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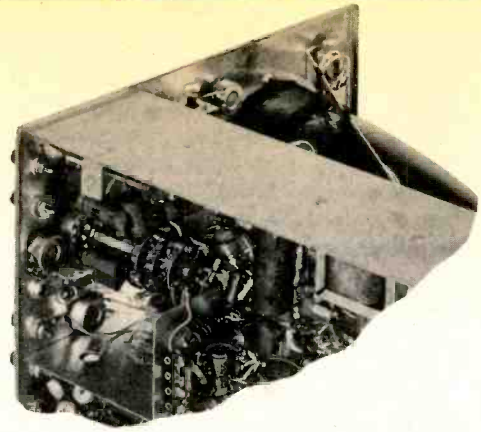
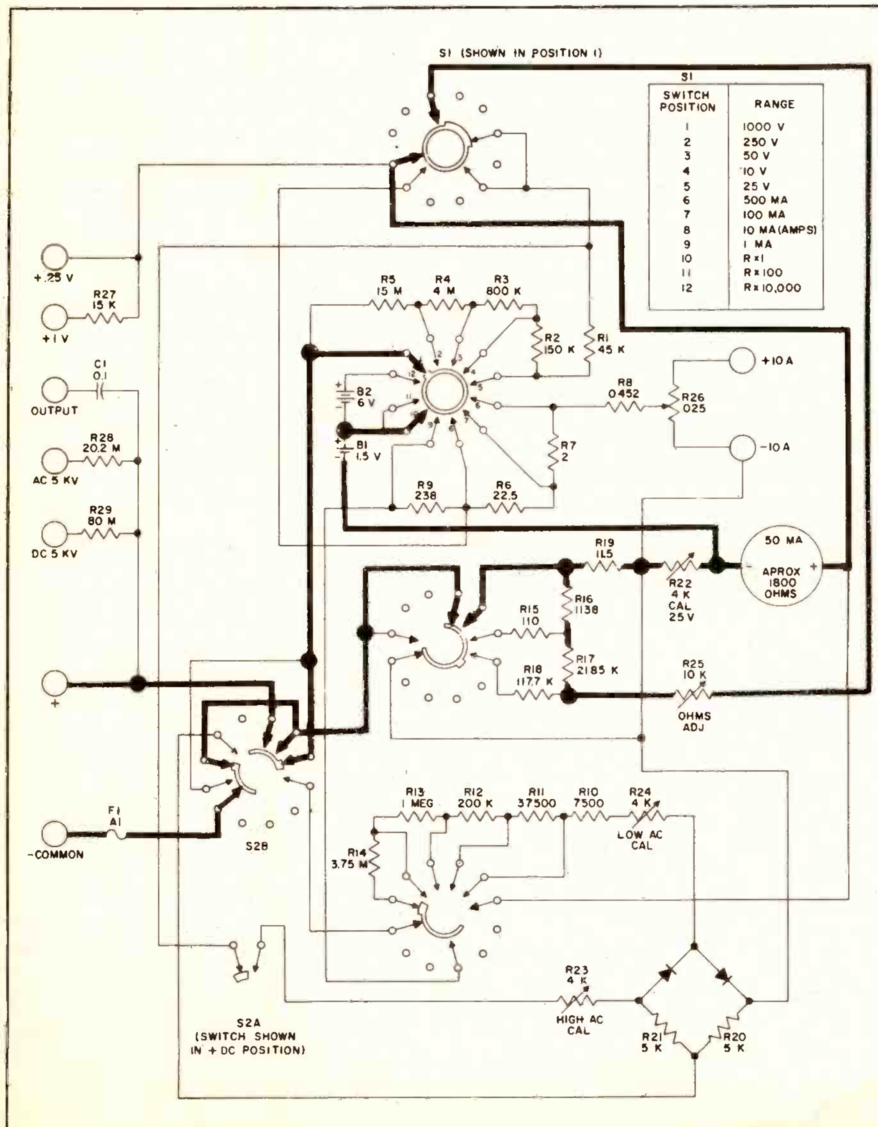
A KEY TO TEST EQUIPMENT CIRCUITS



Increase your understanding of instrument operation.

Service technicians depend for their livelihood on their understanding of electronic circuits, and on their ability to repair them. And yet, surprisingly few servicemen have a really concrete knowledge of what's inside the test instruments they use every day. Not too many of them realize how much easier it would be to use test equipment if only they understood it more completely. In this special book section, you'll learn what is actually happening inside various test apparatus when you take a measurement, look at a waveform, or feed a signal into an ailing set.

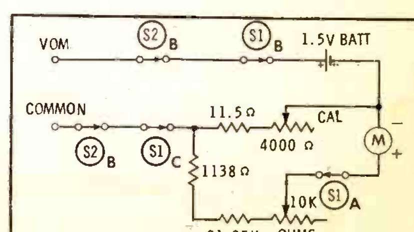


(A) Original schematic

Circuits Are Simple

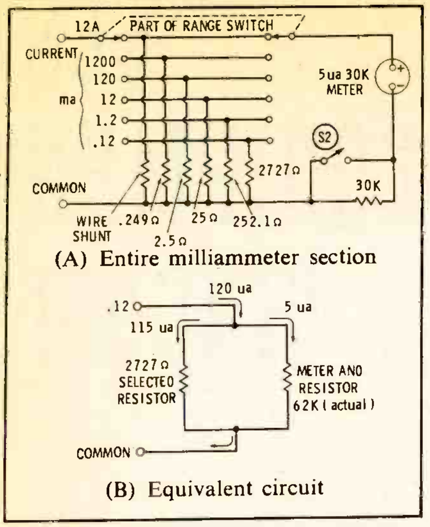
At first glance, most test instruments appear to contain either a maze of complex wiring, or a printed board with numerous components mounted in neat, but confusing, rows. An analysis of the wiring diagram may only add to your uncertainty, since it appears different from anything you've seen in a television or radio schematic. But, take a second glance at the diagram. You'll notice it contains the same components you work with every day, and you'll soon find they're connected into circuits that are not nearly so complex as they may seem. To prove this point, consider that a television set contains several times as many parts as your voltmeter or scope, and its schematic is even more complicated than that of the test instrument—*if you look at the entire schematic at once*. However, when you analyze a TV set, you concern yourself with only one portion at a time; this method will work just as well with test-equipment schematics.

One feature of instrument diagrams seems to offer a stumbling block: Connections through multisection switches can be difficult to trace if you're not familiar with them, especially when the schematic shows the switch set at



(B) Sketch of ohmmeter portion

Fig. 1. Technique of "extracting" simplified schematic for easier understanding.



(A) Entire milliammeter section

(B) Equivalent circuit

Fig. 2. Current-measuring circuits consist of meter with resistive shunts.

some position other than for the function in which you are interested. But there is a technique that can be utilized to overcome this problem—that of "lifting out" a portion of the schematic and sketching it in simplified form. This will be done with many of the schematic diagrams shown throughout this text, and you'll be able to see how it's done. Essentially, it involves lightly marking the switch on the original schematic as if the switch were in the desired position, ignoring the actual setting shown. Tracing connections is thus greatly simplified, and any section of the circuit (for example, the ohmmeter portion) can be sketched in simple form. This technique is demonstrated in Fig. 1; a normal VOM schematic is shown in Fig. 1A, with the R x 1 ohmmeter portion marked by heavier lines. Fig. 1B shows the simplified sketch which can then be made for a fuller understanding of the circuit.

With these "tricks" in mind, let's turn to actual equipment, and learn exactly what makes each type of unit "tick." The most-used instruments on the technician's service bench are the VOM, VTVM, scope, and signal generator. We'll examine the circuits commonly found in each, and learn how they function. This information can be put to practical use through a better understanding of how to use the instruments more effectively and how to determine the cause of any malfunction.

The VOM

The volt-ohm-milliammeter centers around a simple current meter, utilizing series and parallel resistances to permit measuring voltage and checking resistance in addition to the basic function of measuring current. To understand the VOM, you should understand the meter movement, because every other circuit component is chosen carefully to complement this "heart" of the instrument.

The Meter

The sensitivity of the entire VOM depends on the meter. Two factors involved in rating meter movements are the amount of current required to drive the pointer to full scale, and the resistance of the coil. The less current that is required to bring its pointer to full scale, the greater is the sensitivity of the meter. The coil resistance depends on the size of the coil wire and the number of turns needed for the required sensitivity. Most meters used in VOM's are 100-ua and 200-ua units with 800- or 1000-ohm coils; less expensive instruments use 1-ma meters, while more sensitive ones incorporate meters as sensitive as 5 ua.

The characteristics of the meter coil determine the sensitivity of the finished VOM. The almost universal sensitivity for VOM's is 20,000 ohms per volt, but there are instruments ranging from 1,000 to 200,000 ohms per volt.

DC Milliammeter

From the schematic of a typical 200,000 ohms-per-volt meter, you can extract a sketch of the milliammeter section (like Fig. 2A) from which you can easily analyze the action of the circuit.

Fig. 2B is a further simplification that shows how the shunt resistor increases the current range of the basic meter movement, for measuring greater amounts of current. As the value of the shunt resistor is decreased, more of the current applied at the terminals is shunted around the meter. If the instrument of Fig. 2B is placed in a circuit carrying 120 ua, only 5 ua will flow through the meter, and 115 ua will go through the shunt resistor. The amount of resistance is carefully picked to calibrate the circuit for exactly the current range desired.

The circuit in Fig. 2A incorporates a feature that can be found in several recent VOM's: Switch S2 is connected to remove the series resistor from the meter circuit. When the series resistor is thus bypassed, the meter-circuit resistance is reduced to only that of the meter. As a result, the entire circuit requires only half as much current to drive the meter to full deflection, so each scale reading must be divided by 2; thus, the .12-ma (120-ua) scale actually reads .06 ma, or 60 ua.

One other point to notice: For the 12-amp scale, a wire shunt is used. This is a carefully selected piece of low-resistance wire, for it must pass almost the full 12 amps of current. (Only 5 ua can pass through the meter, leaving 11.999995 amps to pass through the shunt.)

DC Voltmeter

In Fig. 3, a 50-ua, 1800-ohm meter movement is being used in a VOM to measure DC voltage. A voltmeter, probably the simplest of circuits to understand, always consists of dropping resistors (multipliers) in series with the meter movement. The multiplier resistors can be considered in either of two ways: They can be looked on as dividers that reduce the voltage to the correct amount for the meter, or they can be thought of as current-limiting resistors to lower the current so it is just enough to drive the meter to full scale. Whichever way you prefer to think of them, the multiplier resistors in a voltmeter are always in series with the meter. This is opposite to the arrangement used with current meters, which invariably have the resistances in parallel with the meter movement.

Some VOM's incorporate a reversing switch for the DC voltmeter, to make it unnecessary to reverse the test

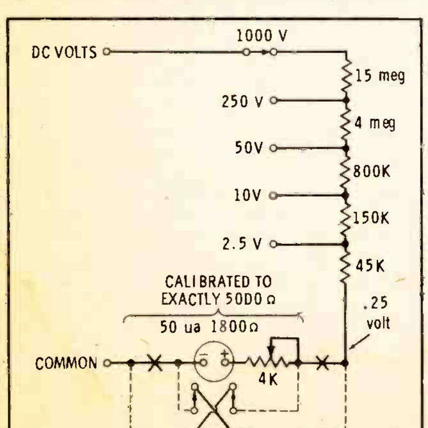


Fig. 3. Common DC voltmeter section is characterized by series-resistor chain.

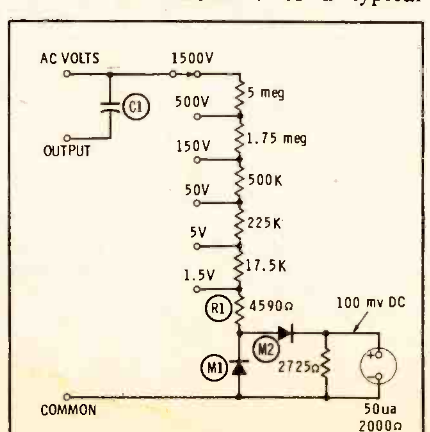


Fig. 4. Rectifiers are used in every AC voltmeter — sometimes they're tubes.

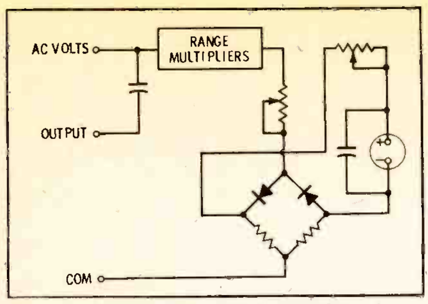


Fig. 5. Bridge-type AC rectifier is a bit more sensitive than half-wave type.

leads when measuring certain voltages. When it is included, the switch is usually placed in the metering circuit as shown in Fig. 3.

AC Voltmeter

To measure AC voltages with the ordinary DC meter movement, it is necessary to rectify the input voltage. Fig. 4 shows a typical AC voltmeter, using a 50-ua, 2000-ohm meter with semiconductor rectifiers M1 and M2. In a number of VOM's, M1 and M2 are a single dual-diode unit. The multiplier resistors are almost the same as with the DC ranges; the only difference is in the values, which must be changed to compensate for the addition of the meter rectifiers. This means the meter sensitivity can't be used directly in calculating the values for multiplier resistors, because the internal resistances and rectifying effects of M1 and M2 must also be considered. This difference is also corrected for, in many VOM's, by a special scale on the meter face for AC volts.

Careful analysis of the circuit in Fig. 4 will help explain one of the precautions which you must ordinarily observe when measuring signal voltages in certain electronic circuits. For example, if you were to measure the audio voltage at the plate of an output stage, the DC voltage present would also have considerable effect on the meter indication, because a positive DC voltage can pass through rectifier M2 and cause a reading on the meter. The result might be a fairly high indication, even though audio voltage might actually be almost nonexistent.

Such readings can lead to confusing results. To eliminate this error, you can try making a second measurement with the test leads reversed, and accepting only the lesser reading of the two. This precaution is sometimes unnecessary, because a number of AC voltmeters include a blocking capacitor (such as C1 in Fig. 4) for measuring AC in the presence of DC. In most instruments, the capacitor is connected to a jack called OUTPUT because it is used primarily in testing audio output stages. Very often, the scale card of the meter is provided with an extra scale — usually calibrated in decibels — to facilitate output readings and allow for the difference in accuracy introduced by adding the capacitor to the divider network.

Fig. 5 shows a slightly different AC voltmeter. In this circuit, the rectifier unit is wired into a bridge network. This arrangement, being full-wave, is somewhat more sensitive than the system shown in Fig. 4. One noteworthy difference about this circuit concerns the erroneous readings that may occur in DC-carrying circuits. In the circuit of Fig. 5, reversing the test leads will have little effect in correcting the error. Therefore, it is necessary to use the "output" function when DC is present in the circuit being tested.

Ohmmeter

Resistance can be measured relatively easily; it is necessary only to apply a known voltage to the unknown resistance, measure the resulting current, and use Ohm's law to compute the resistance. All three steps can be handled automatically by the circuit in Fig. 6.

A 1½-volt battery is used as the voltage source for the R x 1 scale. To set the meter for testing, the ZERO ADJUST potentiometer is set for a full-scale reading with the unknown resistance at zero ohms (leads shorted together). This means the scale card will read from right to left for increasing values of resistance. Practically all VOM's are designed this way, and are thus called *right-hand-zero* ohmmeters. As the unknown resistance increases, less current flows in the meter, and the pointer indicates a higher resistance value on the scale card.

The highest range of this particular ohmmeter (R x 10K) is powered by 7½ volts — usually four 1½-volt flashlight cells in series with the single cell used for lower ranges. Switching to the highest range also connects the measuring circuit to a different point on the divider network. All the resistors in the network are carefully chosen so that, once the meter has been "zeroed" (remember, this is at full scale), a zero reading will occur at every setting of the range switch when the test leads are shorted together. In this type of ohmmeter, when

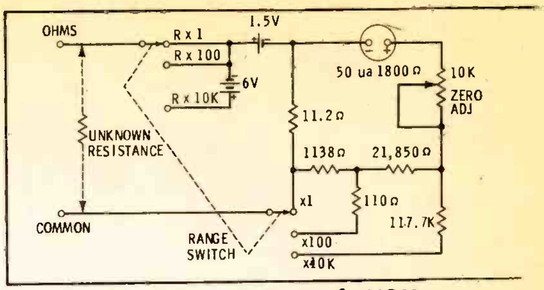


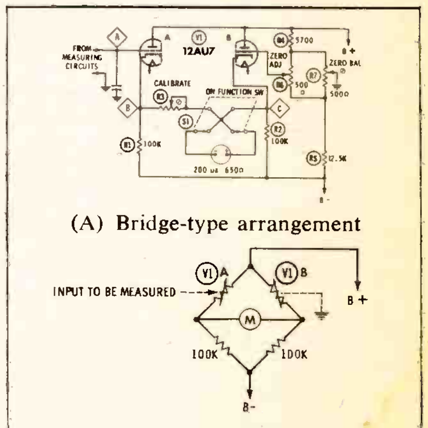
Fig. 6. Ohmmeter section of VOM changes dividers, voltages with range.

you find it fails to "zero" on one range or another, you can blame slight variations in the resistors which make up the divider network. (Of course, this assumes the batteries are fresh.) However, this slight shift can be taken care of by resetting the ZERO ADJ potentiometer, and will have little effect on resistance readings.

The VTVM

It has been truthfully said that a VTVM is merely a glorified VOM. However, this "glorification" is not without good cause. One of the assets of the vacuum-tube voltmeter is its input impedance, which is constant for all its ranges and very high in value—10 megohms is common, compared with 20,000 ohms per volt for most VOM's. This means that, on its 500-volt scale, a VOM would have an input impedance of 10 megohms—comparable to the impedance of a VTVM; but, on the 10-volt scale the VOM would have an input impedance of only 200K ohms (which would load down some high-impedance circuits), while the VTVM still would maintain its 10-megohm input impedance.

The VTVM also has other advantages. The use of a vacuum tube makes it possible to incorporate a relatively inexpensive meter movement, yet obtain instrument sensitivity far exceed-



(A) Bridge-type arrangement

(B) Equivalent circuit

Fig. 7. Metering circuit for VTVM uses vacuum tube to increase sensitivity.

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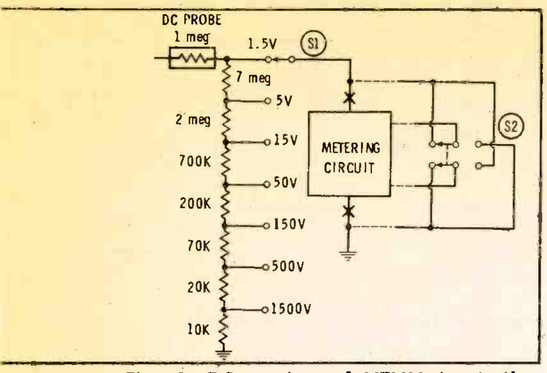


Fig. 8. DC section of VTVM is similar to its counterpart in the usual VOM.

ing that of the VOM. Also, it permits easy conversion of the ohmmeter scale into a *left-hand-zero* type, making it more consistent with the rest of the scale card. Much higher ohmmeter ranges can be used, because of the increased sensitivity of the metering circuit.

The Metering Circuit

The main difference between the VTVM and VOM is in the metering circuit. Most modern VTVM's use a bridge circuit like that shown in Fig. 7, with a vacuum tube as two "legs" of the bridge. The meter itself is connected between the cathodes, which represent the balance points for the bridge, as shown in Fig. 7B; the tubes then represent variable resistances in the two upper legs of the bridge. One tube maintains balance in the bridge when the input is zero; the other "senses" the value of any input voltage and unbalances the circuit, causing an indication on the meter.

Let's examine the circuit a bit more closely. First, the input: The voltage from the measuring circuits (multipliers, range switch, etc.) is developed between the grid of V1A and ground; therefore, it is actually applied between the grids of the two tubes, since the grid of V1B is returned to ground through R6 and the slider of R7. Thus, a positive voltage at point A will cause greater conduction in V1A and reduce conduction in V1B, causing point B to become more positive and point C to become more negative. The meter indicates this change by an upscale movement of the pointer. If a negative voltage is applied to point A, point C becomes more positive (from increased conduction in V1B) and point B becomes more negative. The result is a downscale swing of the needle, unless polarity switch S1 is changed to cause the meter to read upscale.

When the value of the applied voltage is known, R3 can be adjusted until the current through the meter is just enough to make the pointer fall at the proper marking on the scale card, thus calibrating the instrument.

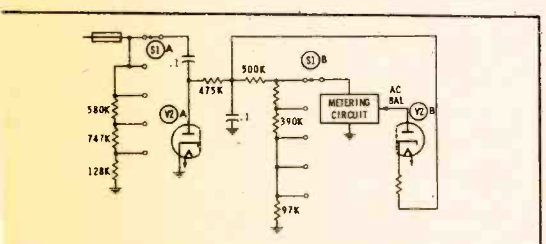
If the input voltages are not applied at just the right "point" in the bridge, the positive and negative swings will not be symmetrical—that is, a 10-volt positive swing will not unbalance the bridge exactly the same amount as a 10-volt negative swing. The ZERO BAL potentiometer allows for adjusting this balance to suit the tube characteristics.

It is also necessary to establish an equilibrium within the bridge, for it must be exactly balanced so no indication will be passed on to the meter when point A is tied to ground or no voltage is being applied. For this purpose, the ZERO ADJ potentiometer is provided; it will be found on the front panel of most VTVM's, where the operator can adjust it easily.

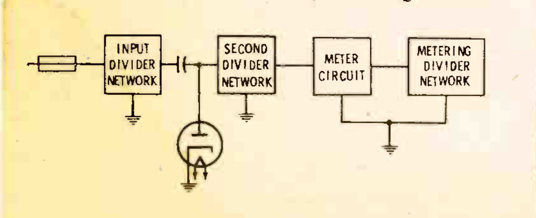
Certain of the above functions are handled somewhat differently in various VTVM's, but you'll find that most follow the same general design pattern. Remember, a circuit such as that in Fig. 7 does not depend on an extremely sensitive meter movement for its sensitivity. In the VTVM whose metering circuit is shown in Fig. 7, a 200-ua, 650-ohm meter is used, although the input impedance of the VTVM is 10 megohms. This demonstrates a basic fact about a VTVM: its input impedance depends essentially on the divider networks used at the input of the instrument, and has little to do with the sensitivity of the basic meter movement.

DC Voltmeter

There is a simple method of analyzing the voltmeter section of a VTVM: merely think of it as a VOM, and consider the vacuum-tube metering circuit as a simple meter. For an example, look at Fig. 8. The input multiplier consists of resistors totaling 10 megohms; various points in this divider chain are connected to the metering circuit to derive the various ranges. Since the metering circuit in this case (the grid circuit of V1A—Fig. 7) has almost an infinite impedance, it has little effect on the divider network, or on the input impedance of the instrument.



(A) V2 forms balancing network



(B) More elaborate dividers

Fig. 9. Special circuit arrangement for AC voltmeter in one popular VTVM.

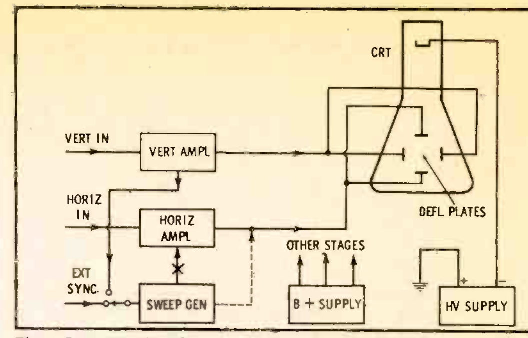


Fig. 10. Basic diagram of oscilloscope includes the functions most necessary.

The DC probe contains a 1-meg resistor, as do most of those used with modern VTVM's. The resistor helps isolate the VTVM tube stages from the circuit being tested—particularly on the lowest range, where the 1-meg resistor is the only isolation between the measured circuit and the grid of V1A. This resistor also makes the overall input impedance of the VTVM 11 megohms on all DC ranges.

Note the similarity between the circuit of Fig. 8 and that in Fig. 3. The metering circuit in Fig. 8 performs the same functions as the meter and the calibration potentiometer of Fig. 3.

In Fig. 8, you'll also notice an extra switch, S2. This is a polarity-reversal switch of a type used in some VTVM's, which "flips" the input connections to the entire metering circuit instead of changing just the meter connections as is done in some instruments.

AC Voltmeter

There are several types of AC voltmeters used in different models of VTVM's: ordinary AC voltmeters, for measuring rms values of power-line and audio voltages; peak-reading voltmeters, which indicate the peak value of any AC waveform; peak-to-peak voltmeters, that can measure complex waveforms such as those found in television sets; and special amplified voltmeters, usually for measuring very small audio or other rms voltages.

The most common of these—the *rms voltmeter*—is found in both VOM's and VTVM's; a typical circuit is shown in Fig. 9A. You'll notice its similarity to the AC voltmeter in Fig. 4; the function of the VTVM metering circuit is the same as in the DC voltmeter just discussed.

You'll notice two divider networks. Since the shunting effect of rectifier

V2A will vary with the voltage impressed across it, allowance must be made for this before the rectified voltage is fed to the metering circuit. The resistive network associated with switch S1 (both sections) takes care of this.

Rectifier V2B feeds a portion of the rectified voltage back to the metering circuit to balance the entire network so it will correctly read both positive and negative excursions of the input AC voltage. This matters little with sine waves, but when the rms (effective) value of an odd-shaped waveform is being measured, it is important that the circuit be effectively balanced.

A more elaborate variation of the AC voltmeter is shown in Fig. 9B, in block form. In this system, three divider networks are incorporated in the measuring circuits; the input divider, the rectifier - compensating network, and a divider network associated with the metering circuit itself. The additional divider merely permits more precise design of the measuring circuit to cover each range more accurately.

Peak-Reading VTVM

In the rms-type meter, the "effective" voltage of a sine wave is only .707 times the peak value, and this is what the instrument measures. To measure peak (and peak-to-peak) voltages, a voltage-doubler rectifier—often a bridge-type—is normally used, along with a filter circuit having a long time constant. The values of the filter components are chosen so the capacitor hardly has time to start discharging before the next half-cycle recharges it. Thus, the reading indicates more nearly the actual peak of the input signal.

In peak-reading VTVM's, the rms scale is merely calculated from the fact that the rms value of a sine wave is exactly .707 times the peak value. Therefore, as a rule, the rms scales are accurate only when a sine wave voltage is being measured. Remember, this applies only to VTVM's that are designed for peak or peak-to-peak measurements.

Current Measurement

Very few VTVM's make any provision for measuring current. When they do, their current-measuring circuits are exactly the same as those used in VOM's, and the bridge circuit is not used. The meters used in VTVM's, as explained before, are seldom as sensitive as those used in VOM's, since this sensitivity is not needed. For this reason, VTVM's are not likely to be capable of measuring very low currents—a slight limitation on their usefulness.

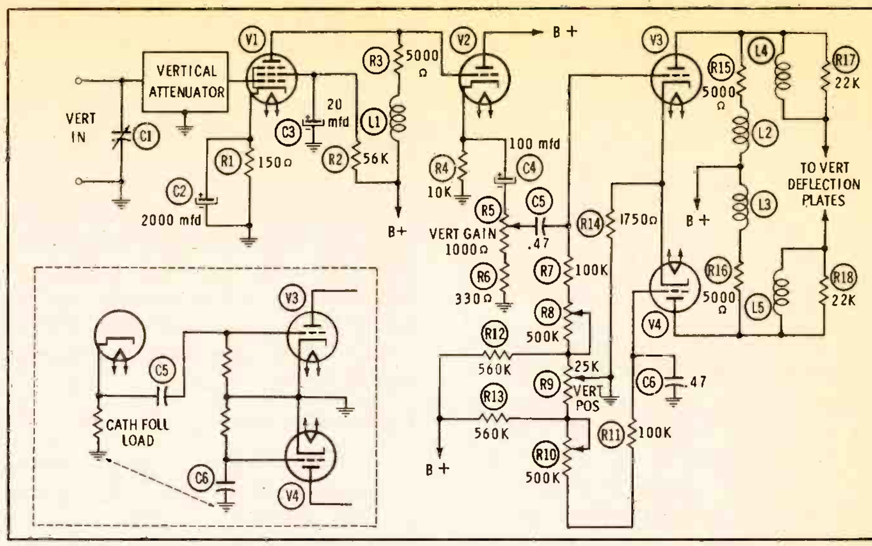


Fig. 11. Vertical amplifier is signal-handling section of the oscilloscope.

Oscilloscopes

Next to the VOM and VTVM, the oscilloscope is undoubtedly the most indispensable troubleshooting instrument for the practical serviceman. With it, he can actually look at the most complex waveforms traced by the continually alternating signal voltages in electronic circuits. To perform this feat, every oscilloscope—even the simplest—must have certain functions. A glance over Fig. 10 will show you the basic sections that every oscilloscope must contain. Each section may be as elaborate or as simple as the application calls for, but the key stages are still the same.

Vertical Amplifiers

Differences you will find in vertical amplifiers will generally concern the input-attenuator arrangement, the amount of amplification, the bandwidth, and the point of sync takeoff. A typical vertical amplifier is shown schematically in Fig. 11.

The first significant feature you'll notice is the fact that the output is push-pull and one output tube connects to each deflection plate of the CRT. Most modern scopes use this arrangement, as it permits the use of tubes which consume little power, while still driving large-screen scope tubes. Single-ended output stages are still used occasionally, but they're not very common.

The push-pull output stage shown in Fig. 11 is unusual in its own right,

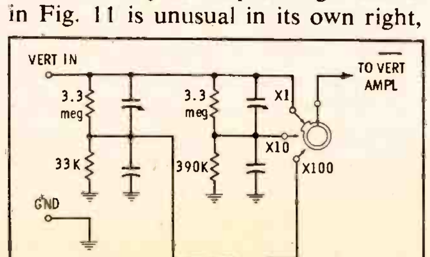


Fig. 12. Vertical attenuator network.

because of the uncommon driving arrangement—usually found only in scopes. Cathode follower V2 is used as the driver tube. C4 couples the signal to the VERTICAL GAIN control R5; the impedance of the capacitor is so low that the cathode-follower signal load effectively consists of R5 and R6 paralleling R4. Capacitor C5 feeds the signal to the grid of V3. But how is the push-pull signal developed and made to drive V3 and V4 on alternate cycles? The insert of Fig. 11 shows the simplified equivalent push-pull circuit. Since C6 grounds the grid of R4 for signal voltages, the cathode-follower load is connected to both grids— one end to V3, and the other to V4. Thus, when the signal waveform is positive-going, V3 conducts; on the negative excursion, V4 conducts. In this way, the tubes act in push-pull, without the conventional phase-splitters, phase inverters, or driver transformers commonly associated with push-pull operation.

You'll also notice that V3 and V4 are connected directly to the deflection plates; no coupling capacitor is used. This means that the deflection plates operate at the same potential as the output-tube plates, and that varying the average plate voltage of either output tube will alter the DC voltage on that one deflection plate, thus offering an easy means of positioning the beam vertically.

