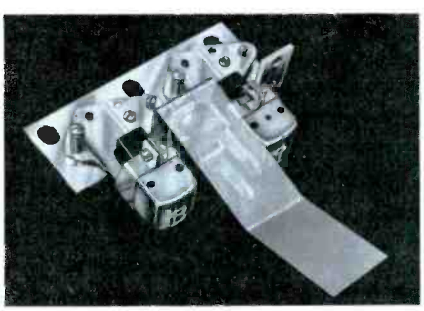
Fig. 9. Peaking coil was mouse food.

Product Report

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

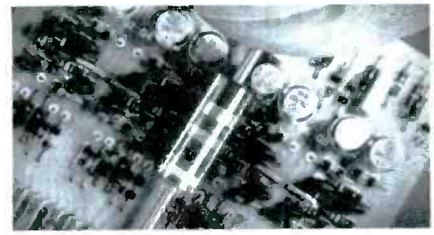
Low-Cost CB Transceiver (139)

A low-cost CB transceiver, designed to meet the requirements of business communications, is offered by **Hammarlund Mfg. Co.** The CB-212 offers crystal-controlled transmit and receive operation on any six of the available CB channels; a front-panel switch determines the channel in use. A built-in, dual power supply is provided, with 117-volt AC input for fixed station applications and 12 volts DC for mobile applications. The unit features all-electronic transmit and receive switching. The receiver has a reported sensitivity of better than .5 microvolts, a 6-db bandwidth of 3.3 kc from 8 tuned IF circuits, an AVC range from 5 to 100,000 microvolts, and an audio-power capability of 3 watts, minimum. The transmitter has a full 5-watt input, with 3 watts minimum output, and is 100% modulated. Output-tuning circuitry matches antennas having input impedances of 30 to 80 ohms. Audio is supplied by a ceramic push-to-talk microphone.



Kits for Cartridge Tape Recorders (140)

Head-bracket kits from **Nortronics** are designed to update existing broadcast tape-cartridge recorders of the Fidelipac and Viking type, reduce head installation and alignment problems, and eliminate the need for rear-mount heads. "Micrometer" adjustments permit easy alignment of head height, face position, and azimuth. A lock screw on each head bracket "freezes" the adjustments. Each kit contains a completely assembled head bracket (less heads), a cartridge guide for installation on the deck plate to insure proper alignment of the 4-inch cartridge as it is inserted into the machine, and a template to position the unit accurately during installation. Kit 114 uses one head for program and cue record only and one head for program and cut play only. Kit 115 uses two mono heads —one head for program record play; one head for cue record play. Kit 117 uses one mono and one stereo head— a mono head for program record only; one channel of the stereo head for program play only and the second channel for cue record/play. This configuration permits monitoring program material while it is being recorded, using a wide-gap record-only head and a fine-gap program play-only head.



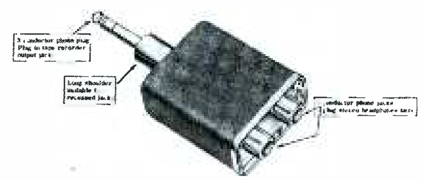
Quarter-Watt Composition Resistors (141)

The industry's first commercial-grade ¼-watt composition resistor is now available from **International Resistance**

Circle 138 on literature card

Circle 66 on literature card

Co. An RC-07 size unit, the GBT-¼ was designed for applications where small size is required, as in transistorized industrial computers, mobile communications equipment, portable radios, and TV tuners. The units are available in EIA values from 10 ohms to 1.0 megohm and are rated ¼ watt at 70°C. They are packaged in bulk, in corrugated strip packs, or on taped reels for automatic-insertion equipment.



Stereo Headphone Adapter (142)

A plug- in stereo headphone adapter allows two stereo headphones to be used with a stereo tape recorder, even though the recorder has only one output. The new adapter, Model 353 by **Switchcraft, Inc.,** is housed in a shielded metal cabinet measuring 2 1/6" x 1 13/16" x 1 1/6". A single 3-circuit phone plug is wired to two 3-circuit phone jacks. Two stereo headphones can be plugged directly into the two phone jacks; the adapter is then connected to the output jack of the tape recorder.

Automatic-Degaussing Kit (143)

A kit to add an automatic degaussing circuit to 1963-1964 color TV sets has been assembled by **Colman Electronics.** The ADG kit comes with detailed instructions and consists of two degaussing coils, and automatic control, and all the necessary wiring. No drilling is needed; it isn't even necessary to remove the chassis for installation, and only two solder connections are needed. Installation usually takes 20 minutes or less and can be completed in the home. Net price is $9.47.