In the circuit of Fig. 11, this beam positioning is done by changing the tube bias; control R9 is the adjustable part of a voltage divider which balances the bias voltage between the grids. Moving the control slider toward V3 will place its grid nearer ground potential, applying more of the cathode bias to the grid. Meanwhile, the V4 grid becomes slightly more positive because of its connection to B+ through R13. Conduction

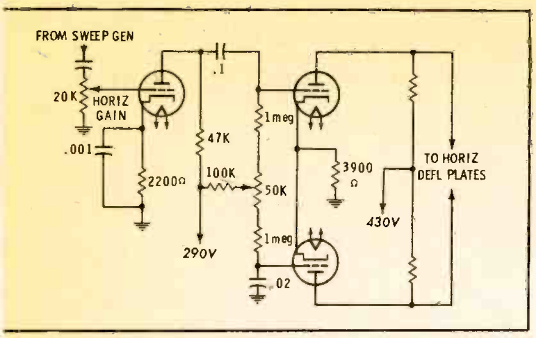


Fig. 13. Horizontal amplifier doesn't incorporate bandwidth-widening parts.

in V3 decreases, while current through V4 increases. The plate of V3 becomes more positive, and so does the corresponding deflection plate—thus attracting the electron beam in the CRT. The plate of V4 becomes less positive, aiding the action and allowing the beam to move toward the opposite deflection plate more easily.

To summarize the action of the output stage: The average position of the CRT beam depends on the bias of the output tubes, and this beam positioning is controlled by R9. The instantaneous movement of the CRT beam in step with the signal is accomplished by the push-pull action of the output stages, caused by the signal being fed to the output grids from the cathode follower.

The input attenuator limits the input signal to a level that will not overload the first amplifier stage. It usually consists of a resistive divider network like that shown in Fig. 12. The capacitors, which prevent favoring certain frequencies, are present only in compensated attenuators. In more elaborate instruments, attenuators of even greater complexity are common.

The gain of the vertical amplifier section is developed mostly in the input amplifier. However, the bandwidth of the instrument is dependent on the bandpass of all the amplifiers. V1 in Fig. 11 uses choke L1 for high-frequency peaking, and high-value cathode-bypass capacitor C2 to prevent low-frequency degeneration. DC coupling to the cathode follower prevents any frequency-response problem there.

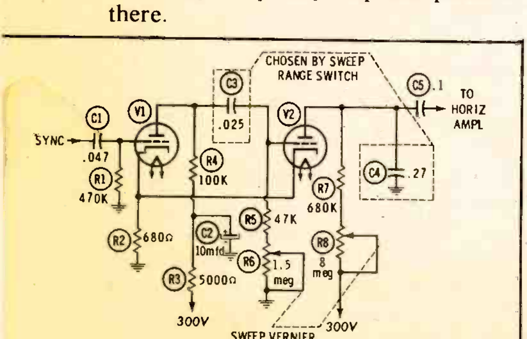


Fig. 14. Multivibrator-type sweep generator uses cathode coupling system.

In the output stage, both series and shunt peaking coils are used to flatten the overall response of the vertical amplifier section. Resistors R15, R16, R17, and R18 serve to dampen any self-resonant characteristics of the peaking coils.

If a single-ended output stage is used, one deflection plate is grounded. Operation is then somewhat similar to the push-pull action described in the insert of Fig. 11, with the ground connection serving as a signal-coupling device.

Horizontal Amplifiers

In many scopes, the horizontal amplifier system is an exact replica of the vertical amplifier, having equivalent sensitivity and bandwidth. In most service scopes this extra gain and response is unnecessary, and the horizontal section has only enough gain to fill the CRT screen with the drive signal from the sweep generator. Some, however, include extra gain so the trace can be expanded for close inspection of some portion of the display.

Fig. 13 shows one of the more common horizontal amplifiers. It is quite similar to the vertical amplifier shown in Fig. 11, except it has less gain, and the bandwidth is more limited. The same push-pull configuration — so common in modern scopes—is used in this amplifier. However, you'll notice the absence of frequency-compensating devices in this amplifier—a clue that bandwidth is not considered important for the horizontal sweep system of this scope.

Sweep Generators

To sweep the CRT beam from side to side, a linear-sawtooth generator is incorporated in every scope. It may be called the sawtooth oscillator, sweep generator, sweep multivibrator, time-base generator, or one of countless other names based on the circuit configuration. The function is always the same: to sweep the CRT beam across the face of the CRT in a linear fashion, and then bring it quickly back across the screen to begin another trace. In a few older scopes, blocking oscillators are used, but nowadays the multivibrator is the more common circuit.

Two types of multivibrators are in general use—the cross-coupled and cathode-coupled circuits. The latter arrangement, using a common cathode resistor to couple the two sections of the multivibrator, is probably a little more prevalent than the plate-to-grid type. A typical cathode-coupled multivibrator is shown in Fig. 14. This circuit is a free-running sawtooth os-

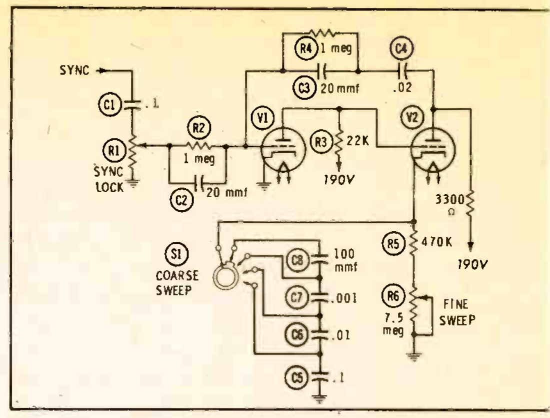


Fig. 15. Frequency-determining parts in cathode of cross-coupled oscillator.

cillator, but can be controlled by a synchronizing signal applied through C1. Feedback is provided primarily by cathode resistor R2, which is common to both stages; however, oscillation is also dependent on the coupling provided by capacitor C3.

The frequency of the circuit in Fig. 14 depends on the time constants formed by C3, R5, and R6 in the grid circuit of V2, and by C4, R7, and R8 in the plate circuit. The main frequency selector is a switch that connects alternate values of capacitors in place of C3 and C4, while a dual-control potentiometer (R6 and R8) serves for "fine tuning." Ranges of sweep frequencies vary with scope application; some sweep only up to 40 or 50 kc, while others provide sweep frequencies as high as 1 mc.

A variation of the cross-coupled multivibrator is shown in Fig. 15. The main frequency-controlling components are connected to the cathode of V2; S1 chooses one of the frequency-determining capacitors, and R6 functions as a vernier tuning control. Also note the DC coupling between the plate of V1 and the grid of V2. This multivibrator can be controlled by a sync signal coupled to the grid of V1 through C1.

The main frequency-selecting switch of most scopes almost invariably includes a position which applies a portion of the AC line voltage to the input of the horizontal amplifier; this permits sweeping the CRT with a

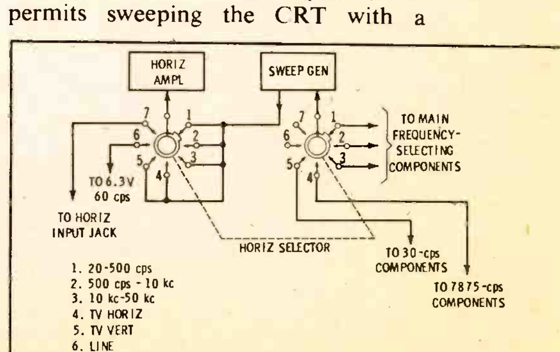


Fig. 16. Horizontal frequency selector.

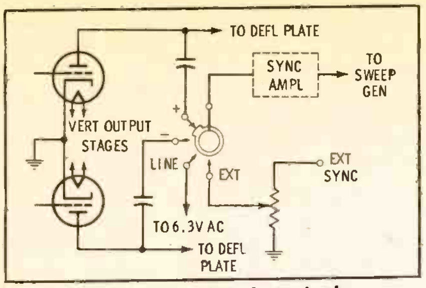


Fig. 17. Sync circuit of typical scope.

60-cps sine-wave trace (useful in certain applications). Other auxilliary positions of the frequency-selector switch provide fixed-tuned TV horizontal and vertical sweep rates; these are usually preset to show waveforms of two or three horizontal lines or vertical frames. Also, the same switch is ordinarily used to connect the horizontal amplifier to the HORIZONTAL INPUT jack on the panel. Fig. 16 depicts a typical frequency-selector switch, and shows schematically the connection made in each position.

Sync Section

Quite a few scopes don't actually have a sync "section," although practically all of them have provisions for synchronizing the trace, so the waveform display will stand still horizontally. Most common is the system shown in Fig. 17 or a similar variation of it.

For the + and – positions of the switch, a sample of the input signal is taken from the plate of each output stage. If the signal is predominantly positive-going, best sync is obtained if the switch is set at the + position; if the signal is mostly negative the – position provides best sync. "Line" sync makes it easy to stabilize patterns that are exact multiples or submultiples of the line frequency—60 cps. An amplitude control is generally used with external sync, since too much synchronizing voltage can sometimes distort the scope's horizontal sweep.

In many scopes of more elaborate design, a sync amplifier is included, as shown by dotted lines in Fig. 17. When this stage is used, the sync-amplitude control is usually placed in the amplifier grid circuit, thus affecting all sync signals—both internal and external.

Auxilliary Circuits

There are a number of circuits, in some scopes, that are not absolutely necessary to the main function of the instrument. These circuits make operation of the instrument easier in many instances; in other cases, they adapt the unit to special applications; sometimes they make it easier to interpret the traces. Among these auxilliary circuits are retrace blanking, Z-axis modulation, triggered sweep, polarity reversal, variable-bandwidth switching, and various calibrating devices.

Retrace blanking simply consists of a negative pulse, derived within the instrument, that is applied to the grid of the CRT during the time when the trace is "snapping back" to begin a new line. In some scopes, the opposite "tack" is taken; the CRT is biased past cutoff and is "unblanked" during sweep time. Fig. 18A shows a waveform with a retrace line visible, while Fig. 18B shows the effects of retrace blanking.

Z-axis modulation has limited use in service work. It is simply a connection, usually on the front panel, by which a signal can be applied to the grid of the CRT to decrease or blank the intensity during negative portions of the Z-axis signal.

A *triggered sweep,* useful for analysis of certain pulse waveforms, is found most frequently on industrial scopes. In these instruments, the sweep generator is not free-running, but depends on an external stimulus or trigger. As a rule, it must be triggered for each excursion of the sweep, but some can be set to run for a definite number of cycles after each triggering pulse. In all models, the trigger pulse is applied in essentially the same manner as the sync signal in ordinary scopes.

Polarity reversal is merely a way of turning the trace upside down so positive-going pulses (such as television sync pulses) point downward, whereas they might normally point upward. This can be done rather easily by providing a switch to reverse the polarity of the signal just before it is fed to the push-pull output stage. With some scopes, this is done by switching the push-pull input from the cathode (as in Fig. 11) to the plate, which must have a suitable plate-load resistor.

A compromise between bandwidth and sensitivity must often be reached in scope design. To get around this, a few scopes offer two *bandwidths,* chosen by a switch on the front panel.

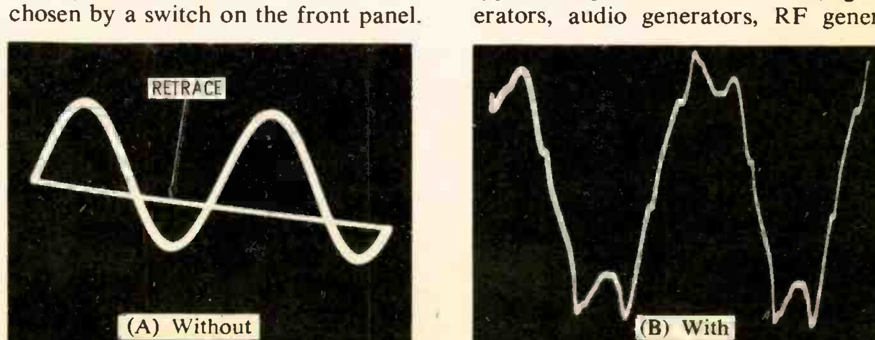


Fig. 18. Effects of retrace blanking.

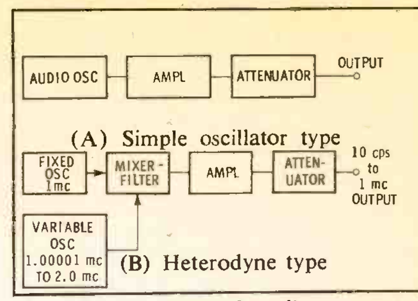


Fig. 19. Two types of audio generator.

The wide-band position sacrifices some sensitivity; but when measurements must be made that demand high sensitivity, the switch can be set for narrower bandwidth and higher gain. The change is accomplished within the instrument merely by removing the effects of some of the peaking components and changing operating voltages of certain tubes.

There are a number of *calibrating* devices and methods. Basically, they all consist of a predetermined voltage that can be applied to the vertical amplifier. The vertical gain control is then set to obtain a certain arbitrary vertical trace size; thereafter, that amount of deflection represents the same value as the calibrating voltage. In most scopes, the markings on the vertical-attenuator switch then represent decimal multipliers for the original calibrating voltage.

The calibrating voltage is usually taken from the filament circuit via a resistive divider which sets the exact voltage—commonly 1 volt. In many scopes, a calibrated graticule aids in reading peak-to-peak signal voltages with the scope; the calibration is simpler and more "automatic."

Signal Generators

Signal injection is recognized as a quick, logical method of localizing trouble in all sorts of electronic circuits. But, as in other phases of service work, the application of any troubleshooting plan is only as thorough as your understanding of the tool—in this case, the signal generator.

There are a number of general types: simple harmonic (noise) generators, audio generators, RF gener-

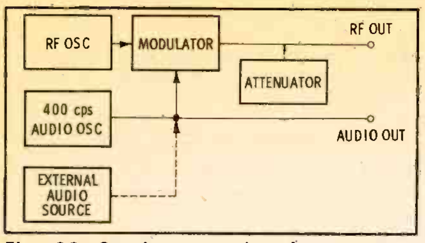


Fig. 20. Service-type signal generator.

ators, modulated RF generators, and special pulse (and pulsed-RF) generators. The simplest of these—the noise generator—consists of a circuit that can produce sharp pulses at some frequency in the audio spectrum. The fundamental frequency can be used for signal injection in audio equipment, while the high harmonic content of the pulsed signal makes its output useful also in RF and IF stages. For example, a 1000-cps harmonic generator can produce a usable signal for troubleshooting IF stages and RF amplifiers at more than 1000 times the fundamental frequency. This is because of the sharp nature of the pulses; the sharper the leading edge and the flatter the top of each pulse, the higher is the harmonic content of the signal.

Audio Generators

For testing audio circuits, two general types of instruments have been developed (Fig. 19). The first, shown in Fig. 19A, consists of a simple oscillator that produces an audio sine wave, an amplifier to raise the signal-voltage level, and an attenuator system. The oscillator can be a phase-shift type, a multivibrator, a blocking oscillator, or any other type capable of producing an audio sine wave. The amplifier increases the signal level sufficiently to permit injection directly into high-level output stages—usually 5 or 10 volts rms. The attenuator may be a carefully calibrated divider network that permits choosing the exact amount of signal—millivolts or volts —for a specific purpose; but in less expensive generators, the attenuator may be only a potentiometer.

Fig. 19B shows a different type of generator, more elaborate than the one shown in Fig. 19A; it is called a *beat-frequency* audio generator. In this instrument, the signal from a variable oscillator (controlled by the frequency dial) is mixed with the output of a fixed oscillator; the resulting beat-frequency signal is amplified and fed to the output network. The advantages of this system are greater accuracy of the audio output frequency, greater stability, and a wider range of available frequencies.

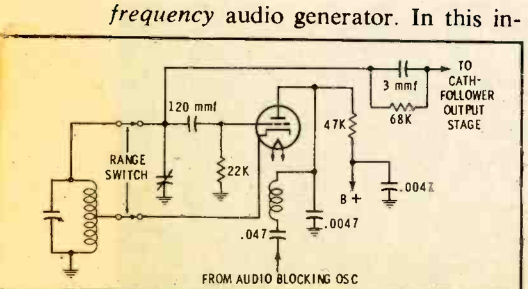


Fig. 21. Hartley oscillator that can be amplitude modulated with audio tone.

RF Generators

The "old standby" of radio and television servicing is the RF generator, usually equipped with an internal audio oscillator so a choice of three output signals—pure RF, modulated RF, or audio only—can be provided. This makes for versatility in application, because the instrument can be used for all sections of radios and television sets—provided the range of RF frequencies is sufficient. Some signal generators make provision for modulating their RF signal with the output from an external audio generator, further increasing the versatility.

Fig. 20 shows the essential portions of a service-type signal generator, with certain more elaborate features added in dashed lines. The oscillator is similar to those found in other RF devices; more often than not, it is a Hartley type. In many instruments, the modulation actually takes place in the RF oscillator tube—at the screen grid, at the plate, or at both. The attenuator shown can be anything from a simple potentiometer to a complex bolometer arrangement used for measuring microvolts of output signal.

The Hartley oscillator shown in Fig. 21 is typical of those found in service generators, although other variations are used. The signal-takeoff point for this circuit, however, is somewhat different from most; the output signal is taken directly from the tuned tank (at the grid connection) rather than from the plate circuit of the tube. This is done to permit use of an inexpensive triode tube and still allow the plate circuit to be connected to the modulating signal without affecting the tuned tank.

To prevent interaction between the tuned tank and the load connected to the instrument, a cathode follower is inserted between the oscillator and the output attenuator system.

If the oscillator tube is a pentode (or a pentagrid type), the circuit can be connected as shown in Fig. 22. In this arrangement, the output is taken from the plate of the tube, while modulation takes place at the screen grid. Thus, the oscillator section controls the plate current at an RF frequency by the action of the control grid, while at the same time the screen grid varies the plate current at an audio rate. The result of these actions is a modulated RF signal fed to the cathode follower, and thence to the output system.

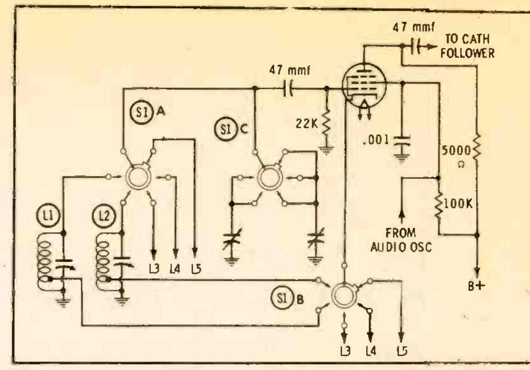


Fig. 22. Bandswitching signal generator with screen-modulated oscillator.

A common attenuator arrangement is shown in Fig. 23. It is essentially a rather simple configuration, but is effective in preventing leak-through of RF signal to the output jack. In use, the COARSE control is set for enough output signal (with the FINE control fully clockwise) to fulfill the needs of the job being done. Then the FINE control couples out only as much of the signal as is needed for each step of the signal-injection or alignment procedure.

Conclusion

The circuits in this section are typical of those found in the most-used bench instruments in the ordinary service shop — the VOM, VTVM, scope, and signal generator. Each circuit has alternate arrangements which may vary from instrument to instrument. You'll find, however, that every instrument in each group *must* perform certain operations, and it is these operations you have learned about in the preceding pages. If you understand the functions described, and the circuits used to perform them, you'll have no difficulty in understanding whatever brand and model of instrument you own. Also, when you understand what's going on inside your test equipment, you'll not only be better able to use each instrument for its basic purposes, but you'll find you can develop many additional uses. Then your instruments will truly be what they're intended to be— the tools of a professional serviceman. ▲

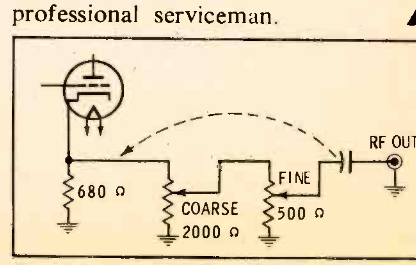


Fig. 23. Common RF output attenuator.

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ABOUT THE COVER

Test equipment is a major factor in a technician's productive capacity, and an important item in his budget; so he needs to keep posted on its availability and proper use. Therefore, we're again presenting a special issue devoted entirely to test instruments for the service shop.

LETTERS TO THE EDITOR

Dear Editor:

I wonder if you could put a note in PF REPORTER to see if I can find a job as a TV repairman? I'm a Seventh-Day Adventist, and would have to be off every Sabbath. I'm 42, am an electronics-school graduate, and have 12 years' experience.

H. A. DODSON

202 Holly Ave.
Charleston Heights, S. C.

Anyone have an opening for a southern gentleman?—Ed.

Dear Editor:

In the article "Unusual Faults in Filament Circuits" (January, 1963), Fig. 5 shows a special method of obtaining DC filament voltage for hum-free operation. My friends and I have examined this diagram and cannot figure out how the circuit works. Would you examine it, and if the wiring is correct, please explain how it works?

LAWRENCE W. HUDSON

Flushing, N. Y.

The schematic is correct. A detailed explanation of voltage-doubler circuits appeared in the article "Debugging B+" (September, 1962). Operation of the filament string can be understood very simply if you consider that a DC voltage (with respect to ground) appears at the junction between the two rectifiers. (Note that the AC line is not returned to ground.) Any circuit connected at this point will receive the voltage—approximately 130 volts DC—developed here. In this case, that circuit is the filament string.—Ed.

Dear Editor:

I'd like to point out that on page 41 of the December issue, capacitor C2 in Fig. 4 is shown as a resistor. The text refers to a capacitor. Which is correct?

HENRY GONDER

West Hollywood, Fla.

The text has it stated correctly. Capacitor C2 across the ringing coil was inadvertently drawn as a resistor.—Ed.

Dear Editor:

Thought it's about time I put in a few words from "down under." Having serviced sets in England, Europe, and Australia, I've come to the conclusion we have the same troubles as you encounter in the U.S.A. I find the articles in PF REPORTER excellent reading and very informtive. They help universally, without regard to the origin of the set. Keep those magazines coming!

CHRIS KNIGHT

Perth, Australia

We've always wondered—being on the underside, do you ever have trouble with tubes falling out of their sockets? Seriously, we "up over" inhabitants are always pleased to hear from our counterparts living "down under."—Ed.

Dear Editor:

I'd like to get a copy of the "Fusible-Resistor Guide" that appeared in the December, 1962 issue, without having to tear it out. I've kept all issues of PF REPORTER since January 1954; I consider them a valuable reference library. Ten of the issues have been slightly chewed by our beagle pup, but they are still usable.

JERRY BIGGER

Kansas City, Kan.

Your pup has unmistakably fine tastes, Jerry. A reprint of the "Fusible-Resistor Guide," on durable card stock, is available free to any PF REPORTER reader who wishes to carry it in his tube caddy.—Ed.

Dear Editor:

In sets which have the dual-diode AFC rectifiers soldered into the printed board. I make a practice of soldering the pins from old tube sockets into the board. Then, whenever I have to replace the diode later, it is a simple matter of plugging the unit in.

SAYREVILLE ELECTRONICS

Sayreville, N. J.

This might save some time if you will be servicing the set year after year, or if you replace them quite often.—Ed.

Dear Editor:

I'd like to see an article, with illustrations, on repairing and adjusting levers, switches, and springs on the clocks in clock radios.

FRED H. ITO

Walnut Grove, Calif.

Just watch future issues, Fred. An article on this subject is in the works.—Ed.

Dear Editor:

I had an interesting experience recently. I spent all morning battling a remote control unit, with little success. At noon, when I went home for lunch, my October issue of PF REPORTER had arrived; so, I looked through it while I ate. Lo and behold, in the *Troubleshooter* section was "Restless Remote," discussing the same chassis on which I'd been working. When I got back to the shop, I spent only minutes in locating the trouble. This is not the first time PF REPORTER has pulled me out of a sticky service situation, but it surely was the most timely.

GILBERT CLEMONS

Georgetown, Del.

Not everyone gets instant troubleshooting for their dessert—just PF REPORTER readers. Be sure to watch our future menus.—Ed.

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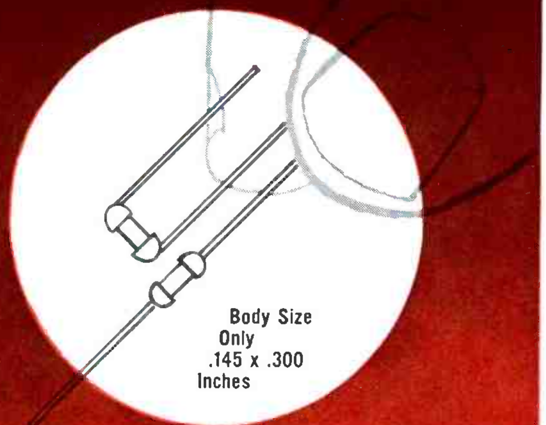

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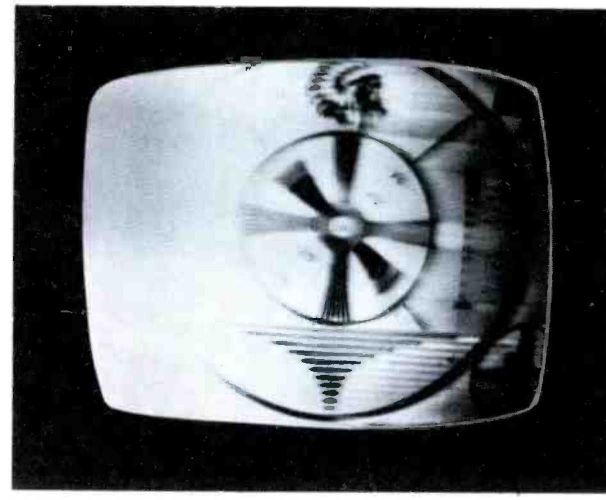

Extreme smearing and apparent overloading are strong clues to the nature of this fault, pointing to a video or IF-stage trouble. The symptoms appear considerably different from those of AGC overload, so you can discount the possibility of the defect being in an AGC-controlled stage. The "whited-out" half of the screen is characteristic of IF regeneration or oscillation, and the ringing points to a stage near the video detector. (A hand brought near the tube in the faulty stage determined positively which one it was. One voltage measurement revealed a bias resistor which had increased considerably in value.)

—From Howard W. Sams "Photofact Guide to TV Troubles"

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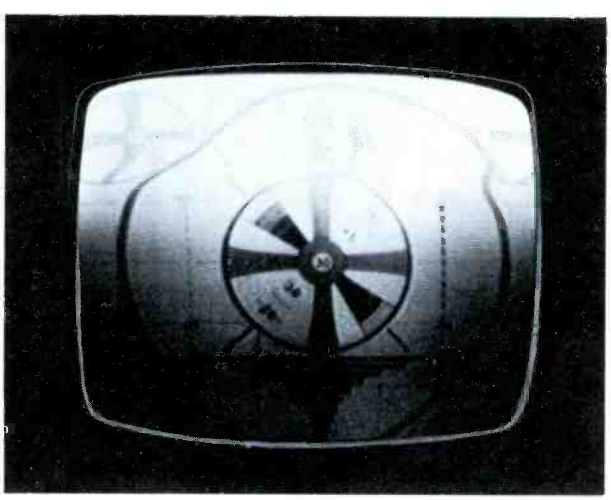

Here's a condition which, on first glance, could indicate trouble in any of several stages. The most prominent symptom is the horizontal pulling at the top. However, look more closely: Poor interlace indicates that the fault is also affecting vertical sync to some extent. A 60-cps hum mingled with some snow in the picture indicates the trouble is probably connected in some way with the earlier stages of the receiver—because the high gain of these circuits tends to magnify even slight faults. (The trouble was traced to an open resistor connecting the AGC line to the grid of the first IF tube.)

—From Howard W. Sams "Photofact Guide to TV Troubles"

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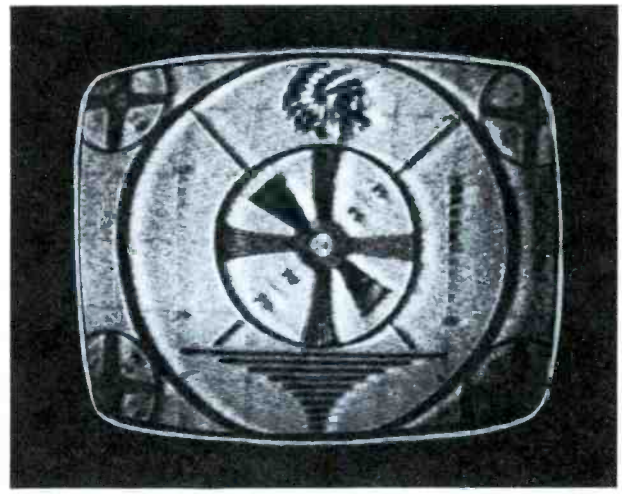
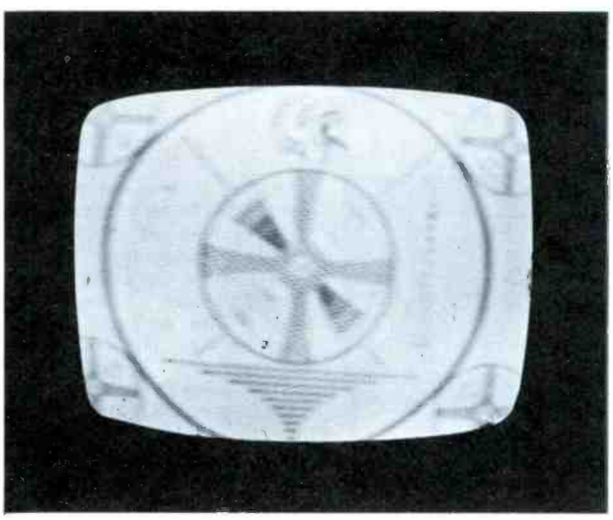


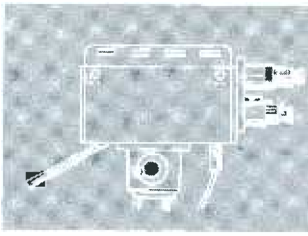
This symptom offers a number of clues which can help pinpoint the location of the faulty component. For example, heavy snow means the front-end circuits must be amplifying; indeed, the sparkle and the heavy, coarse snow are indicative of operation at full gain, as when AGC bias is lost. In this set, only the first IF and the RF amplifier are AGC-controlled. The slight ringing helps eliminate the RF amplifier from suspicion, since this symptom is seldom caused by this section. Thus, the field is narrowed down to the first IF stage. (The trouble was a shorted capacitor in the grid circuit, altering AGC voltage and stage tuning.

—*From Howard W. Sams "Photofact Guide to TV Troubles"*



This picture is faded and washed out, but not snowy—indicating considerably reduced gain in the video amplifier or in one of the later IF stages. (Snow is missing because the faulty stage is not amplifying noise developed in the front end.) The video in the background, even though washed out, shows noticeable variations in shading instead of a dull, flat tone; this fact points more conclusively to a middle- or last-IF fault than to trouble after the video detector. (Voltage measurements on the second and third IF stages revealed a plate-supply resistor greatly increased in value.)

—*From Howard W. Sams "Photofact Guide to TV Troubles"*



The Electronic Scanner

Visual Call System

Depicted in the photo is one of two new "Videosentri" CCTV systems now being manufactured by **Industrial TV Utilities.** This system, primarily for use in apartment buildings, includes a master 8" monitor screen in the lobby and a private monitor screen in each individual apartment. When a visitor enters the lobby to call on a tenant, he presses the appropriate call button: the apartment monitor then shows a picture of the visitor. If desired, conversation between the two parties can be held through the audio system. To prevent tenant "snooping," the apartment monitor cannot be set to view the lobby area without a call-button signal from the lobby. A similar system for commercial and industrial applications is also available. Both types of systems are being marketed through service dealers.

Novar Production

Sylvania's tube division has begun manufacturing a number of novar receiving tubes for use in television receivers. Included are: 6GJ5, 12GJ5, 6GT5, 12GT5, 17GT5, and 6JB6—all horizontal output amplifiers: 6BH3, 17BH3, 22BH3, 6DW4, and 17BS3—dampers: and 5BC3—a low-voltage rectifier. Sylvania is developing additional novar types for future release.

Long Live the King

Mr. A. A. Ward, president of **Altec Lansing,** and Mr. H. S. Morris, vice president of the firm, are shown congratulating Milton G. Thomas, Southeastern Regional Sales Manager, on his winning a recent nationwide sales campaign. The mock coronation ceremony, proclaiming Mr. Thomas "King Mike I," highlighted the company's recent annual sales meeting held at the Riviera Hotel, Palm Springs, California.

Fishin' Time's A-Comin'

A free fishing rod or reel is being offered by **Permacel** with the purchase of 288 rolls of plastic electrical tape. The purchaser has a choice of either a Wright-McGill "Grainger" spinning rod or a Garcia-Mitchell spinning reel. The offer, which expires April 15, 1963, applies to the purchase of 29D, 29L, 295D, or 295L plastic tapes.

Instant Credit

Mr. Harry R. Ashley, president of **EICO Electronic Instrument Co., Inc.,** recently announced his firm has joined the "Uni-card" Credit Plan. Now, any Uni-card holder can purchase EICO electronic equipment—hi-fi and test instruments, for example—from any authorized EICO dealer, without a down payment.

Go-Togethers

Service technicians will find, for a limited time, a free 3-oz. (caddy-size) can of "Trol-Aid" packaged with every large, economy-size can of "Tun-O-Lube" tuner cleaner. **Chemtronics,** manufacturer of these products, is offering the special purchase to acquaint technicians with the new 16-oz. can of "Tun-O-Lube."

ITT batteries...and ITT tubes...give you first-line quality ...and extra profit margin

ITT batteries—penlites, C, D, and 9-volt miniatures – now offer the same "extra value" and acceptance already experienced with fast-moving ITT Receiving Tubes.

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ITT

SENCORE

SIMPLIFIES COLOR SERVICING

NEW! CA122

COLOR CIRCUIT ANALYZER

A simple approach to a complex problem

A must for color . . .

a money maker for black and white TV servicing

Here is an instrument that is designed to eliminate the guesswork in color TV servicing. A complete analyzer that provides all required test patterns and signals for testing from the tuner to the tri-color tube. Additional analyzing signals for injection at each stage including audio, video and sync, brings to life a truly portable and practical TV analyzer for on the spot service; virtually obsoleting other analyzers with the advent of color. Sencore's simplified approach requires no knowledge of I, Q, R-Y, B-Y, G-Y or other hard to remember formulas. The CA122 generates every signal normally received from the TV station plus convergence and color test patterns.

The CA122 offers more for less money:

TEN STANDARD COLOR BARS: The type and phase that is fast becoming the standard of the industry. Crystal controlled keyed bars, (RCA type) as explained in most service literature, offer a complete gamut of colors for every color circuit test.

WHITE DOTS: New stabilized dots, a must for convergence, are created by new Sencore counting circuits.

CROSS HATCH PATTERN: A basic requirement for fast CRT convergence.

VERTICAL AND HORIZONTAL BARS: An added feature to speed up convergence, not found on many other color generators.

SHADING BARS: Determines the ability of the video amplifier to produce shades (Y Signal) and to make color temperature adjustments. An important feature missing on other generators.

COLOR GUN INTERRUPTOR: For fast purity and convergence checks without upsetting color controls. Insures proper operation of tri-color guns, preventing wasted time in trouble shooting circuits when CRT is at fault.

ANALYZING SIGNALS: RF and IF signals modulated with any of the above patterns for injection into grid circuits from antenna to detector. IF attenuator is pre-set for minimum signal for each IF stage to produce pattern on CRT thus providing a check on individual stage gain. Sync and video, plus or minus from 0 to 30 volts peak to peak, have separate peak to peak calibrated controls for quick checks on all video and sync circuits. Crystal controlled 4.5 mc and 900 cycles audio simplify trouble shooting of audio circuits.

NEW ILLUMINATED PATTERN INDICATOR: A Sencore first, offering a rotating color film that exhibits the actual color patterns as they appear on color TV receivers. Locks in with pattern selector control.

You'll pay more for other color generators only.

Dealer Net **187.50**

NEW! PS120 PROFESSIONAL WIDE BAND OSCILLOSCOPE

A portable wide band 3 inch oscilloscope for fast, on-the-spot testing. An all new simplified design brings new meaning to the word portability...it's as easy to operate and carry as a VTVM. Though compact in size, the PS120 is powerful in performance: Vertical amplifier frequency response of 4 MC flat, only 3 DB down at 7.5 MC and usable to 12 MC, equips the technician for every color servicing job and the engineer with a scope for field and production line testing. AC coupled, with a low frequency response of 20 cycles insure accurate low frequency measurements without vertical bounce. Sensitive single band vertical amplifier; sensitivity of .035 volts RMS for one inch deflection saves band switching and guessing. Horizontal sweep frequency range of 15 cycles to 150 KC and sync range from 15 cycles to 8 MC (usable to 12 MC) results in positive "locking" on all signals. New exclusive Sencore features are direct reading peak-to-peak volts —no interpretation; dual controls to simplify tuning; lead compartment to conceal test leads, jacks and seldom used switches. Rear tilt adjustment angles scope "just right" for easy viewing on bench or production line.

Size: 7"w x 9"h x 11¼"d. Weight: 12 lbs.

Dealer Net **124.50**
(with low cap. probe)

Kit **74.50**

A must for servicing color TV in the home . . . lowest priced broad band scope. All hand wired — all American made

SENCORE

SIMPLIFIES SWEEP CIRCUIT TROUBLE SHOOTING

SS117
SWEEP CIRCUIT ANALYZER
For Color and Monochrome Testing

A professional trouble shooter that helps you methodically walk the trouble out of "tough-dog" sweep circuits in monochrome and color receivers. The SS117 provides a positive but simple push button test on all circuits indicated in the block diagrams. These time-consuming circuits are checked step-by-step with tried and proven signal injection and substitution methods. All checks can be made from the top of the chassis or from under the chassis when it is removed from the cabinet.

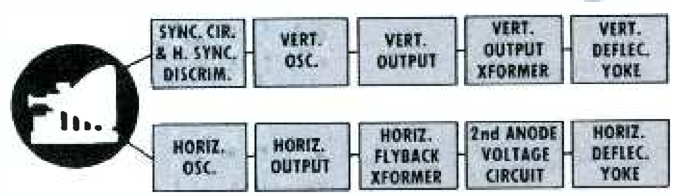
TV horizontal oscillator check is made by substituting a universal oscillator known to be good. Horizontal output check consists of a cathode current and screen voltage test. The TV horizontal yoke is checked by substituting a universal yoke from the SS117 and viewing brightness or restoration of 2nd anode voltage. Horizontal flyback is checked dynamically in circuit by measuring the power transfer to the yoke when TV is turned on. TV horizontal sync can be used to control the SS117 horizontal oscillator, providing a positive check on sync from the video amplifier to the TV oscillator. Vertical circuits are tested by simple signal injection from vertical yoke to oscillator for full height on CRT. The SS117 with the CA122 Color Analyzer provides a complete TV analyzer for virtually every stage in monochrome or color receivers.

External checks for AC, DC, peak to peak voltage readings and DC current in the upper right hand corner save using a separate VTVM. Accurate 2nd anode measurements up to 30,000 volts are made with a sensitive 300 microamp meter and the attached high voltage probe. AC outlets, all steel construction and mirror in the cover makes every servicing job easier.

Size: 10¼" x 9¼" x 3½". Wt. 10 lbs.

Dealer Net **89.50**

The SS117 checks them all



FREE—A 33 RPM half hour permanent record packed with every unit explains each test.

FOR FASTER MORE ACCURATE TUBE TESTING

TC114 MIGHTY MITE
TUBE CHECKER

This is the famous Mighty Mite, acclaimed by over 25,000 servicemen, maintenance men and engineers as "the best they've ever used." A complete tube tester that is smaller than a portable typewriter yet finds tubes that testers costing hundreds of dollars miss, thus selling more tubes and reducing call backs. A real money maker for the serviceman and a trusty companion for engineers, maintenance men and experimenters. The Mighty Mite has been acclaimed from coast to coast as the real answer for the man on the go. Even though the Mighty Mite weighs less than 8 pounds, new circuitry by Sencore enables you to use a meter to check grid leakage as high as 100 megohms and gas conditions that cause as little as one half microamp of grid current to flow. Thus, too, it checks for cathode current at operating levels and shorts or leakage up to 120,000 ohms between all elements. And it does all this by merely setting four controls labeled A, B, C, & D with new type easy grip knobs. Check these plus Sencore features... Meter glows in dark for easy reading behind TV set... The new Mighty Mite has large size Speedy-Setup Tube Chart inside of cover—cuts setup time for even faster servicing. New stick proof D' Arsonval meter will not burn out even with shorted tube... Rugged, all steel carrying case and easy grip handle.

The improved Mighty Mite will test virtually every radio and TV tube that you encounter, nearly 2000 in all, including foreign, five star, auto radio tubes plus the new Compactrons, Novars, Nuvistors and 10 pin tubes. Has larger, easy-to-read type set-up booklet for faster testing.

Size: 10¼" x 9¼" x 3½". Weight: 8 lbs.

Dealer Net **74.50**

Fast, Accurate . . . never lets you down

A must for color

TM116 TUBE TESTER MODERNIZING PANEL

New tube adapter for testing Compactrons, Novars, Nuvistors and 10 pin tubes in any tube tester except cardomatic types. Plugs into octal socket of your tube tester enabling you to test these new tubes in the same manner that your tester checks conventional tubes. Tube set-up chart included with each adapter.

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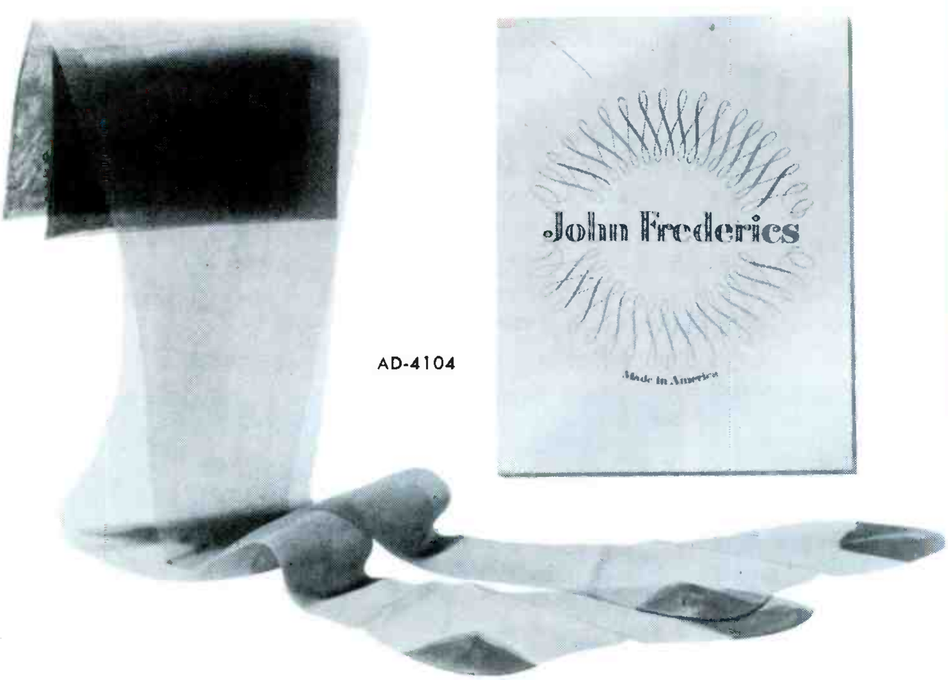

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*Or any Combination of CR Tubes and Receiving Tubes. One Philco Star Bright 20/20 CR Tube equivalent to 25 Receiving Tubes.

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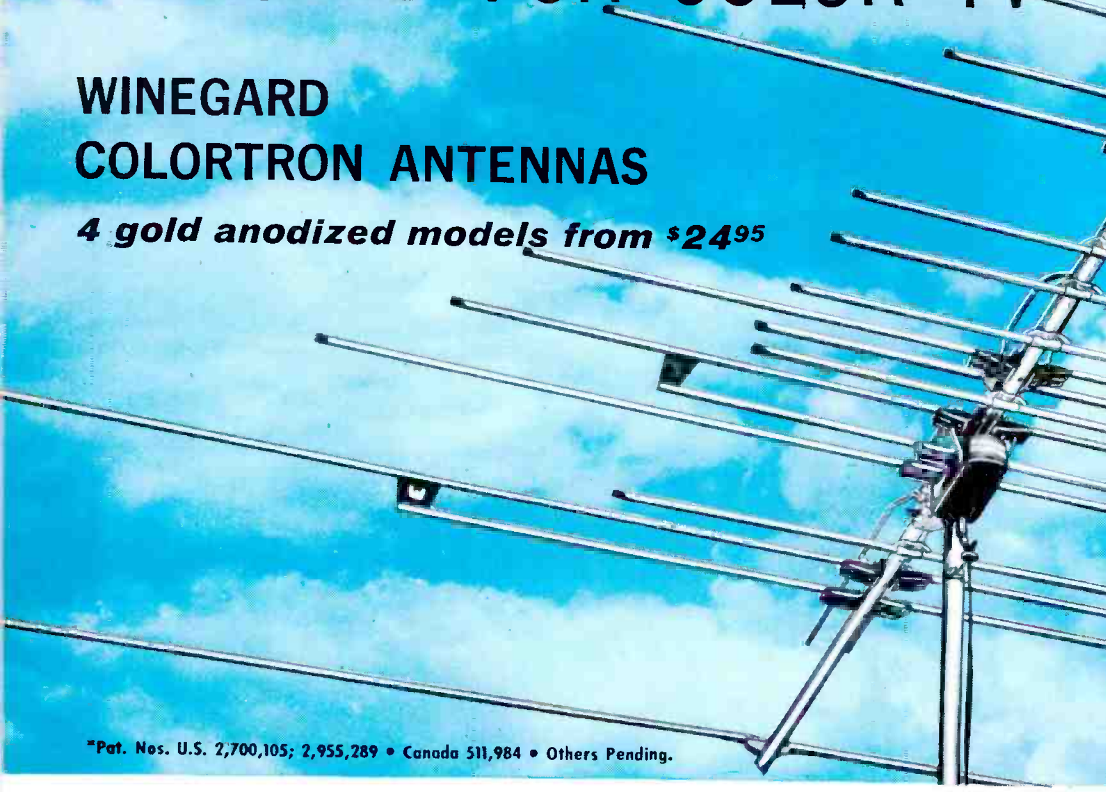
DESIGNED FOR COLOR TV

WINEGARD COLORTRON ANTENNAS

4 gold anodized models from $24.95



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Now, through continuous Winegard research, a new, improved Electro-Lens yagi has been developed—the NEW WINEGARD COLORTRON—PERFECT ANTENNA FOR COLOR TV!

Colortrons have a flat frequency response (plus or minus ½ DB across any 6 MC channel), no "suck-outs" or "roll-off" on end of bands . . . accurate 300 ohm match (VSWR 1.5 to 1 or better) . . . unilobe directivity for maximum ghost and interference rejection. They deliver today's finest color reception, give a new picture quality to black and white. Colortrons are the only outside antennas that carry a WRITTEN FACTORY GUARANTEE OF PERFORMANCE.

And Colortrons are built to last. High tensile aluminum tubing for rigidity and stability, insulators with triple moisture barrier, GOLD ANODIZED for complete corrosion-proofing.

There are 4 Colortron models to cover every reception need, from suburbs to distant fringe areas . . . $24.95 to $64.95 list.

New Winegard Colortron twin-nuvistor amplifier perfectly matches Colortron antennas. Gives added gain and sensitivity on both color and black and white. Ultra-low noise, high gain Colortron Nuvistor Amplifier can easily drive 6 or more TV sets.

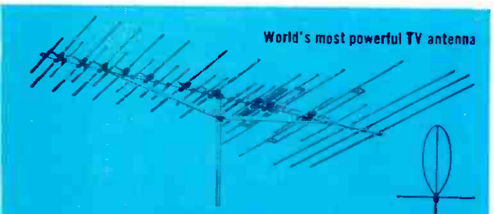
With revolutionary twin-nuvistor circuit, Colortron amplifiers can handle up to 400,000 micro-volts of signal without overloading. *This is 20 times better than any single transistor amplifier.* The Colortron Amplifier will bring the weakest signals up out of the snow, yet strong local TV & FM signals will not overload it. A special life saver circuit gives the two nuvistors a life of 5 to 8 years.

This amplifier is completely trouble free and the finest performing antenna amplifier you can own.

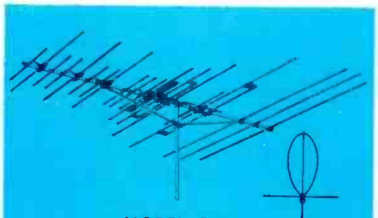
Completely weather sealed, nothing is exposed to corrode and cause trouble . . . has all AC power supply with 2 set coupler. (Model No. AP-220N, $39.95 list). Twin transistor model also available up to 80,000 micro-volts input. *New type circuit protects transistor from static electricity built up in lightning flashes.* (Model No. AP-220T, $39.95 list).

Colortron Amplifier can be added to any good TV antenna for sharper, clearer TV reception.

Ask your distributor or write for technical bulletin.



MODEL C-44
GOLD ANODIZED $64.95



MODEL C-43
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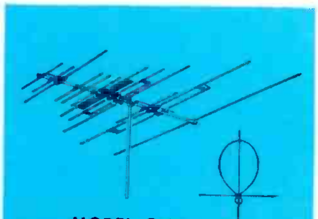
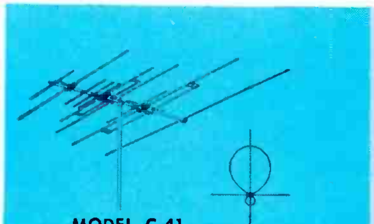


MODEL C-42
GOLD ANODIZED $34.95



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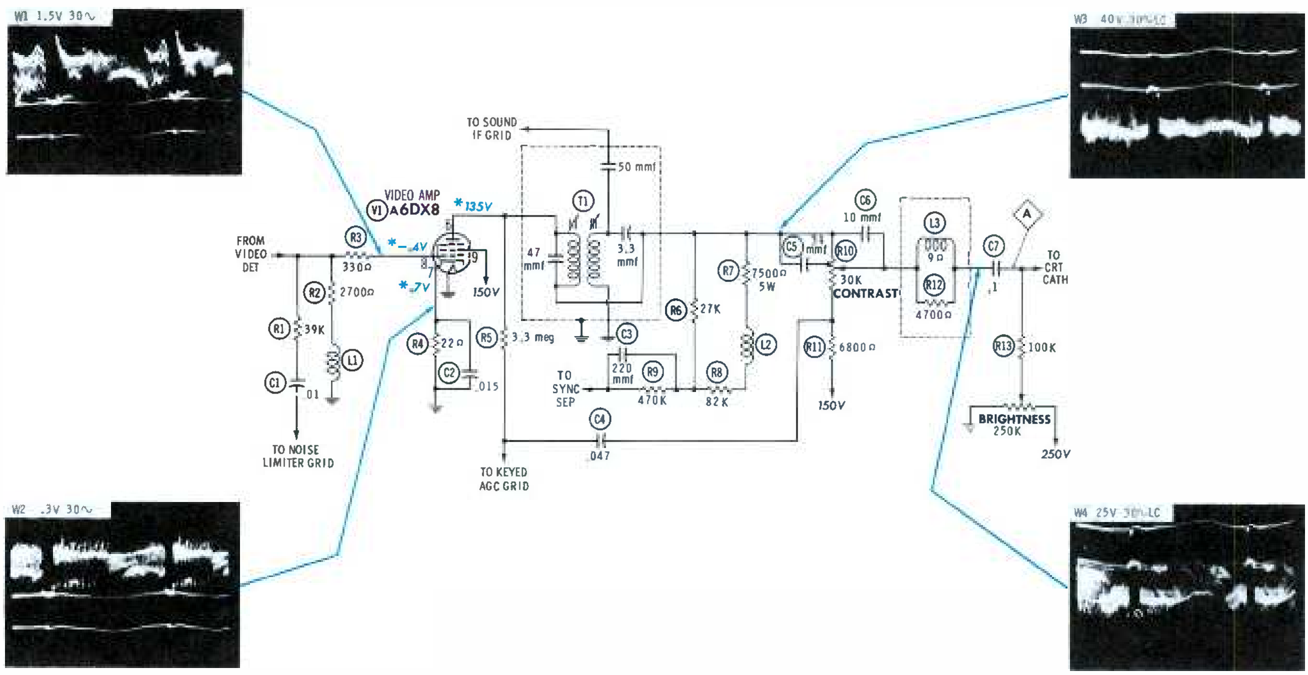
PF REPORTER Symfact

Video Output

Contrast Control at Plate



DC VOLTAGES taken with VTVM, on inactive channel; antenna terminals shorted. * Means voltage varies with conditions — see "Variations."

WAVEFORMS taken with wide-band scope; controls set for 25-volt p-p video to CRT. Low-cap probe (LC) used where direct probe distorts signal.

Normal Operation

Pentode section of 6DX8 functions in single video output stage. Detector load is DC-coupled to grid circuit, and input signal determines grid bias of V1A. Type of circuit shown here has constant gain regardless of contrast-control setting. Control doesn't change operating voltages on tube; it merely taps off wanted amount of signal to be fed to CRT cathode. (Principle of operation is similar to that of many volume-control circuits.) Plate circuit of V1A has three different parallel paths to B+ voltage sources: R7-L2 in series, R6-R8 in series, and R10-R11 in series. As a result, plate voltage is little affected by any one open component. Sync signal to separator is taken off via voltage divider (R6-R8) in plate circuit. AGC takeoff is from two different points; R5 provides a DC voltage for keying-tube grid, while a video signal for this grid is coupled via C4. Correct operation of AGC is dependent on both these inputs; therefore, almost all troubles in video output stage will upset AGC action to some degree. As a result, bias on AGC-controlled stages may be upset enough to create RF-IF signal distortion that aggravates trouble symptoms.

Operating Variations

PIN 6 With station signal present, voltage increases from 135 to 145 volts. Adjusting AGC control for more gain through front-end stages causes proportional increase in W3 amplitude; DC plate voltage also increases, since average conduction of V1A is reduced.

PIN 7 Very little change in DC voltage results from applying signal or adjusting contrast control.

PIN 8 DC voltage shifts from −.4 volts to −1 volt when signal is present; remains close to this value at all moderate or strong input-signal levels. Rotating AGC control causes larger shift in voltage here; maximum setting without overload is −3 volts, and minimum (which results in weak picture and unstable sync) is −.1 volt.

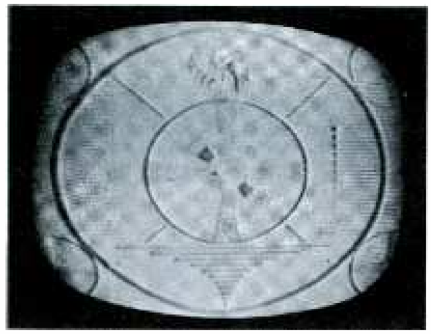
A CRT used in this set is a "low-drive" type; 25-volt video signal applied to cathode is sufficient for normal contrast. W4 amplitude varies from 8 to 40 volts with adjustment of contrast control.

SYMPTOM 1

Insufficient Video

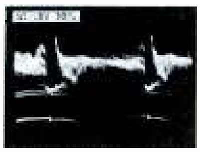
No Snow; Normal Sound

R11 Open

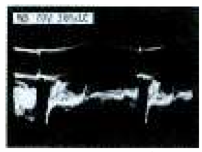


Symptom Analysis

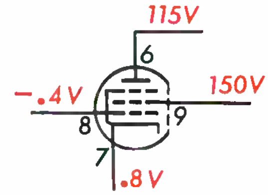
Picture has "washed-out" appearance. Absence of snow, and good sound, suggest front-end stages are probably not at fault. Contrast adjustment causes only minor change in picture; AGC control is operative, but adjustment doesn't clear trouble. Overload doesn't occur as usual at maximum setting.



Waveform Analysis



Voltage and Component Analysis



W1 is lower in amplitude than normal—only .8 volts at an AGC setting that would normally yield 1.5 volts—but it is passing through front end without distortion. W3 is also properly shaped, but measures 20 volts (a 50% drop from normal). W4 offers good clue to trouble spot, for its amplitude won't change with contrast adjustment. However, a slight change in frequency response does occur when control is set to minimum. These indications call for further checking in and around contrast-control circuit.

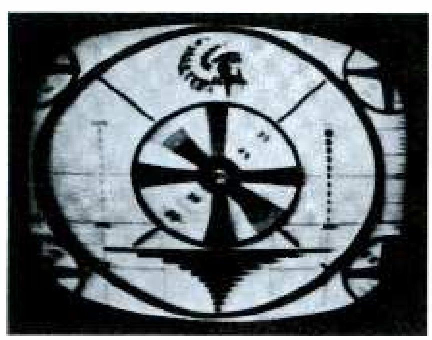
Biggest clue to trouble is plate voltage. With R11 open, one of parallel B+ paths to plate of V1A is broken, and plate voltage drops to 115 volts. Voltages on grid and cathode stay within normal limits. DC-voltage decrease is passed to AGC grid via R5, but signal input to same point via C4 increases because open R11 prevents voltage division. Net result is that AGC circuit receives false impression of strong station signal, and overbiases RF-IF stages. If C4 or bottom of R10 were to open, AGC would cut off front end.

SYMPTOM 2

Overloaded Video

Buzz in Sound

R7 Open

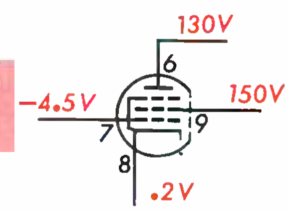


Symptom Analysis

Problem looks like typical AGC overload trouble, with picture tearing, and loud buzz in sound. Adjusting contrast control for lower video-signal input to CRT cathode changes contrast of picture on screen only slightly. Rotating AGC control to its minimum position will affect picture, but won't cure fault.

Waveform Analysis

Voltage and Component Analysis



Excessive (10-volt) amplitude of W1 is big clue that RF-IF stages are running at high gain. Undistorted shape of this waveform, coupled with fact the AGC control is operative, is a clue that trouble isn't caused by AGC circuit alone. W3 is much too high in amplitude, shows compressed sync pulses, and thus ties trouble to video amplifier. Gain of stage has actually decreased—grid signal is amplified 15 times, rather than normal 25 or 30 times. Excessive RF-IF gain is consequence of defective signal fed to AGC system.

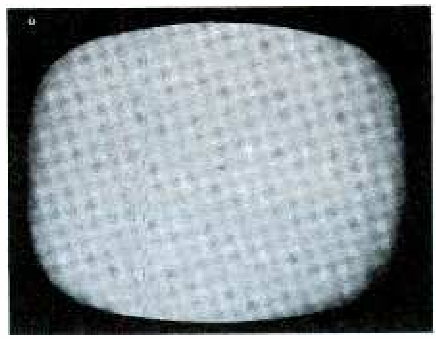
High negative voltage on grid of V1A is due to excessive signal amplitude; W1 is so strong that negative peaks drive V1A into cutoff, accounting for flattened positive peaks of W3. With high average bias, tube presents abnormally high resistance from plate to ground. Since lowest-resistance branch of plate load is open, total plate-to-source resistance is also higher than normal. *Ratio* between these resistances stays nearly constant; thus, plate voltage is deceptively close to normal. High-wattage R7 is among first suspects.

SYMPTOM 3

No Video

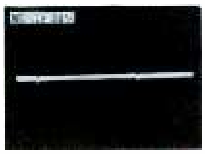
No Audio; No Snow

R4 Open

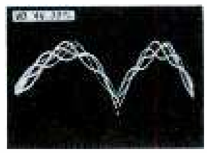


Symptom Analysis

Raster is present, but no video or audio. Slight buzz can be heard in sound at high volume setting. Rotation of AGC control to maximum position reveals weak, garbled station audio and increased buzz; this proves tuner oscillator is working. Weak audio could be capacitively coupled through dead video stage.

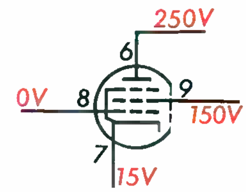


Waveform Analysis



No video, but only random circuit noise, is present in W1 and W3. Trouble could be caused by defect in AGC circuit cutting off RF and IF stages. Clamping AGC fails to produce picture on CRT; but causes normal W1 to appear at grid of V1A, proving fault involves AGC, and indicating a check on the video amplifier is in order. Injection of signal to grid of V1A fails to give any indication on CRT screen. This case demonstrates that trouble is difficult to isolate to video stage without taking AGC into account.

Voltage and Component Analysis



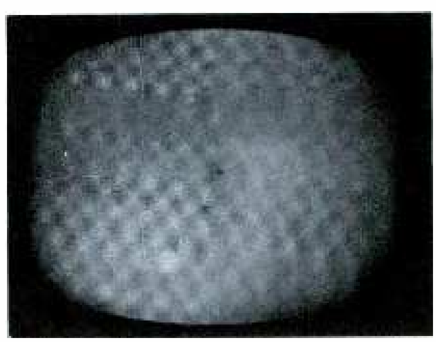
Full 250-volt B+ on plate of V1A indicates tube is not passing plate current. Voltage on the grid is zero, which would permit tube to conduct heavily under normal conditions. Screen is receiving normal supply voltage, so cathode-return path must be open. 15-volt reading on cathode further confirms cathode circuit is causing tube cutoff. If tube conduction were developing this high drop across cathode resistor, plate voltage would be drastically reduced—not high. If R4 merely increased value, weak picture might appear.

SYMPTOM 4

No Raster

High Voltage and Sound Normal

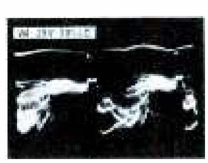
C7 Shorted



Symptom Analysis

High voltage is present, and picture-tube checker shows CRT to be good; so trouble is probably in circuitry associated with CRT gun—probably wrong operating voltage on some element. Station audio is good in volume and clarity, almost ruling out defective front end or AGC, and most video troubles.