Hole Saws (147)

To help busy technicians accurately locate and cut holes of precise diameters in all kinds of panels and chassis, **Proto Tool Co.** has announced two new series of high-speed hole saws. PROTO-MOL and PROTO-QUIK are the trademarks designated by Proto for distribution. The PROTO-MOL hole saw is made of molybdenum steel and has a quick-change mandrel. It also has a follow-through feature for cutting successive pieces in stacked material for easy core removal. Saw diameters range from ¾" to 2½", and depth of the cut is 1⅛". Standard mandrels are used with ¾" to 1½" diameter saws, and the quick-change mandrel is used for the 1¼" to 2½" saws. The PROTO-QUIK hole saw is made of a steel alloy. Although it has a standard mandrel, it has the follow-through design feature for deeper hole-cutting capability and removal of cores as cutting progresses. It ranges in size from ¾" to 2½" in diameter, with a cut depth of ⅞".

Portable Megaphone (144)

This new combination portable megaphone and PA system, called Amplivoice

2583, is an improved version of the original Amplivoice introduced by **American Geloso Electronics** last year. Incorporating lightweight portability and long-range sound sharpness, the new 2583 has been updated with an external volume control, a new five-transistor amplifier that uses less battery power, greater voice projection, shockproof case and microphone, and all-weather air-tight sealed circuitry. A remote microphone with 9" cable attaches to the unit for quick conversion to a portable public address system. With shoulder strap and batteries, the unit carries a suggested list price of $89.95.

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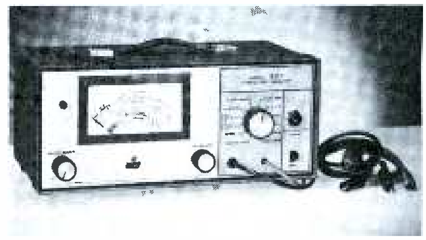
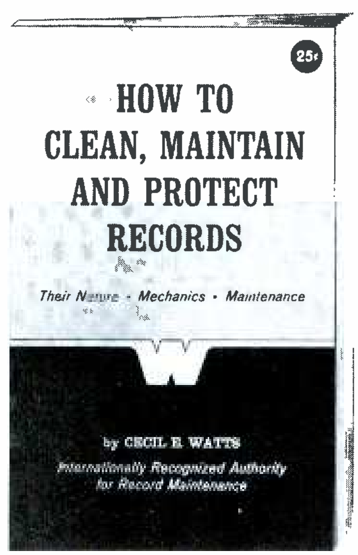


Analyze Capacitors (145)

The Model 801 Capacitor Analyst is designed to measure capacitance, leakage resistance, and to find opens and shorts both in and out of the circuit. This **B & K Mfg. Co.** instrument will test electrolytic capacitors as large as 2000 mfd, using a balanced bridge, and predicts the life expectancy of any electrolytic capacitor rated 3 volts or more. An in-circuit leakage test eliminates the need for disconnecting a capacitor from its associated circuit to measure actual leakage resistance. Net price is $99.95.

New Literature

Technical Booklets You Can Buy



Record Care and Protective Guidebook

Elpa Marketing Industries announces the availability of a guidebook, "How to Clean, Maintain, and Protect Records," prepared by Cecil E. Watts, a noted authority on maintenance of records. The 16-page manual describes professional procedures for handling, storing, and cleaning records, along with tips on rejuvenating old records for extended life. Cleaning equipment for the protection and maintenance of either LP or stereo records is listed in the manual. The guidebook may be purchased from **Elpa Marketing Industries, New Hyde Park, New York,** for $.25. ▲

FREE Catalog and Literature Service

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

Please allow 60 to 90 days for delivery.

ANTENNAS & ACCESSORIES

70. *ALL-CHANNEL PRODUCTS* — Catalog showing *Rembrandt* Model 283 outdoor antenna for VHF, UHF, and FM reception.
71. *ALLIANCE*—Flyer describing Model 300 broad-band VHF booster; suitable for black-and-white or color.*
72. *ANTENNACRAFT*—Latest literature on *Channel-Spanner*, a new broad-band high-gain VHF-UHF TV antenna.
73. *CORNELL - DUBILIER* — Replacement component selector, TV - FM reception booklet, 4 - page rotor brochure, and vibractor replacement guide.
74. *FINNEY*—Catalog UVF describes new swept-element log-periodic type VHF-FM antennas.*
75. *JFD*—Literature on complete line of log-perodic antennas for VHF, UHF, FM, and FM stereo. Brochure showing converters, amplifiers, and accessories; also complete '64-65 dealer catalog plus dealer wall chart of antenna selection by area.*
76. *MOSLEY ELECTRONICS* — Illustrated catalog giving specifications and features on large line of antennas for Citizens band, amateur, and TV applications
77. *PARKER METAL GOODS*—New catalog listing complete line of TV installation accessories; also indoor and outdoor VHF-UHF antennas.
78. *STANDARD KOLLSMAN* — Catalog sheet on UTC-051 transistor UHF converter kit with IF amplifier.
79. *TRIO*—Brochure on installation and materials for improving UHF translator reception.
80. *ZENITH*—Informative bulletins on universal loudspeakers and a new line of log-periodic vee-type antennas for FM and monochrome or color TV.*