Waveform Analysis



Symptoms noted during home call focus attention directly on CRT signal and bias circuitry. Normal appearance of W3 further confirms that video output and previous stages are operating normally. Scope check of W4 during rotation of contrast control shows amplitude variations, proving control is doing its job. Normal W3 and W4, even with C7 shorted, could be misleading in one sense, but a valuable clue in another—they further tie trouble to wrong DC operating voltage on grid or cathode of picture tube.

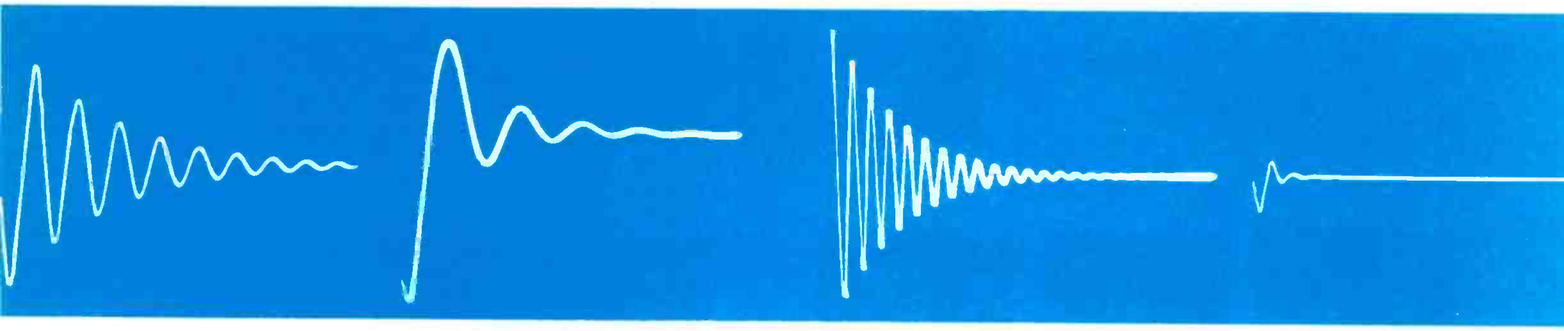
Voltage and Component Analysis

NO VOLTAGE CLUES

No meaningful voltage change takes place on any element of V1A. Voltage reading on cathode of CRT (point A) reveals 145 volts. (Normal cathode voltage on this "low-drive" CRT is 30 to 35 volts, variable with brightness control.) Only feasible way a voltage this high could reach cathode is via shorted C7. Leakage in C7 will lower brightness-control range, but defect must become very bad before customer will complain. He'll call much quicker if C7 opens; video will be very weak, giving appearance of defective CRT.

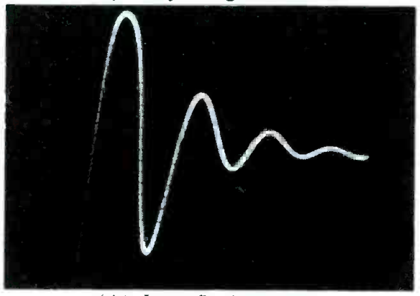
by Allan F. Kinckiner

RINGING CHECKS FOR SWEEP COILS

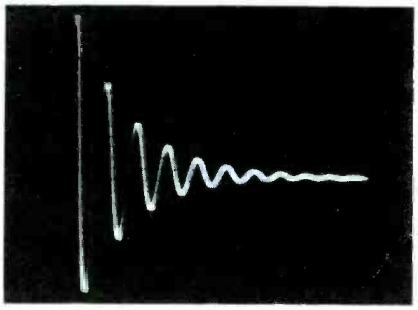


A large number of different defects are capable of causing a partial or complete loss of raster and high voltage, so the serviceman generally shifts his mental apparatus into high gear whenever he is confronted with this complaint. Defects can range from simple short or open connections to complex malfunctioning of entire circuits. Componentwise, trouble may be caused by anything from a "two-bit" resistor or capacitor to a transformer costing as much as twenty dollars.

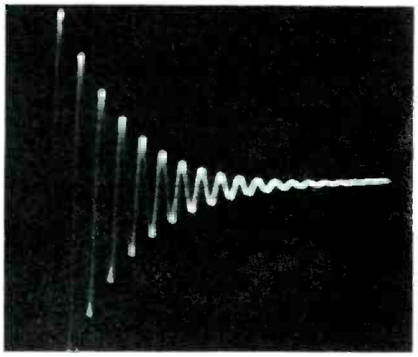
In an overwhelming majority of raster and high voltage troubles, routine voltmeter and scope readings—coupled with tube changing and component checking or substituting—will reveal the source of trouble. In the remainder of cases, where these procedures give indefinite results, the inductances in the circuit (yoke, flyback, and width coil) become suspect. Resistance checks of their windings often fail to disclose faults, so a better means of checking these parts is needed.



(A) Low-Q, iron-core



(B) Medium-Q, ferrite-core



(C) High-Q, ferrite or air core

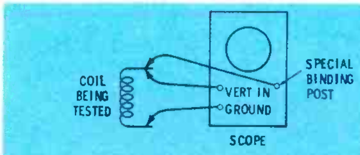
Fig. 1. Typical coil ringing patterns.

Coil Ringing Characteristics

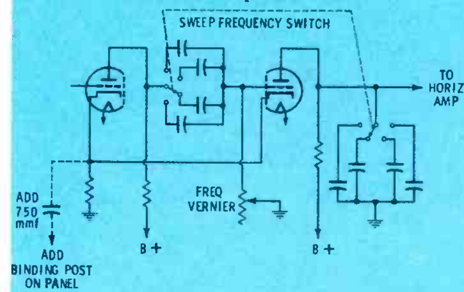
One reliable means of determining the efficiency of an inductive component is to examine the damped wave train generated when the inductor is excited by a sharp pulse. The sudden change in applied voltage sets off several cycles of oscillation or "ringing" that can be scoped as shown in Fig. 1. The number of ringing cycles and the rate of their decay are determined by the efficiency or Q of the coil. Low-Q inductors, such as audio or vertical output transformers and other laminated iron-core types, ring as in Fig. 1A. Units with powdered-iron or ferrite cores, like those in horizontal deflection circuits, produce more cycles of ringing (Fig. 1B)—showing that such inductances have considerably higher efficiency or Q factors. A very high-Q coil will ring in the manner shown in Fig. 1C; although this pattern was obtained from an air-core choke wound in special fashion with Litz wire, it is not much different from the waveforms generated by the latest 114° horizontal sweep components.

This indication of Q is far more useful than any DC test for spotting slight defects in coils. For practical purposes, it is not necessary to make an exact measurement of Q; a comparison with a known good coil of a similar type furnishes sufficient evidence to spot trouble. However, a numerical understanding of the Q factor will help explain why the ringing test is useful.

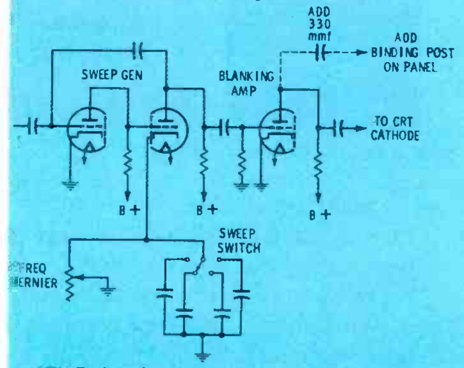
Q is actually the ratio between



(A) External hookup for all tests

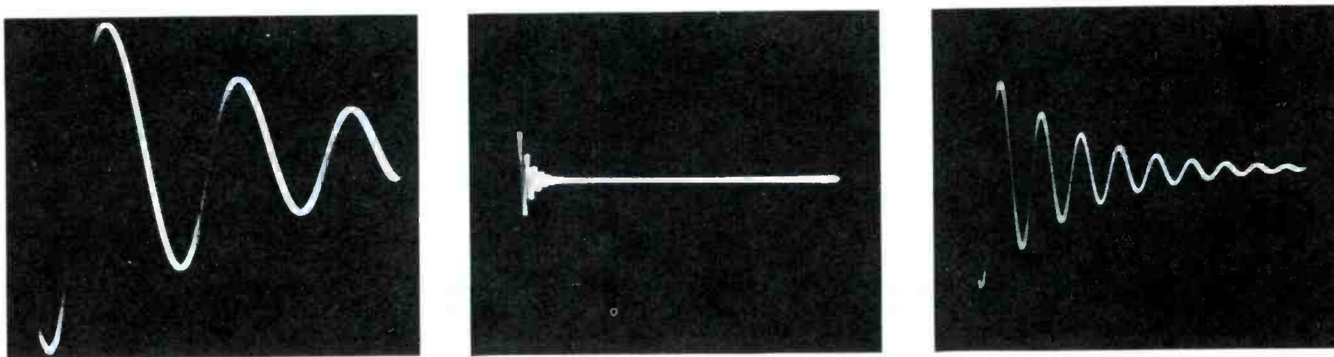


(B) Sweep-generator pulse takeoff



(C) Pulse from blanking amplifier

Fig. 2. Connections for obtaining pulse from scope for ringing tests.



(A) 10 kc—too few cycles shown (B) 300 cps—dies out too fast (C) 2600 cps—close to ideal

Fig. 3. Proper scope-sweep frequency is a "must" for good check of flyback.

a coil's inductive reactance and its AC resistance—the higher the ratio, the greater the Q. Shorted turns and similar defects increase the AC resistance by absorbing power in the defective winding; therefore, the Q is lowered. It should be noted that the AC resistance behaves differently from the DC resistance. In a DC ohmmeter check, a few shorted turns merely lower the apparent resistance — sometimes by such a small amount that the fault goes undetected.

The relative effect on AC and DC resistance is clearly shown by the following example. In one specific type of deflection yoke, the vertical windings normally have an inductance of 44.3 millihenries. Special measurements in a 1-kc bridge circuit indicate a Q of 4 and an AC resistance of 69 ohms, whereas the indicated DC resistance is 60 ohms. With a short between turns of the vertical winding, one yoke of this type was found to have an inductance of 38.6 millihenries, a Q of 2.7, and an AC resistance of 90 ohms, even though the DC resistance was still almost exactly 60 ohms. This trouble could have been discovered quickly, without computations, by someone who was experienced in using a scope for ringing checks.

Test-Pulse Source

Many servicemen receive the suggestion of ringing checks with more than a little skepticism. "Where," they want to know, "do I get the pulse needed to generate the ringing?" Actually, it is seldom necessary to look any farther than the scope itself.

Many models of scopes have usable pulses already present at panel jacks bearing such diverse names as Z AXIS, HORIZ IN, NEG GATE, and SAWTOOTH. The presence of such signals is generally not revealed by connecting the scope's

• *Please turn to page 87*

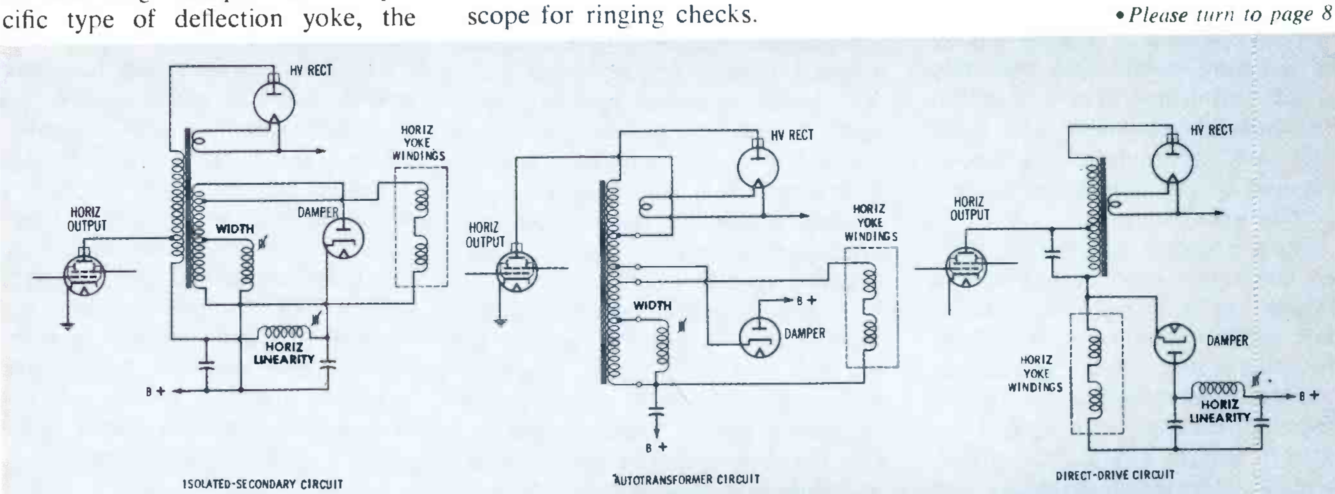


CHART OF RESULTS

CONDITION	PATTERN FOR: Isolated-Secondary	Autotransformer	Direct-Drive
Flyback, Yoke, and Width Coil Normal	A	A	A (1)
Short In Flyback	B	B	B (1)
Yoke Short (Mild)	C (3)	B or D (3) (5)	A (3)
Yoke Short (Severe)	D (4)	B (5)	A (6)
Short In Width Coil	B (2)	B	--

REFERENCE NOTES

(1) Yoke must be connected in circuit.
(2) As little as one shorted turn.
(3) Keystone-shaped raster.
(4) No raster or high voltage.
(5) Might kill raster, or shrink raster without keystoning.
(6) Will not kill high voltage; raster will be thin vertical line.

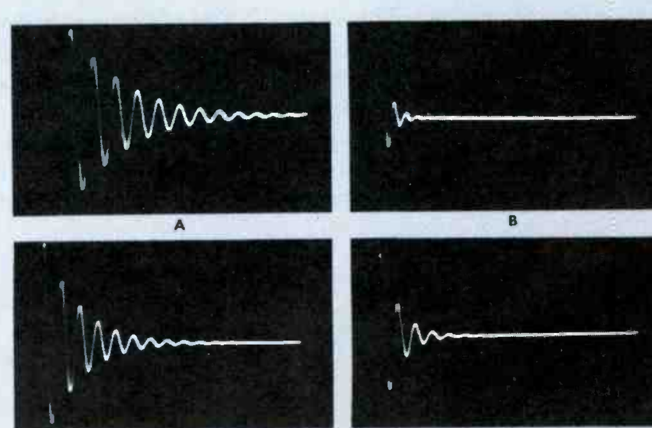
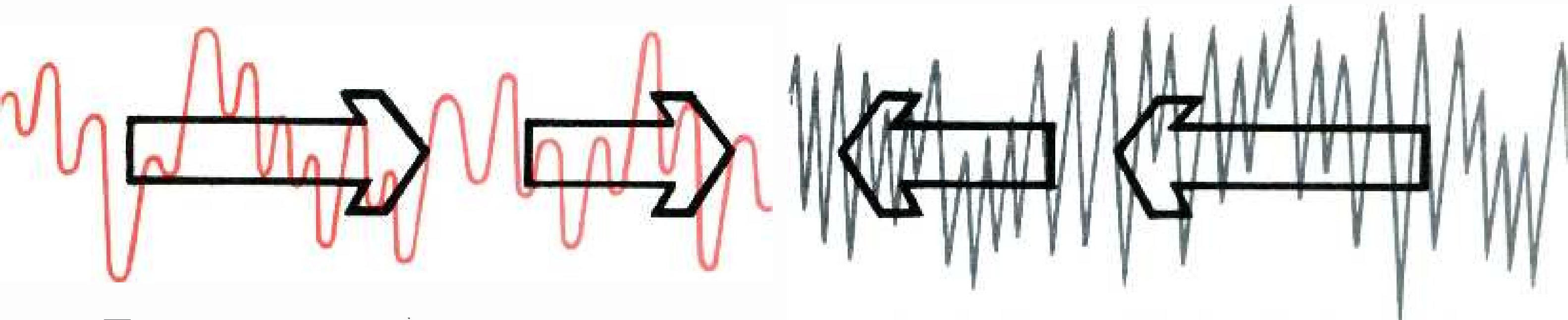


Fig. 4. Ringing tests in horizontal sweep circuits characteristically give these results.



ALIGNMENT EQUIPMENT FOR STEREO FM

What you need and how to use it.

by Fred G. Biesecker

It has been almost two years since the Federal Communications Commission (FCC) held the press conference announcing a new medium in broadcasting—stereo FM. The long-awaited stereo standards were described, and approval was granted to begin stereo-FM broadcasting as soon as equipment could be installed. Now there are nearly 300 FM stations broadcasting stereo, and many more are contemplating the idea.

Many servicemen have been wondering what's happened to stereo FM — why don't they hear more about it? The answer is: There's a steady build-up of interest among the listening public, but the only service technicians who are "in" on this quiet development are those who have accumulated the know-how and special equipment to handle multiplex receivers.

These receiver or adapter units are much less complicated than a TV set, even though the circuits may seem unfamiliar. The usual multiplex section of an FM receiver consists of an amplifier or two, a frequency doubler or a locked oscillator, several tuned coils, transformers, capacitors, resistors, and sometimes trap circuits. The main difference between these circuits and those with which you're already familiar is in the special signal that must be handled, bringing about the need for specialized test instruments. If you have this equipment, and understand its use, you should find servicing stereo FM both easy and interesting.

Characteristics of the Signal

The stereo-FM signal contains all the information needed to enable multiplex receivers to reproduce the original stereo program. In addition, the stereo signal is compatible; that is, it provides an FM signal for listeners who have only ordinary FM receivers that are not equipped for stereo.

Although the stereo-FM signal is similar in many ways to the monophonic FM signal, it cannot be transmitted over as long a distance without deterioration of stereo quality; the stereo signal has only one-half to two-thirds the coverage range of a monophonic signal. Therefore, it is necessary that receiving equipment be in peak operating condition to produce acceptable results.

The compatible signal used by monophonic receivers is the sum of the left and right stereo channels (L + R). The FCC specifies that the signal should frequency-modulate the station carrier the same as an ordinary monophonic signal. The difference between the left and right stereo channels (L − R) amplitude-modulates a 38-kc subcarrier; the latter is then suppressed, leaving only its upper and lower sidebands (23 to 53 kc) to modulate the main carrier. The two signals, L + R and L − R, are interleaved at the transmitter, frequency-modulating the station carrier at 90% modulation, or ±67 kc deviation from center frequency.

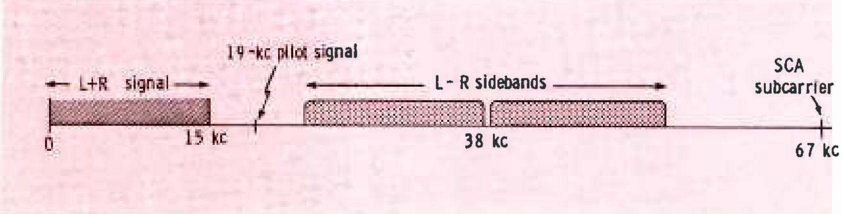


Fig. 1. Composite stereo FM. signal is made up of several different parts.

Fig. 1 shows the composite stereo FM signal as it is put together at the transmitter, with the L + R and L − R signals shown in their respective portions of the channel spectrum. Located between the L + R and L − R signals is a 19-kc signal known as the pilot carrier. This signal is used to synchronize the L − R demodulator in the receiver, to keep the phase of the resulting signals precisely the same as in the transmitter. This 19-kc pilot carrier must be transmitted with an accuracy of ±2 cps, according to FCC requirements. The 67-kc carrier signal—indicated at the right in Fig. 1 — is known as the SCA (Subsidiary Communications Authorization) subcarrier. It is authorized by the FCC for use by some stations to transmit special program information, such as background music or a similar service. It can operate simultaneously with either mono- or stereo-FM programs.

Prealignment Information

Fig. 2 shows a block diagram of a typical stereo-FM multiplex adapter. Let's go through it, especially noting the tuned circuits and how they affect operation.

The composite stereo signal is coupled to input amplifier V1A through C1. At the output of V1A, the signal is split; a portion is applied to cathode follower V1B, and then sent through a low-pass filter composed of L1, C2, and C3. This filter network eliminates all except the L + R signal (below 15 kc), which is applied to the separation control for insertion into the matrixing circuit.

The above-15 kc portion of the signal from V1A is applied to the grid of V2A. The L − R sidebands, the pilot carrier, and any SCA signals are amplified and fed through a bandpass filter composed of C5, C6, and L2. The filter passes the L − R signal and works in conjunction with another filter — R1, L3, and C7—to eliminate any SCA information. Notice that L2 and L3 are tunable; they must be adjusted during alignment to pass a maximum of the 23- to 53-kc energy while eliminating the 67-kc signal.

From the plate of V2A, the 19-kc pilot carrier is applied to tuned transformer T1, to synchronize a keyed Hartley oscillator — V2B. The 38-kc output of V2B is coupled through transformer T2 and inserted at the demodulator network to recover the L − R signal from the 23- to 53-kc sidebands. The demodulator consists of balanced diodes X1 and X2. Diode X1 develops the L − R signal directly, while diode X2 inverts it—resulting in an R − L signal. The two are sent to the matrix network for mixing with the L + R signal, thus reclaiming the left and right signals in their original form. Then, following a de-emphasis network, the signals are coupled to their respective left- and right-channel amplifiers.

The Front End

Before alignment of a stereo FM multiplex adapter is attempted, it is important that the FM receiver section be properly aligned. Since the information contained in the stereo signal extends to 53 kc, the IF bandwidth must be at least 150 kc to accommodate the entire signal, and a 200-kc bandwidth is preferred to allow for any slight mistuning or drift.

The response of the FM detector in the receiver or tuner must be linear over a frequency range from 50 cps to 53 kc. If it isn't, one of several results might occur. First, attenuation or loss of the L − R signal might cause inadequate stereo separation. Second, a nonlinear response can induce a phase shift between the sidebands, causing unwanted modulation and resulting

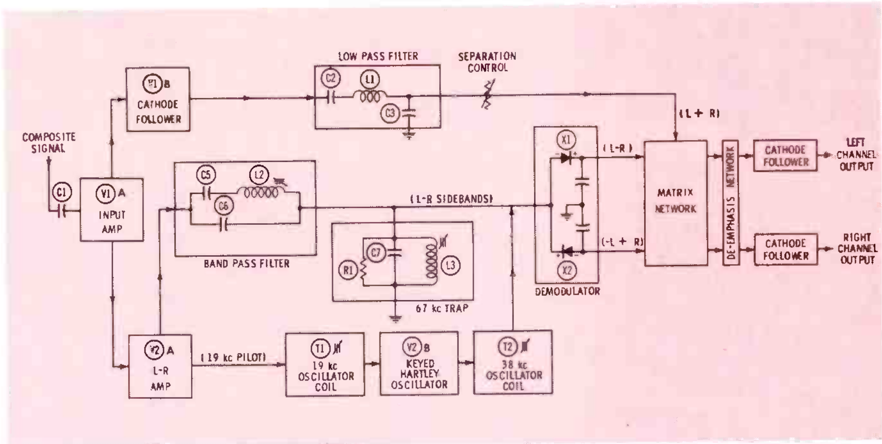


Fig. 2. Adapter reinserts 38-kc subcarrier and matrixes L + R with L − R.

in distortion as well as poor channel separation; these effects are especially noticeable at higher frequencies. Third, a nonlinear detector can result in a phase shift between the pilot carrier and the L − R sidebands, causing improper reinsertion of the subcarrier; this, too, would result in distortion and a loss of channel separation.

The Multiplex Section

Stereo-FM equipment that is in need of multiplex adjustment often provides significant clues. For example, a fluttering 400-cps tone is a good indication that alignment of the 38-kc oscillator (if this system is used) is necessary; this trouble can sometimes be taken care of simply by adjusting the oscillator slug until the tone is no longer heard.

Insufficient channel separation can also be caused by a misaligned 38-kc oscillator. But, before making adjustments for this reason, be sure the local station is transmitting stereo.

Low "whistle" tones heard during a stereo broadcast indicate interference from the 67-kc SCA subcarrier beating with the second harmonic of the 38-kc signal. There are three possible cures for this interference. First, try retuning the FM dial for minimum interference; then, if it is still objectionable, adjust the 67-kc trap in the multiplex circuitry. If this doesn't help, it may be necessary to realign not

• *Please turn to page 92*

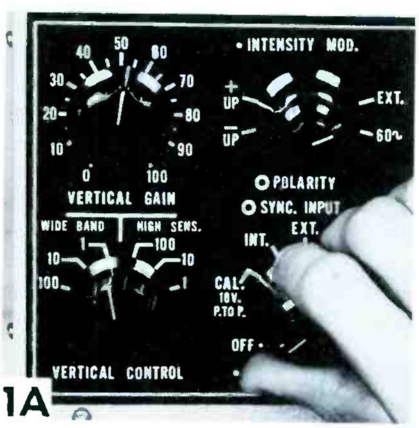
CHART I—Features of Stereo FM Signal Generators

Manufacturer	Model	Built-In RF Generator	Stereo Signal Output	Modulation Indicator Meter	Crystal-Controlled 19 kc	SCA Facilities	Built-In Audio Oscillator	List Price	In Kit Form
Calbest	MX625SG	Preset 88-90 mc	0-1V rms	Yes	Fixed	Input Jack	No	$495.00	No
Fisher	300	Preset 100 mc (97-103 mc)	0-6V p-p	Yes	Phase Adj'ble	Input Jack	1000 and 1200 cps	$495.00	No
Hickok	725	Variable 92-104 mc	0-4V p-p	No	Phase Adj'ble	Built-In 67-kc Subcarrier	400 and 1200 cps	$495.00	No
Karg	MX-1G	None	0-10V p-p	No	Fixed	None	No	$250.00	Yes
Precision Apparatus	E-490	None	0-12V p-p	No	Phase Adj'ble	None	No	$229.00	Yes
RCA	WR-51A	100 mc	0-10V p-p	No	Phase Adj'ble	67-kc Subcarrier	400 and 1000 cps		No
H. H. Scott	830	None	0-5V rms	No	Phase Adj'ble	None	No		

SKOPE SKILLS

The oscilloscope is a jack of all trades; it can serve as a signal tracer, distortion analyzer, AC voltmeter, frequency meter, alignment indicator, and test-signal source, among other things. The key to making full use of its versatility is deft and intelligent operation of the many panel controls. Most technicians have learned at least the rudiments of scope operation—setting up the brightness, focus, and positioning controls, and bringing at least an approximation of the correct signal waveform into view. For those who are having difficulty in progressing past this point, the hints on these pages should open the door to the many advantages of operating a scope like a "pro."

1 Many scope users—even experienced ones—don't obtain maximum benefit from waveform analysis because they don't have a keen awareness of the relation between vertical gain settings and peak-to-peak voltage readings. Yet, exact amplitude measurements are just as important as waveshape analysis in the diagnosis of signal faults. The most common method of checking waveform amplitudes is by comparison with a test signal of known peak-to-peak voltage. Most service scopes have some type of built-in calibrating signal, fed to the CRT either internally (by a CAL switch—photo 1A) or from a panel jack via the vertical input terminal (photo 1B).

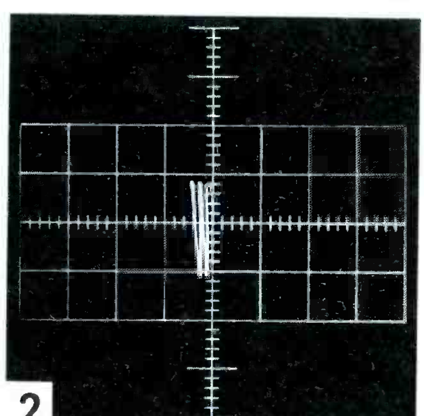


1A

1B

2 With this signal applied, the vertical-gain vernier control is adjusted until the waveform extends some specific number of divisions on a scale or graticule placed in front of the CRT. (If a sine wave is used, reducing the horizontal gain will make it easier to set up the calibration.) Now, if the vertical gain is left untouched, the sizes of all other waveforms will indicate their amplitudes, relative to that of the calibrating signal. For waveforms too high to fit on the screen, all you need to do is switch the vertical attenuator to a higher position, and multiply the measured voltage by the attenuation factor.

3 Once the vertical-gain vernier setting has been "frozen" by calibration, waveform height can be adjusted only with the decade attenuator; thus, it will naturally vary over a wide range. However, usable waveforms can be obtained without constant recalibration, if the scope is set up so that nearly all patterns will be between 0.4" and 4" in height. One popular calibration standard makes 1 volt peak to peak equal to 1" deflection on the x1 range; then this range is most suitable for viewing signals of between 0.4 and 4 volts peak to peak. At the same time, effective spans of the x10 and x100 ranges are 4-40 and 40-400 volts.



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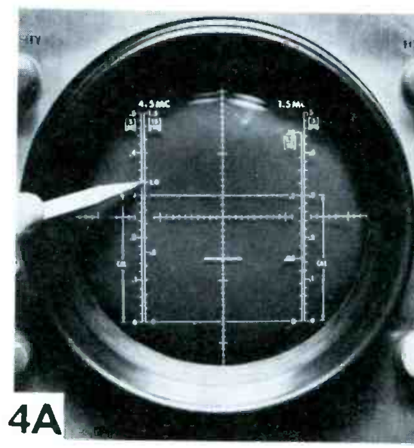
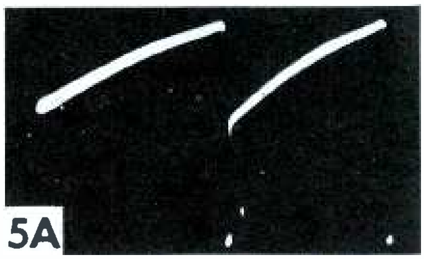


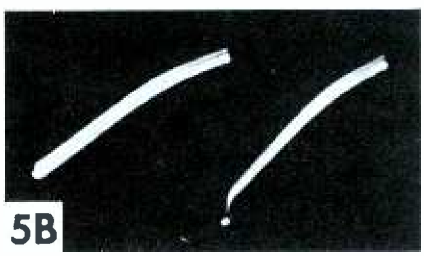
4A

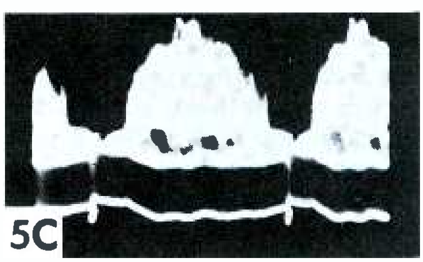
4B VERTICAL INPUT

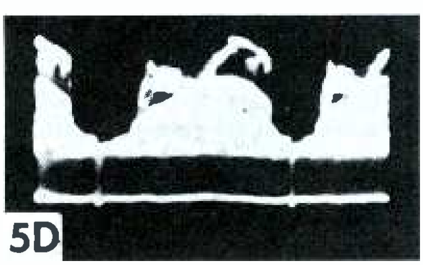
You'll occasionally want to change the fine adjustment to expand or reduce waveform height for a better view. To avoid losing calibration, why not mark the vertical dial with the correct position?

4 There's a trend afoot to provide "direct readout" of vertical gain settings in peak-to-peak voltage values, instead of the arbitrary decade multipliers and 0-to-100 vernier logging scales which have long been conventional for scopes. One recently introduced model has voltage values marked on the CRT graticule (photo 4A); although the preliminary calibration procedure is basically similar to that used on other scopes, the numerical scale simplifies the process by making it unnecessary to count squares on an unmarked scale. Another approach (photo 4B) is to set the unknown waveform to a prescribed height on the CRT screen, and then read the peak-to-peak voltage directly from the control dial (multiplying the vernier setting by the factor that appears in the small window).


5A

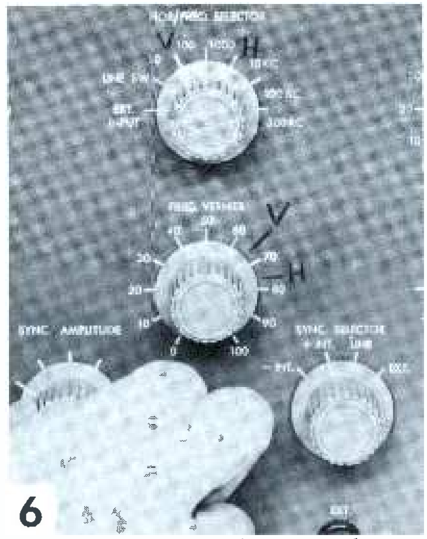

5B


5C


5D

5 Touching the direct probe of a scope to a circuit is the same thing as placing a 20- to 100-mmf capacitor across it. This shunt capacitance can throw sensitive sweep oscillators off frequency and decrease the amplitude of video waveforms at high-impedance points. Adding a low-capacitance probe reduces the capacitive loading caused by the scope to a small proportion (typically 1/10) of the original amount; but at the same time, the signal reaching the scope terminals is only 1/10 of that picked up by the probe.

At most TV test points, signal



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strength still is ample to produce a clear pattern; the vertical amplifier is simply operated at higher gain. In critical circuits the user is rewarded by more accurate waveforms. For example, photo 5A shows the modified sawtooth waveform at the plate of a vertical multivibrator, as viewed with a low-capacitance probe. Use of a direct probe (photo 5B) greatly attenuates the negative spikes in this waveform, and also tends to induce vertical rolling.

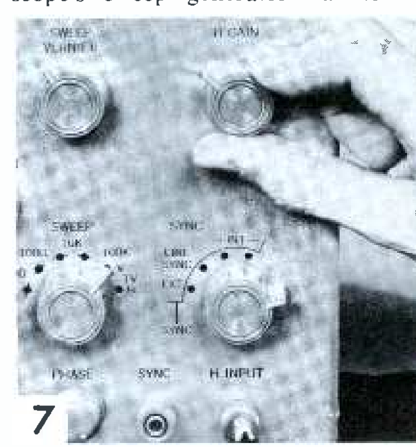
The direct probe has an advantage over the low-cap probe, however, in viewing weak signals and ripple waveforms under 1 volt peak to peak. To use a low-cap probe in such cases, the scope has to be operated at close to maximum gain, and is subject to stray pickup of hum and hash. Photo 5C shows the cathode waveform of a video output tube (this happens to be W2 in this month's *Symfact*) as it would appear if taken with a low-cap probe; notice the waviness due to hum. By use of a direct probe, the scope can be operated on the next higher attenuator setting, with the improved results shown in photo 5D.

6 Practically all scoping done in TV work requires setting the scope's sweep oscillator at either 30 or 7875 cps, to display two cycles of either vertical or horizontal sync or sweep signals. (Viewing only one cycle isn't recommended, since retrace is likely to occur at a critical point.) Even if the sweep switch has special "V" and "H" settings to aid in locating these important frequencies, the sweep vernier has to be adjusted critically to "tune in" a signal. If the scope has a sync-amplitude control, applying a moderate amount of sync at first will help in location of the proper vernier setting; but the less sync is used, the less chance there is of distorting the sweep trace.

Solidly locking in a waveform can be one of the most difficult aspects of scope operation. The source of the sync, as well as its amplitude, affects stability. Many scopes now provide a choice of negative or positive polarity for internal sync, since many waveforms respond much better to one than to the other.

Since internal sync is derived from the signal in the scope's vertical amplifier, a change in the vertical-gain setting may alter the sync strength. This tends to let the sweep oscillator drift off frequency, especially if you are depending too heavily on sync to stabilize the pattern. For easier lock-in of signals at 7875 cps, try switching to external sync and running a clip lead from the panel SYNC jack to the general vicinity of the set's high-voltage cage. Direct attachment to yoke-lead insulation is not recommended because the induced sync signal may have an amplitude of several hundred volts. For 30-cps waveforms, LINE sync may work better than internal sync. Careful attention to your sync sources will minimize the annoyance of readjusting the sweep vernier every time you switch back and forth from 30 cps to 7875 cps.

7 Alignment setups, in conjunction with a sweep generator, bring into play a group of scope controls that are ignored in all other service work. The alignment generator takes over the job of horizontally deflecting the scope trace, to make sure this trace will be perfectly synchronized with the frequency-modulated generator-output signal; therefore, the scope's sweep generator has to be

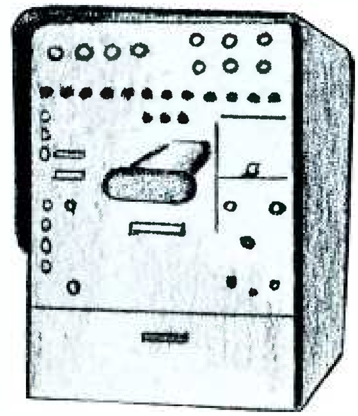


7

disabled. In some scopes, the sweep-selector switch has an OFF or EXT position; in others, switch contacts operated by the sync control render the scope's sweep and sync controls ineffective. The horizontal gain control adjusts the length of the trace line produced by the input from the generator, and the vertical gain controls affect the height of the response curve.

The PHASING control is effective only when the horizontal plates of the scope CRT are being driven by an *internal* 60-cps sine-wave signal (line sweep); therefore, this control is inactive in a normal alignment setup. ▲

Industry uses UNIQUE TEST EQUIPMENT



by Joseph A. Risse

Many test instruments for industrial-electronics troubleshooting are general-purpose units, not unlike those used in servicing entertainment equipment. Some industrial test instruments, however, are single-function types that have been designed for a specific type of job and are not usually well suited to other unrelated purposes.

Editor's Note: This article was prepared from material in Howard W Sams' "Electronic Test Instrument Handbook."

In industrial electronics, many of the instruments and devices are not designed for testing as such, but rather for measurement of particular parameters or processes, such as metal thickness, radiation, vibration, transistor characteristics, shaft rotation, temperature, etc. Here are some of the instruments with which industrial electronics technicians will want to be familiar.

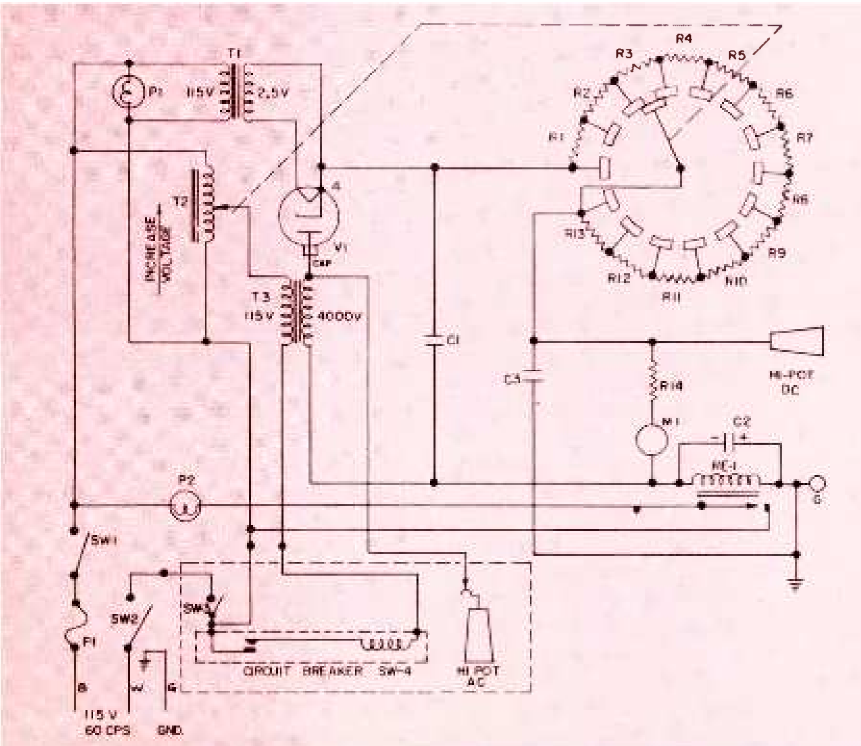


Fig. 1. Voltage-breakdown tester analyzes HV leakage through dielectrics.

Stroboscopic Tachometer

A stroboscopic tachometer is a stroboscope calibrated in flashes per minute, or in rpm (revolutions per minute). In use, a stroboscopic lamp is aimed at a rotating device such as a rapidly revolving shaft—and the flash rate of the stroboscope is adjusted until the shaft or other device appears to stand still. The speed, or a multiple or submultiple of it, can then be read directly from the scale of the instrument.

Voltage-Breakdown Tester

An instrument designed for testing the breakdown voltage of dielectrics and insulation is shown schematically in Fig. 1. Depending on whether the insulating material is to be tested for AC or DC breakdown, it is connected from either a high-voltage AC or a high-voltage DC terminal to ground.

The test voltage (up to 3 kv AC or 4 kv DC) is brought to the desired level by a control knob on the panel. For AC testing, an instantaneous-type circuit breaker SW4 serves as both a breakdown indicator and a protective device. In DC testing, variable series resistances R1 through R13 are inserted to limit the maximum current drawn from rectifier V1. Indicator light P2 is energized when the current exceeds a preset value. The DC output voltage present at the "Hi-Pot DC" jack is indicated on voltmeter M1.

Automatic *Hi-Pot* Tester

The tester shown in Fig. 2 is designed for voltage-breakdown or dielectric testing between two or more conductors. A known high voltage is applied between the conductors under test for a specific period of time. Breakdowns are indicated when and where they occur. A control console houses the high-voltage supply, the overload system, the timing mechanisms, and the sequence-control system. The glass-covered test-jig receptacle houses the high-voltage transfer relays, the position-indicator lamps, and a transformer for continuity testing at lower voltages.

A dual-scale meter shows the value of the test voltage, and a line-voltage regulator compensates for line-voltage variations. A specially designed relay in series with the high voltage provides high sensitivity to breakdown. The test voltage—from 0 to 2000 volts rms —may be applied to as many as 11 devices, either sequentially or simultaneously, for periods of 2 to 120 seconds.

Digital Voltmeter

Digital instruments of high accuracy are being used in industry for both manual and automatic measurements. A typical example is the voltmeter shown in Fig. 3.

The particular advantage of a digital voltmeter is that it makes high-precision readings possible. The range covered is from 9.999 to 999.9 volts, with an average measuring time of 1 second. The measured voltage is displayed in a row of four 1″-high numerals.

In a digital voltmeter (DVM), the unknown voltage is applied to one side of an electronic balance detector. At the same time, precise voltage increments are added by the DVM to the other side of the detector until the two voltages are equal. The voltage value added by the DVM to balance the unknown is displayed as its readout.

The DVM measurement technique is called the potentiometric or comparison method, in which a second voltage is developed to equal the unknown. As is shown in the functional diagram of Fig. 4, the potentiometric voltage is taken from a voltage divider connected to a very stable source known as the reference voltage or working reference. Programmed stepping switches vary the voltage-divider setting until the potentiometric voltage is equal to the unknown input voltage; at the same time, they operate the digital readout. The voltage-comparison amplifier informs the programming circuits of the relative amplitude of the unknown input and potentiometric voltage to each step of the switches. A polarity-reversing switch for the reference voltage permits measuring both positive and negative inputs. The range switch varies the setting of an input attenuator so voltages greater than the reference voltage can be measured. Range changing may also be accomplished by choosing a different reference-voltage value, generally changing to 1 volt or 100 volts.

Fig. 2. *Hi-Pot* tester locates breakdowns in insulation between conductors.

Taut-Band Meter Movements

In meters designed for portable use in industry, a unique meter-movement construction is often employed — taut-band suspension. A basic movement in which this suspension is utilized is shown in Fig. 5. Instead of spiral springs, as in d'Arsonval movements, two metal strips (given a partial twist and held taut by tension springs) serve as springs to hold the pointer against the zero stop. The advantages of this relatively new suspension method include:

1. Elimination of bearings (and thus bearing friction).
2. Relative immunity to vibration and shock.
3. Reduced maintenance because of fewer moving parts.

Fig 3. Digital voltmeter generates voltage to compare with unknown.

4. Increased sensitivity, up to several hundred percent over jewel-and-bearing instruments.

In the figure, the relative size of the taut band has been exaggerated in order to show the construction of the movement more clearly. Actual taut bands are only 0.005″ wide and 0.0005″ thick.

Recording Instruments

Recording instruments are used in industry where it is desired to have a permanent, continuous record of information such as voltage, current, pressure, humidity, flash points, rpm, etc. Any quantity

• *Please turn to page 83*

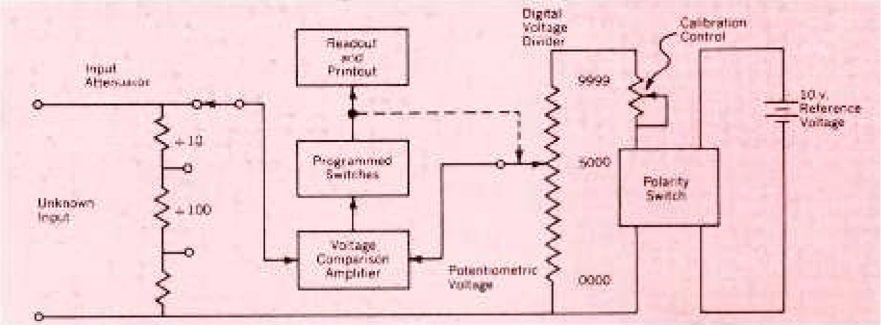
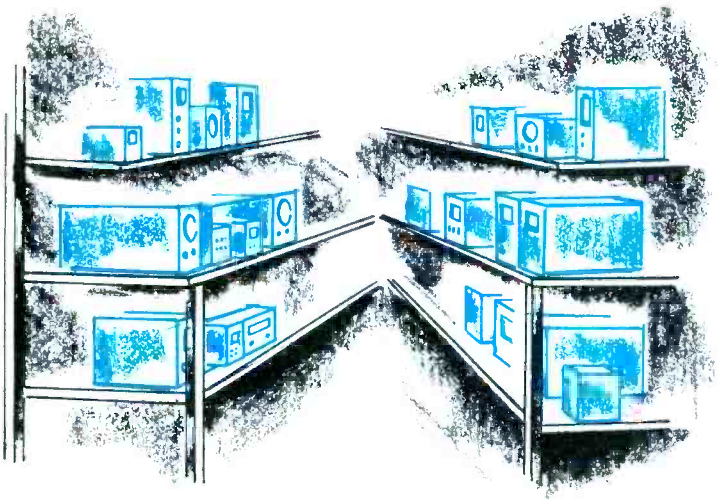


Fig. 4. Programmed switches set up voltage balance and digital readout.

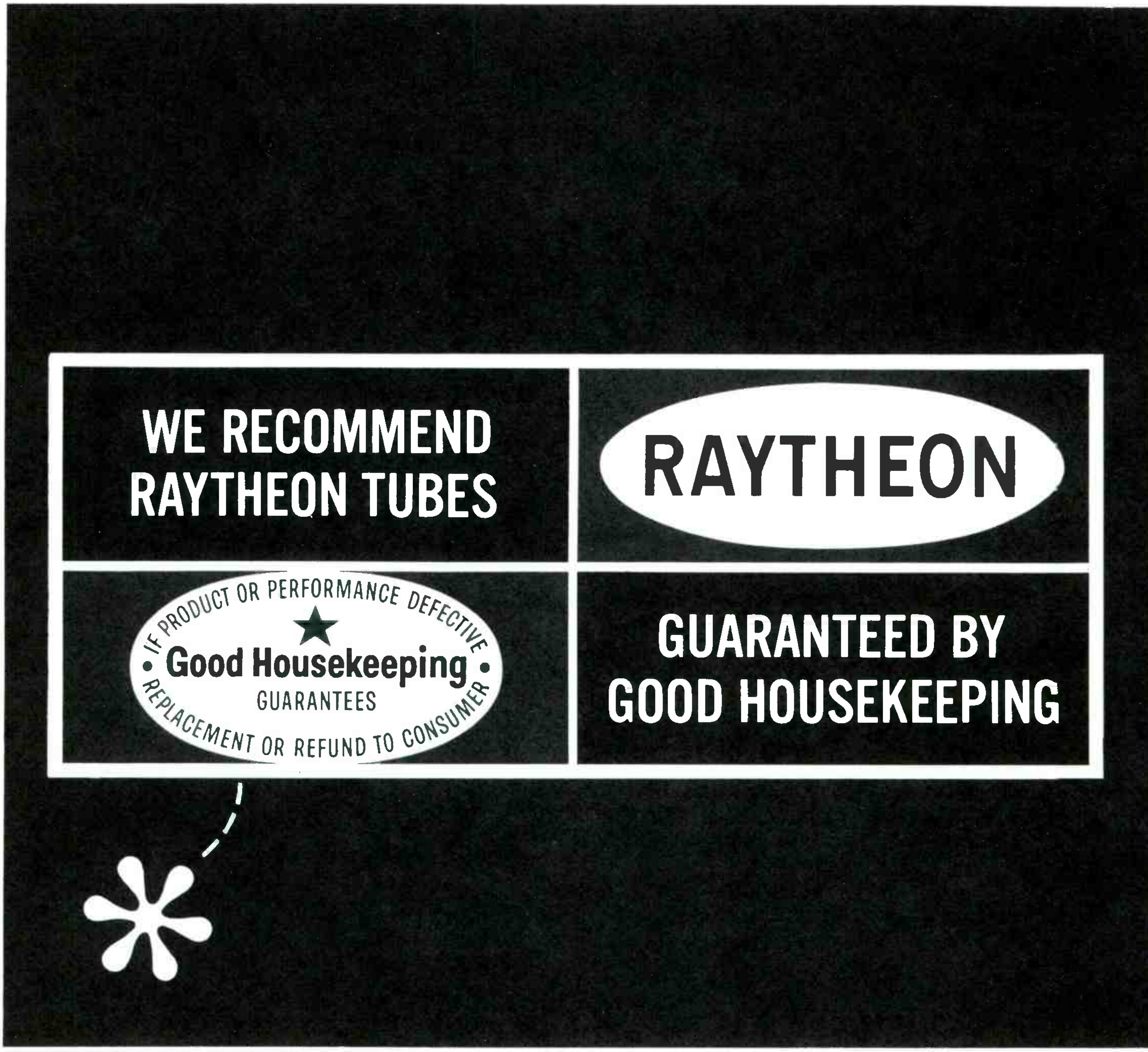


TEST EQUIPMENT *Guide* FOR SHOPS

To keep up with the advancing electronics field, many new and helpful items of test equipment have been developed. The serviceman is faced with the problem of choosing the right instruments to cope with the variety of faulty electronic devices he encounters each day. Purchasing every new piece of test equipment that becomes available is impractical and unnecessary. Each serviceman must weigh his own needs and purchase only those items that can help him make a profit. For example, it would be impractical to purchase a color-bar generator for a shop that repairs only transistor radios. If an instrument is going to remain on a shelf and collect dust, it serves no useful purpose and is an unwise investment. But the serviceman should keep an open mind in considering unfamiliar new types of test equipment, because they may offer him an opportunity to increase his efficiency. Likewise, he should not hesitate to replace obsolete or worn-out equipment, which can waste valuable time by giving false readings or even failing to work when needed.

From a recent survey of service shops, it was found that the VOM, VTVM, oscilloscope, and tube tester are still considered basic instruments. The chart below shows additional test equipment that will prove helpful for various types of service work. It is divided into categories in case you want to concentrate on one or more specialized fields.

Test Equipment	VOM	VTVM	Oscilloscope	Tube Checker	CRT Tester	Transistor Checker	Signal Generator	Sweep Generator	Harmonic Generator	Signal Tracer	Capacitor Checker	Substitution Boxes	Yoke-Flyback Tester	AC Wattmeter	Frequency Meter	Modulation Monitor	Field Strength Meter	Dummy Load	Isolation Transformer	DC Power Supply	Special Circuit Analyzers
B-W TV	◆	◆	◆	◆	◆	◆	◆	◆			◆	◆	◆	◆			◆		◆		◆
Color TV	◆	◆	Wide Band	◆	◆		Bar Dot	◆			◆	◆	◆	◆			◆				◆
AC-DC Radio	◆	◆	◆	◆			◆		◆	◆	◆	◆							◆		
Xstr Sets	◆	◆	◆	◆		◆	◆		◆	◆	◆	◆								◆	◆
Hi-Fi	◆	AC Type	◆	◆		◆	Stereo Audio	FM	◆	◆	◆	◆									◆
Auto Radio	◆	◆	◆	◆		◆	◆		◆	◆	◆	◆								◆	
CB	◆	◆	◆	◆		◆	◆			◆	◆	◆			◆	AM	◆	◆		◆	◆
2-way	◆	◆	◆	◆		◆	◆			◆	◆	◆			◆	AM FM	◆	◆		◆	



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This business-builder makes real sense—the new customer-catching Good Housekeeping Seal decal for service dealers who replace with Raytheon receiving and picture tubes. It's yours—part of Raytheon's 1963 "Deal with the Seal," created to help boost your profits and enhance your own fine service reputation.

We're using full-page advertising in Good Housekeeping magazine to tell more than 5 million families how the Good Housekeeping Seal guarantees performance and quality of all Raytheon tubes. We're re-

WHEN IT'S TIME TO CALL A TELEVISION SERVICE MAN select the one who uses only first-quality, factory-warranted Raytheon electronic tubes. You can be sure he is an excellent technician who has proven himself through experience and training. You can be sure he has complete service facilities, charges fair prices, and always gives an itemized bill. He's your best bet for fast, dependable television repairs and continuous viewing enjoyment.

WHAT YOUR HUSBAND SHOULD KNOW ABOUT TELEVISION TUBES

First, when it comes time to replace a worn-out big picture tube, it's important that the man of the house be prepared with a few basic facts. For instance, Raytheon picture tubes are made with all new glass.* Many ordinary replacement tubes are not new, through and through, as you have every right to expect them to be. Raytheon Uniline Picture Tubes are completely new—just like your original. They're guaranteed in writing from base to faceplate. New components and all new glass—nothing rebuilt. And, with all these advantages, Raytheon Uniline Picture Tubes are competitively priced. Look for the "All New Glass" sticker on the Raytheon picture tube—to be sure.

WHAT'S BACKING UP THE BIG PICTURE TUBE?

A whole array of smaller receiving tubes. Each of these must be a reliable, tireless performer. Again, the best way to keep your TV perfect for sight and sound is to look for the Raytheon name on all replacement tubes. The reliability of Raytheon tubes is the reason so many television manufacturers use them as original equipment. The strict quality control practiced in building Raytheon tubes makes them a top choice for many important military applications such as missiles and satellites.

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Did you know that every Raytheon television tube—picture tubes and receiving tubes—carries the Good Housekeeping Guaranty Seal? Of all the seals users depend upon, this is the one most looked for. It means the product has been thoroughly checked, and an assurance given that when you buy, you'll get longer, trouble-free performance. You'll find this Good Housekeeping Seal combined with Raytheon's identifying symbol in TV service dealer stores, advertisements and in the Yellow Pages listings. Look for the familiar sign of dependability for the best in TV enjoyment:

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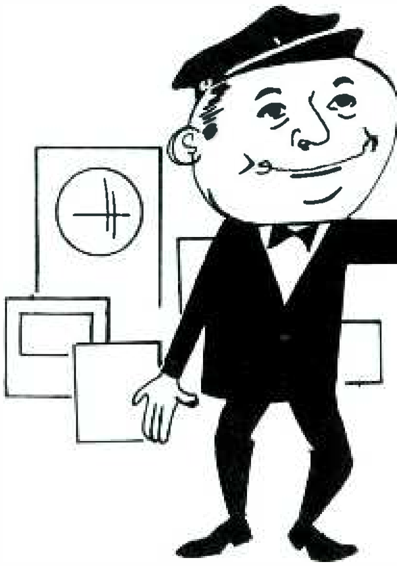
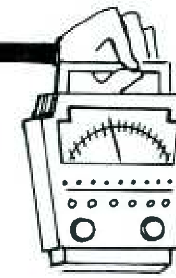


Getting MORE from your TEST EQUIPMENT



Keep looking for new ways to utilize what you now have.

by Robert G. Middleton

Experienced technicians have learned that basic test instruments—such as the VOM, VTVM, oscilloscope, and signal generator—can do many more jobs than are usually expected of them. To develop these additional methods of using test equipment requires a basic understanding of the workings of each instrument, and a certain amount of imagination.

Unusual ways to use test apparatus are illustrated by the following examples, which are all practical techniques you can use in everyday service work. They demonstrate the type of thinking involved in making better use of your basic instruments.

VOM as AC Ammeter

When tracing power-supply shorts, some technicians choose the technique of monitoring the line-current demand of the receiver while disconnecting various power-supply branches. This is a useful method, because when the shorted branch is disconnected, the current decreases sharply. If the excessive current is due to a defect in the power transformer, "unloading" it will leave the input current unaffected. A burned-out tube in a series-string receiver will cause the meter pointer to leap, quiver, and fall back to zero when the receiver is first turned on. The momentary reading occurs because the B+ filters charge up through the semiconductor rectifiers; there is no heater drain, nor is any current drawn from the power supply.

The initial surge in a normal TV receiver is from 5 to 15 amperes.

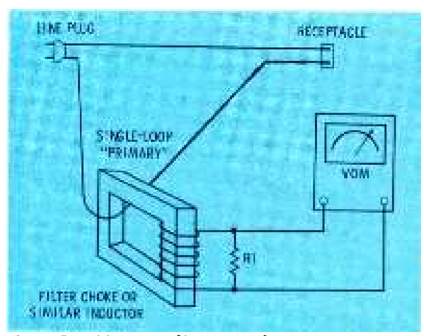


Fig. 1. Line splitter adapts VOM to measure AC current on voltage ranges.

The ammeter will then drop quickly to a reading of 0.5 to 1 amp, and creep up until the raster is about to appear. Then, as the horizontal system swings into operation, the ammeter reading will rapidly climb to the normal operating value.

Very few service-type VOM's have a built-in AC ammeter function, but some manufacturers build adapters or accessories for this purpose. In fact, it is a simple matter to make up your own adapter, as shown in Fig. 1. The *line splitter* is a short length of AC cord, interconnecting a standard AC plug and receptacle. One of the wires in the line splitter is run through the core window of the current transformer (any small iron-cored inductor). The male end of the splitter is plugged into the female receptacle.

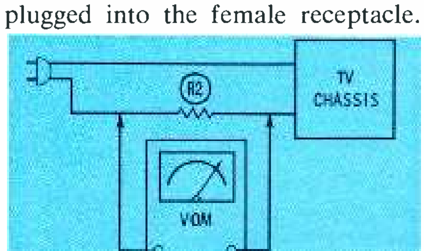


Fig. 2. Use current through R2 as a reference for calibrating line splitter.

R1 is a calibrating resistor, and its value will be selected during the initial calibration. Of course, the adapter should be enclosed in a small box, for the sake of neatness and to keep the position of the single-turn primary fixed.

To calibrate your adapter, use the reference setup shown in Fig. 2. The VOM is set to the AC-voltmeter function—usually on the lowest range, unless the inductor you are using as a current transformer has a rather large inductance. R2 is a power resistor having a low value, such as 1 or 2 ohms. After the chassis has warmed up, and is drawing steady current from the line, measure the AC voltage drop across R2 and calculate the current from Ohm's Law: $I = E/R$. Do not remove the resistor from the power line.

Plug in the current adapter, and connect the VOM to the adapter output. Now, select a value for R1 (in the adapter) which causes the VOM to read 1 volt for each ampere in the line. For instance, if the chassis is drawing 2.25 amperes, select a value for R1 which makes the VOM read 2.25 volts. Then, the AC voltage scale can be used to read AC amps. If the inductor does not give enough output voltage, simply utilize a choke with more turns. Small filter chokes with high inductance are best and usually will provide ample output to "trim down" with the shunt resistor. Or, you may even find that a two-turn primary suits the characteristics better than a one-turn primary. In any case, do not omit R1 from the adapter, or transients that occur when the line splitter is connected or disconnected might cause arcing between layers of the inductor secondary. The resistor serves not only to calibrate the readings, but also to protect the inductor.

VTVM as RF Voltmeter

Most VTVM's have an RF probe, or such a probe can be obtained from the manufacturer. Vacuum-tube diode probes will withstand considerable input voltage without being damaged, while semiconductor types are somewhat limited in this latter respect. Since nothing is ahead of the RF probe, signal frequencies up to 100 mc and sometimes 250 mc can be applied. If the lowest full-scale range of the meter is .5 volt, or thereabout, as little as .01 volt (10 mv) rms will be readable on the scale, and the instrument can be used as a high-frequency signal tracer.

You can make a quick check for local-oscillator operation in a TV set by touching the RF probe to a floating tube shield placed over the oscillator tube. Furthermore, the IF signal can be traced through the IF strip. You should measure about 0.1 volt at the first IF grid, if the set is receiving a fairly strong signal. In normal operation, a greater signal voltage is measured at each successive plate and grid terminal. Of course, the probe tends to detune the IF circuits, so the readings are only relative; but this procedure will enable you to isolate the trouble area, in case the signal is being stopped or attenuated somewhere.

If you suddenly get a very high reading when testing at an IF terminal, detuning has caused oscillation. Disregard this reading, and simply proceed to the next grid or plate terminal.

Beginners are sometimes confused when the VTVM shows a reading as the probe is moved about in the air; but the unconnected probe tip is only picking up stray fields. To avoid errors from this source, make it a practice to short the probe tip to the ground lead when zeroing the meter.

The short ground lead provided with an RF probe should always be used, because a long ground lead (Fig. 3) develops excessive reactance at higher frequencies. This will cause the RF reading to be low. To prove this fact, first ob-

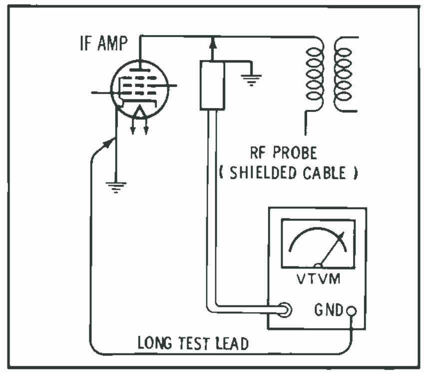


Fig. 3. Long test lead is poorer RF ground than outer conductor of cable.

serve the signal-voltage reading with both ground leads connected. Then, disconnect the short ground lead, forcing the RF signal to return via the long test lead. The scale reading will take a nose dive.