AUDIO & HI-FI

81. *ADMIRAL* — Folders describing line of '65 equipment; includes black-and-white TV, color TV, radio, and stereo hi-fi.
82. *ATLAS SOUND* — Illustrated data sheet describing C-46 and C-66 sound columns, two-way wall speaker system, and bidirectional baffle speaker combinations.
83. *DUOTONE*—Booklet No. EL-1 describing *Elipticon* stylus.
84. *JENSEN*—24-page catalog, No. 165-K, illustrates and describes speakers and speaker system kits.*
85. *NUTONE*—Two full-color booklets illustrating built-in stereo music systems and intercom-radio systems. Includes specifications, installation ideas, and prices.
86. *OAKTRON* — "The Blueprint to Better Sound" an 8-page catalog of loudspeakers and baffles giving detailed specifications and list prices.*
87. *OXFORD TRANSDUCER*—Product information bulletin describing complete line of loudspeakers for all types of sound applications, including replacements for public address and intercom systems.
88. *QUAM-NICHOLS* — Automotive speaker guide listing cross-references on all automotive speakers from 1955 through 1963—both front- and rear-seat replacements.*
89. *SONOTONE*—Brochure on micro-ceramic stereo cartridge for low-mass, lightweight tonearms.*
90. *SWITCHCRAFT* — Product bulletin No. 149 describes tangle-free molded head-phone coiled cord.*
91. *TURNER* — 16-page catalog shows complete line of microphones for various applications.

COMMUNICATIONS

92. *PEARCE-SIMPSON* — Specification brochure on IBC 301 business-band two-way radio, *Companion 11, Escort,* and *Guardian 23* Citizens-band transceivers.
93. *SONAR RADIO* — Specification sheet on Model FM-40 business radio.

COMPONENTS

94. *BUSSMANN* — Bulletin SBCU on BUSS fustat box cover units that offer simple, low-cost way to protect work bench tools, soldering irons, drills, etc. against damage and burnout.*
95. *CBC INDUSTRIES*—Catalog of picture-tube brighteners; featuring new all-voltage types.
96. *COMPONENTS SPECIALTIES* — 36-page catalog No. 100 listing line of electronic replacement components.
97. *CENTRALAB*—Catalog No. 42-1910 listing *Fastatch II* exact replacement controls and accessories.
98. *E-Z-HOOK*—Catalog sheets showing complete line of test connectors, harness-cable-board binding posts, and test leads and clips.
99. *GC ELECTRONICS* — 80-page industrial catalog FR-66-1 showing newly introduced products.*
100. *PERMACEL* — Product specifications on plastic tapes listing types, technical data, uses, and product features.
101. *RCA BATTERIES*—Brochure 1P1190 illustrates 1965 line of battery merchandisers and promotional material.*
102. *SPRAGUE* — Latest catalog C-616 with complete listing of all stock parts for TV and radio replacement use, as well as *Transfarad and Tel-Ohmike* capacitor analyzers.*
103. *TRW*—General catalog No. 165 covers all standard capacitors offered by company. Other technical information on tolerance, reliability, and other characteristics of capacitors.
104. *WORKMAN* — Circuit breaker replacement guide for all TV set manufacturers.