Sensitizing Your Capacitance Bridge

Most capacitance bridges use an electron-ray tube as a null indicator. There are probably times when you have wished the null indication were more sensitive, so you could adjust the bridge with greater accuracy. It's easy to sensitize the null indication by using your scope in place of the electron-ray tube. Connect the vertical-input lead of the scope to the electron-ray tube input terminal of the bridge, and the ground lead to the bridge's "common" bus.

A 60-cps sine-wave pattern will appear on the scope screen. As the bridge approaches a balanced condition, the amplitude of the pattern will drop sharply and become very small at the well-defined balance point. At the same time, the "eye" indicator will be changing its pattern very slowly.

Scope as P-P Voltmeter

Interpreting wave *shapes* is one thing, and measuring waveform *amplitudes* is another. We sometimes tend to neglect peak-to-peak voltage measurements in service work, and this is unfortunate, since amplitude is just as important as shape—sometimes even more so. In other words, a signal-circuit fault may result in a large change of signal amplitude with little or no change in waveshape. If we fail to measure the peak-to-peak voltage, we miss the boat. It does take a little time to calibrate a scope for peak-to-peak measurements, but it is time well spent. Let's summarize the basic facts about peak-to-peak voltage measurements:

1. As depicted in Fig. 4, the vertical attenuator in most modern scopes has a "step" switch and a fine control. With the calibrating voltage applied, note what settings of both controls are necessary for a reference deflection (usually of 1″ or 2″).
2. After making these settings, use only the step attenuator to provide patterns of usable height; if you change the setting of the fine control, the basic calibration is lost.
3. The step attenuator (Fig. 5) is a decade, or decimal, device. In other words, the pattern height is increased or decreased by a factor of 10 when you switch to an adjacent position. This makes it simple to keep track of the vertical sensitivity for whatever pattern height was chosen for calibration.

An example will help clarify these steps. Suppose the calibration voltage is 1 volt peak to peak, and you adjust the vertical gain control for a 1″ deflection on the scope graticule. Then, as long as the attenuator (step) switch remains at the 1 position, 1″ will represent 1 volt of input signal; thus, a 3″ pattern will be caused by a 3-volt signal. If the attenuator switch is changed to 100, each 1″ of deflection automatically represents 100 volts; a 3″ pattern would indicate the presence of a 300-volt peak-to-peak signal.

The same technique will apply no matter what calibrating voltage

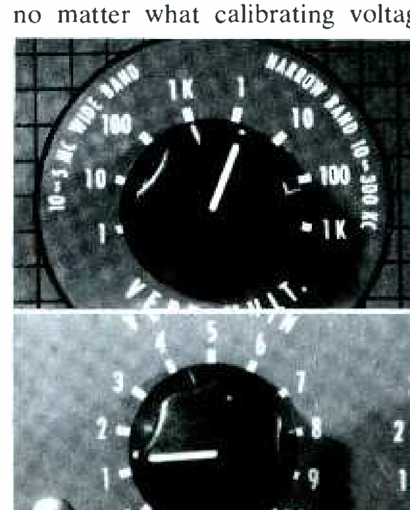
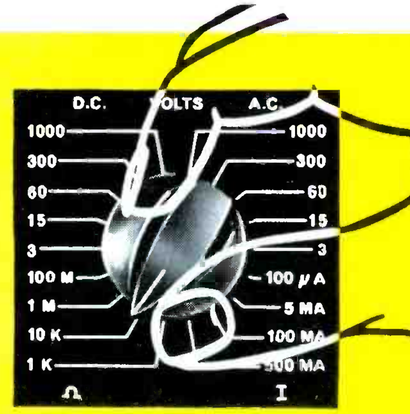


Fig. 4. Scope vertical gain is adjustable by step switch and fine control.

See Only the Scale You Want . . . in the Exact Range You Want

just set the range switch



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Accuracy ±3% full scale AC and DC. **Sensitive** 100 microampere meter movement. **DC Volts** in 7 ranges 0-1500. **AC Volts** (rms) in 7 ranges 0-1500. **AC Volts** (peak-to-peak) in 7 ranges 0-1500. **DC Current** in 3 ranges 0-500 ma. **Ohms** in 7 ranges 0-1000 megohms. Utilizes single DA-AC ohms probe and anti-parallax mirror. Swivel stand converts to carry-handle. Includes 1½ volt battery. Operates on 117 volts 50-60 cycle AC. Net, **$89.95**

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you use—2 volts could be set up as a 2" deflection. Also, some scope graticules are marked in divisions other than inches. If so, these divisions can be used the same as described for inches: one division can represent 1 volt, and so on.

Normal peak-to-peak voltages at key check points are specified on most receiver service diagrams. Don't overlook this valuable troubleshooting aid—there are many circuit faults which can't be pinpointed by ordinary DC voltage and resistance measurements, but can be located quickly by checking signal amplitudes with a scope.

Signal Generator for Gain Tests

A signal or marker generator is an indispensable adjunct to the foregoing instruments. Tests may show that RF and IF stages are operating, but the signal level still is suspiciously weak. In such cases, a gain measurement of each stage is in order. Proceed as follows:

1. Connect a VOM or VTVM at the detector output.
2. Apply the generator output—at a frequency in the middle of the IF band—to the grid of the suspected stage, and then to the following grid. (Clamp the AGC line in this test; also keep the signal level low, so it won't overload the set.)
3. The ratio of the voltmeter readings is the approximate stage gain. In Fig. 6, for example, if the voltmeter readings are 2.5 volts and .25 volt, the stage gain is 10.

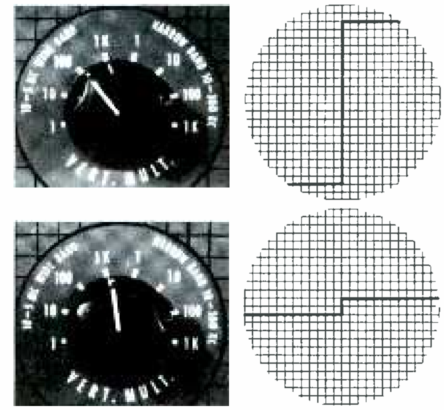


Fig. 5. Effect on waveform when attenuator is switched to higher position.

The generator should have a blocking capacitor in series with the output lead to prevent disturbing the DC grid bias; a 250-mmf capacitor is satisfactory. The VTVM should be set to measure DC volts. As a general guide, a stage gain of about 10 is normal for low values of AGC clamping voltage. High AGC bias will reduce the measured gain in normal operation, but will not block the controlled tubes because they generally are remote-cutoff types.

In summary, basic test instruments will give much greater benefits if full advantage is taken of their capabilities. It is a fact that many tests and measurements commonly considered to be in the province of elaborate and expensive instruments can be made with basic test equipment, provided you know how to use it. ▲

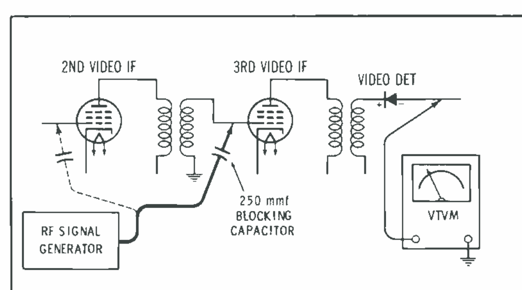
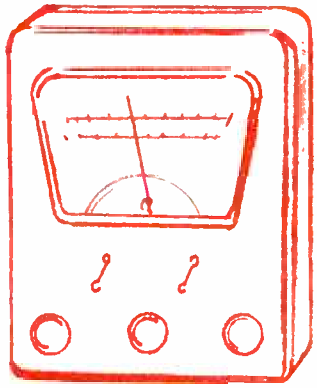


Fig. 6. Test setup to check IF stage gain with signal generator and VTVM.

QUICKER SERVICING
by George F. Corne, Jr.

you Can service transistors with a VOM



Many servicemen have perfectly good VOM's in their shops doing nothing but sitting and collecting dust on the shelf; others may be using their VOM's now and then, but only on tube radios and TV sets. Most technicians really haven't given much thought to using a VOM for servicing transistorized equipment. They usually prefer to use a VTVM for transistor work simply because they feel their VOM can't do the job as well, or that it might "load" transistor circuits enough to affect their operation. If you have similar impressions about the VOM, you may be missing some of its features that can be put to good use on transistorized sets.

One of these features in particular—current-measuring capability—is certainly applicable to transistor-radio repair. Don't forget, the transistor is a current-operated device, and current readings are very helpful (sometimes even necessary) in checking and troubleshooting transistor radios. Most vacuum-tube voltmeters don't have this feature, and you must use a separate milliammeter to check current in a receiver. There are special test instruments designed especially for transistor work, most of which come equipped with a current meter—but so do VOM's.

Voltage Measurements

The majority of VOM's, especially newer ones, have a sensitivity rating of 20,000 ohms per volt (ohms/volt). This means that when the range switch is set to read 1 volt full scale, the shunt resistance connected to the circuit under test will be 20K; on the 2.5-volt range, the resistance will be 2.5 times 20K, or 50K. The shunt resistance increases proportionately as the voltage range is increased. The accuracy of the voltage reading obtained will generally increase, since less circuit loading will occur.

A VOM with a sensitivity of at least 20K ohms/volt *can* be used to measure transistor-radio voltages, with suitable accuracy. Circuits that use transistors have low impedance and are less likely to be upset by the low shunt resistance of the VOM than, for example, the high-impedance grid circuit of a vacuum-tube oscillator. (A VOM with an ohms/volt rating *lower* than 20K may tend to load circuits an undue amount, affect their operation, and cause inaccurate voltage readings. For this reason, it shouldn't be used for transistor servicing.)

Ranges

The best VOM's for transistor work are those in which the lowest DC voltage range is only 1 or 2.5 volts, full scale. (Many newer instruments have even lower voltage scales especially intended for transistor measurements, so keep this in mind if you're thinking of buying one.) A meter with a range this low is useful for measuring the low bias voltage between the base and the emitter of a transistor. This bias voltage is normally just a few tenths of a volt, and reading it becomes a guessing game on a higher voltage scale—say the 10-volt scale, for instance.

On the other hand, in case your present VOM doesn't have a 1- or 2.5-volt range, don't worry about it; you can still measure the bias voltages mentioned above, merely by adopting a different method. Using the chassis as ground, meas-

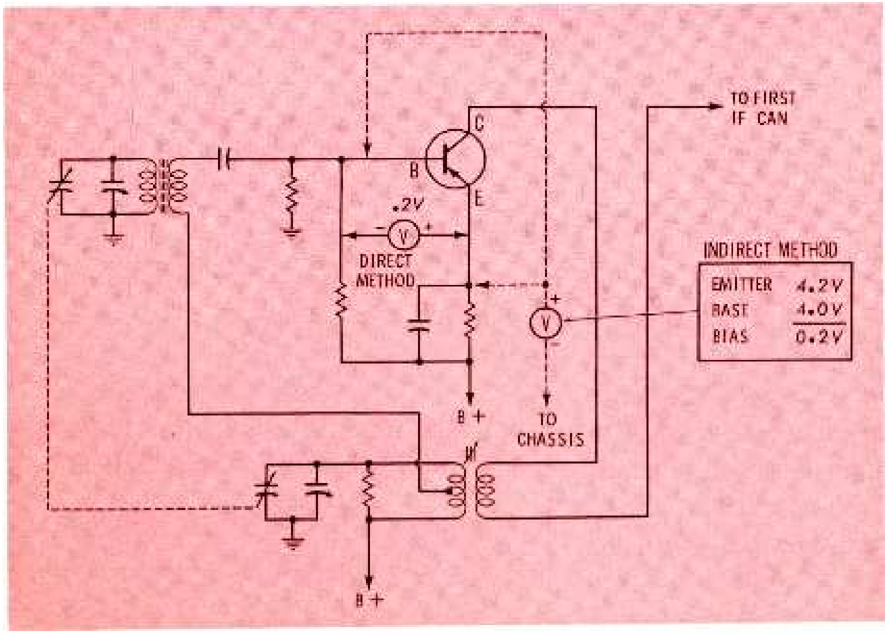


Fig. 1. Two methods to measure base-to-emitter voltage in transistor stage.

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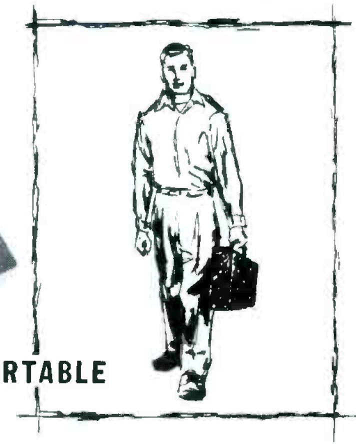

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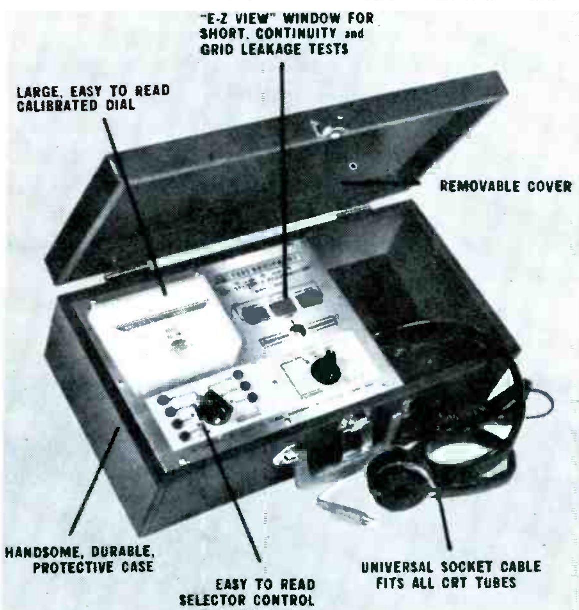

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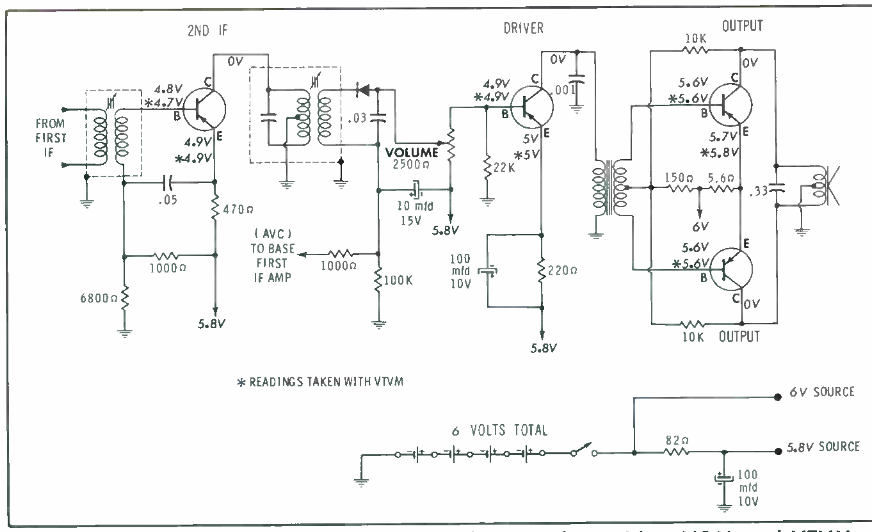


Fig. 2. Partial schematic demonstrates voltages taken with a VOM and VTVM.

ure the voltages on both the base and the emitter of the transistor, and then compare these two voltages. Their difference represents the bias between those two elements of the transistor. As pointed out before, the readings will be fairly accurate — especially when measured on the 10-volt range.

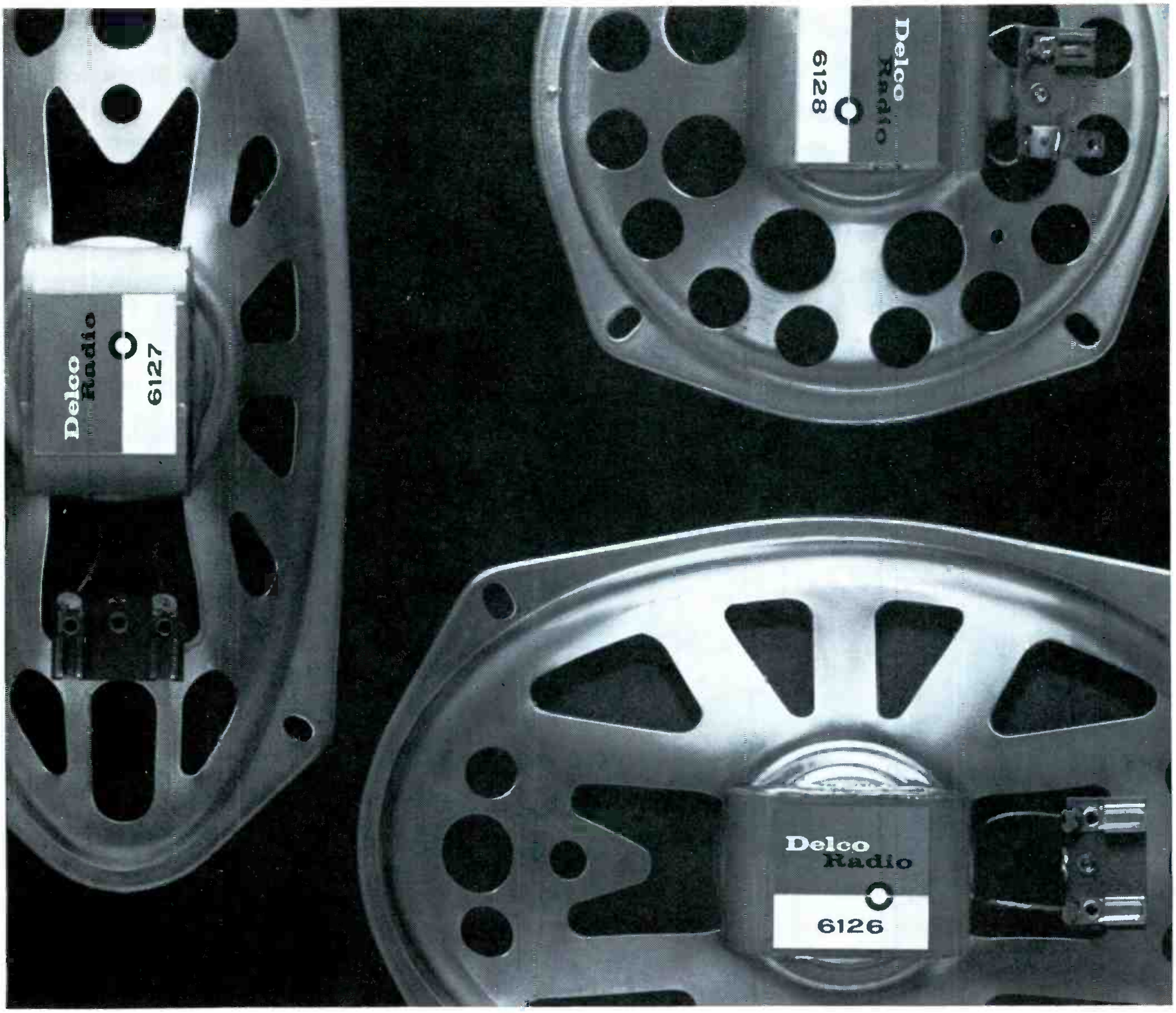
These two methods of measuring bias voltage with a VOM are demonstrated in the partial schematic shown in Fig. 1. In the direct method, the test leads are connected between the base and the emitter of the transistor, and the bias is read directly from the meter. The indirect method involves measuring the base-to-ground and emitter-to-ground voltages separately, and subtracting one from the other to obtain the bias voltage.

Readings—VOM vs VTVM

To illustrate that the VOM will give suitable indications of voltage on transistor elements—base, emitter, and collector — without loading the circuit, let's check some actual VOM readings against those obtained with a VTVM. (These readings are for the purpose of pointing out that the VOM is applicable to transistor work—not as a proving ground for demonstrating the advantages of one meter over the other.) The "guinea pig" is a typical six-transistor radio, of which a partial schematic is shown in Fig. 2.

The negative side of the 6-volt battery is connected to the chassis, and this point serves as common ground for all the voltage measurements. The VOM is a 20K-ohms/volt type, and two voltage ranges are used—2.5 and 10. Voltages measured in the stages not shown will give similar results.

The two sets of voltages shown for the transistor elements in Fig. 2 point out that, in almost every measurement, the VOM gives nearly the same reading as the VTVM. Special attention was paid to the performance of the oscillator-converter when the VOM was connected to it, but there was no ma-



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jor change in its operation due to circuit loading. This was true for the other circuits in the receiver, too.

Current Measurements

The current-measuring feature of a VOM also makes the instrument valuable in transistor repair work. Not only can you check to see that the total current drawn by the radio is within limits (good callback insurance after a repair job is complete), but you can also use current readings to check the operation of each transistor stage —as you'll see presently.

The total current drawn by a transistor radio varies from one receiver to another, of course, as does the amount required by a single stage. The RF and IF stages draw considerably less current than the driver and output stages—particularly if the output is wired in push-pull. For this reason, it's well to have some idea what values of current you might expect to find in individual transistor stages. Here are some typical values: RF and IF stages normally draw from .5 to 1.5 ma; driver stages from 1.5 to 3.5 ma; output stages, 5 ma or more, depending on the setting of the volume control. Let's take a closer look at a typical six-transistor radio, especially noting the current distribution throughout the stages.

Under idling conditions—no input signal, and volume control set to minimum—the total current measures 10.2 ma. The current distribution for each stage is as follows: converter, .5 ma; first IF amplifier, 1.4 ma; second IF amplifier, 1.2 ma; driver, 1.6 ma; push-pull output stage, 5.5 ma. Again, these current values are for no-signal conditions. Tuning in a station and rotating the volume control for a normal listening level, we see the *total* current drawn by the radio zoom to 35 or 40 ma, and at maximum volume, 60 to 70 ma. The majority of this current is drawn by the class-B driver and output stages.

The actual measurement of the current through an individual transistor stage can be accomplished by several different methods. One way is to measure the voltage drop across the emitter resistor (or col-

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A third method (which is also one of the quickest means of locating a defective transistor stage) involves connecting the meter to monitor the *total* current drawn by the radio. Then, one transistor at a time can be checked by shorting the base to the emitter while watching the meter for a change in current. The total value of current drawn by the radio will decrease a small amount when this test is performed, *if* the transistor is working; removal of the bias voltage stops current flow through the transistor. Make sure you check any stage that doesn't cause a change in current when this test is performed—it is probably inoperative. Caution: *Do not* short any element of a transistor to chassis as you might do in tube circuits—grid to ground, for example—because, in some circuits this action could cause excessive current and ruin the transistor.

Resistance Measurements

For all general purposes, the ohmmeter section of a VOM operates in the same manner as that of many VTVM's. When using an ohmmeter in transistorized circuitry, you should guard against possible damage to the transistors. Many ohmmeters are capable of delivering enough voltage and current to ruin low-power transistors —those used as RF and IF amplifiers, for example. For this reason, it's best to follow two simple rules governing resistance measurements when semiconductors are present:

Test Voltage

First, before you use the instrument, measure the voltage that is available at the ohmmeter's test leads. Most ohmmeters are powered by a single 1.5-volt dry cell, or two cells connected in series for a total of 3 volts. But, there are instruments that use higher voltages

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on certain positions of the range switch. One unit uses 1.5 volts for the R x 1 and R x 100 ranges, and 7.5 volts for the R x 10K range. A few have as much as 15 to 30 volts available at the test leads. So, if you haven't already done so, rotate the selector switch on your meter to each resistance range and check the output voltage with a separate voltmeter. This way, you'll know how much voltage is available.

If more than 3 volts are present at your meter leads, on any range, you'd do well to check the voltage rating of the transistors before you connect the test leads. The voltage rating of a transistor varies with the type, of course, as does the breakdown voltage between the base, emitter, and collector elements. Usually, transistor manuals list the breakdown voltage from the collector to the other two elements, but breakdown voltage isn't normally given for the base to the emitter. As a rule of thumb, don't apply to the *collector* of a transistor a DC test voltage that exceeds the supply voltage of the receiver, and don't apply a DC test voltage from the emitter to the base of a transistor in excess of 3 volts. Generally, the 1.5 volts found in modern ohmmeters should be safe enough.

In passing, we might caution against the use of component checkers — a resistance-capacitance checker, for example—to measure the resistance of a transistor. Most of these instruments use bridge circuits, with a fairly high test voltage (AC in some)—enough to damage a transistor.

Test Current

The second rule to remember involves the current available from the ohmmeter's test leads. When measuring the resistance of circuits containing low-power transistors (or when checking the transistor out of circuit), use a high resistance scale—at least R x 100. Maximum current flows from the meter test leads when the range switch is in the R x 1 position. In this position, an excessive amount of current might be drawn by a transistor with low-resistance diodes—enough to ruin it, and quick. The R x 1 scale may be used to check high-power output transistors, for they are capable of handling the higher current available from the meter (often several hundred milliamperes).

Summary

The VOM is a versatile instrument for use in servicing transistor radios. In addition to having features to measure current, voltage, and resistance, (all needed for transistor troubleshooting) it is usually portable and ready for instant use, needing no external power.

If you will equip it with a few special probes for transistor servicing (alligator clips and needle-point tips, in particular) and keep it as a permanent test instrument on your transistor servicing bench, you'll find each repair job a bit easier; and your VTVM will be free for other applications.

Handful of Testers

The unit pictured, Heath Co.'s Model IM-20 *Handy Lab*, has quite a few instruments packed into its 52½ cubic inches—a DC voltmeter, a resistance and capaci-

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Provides Exclusive Color Gun Killer—Front-panel switch control makes it easy to disable any combination of the three color guns. Eliminates continuous adjustment of the background or screen controls, or connection of a shorting clip inside the receiver. The switch also selects the individual grids of the color tube and connects to a front-panel jack to simplify demodulator alignment.

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tance substitution box, an AC indicator, a continuity tester, and an AF and RF signal generator.

The DC voltmeter is built around a 1-ma meter movement, and the input sensitivity of the instrument is 1000 ohms per volt. It has four ranges—15, 50, 150, and 500 volts DC—with an accuracy of ± 10%.

The resistance-substitution section contains five values (100, 1000, 10K, 100K, and 1 meg); all are rated at 1 watt, with 5% tolerance. The capacitor portion of the *Handy Lab* consists of five 400-volt capacitors: .001, .005, .02, .1, and 8 mfd; the latter is an electrolytic unit.

An NE-51 neon lamp is incorporated as the AC indicator, and a #49 pilot lamp works in conjunction with a pair of penlight cells to form a continuity checker—effective for circuits with resistance less than 50 ohms.

Two transistors are wired into Hartley oscillator circuits—one operating at approximately 1000 cps and the other between 450 kc and 700 kc. The 450-kc RF output can be modulated by the 1000-cps audio tone, providing a modulated RF test signal.

The several functions of the Model IM-20, coupled with its small size, make it a handy device for the service caddy. It can be used in a number of servicing situations in the home: for locating open filaments by continuity or voltage tests; for measuring B+ and other DC voltages in the set; for checking resistors and capacitors by substitution; for checking the effectiveness of most electrolytics; and for signal injection to help isolate faulty stages. ▲

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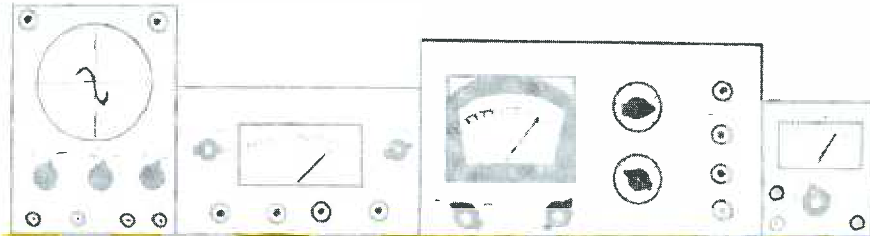

NOTES ON TEST EQUIPMENT

by Forest H. Belt

Picture-Window Color

A rather novel idea has been incorporated in the Model 850 *Color Analyst* (Fig. 1) designed and built by the B & K Division of Dynascan Corp. A window in the panel of the instrument displays the hue and the design of the color test pattern that should be seen on the color-set screen. No matter what pattern is selected — color or convergence signals—it appears in the window of the Model 850 exactly as it should appear on the receiver CRT, making comparison easy.

Specifications are:

1. *Power Required — 117 volts AC, 60 cps, 36 watts.*
2. *RF Output—Channel 3, 4, or 5 selected by rear-panel switch; unmodulated sound carrier displaced 4.5 mc from the video carrier.*
3. *Video Patterns — Convergence signals consisting of 300 dots, 10 vertical lines, 14 horizontal lines, or crosshatch of 10 vertical and 14 horizontal lines; video available at panel jack, with polarity and amplitude controlled by a panel potentiometer.*
4. *Color Signals — Burst, yellow, I, red, R-Y, magenta, Q, B-Y, blue, cyan, and green; signal phases all correspond to those on the NTSC color-phase wheel.*
5. *Controls and Terminals — four rotary switches:* PATTERN, COLOR, POWER, *and* GUN KILLER; *two slide switches:* COLOR SYNC-NORMAL *and* CHANNEL *(on rear panel); pin jacks:* HORIZONTAL, VIDEO, DEMODULATOR, *and* GROUND; *permanently attached CRT cable, deconvergence cable, and RF cable.*
6. *Other Features — Metal mirror in cover; rear compartment for storing leads and cables; window on front panel, indicating pattern being generated; carrying handle for portability.*
7. *Size, Weight, Price — 9" x 12¾" x 9"; 13 lbs; $199.95.*

The Model 850 is a color-signal generator for use with any color TV receiver. It will provide all the signals normally needed for chroma-circuit adjustments, demodulator phasing, and convergence. The signal can be applied to the antenna terminals of the TV set, or else connected at the output of the video detector, since both RF and video outputs are provided from the Model 850. The VIDEO control on the front panel of the instrument makes it possible to produce either positive-going or negative-going video signals, for injection at any point in the video amplifiers of a receiver.

An examination of the block diagram in Fig. 2 will point out some of the features of this instrument. In many sections, it is similar to other color generators; for example, the dot-bar section uses the blocking-oscillator frequency dividing arrangement that is extremely popular in modern instruments because of the excellent stability. The 31.5-kc divider, however, is a multivibrator.

The Model 850 is one of the first such instruments to make extensive use of transistors—four in all. Most of them are used as pulse shapers in the various circuits.

The operation of the Model 850 is as follows: The 189-kc master oscillator controls all actions. When the PATTERN switch is set for one of the convergence patterns, the divider oscillators reduce the frequency of the pulses to form horizontal sync from the 15.75-kc divider, vertical sync from the 60-cps divider,

Fig. 1. Window of this color-bar unit shows color pattern to aid servicing.

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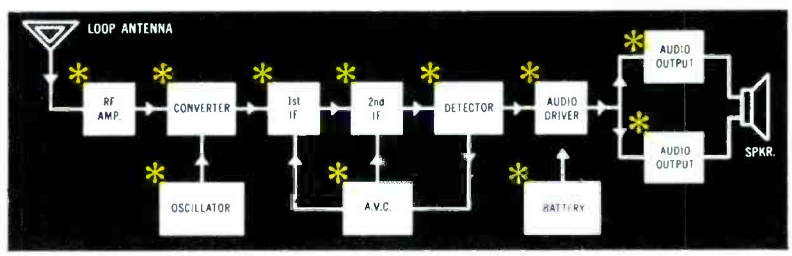

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The ANALYST gives you a complete signal-generating source for point-to-point signal injection. Easily enables you to trouble-shoot any transistor radio—check all circuits stage-by-stage—isolate and pinpoint the exact trouble in minutes.

Supplies modulated signals, with adjustable control, to check r.f., i.f., converter, and detector. Supplies audio signal to check audio driver and audio output. Provides unmodulated signal to test local oscillator. Provides separate audio low-impedance output for signal injection into loudspeaker voice coils to check speaker performance.

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Includes high-input-impedance vacuum-tube voltmeter, which is so necessary for transistor radio servicing.

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Meter has "Good-Bad" scale for *both* leakage and beta. Also has direct-reading Beta scale, calibrated 0-150. Assures quick, accurate test. Also automatically determines whether transistor is NPN or PNP. Meter is protected against accidental overload and burn-out.

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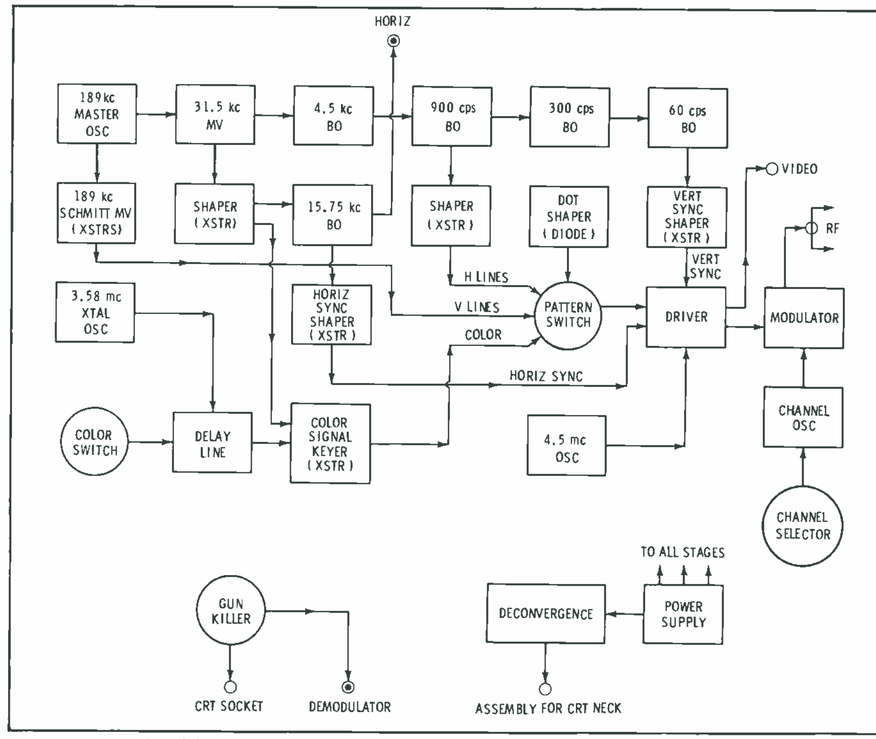

Fig. 2. Gun-disabling section of Model 850 is separate from rest of instrument.

and horizontal convergence lines from the 900-cps divider; vertical convergence lines are taken directly from the 189-kc master oscillator. The sync signals are fed to the driver stage to be mixed with the rest of the composite video signal. The pulses for convergence lines are coupled to the pattern switch, which selects the pulses to be sent to the driver stage, For dots, a diode arrangement clips out the lines from a basic crosshatch pattern, leaving only the crossover points, and forming approximately 300 dots for the video signal.

When the PATTERN switch is set for color patterns, the color circuits are coupled to the driver stage. A pulse from the 31.5-kc multivibrator serves to key the color signal in such a way as to form a "bar" in the center of the color screen. This bar contains no color information, resulting in the display shown in Fig. 3—a dark bar in the center with color on both sides.

The different colors are developed in a delay line which alters the phase of the 3.58-mc chroma signal in accordance with NTSC standards. The COLOR switch picks off signals at specific points on the delay line for the color keyer, which then sends the chroma signal to the driver tube for mixing with the sync signals.

A three-channel RF oscillator permits the choice of channel 3, 4, or 5. The RF signal is fed to a modulator where the video and/or chroma signals are impressed on the carrier, and the modulated RF signal is coupled to the RF output cable. A VIDEO jack at the output of the driver stage permits direct injection of the signal into the receiver video stages, if this form of connection is desired. In case the user may need to adjust 4.5-mc traps, a signal from a crystal-controlled 4.5-mc oscillator is provided. It is fed into the driver stage, where it beats against the carrier signal in the modulator and produces a sound carrier. There is no audio modulation.

GUIDE TO PROFITS

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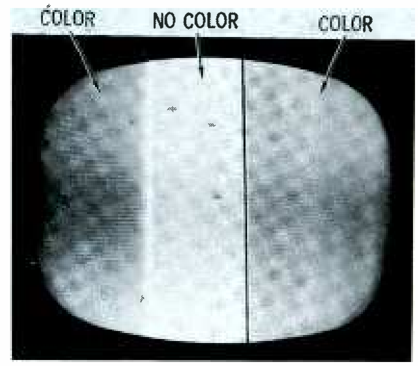

Fig. 3. Bar pattern of color generator.

The gun-killer section is independent of the other circuits in the instrument. It is connected to the receiver by an adapter socket that plugs into the base of the color CRT and accommodates the regular CRT socket. The industry hasn't standardized on labeling of switches used in instruments of this type, so various labels may indicate either the gun or guns that are disabled or the gun or guns left on. The GUN KILLER switch on the Model 850 follows the practice of indicating which guns are on. The guns are disabled by the time-honored method of shunting a 100K resistor to ground from the CRT grids. Positions are provided to leave any single gun operating, or any combination of two guns.

A unique feature of the Model 850 is the deconvergence attachment. In operation, an electromagnet is clamped on the neck of the CRT and positioned between the red and blue convergence coils. By rotating the POWER switch to the "deconverge" position, you send DC current through the deconvergence coil and thus displace the dots on the color screen. In this way, the dots can be deconverged for inspection at any time during normal convergence procedures.

Using the Model 850 on one of our lab receivers proved its usefulness, especially for demodulator-phase adjustments. The gun-killer circuit provides a jack for connecting a scope to check demodulator adjustments, or they can be monitored by watching the screen of the color CRT. Color-generator instruction manuals often differ from one another in the technique recommended for adjusting phase in the demodulators. The booklet included with the Model 850 suggests the "null" method. This consists of feeding the R-Y signal into the receiver, disabling the red and green guns (GUN KILLER switch in the "blue" position), and checking for a uniform dark screen. You see, if the phasing adjustments are correct, no R-Y color signal should appear on the blue CRT gun, and it should be cut off. Then, since the red and green guns are disabled, the portions of the screen where color normally appears (Fig. 3) should look the same as the dark section. To check the other demodulator adjustment, feed the B-Y signal to the set, disable the blue and green guns (turn the GUN KILLER to "red"), and tune for a null — a dark

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So how would you rather be pushed?

By an engine in the rear?

Or by your friends?

screen all the way across. If both tests show a "nulled" screen, the phasing adjustments are okay.

The instruction manual is very thorough in describing color alignment setups for all major color television chassis, and goes into considerable detail on various other phases of color-TV servicing with the Color Analyst.

Semiconductor Analyzer

One of the more recent entries in the semiconductor-tester field is the Seco Model 250 *Transistor and Tunnel Diode Analyzer* (Fig. 4). This unit can perform comprehensive tests on both low and high power transistors, as well as on tunnel diodes, zener diodes, and ordinary germanium diodes.

1. *Power Required — 117 volts AC, 60 cps, 11 watts; available also in battery-powered model using three 1.5-volt flashlight cells.*
2. *Transistor Tests — both signal and power types, NPN or PNP, and tetrode types; tests quality, Icbo, Iceo, and DC beta; special circuit for balancing out Iceo during gain tests; quality can be checked with transistor in circuit or out.*
3. *Diode Tests—Signal or power types, zeners, tunnel (Esaki) diodes; forward and reverse current; checks negative resistance in tunnel diodes.*
4. *DC Voltmeter—Three ranges, from 0 to 1, 10, and 100 volts DC; sensitivity 5000 ohms per volt.*
5. *DC Milliammeter — Three ranges, from 0 to .2, 10, and 100 ma.*
6. *Ohmmeter — One range, with 150 ohms center, 5000 ohms highest readable scale mark.*
7. *Signal Generator — Uses any good transistor plugged into test socket; audio frequency on fundamentals; RF-IF signals on harmonics.*
8. *Panel Meter — 3½" face size; sensitivity 200 ua; scales: from 0 to 200 and 0 to 10 for reading microamps.*

Fig. 4. Unit can test many different kinds and types of semiconductor units.

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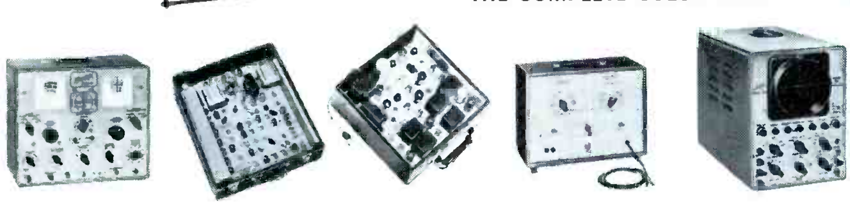

MODEL 615 MODEL 656XC MODEL 660 MODEL 661 MODEL 675A

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milliamps, volts, and beta; 0 to infinity for ohms; Iceo, Icbo, and diode quality; meter movement protected from overload by internal diode.

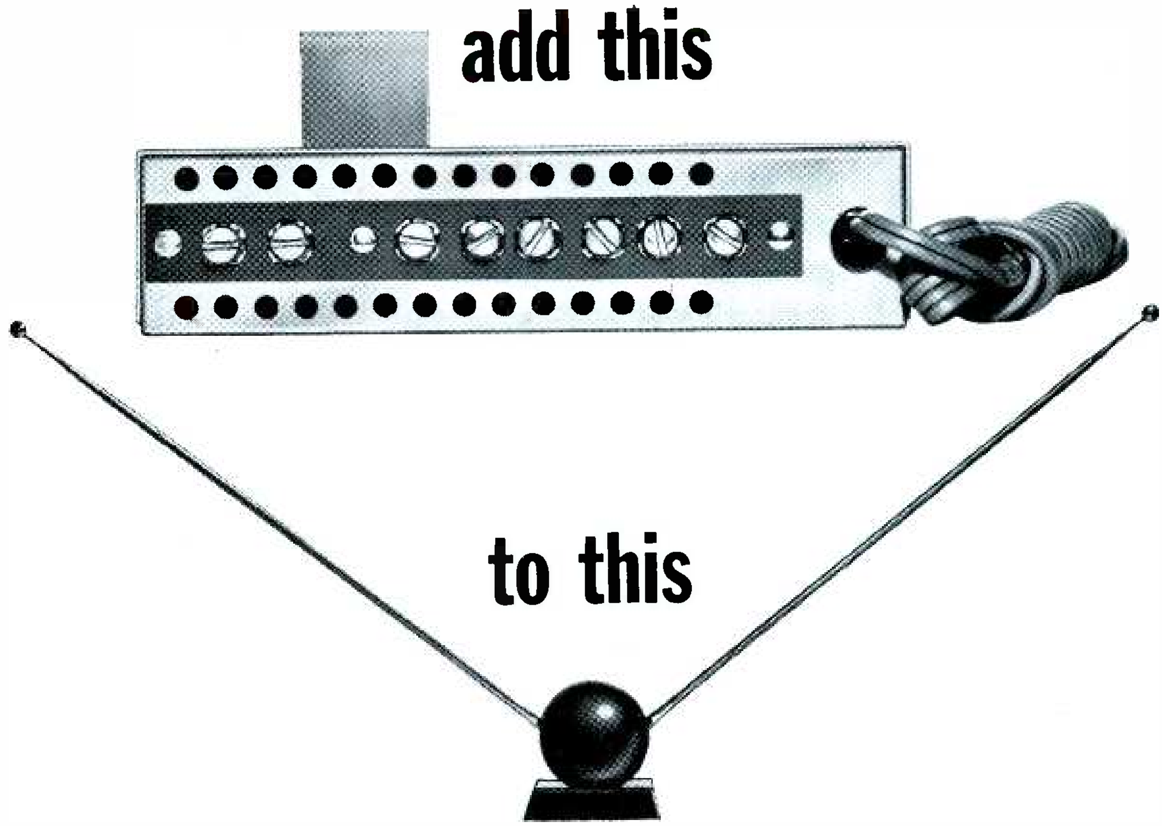
9. *Controls and Terminals—three potentiometers:* FEEDBACK, A *and* B *(for test-circuit adjustments); two rotary switches:* TYPE SELECTOR *and* FUNCTION SELECTOR; *slide* POWER *switch; momentary contact* CANCEL *button for Iceo; ten banana jacks: two for* OHMS *and* DIODE *tests, three for DC voltmeter, and one each for* COMMON, MA, AF, RF-IF, *and* B_2 *connection for tetrode transistors; two transistor sockets; three built-in test leads for transistors.*
10. *Size, Weight, and Price—10" x 7¾" x 4½"; 4½ lbs; $86.50 AC-powered, $74.50 battery-operated.*

The Model 250A offers a number of functions in addition to its basic purpose of testing semiconductors. For example, it can be used as a harmonic generator for signal injection into RF, IF, or audio stages of radio receivers. To operate the unit in this fashion, it is necessary only to insert a good transistor in the test socket and adjust the instrument for a dynamic test of the transistor. When the transistor is oscillating in the test circuit, a pair of test leads plugged into the jacks on the panel will connect the oscillator signal to the set under test.

This signal-generator function is possible because of the manner in which the 250A tests transistors—by measuring their efficiency in an oscillatory circuit. With the feedback control set just high enough for oscillation, the transistor usually generates an approximate sine wave; this signal is excellent for audio tests. When the control is advanced further, the waveform begins to resemble a square wave, and is much richer in harmonics; this is the signal to use for RF and IF signal injection.

Also included in the Model 250A are circuits for operating the unit as a VOM. Ranges are provided which will permit most or all of the measurements that must be made in the average tran-

"Aw right now! Who has my solder gun?"



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BLONDER-TONGUE B-24c INDOOR BOOSTER

Some people think a booster is only for use with outdoor antennas. Not so. In many cases, the new Blonder-Tongue B-24c indoor TV FM booster produces a dramatic improvement in reception when used with an indoor antenna. Simply add it to any garden variety indoor antenna, and you get up to 12 db gain in signal strength—enough to turn your indoor antenna into a powerful antenna system.

The Blonder-Tongue B-24c is easy to install anywhere in the home—patented, stripless screws eliminate the need to cut and twist twin lead. It can be used to amplify signals from any indoor or outdoor antenna. It's an excellent solution where your customers can not or do not want to utilize an outdoor antenna. Hook up a B-24c and show your customers how much sharper and clearer it makes the picture. Tell them of the extra TV or FM sets they can operate from single indoor antennas — up to 4. You've got a profitable sale.

In very difficult reception areas an outdoor antenna is necessary because it delivers a better signal-to-noise ratio than an indoor antenna. In that case you still can use a B-24c indoor booster, or any one of the indoor or outdoor boosters in the Blonder-Tongue line. Blonder-Tongue boosters perform best. Try them today.

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sistor receiver — volts, milliamps, and ohms.

An interesting feature of the Model 250A is the thoroughness of its transistor analysis. First, the suspected component can be checked—in or out of the circuit — for quality. If the in-circuit dynamic test is inconclusive for any reason, the transistor can be removed from its circuit and plugged into a test socket (or connected to the built-in clip leads). Next, the leakage between the collector and base (Icbo) is tested with the emitter open. The scales on the instrument reveal whether the leakage is abnormal for the type of transistor being analyzed (power or signal type). Then, the emitter-collector leakage (Iceo) is measured with the base "floating." Again, scales on the panel meter indicate if the reading is acceptable.

Lastly, DC beta — the gain of the transistor — can be measured. Before this reading is taken, a special arrangement permits adjusting the test circuit to "ignore" the Iceo of the transistor, which otherwise might upset an accurate beta evaluation. After the Iceo CANCEL control is adjusted, beta can be read directly from the meter scale.

In addition to the usual tests for transistors, forward and backward resistances between the various elements can be measured with the Model 250A, utilizing the ohmmeter section. The same test setup is used to check the forward and reverse current in signal and power diodes. Scales on the meter are labeled with normal readings.

Tunnel diodes have a very special characteristic, and require special testing techniques. When a very minute voltage is applied to a normal tunnel diode, current begins to flow. Many of them start conducting with only a few microvolts. Fig. 5 shows a graph of voltage versus current in a typical tunnel diode. As the applied voltage increases, the current rises proportionately—up to a point. The voltage soon reaches a value (known as the *peak* point—typically 55 to 65 mv) at which the current stops rising; as the voltage continues to increase beyond this point, the current begins dropping off. Finally, at a few hundred millivolts, the current decreases to a minimum, at what is called the *valley* point. As the voltage increases

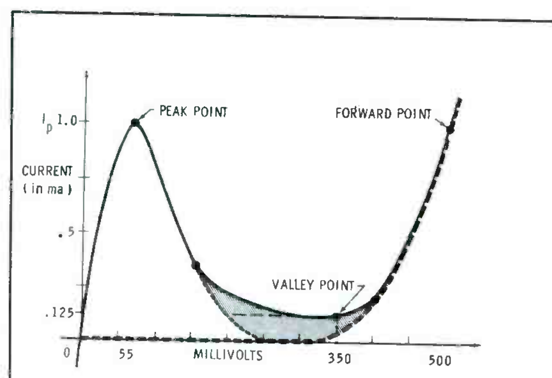

Fig. 5. E and I curve of tunnel diode.

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Fig. 6. Cover converts to carrying case.

even further, the current again rises, eventually reaching a practical maximum—known as the *forward* point. Beyond this, the diode could be damaged. The forward-point current has the same value as the current at the peak point.

In the graph the peak point of 1 ma is reached at an applied voltage of 55 mv, the valley point of 125 ua is at 350 mv, and the forward point (again 1 ma) occurs at approximately 500 mv. The region where the current *decreases* with *increased* voltage — an apparent violation of Ohm's law — is known as the *negative resistance* region. This characteristic is important to the operation of tunnel diodes, and should be checked with the 250A.

Zener diodes can be checked on the Analyzer, too. The same test procedures that apply to tunnel diodes are used for testing zeners. The key to the tests is the voltage and current at which the zener *begins* to conduct; beyond that point, the current merely rises as the voltage increases.

The instruction manual included with the Analyzer gives detailed information about each test the unit performs. In addition, a chart of popular transistor types indicates normal gain readings and dissipation ratings. A chart of tunnel diodes lists test connections for a number of popular types, and indicates normal peak and valley currents.

The cover of the Model 250A is unusual. A condensed chart of test procedures is included on a card in the cover of the instrument. When folded back, the cover holds the procedure chart in view for easy reference; when in place — as shown in Fig. 6 — it forms a handgrip for carrying the unit. ▲

now in our lab . . .

We're analyzing these test instruments for future "Notes" columns.

Electro Model EC-3 Power Supply
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Hickok Model 725 Stereo Generator
Heath Model IO-10 DC Scope
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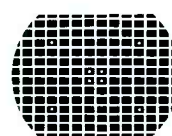
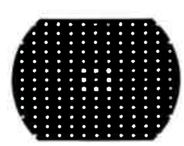
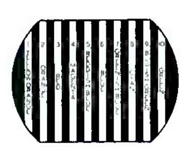


Enables you to troubleshoot and signal trace color circuits in color TV sets, or facilitate installation.



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



Generates full color rainbow display and color bar pattern to test color sync circuits, check range of hue control, align color demodulators. Demonstrates to customers correct color values.

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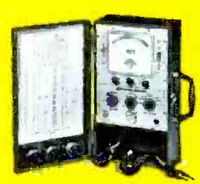

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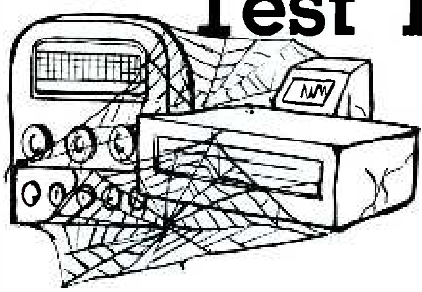

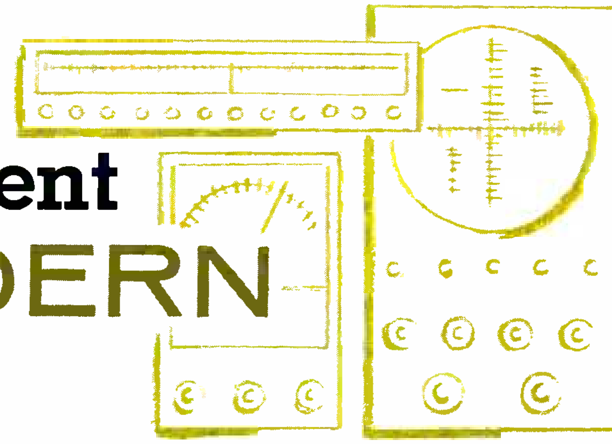

by Ernest Tricomi

A man walked into his psychiatrist's office. On his head was perched an owl. The owl spoke first. "Doc," it said, "how do I get this thing off my feet?"

Which illustrates very clearly that things are not always what they appear to be at first glance. Like the cost of test equipment. A good test instrument might carry a price tag that seems rather high to you; but when you consider how much time it can save you in the customer's home or at your service bench, it's easy to realize its cost is outweighed by the savings that result from doing jobs in less time.

Suppose you're called to a customer's home to repair a television set. Your minimum charge is $5.00 for the first half-hour, and $5.00 per hour thereafter. Now, if you had a little genie by your side to aid in diagnosis, pointing out a weak tube here, a leaky capacitor there, or a source of future trouble somewhere else, it might result in saving of a full ten minutes in the course of the call. If you make six or seven such calls a day, that extra ten minutes could easily amount to time enough for still another call that day!

The same idea applies in the shop. Suppose you pay your technicians $2.40 per hour. If a man loses *only five minutes* of each hour, from lack of proper equipment, it can cost you a considerable amount—as shown in Table I.

Table 1—Cost of Lost Time

No. of Men	Cost Per Day	Approximate Cost Per Year (240 days)
1 5	1.60 8.00	384.00 1920.00

New Equipment—Which Types?

New test instruments are introduced every month. The trend is to combine three and four different functions in one instrument whenever it is practical. Multipurpose instruments save money on the original investment, as well as saving time in actual test procedures. Most of the new equipment is also portable so it can be carried into the customer's home or used at the service bench.

The test instruments you should have depends on what types of equipment you service. For example, if you service mostly transistor radios, you need a transistor tester more than you need a scope; and if you specialize in two-way gear, you'll find a frequency meter more helpful than a sweep-circuit analyzer.

Look over your present equipment. What modern features are missing in the instruments you have now? Can you think of other features which would make servicing faster and more convenient for you? When you've analyzed these factors, make a list of special functions you need in your work, and then decide which instruments should be replaced to fulfill these needs.

How Much to Buy?

A shop owner could easily become test-equipment poor if he went out and bought everything that came down the pike. You need to decide how much of your total income you should reinvest in updating your test equipment, and then spend this money judiciously.

An average shop may have a total of about $2500 invested in test equipment, according to a recent survey. If you consider obsolescence and use, four or five years is a good economic life for test equipment. This means you should spend $500 or $600 per year to keep modern, dependable instruments available. According to Table I, saving just five minutes of each working hour will result in a cash saving of more than half that amount. So, again you see it pays to have modern test equipment.

You can budget a portion of your total service income for test equipment purchases. The percent-

Table II—Test Equipment Budget

Investment in TE	On Eqpt. Per Yr.	Gross Income	Approx. Portion
2,500	500	7,500 10,000	7% 5%
	750	7,500 10,000	10% 7%
5,000	1,000	15,000 25,000	7% 4%
	1,500	15,000 25,000	10% 6%

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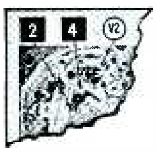
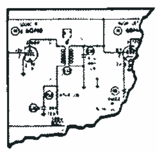
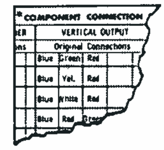


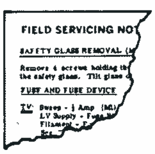
CircuiTrace® saves countless hours of foil tracing time. This exclusive Sams system pin-points junctions and test points on schematic and printed board.



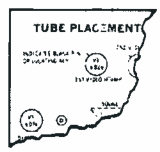
Famous Standard Notation Schematic saves valuable hours—always uniform, accurate, complete for every model.



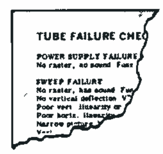
Exact Terminal Connections are indicated—no need for trial-and-error methods—a real time-saving feature.



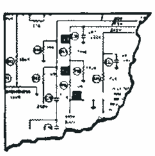
Field Servicing Notes spell out locations of adjustments for speedy "in home" servicing. Saves time spent in hunting for hidden adjustments.



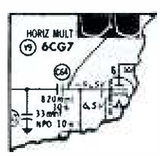
Tube Location Guide enables you to locate and replace proper tubes in seconds—a big time-saver on most repair jobs.



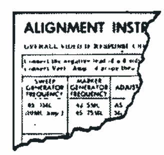
Tube Failure Check Charts spell out probable tubes responsible for failure—no need to waste time studying circuitry.



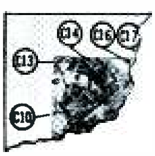
Clear Parts Symbols with values and associated information are shown plainly on the schematic—no time wasted in cross-reference "look-up."



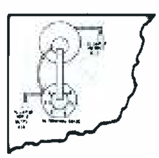
Waveform actual photos are shown on schematic for quick comparison of patterns on your scope. No time wasted in guesswork.



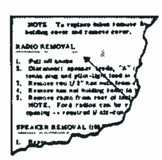
Unique Alignment System eliminates guessing; you get complete instructions with response curves, how to connect test equipment, proper adjustment sequence.



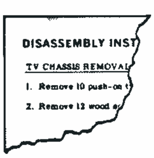
Full Photo Coverage of the actual equipment makes identification of all components and wiring easy—you can *see* everything.



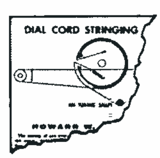
Terminal Identification saves you time; transformer and coil terminals quickly identified by color code or basing diagram shown on schematic.



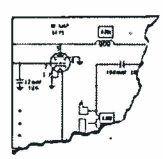
Auto Radio Removal instructions show you step-by-step procedure for removal of even the most complicated models—a big time-saver.



Disassembly Instructions, step-by-step, help you remove difficult chassis, subchassis, and assemblies in minutes.



Dial Cord Stringing instructions save you up to an hour or more of time and headaches on a single job.



Alternate Tuner Data—separate schematics, alignment data and parts lists are provided—no time wasted interpreting various tuner versions.

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age will depend on your gross volume, and can be figured according to the chart in Table II. For example, suppose your investment in test equipment is $2500, and its average useful life is five years. This means you should budget approximately $500 each year for test-equipment replacement. Now, if your gross income from service labor is $10,000, you will be laying aside about 5% of your gross income for keeping your test equipment modern.

Depreciation Helps, Too

Be sure to use whatever tax advantages result from the purchase of new equipment. The revision in depreciation methods made recently by the Internal Revenue Service is designed to encourage businessmen to spend money for modernization. Thus, it is now more attractive than ever to invest in up-to-date test equipment.

If you can prove to the satisfaction of your IRS office that any item of your test equipment becomes obsolete after only three years, you may depreciate one third of its value each year, for tax purposes. This can result in some very substantial tax savings, which will help pay for the cost of modernization.

Finding Information

To keep well informed of current trends in test-equipment design, you may want to look carefully through the pages of your trade magazines. For example, in this very issue you'll find several pages of fact-filled advertisements intended specifically to provide full information on the instruments being offered. Our regular test-equipment features (such as *Notes on Test Equipment*) are written to help you "size up" each instrument or group of instruments, and determine which ones fit your requirements.

Another helpful source of information is literature from test equipment manufacturers and other sources. This information will point out the "what" and "where" of using test equipment profitably.

Review Your Needs

Sit down some quiet evening and look over your shop and equipment with the question in your mind, "What test instrument could have improved my time and accuracy in each recent job?" This will help you pinpoint the type of equipment you will find most useful. After you have selected the broad type of instrument you need, shop for it as carefully as you would for a new car or a new location. Keep in mind its utility, convenience, appearance, and quality, as well as its price. Your local electronic parts distributor can often help you considerably in making a wise choice.

The success of your service business depends on your skill in swiftly and surely diagnosing whatever ills may befall electronic products. The secret is no secret at all —it's the judicious choice and expert use of good, dependable test equipment. If you haven't already done so, review your test-equipment rack now and determine what you need to bring your own shop up to date in testing instruments. Next — plan carefully, along the lines pointed out in this article, how much money you should spend on keeping your equipment modern. Then, do it! ▲

RCA Color-Bar/Dot/Crosshatch Generator

Low-cost, lightweight, portable instrument that provides all essential Color-TV test patterns. Simple to operate: only 3 controls. RF output leads connect directly to antenna terminals of receiver; no external sync leads required. Crystal-controlled signals assure rock-steady patterns, free from "jitter" and "crawl." Extra-wide-range chroma control. Generates:

- **Color-bar pattern**: ten bars of color, including R-Y, B-Y, G-Y, I and Q signals spaced at 30° phase intervals for checking phase and matrixing, and for automatic frequency and phase alignment. Permits accurate alignment of the "X" and "Z" demodulators which are used extensively in RCA Victor and many other makes of color TV receivers
- **Crosshatch pattern**: a grid-like pattern of thin sharp lines for adjusting vertical and horizontal linearity, raster size, and overscan
- **Dot pattern**: a pattern of small sized dots facilitating accurate color convergence adjustments

$189.50* with output cables.

RCA 5-Inch Oscilloscope for Color-TV

A wideband scope excellent for checking colorburst signals and general troubleshooting of wideband color circuits and other electronic equipment. Muilt-scale calibrated graph screen makes measurement of peak-to-peak voltage as easy as with a VTVM.

- New 2-stage sync separator assures stable horizontal sweep lock-in on composite TV signals
- Dual bandwidth: 4.5 Mc at 0.053 volt rms/in. sensitivity. 1.5 Mc at 0.018 volt rms/in. sensitivity
- Continuously adjustable sweep frequency range: 10 cps to 100 Kc
- 3-to-1 voltage-calibrated, frequency-compensated step attentuator for "V" amplifier
- Simplified, semi-automatic voltage calibration for simultaneous voltage measurement and wave-shape display
- Vertical-polarity reversal switch for "upright" or "inverted" trace display

$249.50*, including direct/low capacitance probe and cable, ground cable, and insulated clip.