SERVICE AIDS

105. *CASTLE*—How to get fast overhaul service on all makes and models of television tuners is described in leaflet. Shipping instructions, labels, and tags are also included.*
106. *CHEMTRONICS* — Colorful catalog No. 64 contains information on chemicals as aids to the electronics serviceman.*
107. *ELECTRONIC CHEMICAL* — Catalog sheet on contact cleaner; brochure on tape recorder head cleaner.
108. *OELRICH PUBLICATIONS* — 16-page catalog of TV service order forms, service-call tickets, phone message books, and many other items.
109. *PRECISION TUNER*—Literature supplying information on complete, low-cost repair and alignment services for any TV tuner.*
110. *YEATS* — The new "back-saving" appliance dolly Model 7 is featured in a four-page booklet describing feather-weight-aluminum construction.*

SPECIAL EQUIPMENT

111. *ATR* — Descriptive literature on selling new, all-transistor *Karadio* Model 707, having retail price of $29.95. Other literature on complete line of DC-AC inverters for operating 117-volt PA systems and other electronics gear.*
112. *GREYHOUND* — The complete story of the speed, convenience and special service provided by the Greyhound Package Express method of shipping, with rates and routes.
113. *TERADO*—Bulletin on *Galaxy* Model 50-205 transistorized DC-AC power inverter.*
114. *VOLKSWAGEN*—Large, 60-page illustrated booklet, "The Owner's Viewpoint," describes how various VW trucks can be used to save time and money in business enterprises, including complete specifications on line of trucks.

TECHNICAL PUBLICATIONS

115. *CLEVELAND INSTITUTE OF ELECTRONICS*—Free illustrated brochure describes electronic slide rule with four lesson Instruction Course and grading service.*
116. *HAYDEN BOOK CO.* — New 80-page catalog lists and describes books published by John F. Rider and Hayden Book Co.
117. *RCA INSTITUTES* — 64-page book, "Your Career in Electronics," detailing home study courses in TV servicing, communications, automations, drafting, and computer programming; for beginners and experienced technicians.*
118. *HOWARD W. SAMS* — Literature describing popular and informative publications on radio and TV servicing, communications, audio, hi-fi, and industrial electronics, including special catalog of technical books on every phase of electronics.*

TEST EQUIPMENT

119. *B & K*—Bulletin 108-R on Model 801 Capacitor Analyst. Bulletin No. 124-R on Model 1240 color generator. Catalog AP-21R describing uses for and specifications of Model 1076 Television Analyst, Model 1074 TV Analyst and Color Generator, Model 700 and 600 *Dyna-Quik* Tube Testers, Model 445 CRT Tester-Reiuvenator, Model 960 Transistor Radio Analyst, Model 360 *V-O-Matic* VOM, Model 375 *Dynamic* VTVM, and other test instruments.*
120. *EICO*—New 1965 catalog listing over 200 products including color-bar generator, oscilloscopes, and others; all available in kit form.*
121. *HICKOK*—Specification sheets on Model 662 installer's color generator, Model 677 wideband scope, Model 470A uni-scale VTVM, and Model 799 *Mustang* tube tester.*
122. *LECTROTECH*—Bulletins on new color TV test instruments, horizontal deflection circuit meter, meter protective devices, and substitute for VTVM battery.*
123. *JACKSON* — Complete catalog describing all types of electronic test equipment for servicing and other applications.
124. *MERCURY*—Literature covering Model 1100A, 1101, and 202E tube testers; Model 1500 signal generator and entire line of test equipment.*
125. *SECO*—Data sheets on self-service tube testers and caddy-pack tube testers that carry over 200 tubes.*
126. *SENCORE* — New 8-page catalogue No. 257 on complete line of company products; oscilloscopes, generators, testers, and many others.*
127. *SIMPSON* — Complete 16-page brochure on entire line of electronic test equipment; also, catalog on line of panel meters.*
128. *TRIPLETT*—All new test-equipment catalog No. 46-T showing complete line of VOM's, tube testers, transistor analyzers, and signal generators.*

TOOLS

129. *ACME LITE* — Descriptive bulletin on line of high-intensity lamps.
130. *AMERICAN ELECTRICAL HEATER*—Catalog detailing the latest in soldering equipment; also booklet "Principles of Resistance Soldering."
131. *ENTERPRISE DEVELOPMENT*—Time-saving techniques in brochure from Endeco demonstrate improved desoldering and resoldering techniques for speeding up and simplifying operations on PC boards.
132. *UNGAR*—Catalog No. 763 giving information on series of soldering irons and accessories.
133. *UPSON*—Catalog No. 65 covering complete line of Standard screwdrivers, Nut drivers, and Scratch awls; also Hold-E-Zee screwdrivers.
134. *VACO*—16-page hand tool catalog covering 250 individual items.*

Modern merchandising demands that a package do its own selling. And modern blister packs for RCA batteries do just that. Even the back of the pack gets into the act.

THE BACK OF THE RCA ALKALINE BATTERY CARD highlights the longer service customers can expect from this new and superior type of battery. With RCA Alkaline batteries the customer gets more for his money. The dealer makes more profit per sale. The package, itself, helps seal that sale.

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