RCA Television FM Sweep Generator

Specifically designed for visual alignment and troubleshooting of color and black-and-white TV receivers, and FM receivers. The RCA WR-69A has pre-set switch positions for all VHF TV channels, FM broadcast band, and TV video, chrominance, and IF frequencies. The WR-69A has these important features:

- IF/Video output frequency continuously tunable from 50 Kc to 50 Mc
- Sweep-frequency bandwidth continuously adjustable from 50 Kc to 20 Mc on IF/Video and FM; 12 Mc on TV channels
- Output level—0.1 volt or more
- Attenuation range: TV channels, 60 db IF/Video, 70 db FM, 60 db
- Return-trace blanking
- Two adjustable bias voltages on front panel

$295.00* including all necessary cables.

RCA RF/VF/IF Marker Adder

Designed for use with a marker generator (such as RCA's WR-99A) and a sweep generator (such as RCA's WR-69A), this instrument is used for RF, IF, and VF sweep alignment in both color and black-and-white TV receivers. In visual alignment techniques, it eliminates distortion of sweep response pattern. Important features:

- Choice of four different marker shapes provided by front panel switch for different types of sweep-response curves and for positive and negative sweep traces
- Provides very high-Q markers of high-amplitude and narrow bandwidth
- Complete front panel control of marker shape, marker amplitude, marker polarity, sweep amplitude, and sweep-trace polarity

$74.50* complete with cables.

RCA Crystal-Calibrated Marker Generator

Supplies a fundamental frequency RF carrier of crystal accuracy for aligning and troubleshooting color and B&W TV receivers, FM receivers and other electronic equipment in the 19-260 Mc range. Combines functions of multiple-marker generator, rebroadcast transmitter, and heterodyne frequency meter.

- Highly stable output
- May be calibrated at 240 separate crystal check points—accurate calibration provided at 1-Mc and 10-Mc intervals
- Matched-impedance pad-type attenuator and double shielding of the oscillator provide effective attenuation of all frequencies
- Most-used IF and RF frequencies are specially indicated on the dial scale
- Sound and picture carrier markers available simultaneously

$242.50* complete with output cable and phone tip.

RCA ELECTRON TUBE DIVISION, Harrison, N. J.

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*User Price (Optional)

THE TROUBLESHOOTER

answers your service problems

Sweep-Alignment Touchup

In sweep alignment of video IF's, I have a difficult time figuring out how to position markers correctly on the scope trace during the final overall check. For instance, take the stagger-tuned set I aligned today. All the various slugs seemed to peak normally, using a marker generator and VTVM; but when I checked the results with a scope, the 45.75-mc marker was too far down on one side of the curve. I thought it would be boosted higher by

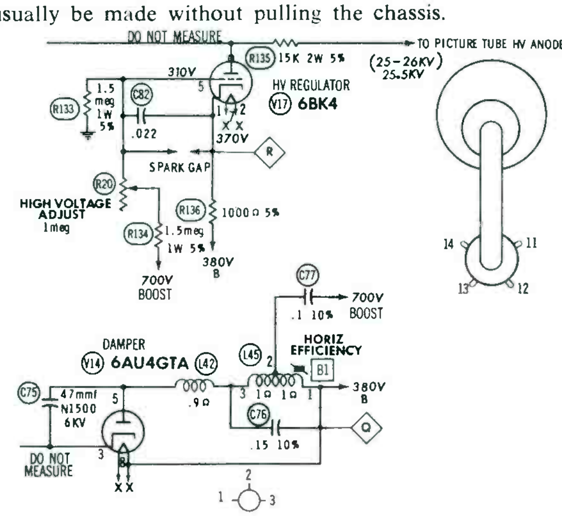
COLOR COUNTERMEASURES

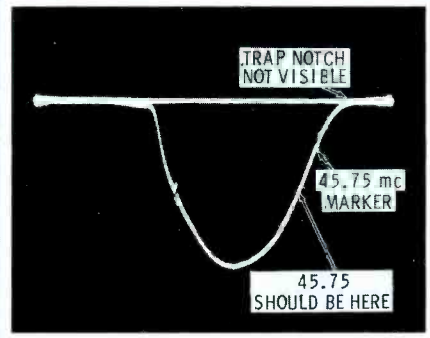
Symptoms and service tips from actual shop experience

Chassis: Zenith 27KC20, 29JC20

Symptoms: Intermittent focus.

Tip: This trouble is generally caused by nothing more than misadjusted controls in the horizontal circuits—the horizontal efficiency coil and high-voltage potentiometer. The symptom will be further aggravated if the CRT controls happen to be set too high, so check them first and readjust if necessary; it's a good idea to keep the screen controls at the lowest possible level consistent with proper gray-scale tracking. Next, adjust the high voltage, output current, and regulator current as described in the service information. All these adjustments can usually be made without pulling the chassis.





adjustment of a coil tuned to 45.5 mc, but turning this slug only distorted the shape of the trace. By adjusting more than one slug, I finally obtained a fairly good curve.

I was also unable to make the 47.25-mc trap notch show up at first.

CARLTON G. MEANS
Troy, W.Va.

You'll frequently find it necessary to readjust more than one coil during the final touchup, since there is a certain amount of interaction between the various IF tuned circuits. Even though all the coils seemed to peak normally, aging of a set can cause some peaks to become lower and broader than in a new set; therefore, you may find it necessary to take steps such as you describe.

The initial step-by-step adjustments occasionally result in a curve which has the correct shape, but which is shifted in frequency so that none of the markers fall at the proper points. This doesn't happen often; but if it does, here's a remedy: Using an accurate marker as a reference, "move" the entire curve under it (by slightly turning every coil in the same direction) until the marker rests at the desired point.

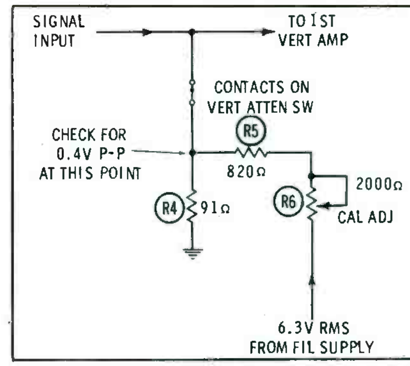
When the curve winds up distorted, as you describe, try turning each slug slightly and noting which portion of the curve is most affected. By thus locating the coil that must be tuned for each specific change, you can generally "shape up" the response curve with a minimum of "twiddling."

On the Level

I can't measure DC voltages accurately with my direct-coupled scope (an EICO Model 460), although the waveform displays seem to be okay. At a point where I measure, say, 200 volts with a VTVM, the DC scope indicates only 110 volts—judging from the change in position of the trace on the calibrated scope screen. I've rechecked the calibration, and have checked all tubes, voltages, and resistances, but nothing seems to help.

CHARLES BEY
Richmond, Va.

Your scope's calibrating waveform may be in error. In the Model 460, this is a 60-cps sine-wave signal (0.4 volt peak to



peak) which is injected into the vertical amplifier when the vertical attenuator is switched to the CAL position. (Calibration is accomplished by adjusting the vertical-gain vernier control so the waveform extends 4 divisions on the screen scale, thus making each division equal to 0.1 volt on the x1 position of the vertical attenuator.) The calibrating signal passes through all stages of the vertical amplifier, except the input attenuator network; therefore, it would be affected just the same as any other signal if there were trouble in the amplifier, and calibration should not be upset.

Since the entire amplifier (three push-pull stages) is DC-coupled, the amount of vertical deflection caused by a DC voltage shift should be the same as for an equivalent swing of instantaneous AC voltage. Therefore, any trouble that might cause nonlinear response to different amounts of DC-voltage change would also cause waveform distortion. If all DC voltages read too low, the calibrating signal is probably too strong. On the schematic, note that it is derived from the filament voltage via R4, R5, and R6. Check the voltage at the junction of R4 and R5 with a sensitive VTVM that gives peak-to-peak AC readings. If the voltage is more than 0.4 volt peak to peak, try resetting R6; if this fails to solve the problem, carefully check the values of R4 and R5.

If the trouble is not in the calibrating-voltage source, the next most likely spot is the vertical input attenuator. To help in isolating a fault here, check to see if the incorrect readings occur on all attenuator-switch settings, or on only one or two ranges.

Blister on the Trace

I have a kit-type scope which operates normally except that a small area on the trace bulges upward. This spot is about 1/2" wide, and rises about 1/16" above the normal trace level. It appears once, near the center of the screen, when the sweep controls are set for 60 cps; at higher sweep frequencies, several of the bulges are seen. The symptom is unaffected by shorting either the vertical or horizontal input terminal to ground, or by switching to 60-cps line sweep. When I apply the calibrating signal from the front-panel test jack to the vertical input, the "bump" slightly distorts the calibrating waveform, which is normally sinusoidal.

JAMES B. CORUM

Upham, N. Dak.

Since the symptom is a vertical deflection of the CRT trace line, it's most logical to look first in the vertical amplifier for the cause. The action of the sweep controls is positive proof you're dealing with a 60-cps interfering signal of some sort, probably hum or a "glitch" from the power supply.

Try substituting all tubes in the vertical-amplifier section, since one of them may have heater-cathode leakage. If this doesn't help, attempt to isolate the trouble by grounding the grid of each tube in turn. (Do this only briefly, to protect the circuits in case the grid normally runs at a high positive potential.) If the "blister" disappears, the interference is being introduced somewhere prior to the point being checked. Be sure all wiring is dressed exactly as specified, especially near the input circuits.

It's remotely possible that trouble within the CRT itself could cause this form of base-line distortion; so, if all else fails, try a new 5UP1.

Meter Protection

I recently burned out the movement of my 20,000-ohms-per-volt VOM. When I replace it, I'd like to put a fuse in series with the new movement. What would be the proper size to use?

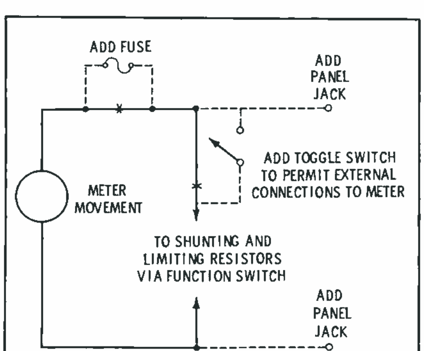
While I'm working on the meter, I would also like to bring two leads out from the movement to an extra set of jacks, so the sensitive movement may be used with other pieces of equipment around the shop. Would this harm the calibration of the meter?

JOHN DAVIS

Brooklyn, N.Y.

A good rule of thumb for calculating a suitable fuse rating is to multiply by ten the current needed to drive the meter to full scale. Most meter movements are rugged enough to survive a considerably higher overload than ten times the rated full-scale current. I've actually seen some meter movements of 50-microampere sensitivity being protected by a 1/200-amp instrument fuse; in this case, the fuse won't blow until the overload amounts to a hundred times the normal full-scale current.

Using the meter movement with other equipment will not harm the calibration,



Checklist for buying a full-power CB 2-way radio

look for these features:

☐ **TRANSMITTER POWER** — For longest transmission range possible, choose a 5 watt unit, the maximum authorized power input for Class D CB radios.

☐ **SENSITIVITY**—A greater sensitivity rating indicates a better ability to reproduce weak signals. Look for a sensitivity rating below 1 microvolt to capture signals transmitted many miles away.

☐ **SELECTIVITY**—A radio's ability to reject interference from channels not tuned in, is largely determined by the type of circuit used: superregenerative, superheterodyne or dual-conversion superheterodyne. The latter circuit, the dual-conversion superheterodyne, is acknowledged by experts to be the best circuitry for clearest reception. Says Len Buckwalter, noted communications author, in *Electronics Illustrated* May 1962. ". . . Look for the dual-conversion feature if you wish to get top receiver performance."

☐ **CRYSTAL-CONTROLLED CHANNELS**—Fixed crystal controls assure accurate, fast communications contact. They enable users to switch quickly from one channel to another to contact different persons, to find a channel that isn't busy. It is best to choose a CB unit with multiple crystal-controlled channels for an efficient, flexible 2-way radio system.

☐ **POWER SUPPLY**—A power supply should be an integrated part of a CB radio. Since full-power CB radios are most often used in vehicles and base stations, a CB radio's power supply should be able to operate from both 12-volt auto battery and 110-volt AC line.

☐ **AUTOMATIC SQUELCH** — This automatically eliminates annoying background noise when a CB radio is on 'standby' (not transmitting and ready to receive any radio calls). Thus, hisses, crackles and other noises can't distract workers, drivers, etc.

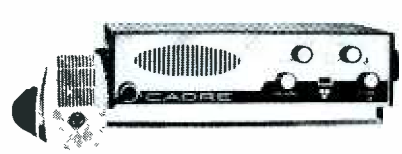
☐ **AUTOMATIC NOISE LIMITER** — An effective automatic noise limiter is necessary, especially in heavily populated areas, to shut out extraneous interferences such as ignition noise. Makes messages more intelligible.

☐ **RELIABILITY** — CB radios must withstand vibration and shock which occurs during mobile use. Solid-state components—transistors and diodes—are less susceptible to damage than fragile tubes.

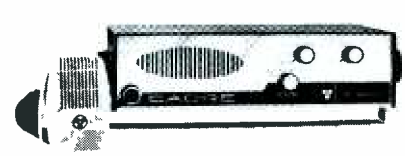
☐ **PORTABILITY** — Some full-power CB radios may be used in the field as portable units when equipped with a portable case-battery accessory. These units are generally lightweight, compactly designed and offer greater operating flexibility.

☐ **INSTALLATION** — Compact CB radios with simple mounting provisions don't steal leg room in vehicles, lower installation and maintenance costs.

Cadre Industries has two 5-watt models that rate high in every category. Each is supplied with a press-to-talk microphone, set of matched channel crystals, universal mounting bracket and AC & DC cords.



Cadre '510'
All-Transistor, 5-Watt, 5-Channel, plus all-channel manual Tuner, **$209.95**



Cadre '515'
All-Transistor, 5-Watt, 5-Channel, **$194.50**

See your Cadre distributor for a demonstration, or for more details, write:

CADRE INDUSTRIES CORP. □ COMMERCIAL PRODUCTS DIVISION □ ENDICOTT, NEW YORK □ AREA CODE 607, 748-3373

Canada: Tri-Tel Assoc., Ltd., 81 Sheppard Ave.West, Willowdale, Ont. Export: Morhan Exporting Corp., 485 Broadway, New York 13, N. Y.

What's A Marker Adder?

This is a question heard often these days. Marker adders are growing in popularity, but a number of servicemen still don't understand them.

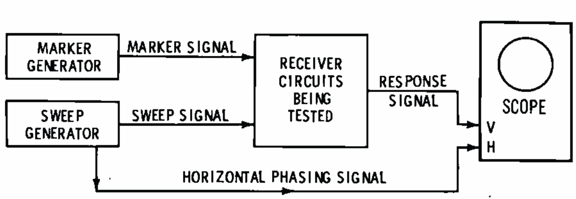
A marker adder is an instrument that will add a marker signal to a sweep-alignment response curve without distorting the curve. More than that: It can develop a marker as large or as small as is desired, can place that marker anywhere on the curve (even in deep trap notches), and will not affect the shape of the alignment curve at all. It does this by the simple expedient of adding the marker *after* the sweep curve is developed on the scope screen. Let's see how it is done.

The figures show two ways of marking the sweep alignment curve. In the method that omits the marker adder, the marker and sweep generators are connected to send the signals into the receiver simultaneously. The marker signal is mixed with the sweep signal in the receiver circuits. If a fairly strong marker is desired—especially in checking the frequency of trap notches—the marker-generator output must be increased, often resulting in overloading of the receiver circuits and severe distortion of the response curve seen on the scope screen.

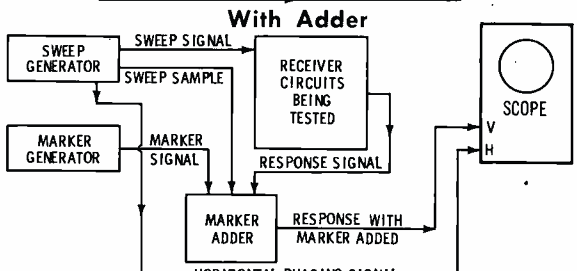
When the marker adder is used, only the sweep-generator signal is fed to the receiver; thus, it can be adjusted to avoid overloading. The receiver response curve is not fed directly to the scope; it is sent, instead, into the marker adder. Meanwhile, a sample of the sweep-generator signal is fed into the marker adder, and there mixed with the marker-generator signal. Since the sweep-signal sample is the same as that being fed to the receiver, the sample signal—with the marker now added—can be superimposed on the response curve coming from the receiver. Both signals are applied to the scope in the normal manner, resulting in a scope display that resembles the usual curve.

The marker size can be controlled by adjusting the amount of signal fed in from the marker generator, but the shape of the response curve is totally unaffected because the marker signal doesn't even enter the receiver. Special circuits in the marker adder allow you to set the width of the marker, as well as its height, making it more visible on the "skirts" of a response curve.

In a few recent sweep generators, a marker-adder circuit is built right into the instrument. This arrangement operates in the same manner, except fewer connections are required. In either form, a marker adder is a very helpful instrument on the alignment bench.



With Adder



Without Adder

provided the movement is not connected to more than one circuit at a time. Be sure to wire the fuse between the jacks and the movement.

Chroma Sweep

I'm looking for a TV alignment generator with which I can perform a complete video and chroma alignment of a color TV set. Will any instrument do the job, or must it be a special type?

CARR TV
South Boston, Mass.

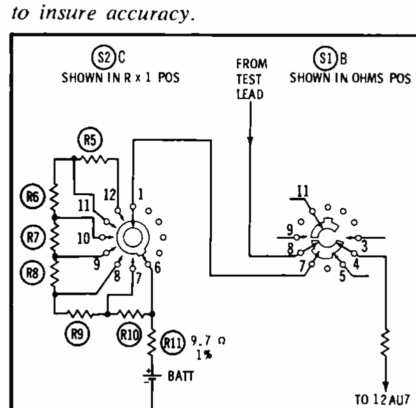
Any good-quality alignment generator can be used for adjusting the RF, video IF, and sound IF stages in a color receiver. However, chroma-bandpass alignment, as pointed out in the recent article "Color Alignment Setups" (June, 1962), requires a sweep generator that will reach well below 3 mc. The minimum center frequency can be higher than 3 mc, if the sweep width is sufficient to cover the desired range. For example, a 4-mc center frequency, with a sweep width of at least 3 mc on each side, will actually result in a signal reaching from 1 mc to 7 mc. Generally speaking, such signals are obtainable with mechanically-swept instruments; but the electronic-sweep types seldom develop sufficient sweep width at low center frequencies.

Ohms Up

I have a problem with my VTVM (schematic enclosed), and hope you can help me with it. The instrument works perfectly except that all ohmmeter readings are 10% high. I've checked the battery, the resistances, the tube, and the test leads; and they all seem okay to me. Can you suggest a remedy?

ROBERT C. MILLER
Bethlehem, Conn.

Since the unit works normally on AC and DC voltmeter readings, the meter movement must be satisfactory; therefore, you must decide which ohmmeter components could affect all resistance readings. Try sketching just the ohmmeter section (the special 8-page Book Section in the front of this issue tells you how), and you'll see that R11 and the OHMS ADJUST *control are the only components common to every ohmmeter range. Chances are that R11 has increased in value. Be sure to use a replacement with a value tolerance of 1%, to insure accuracy.*



Unique Test Equipment

(Continued from page 37)

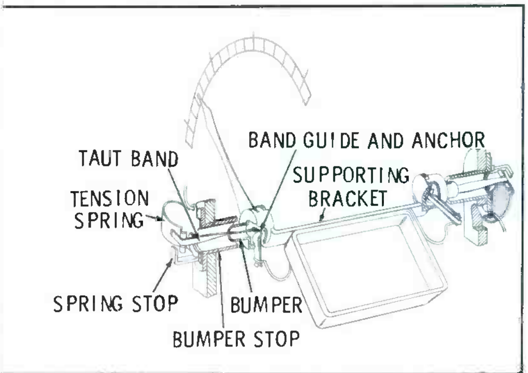


Fig. 5. Taut-band suspension is used in many industrial meter movements.

which can be converted to an electrical signal may be displayed by a strip chart or graphic recorder. These recording instruments employ a pen which is fastened to a movement similar to that used in a standard meter. The pen is held against a chart or graph which either rotates or moves from a roll. As the chart moves, variations in the electrical input signal to the recorder cause the pen stylus to move or vibrate, drawing a graph of the signal on the chart.

Graphic recorders are also utilized to compare one variable function with another: For example, to indicate stress versus strain, speed versus torque, temperature versus pressure, response of an antenna versus rotation, etc. These instruments are sometimes used as a control element, automatically initiating action to return a system to its normal operating conditions in case an input exceeds or falls below a required value. In these applications, the instrument is known as a recorder-controller. A front panel view of a recorder-controller, with a circular chart, is shown in Fig. 6.

A variety of accessories make graphic recorders adaptable to

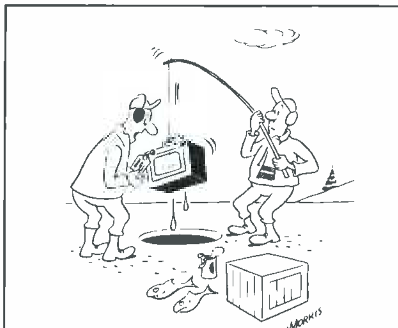
"That's one parrot that won't tell anyone else how to fix a TV!"

Fig. 6. Recorder-controller both indicates and corrects system deviations.

many uses. For example: linear amplifiers permit recording of very low-level signals; special transducers convert physical phenomena to electrical signals; and servo amplifiers are used to supply a feedback signal to control a manufacturing process.

Electronic Quality Control

As the trend in U.S. industry continues toward automated production, the need increases for rapid means of testing, monitoring, or controlling the quality of products being produced or processed. This need has brought about a variety of electronic devices to aid inspection and control people in keeping up with faster production rates. Some of these devices test finished items on either a regular or random sampling basis, with no feedback or error signal returning to control the manufacturing processes. Other test and monitoring devices act automatically, when a flaw or drop-off in quality is detected, to control the production tolerances. In many cases, the necessary corrections are made before even a single item reaches a beyond-tolerance state. In other systems, defective items are automati-



The tag reads, "Impossible—Barney's TV Service!"

cally rejected as the production process, fully corrected, continues at full capacity.

Robotester

Shown in Fig. 7 is a device capable of performing a great variety of automatic troubleshooting or testing functions, either in the production and assembly of components and equipment, or in preventive and corrective maintenance. It's called a *Robotester*.

The basic *Robotester* can perform up to 20 separate circuit tests through sockets on the side panel, at a rate exceeding 60 per minute. The device is adaptable to many types of tests. For example, it can test or measure voltage, current, resistance, inductance, capacitance, frequency, impedance, temperature, and flow rate. The *Robotester's* testing sequence is set up on a punched or perforated tape. For each test, the instrument can indicate acceptance, rejection, or deviation from a required standard. When a rejection occurs, an alarm may signal an attendant who can remove or correct the rejected item.

Optional or accessory units for the *Robotester* include a unit known as a *Robotroller* which will insert a variety of additional test conditions. One or more multiplier units, added to the *Robotester*, can increase the possible tests to 1000 or more. Automatic printers are another optional addition; such printers can automatically record all the data provided by the *Robotester*, permitting later analysis of passed

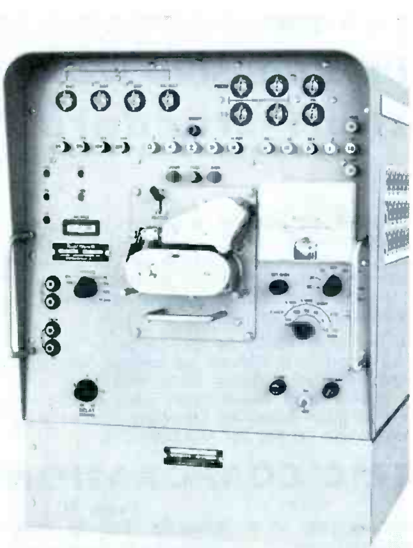


Fig. 7. *Robotester* automatically performs tests programmed on a tape.

and rejected items.

Digital Data Logger

A simplified block diagram of a typical data-logging system is shown in Fig. 8. The data logger can automatically make and record two measurements per second in automatic testing of devices such as missiles, and in reliability and quality-control work. In this system, several inputs (such as voltage and resistance) are sequentially scanned and measured. In addition, their values are displayed on digital indicating instruments and, at the same time, recorded for a permanent record. The input channels are connected to the input scanner, which is a transistorized unit consisting essentially of selector switches. Up to 100 channels are scanned automatically and transferred to the indicating instrument and the data printer and recorder. The scanner also displays the input-channel number while supplying this number to the data recorder which prints it alongside the data for that channel. From the digital-data recording system, an "end-of-recording" signal tells the input scanner when to step to the next input.

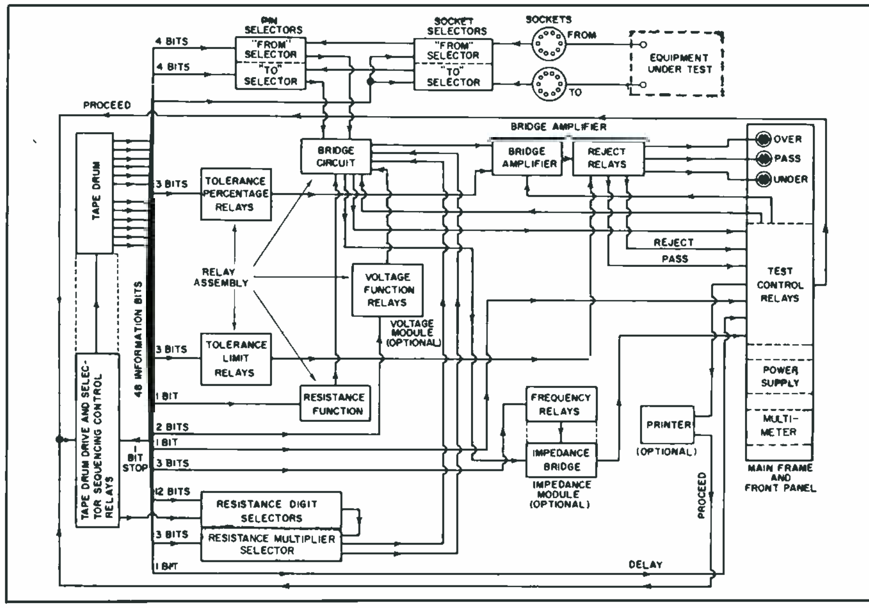


Fig. 8. Data-logging system automatically makes and records measurements.

Conclusion

If some special testing function is needed by an electronic system in industry, rest assured there is some instrument that can do it—with production-line speed and efficiency. The variety of special instruments in industrial electronics seems almost endless, and their complexity is sometimes great enough that special test equipment is required to service them. However, any electronics technician working alone in industry generally handles only a small number of different types of instruments; thus, he can become as familiar with them as with service scopes and generators. ▲

Ringing Checks

(Continued from page 31)

own vertical input lead to the special jack, because the pulse is likely to be derived from the horizontal sweep generator, and ordinarily occurs during retrace of the CRT beam. However, the serviceman can readily check for special pulse signals by using another scope to check all panel terminals of his own scope. A pulse from the horizontal sweep generator makes an excellent test signal because it offers a wide choice of ringing frequencies and automatically synchronizes the ringing waveform with the scope sweep.

If a suitable pulse is found, it can be connected directly to the coil under test, as shown in Fig. 2A. A sawtooth-wave output from the scope can also be utilized by adding a small capacitor (approximately 100 mmf) in series with the lead from the special jack to the coil.

In case the scope provides no ready-made pulse source, there are several other instruments that can supply a signal; one is the square-wave generator used in many shops for checking audio amplifiers. But instead of using an external source such as this, it's easier in the long run to modify a scope so it always has a ringing pulse "on tap." This can be done by simply adding one little capacitor within the scope and connecting it to an insulated binding post on the panel.

The arrangement of the binding post is left to the individual serviceman's discretion. He can either add one more post to the scope panel or convert some post to a ringing-pulse connection.

The internal capacitor hookup depends on the type of horizontal sweep circuit used in the scope. Fig. 2B shows the proper connection for scopes that use a cathode-coupled multivibrator as a horizontal sweep generator. Scopes using the Selzer-Anthony horizontal sweep circuit should be wired as shown in Fig. 2C, to minimize loading of the multivibrator. I have tried to show enough of both these common circuits so that little difficulty should be had by any serviceman in making the ringing-pulse modification. Generally, all he will need to do is to get out the wiring schematic of his scope and match it with Fig. 2B or 2C, correlating tube functions and sweep controls.

Sweep Frequency for Testing

It is very important that the correct scope-sweep frequency be used in making a ringing check. I have observed that the natural resonant frequency of a ringing-test setup including a horizontal deflection component is usually around 30 kc. If ringing at this frequency is examined with a 10-kc scope sweep, only the first three cycles of the damped wave will be visible, as in Fig. 3A; if the scope trace is swept at only 300 cps, the ringing cycles quickly decay and appear bunched at the start of the trace (Fig. 3B). Obviously, neither of these sweep frequencies is appropriate for checking horizontal deflection components.

While using either of the test setups in Figs. 2B and 2C to check yokes or flybacks, I have found that a sweep frequency of approximately 2600 cps presents a wave train that just barely decays to an insignificant amplitude across the full width of the trace (Fig. 3C).

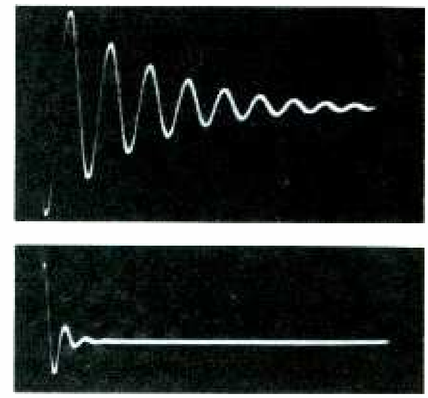


Fig. 5. Out-of-circuit tests of good and bad flybacks give these results.

Locating this approximate sweep frequency is fairly simple: Scope the horizontal drive signal in a properly operating TV receiver, and adjust the scope's sweep-frequency switch and vernier frequency control so that six cycles of horizontal drive occupy one trace. Make a mental or written note of these control settings for future usage.

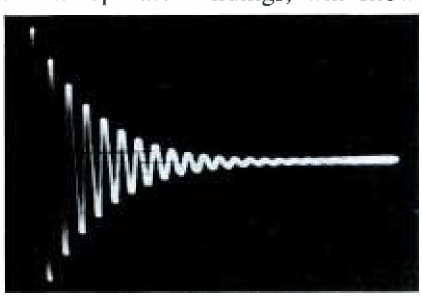
Horizontal-Circuit Tests

One major advantage of the ringing test is that the entire horizontal deflection circuit, or at least most of the inductances in the circuit, can be checked with one test. In this initial check, it is not necessary to disconnect anything—not even the high-voltage rectifier. Merely attach both the vertical-input lead and the pulse lead of the scope to the plate lead of the horizontal output tube, and attach the scope ground lead to the receiver chassis or B minus. Standardize on using this hookup for all types of deflection circuits—straight transformer, autotransformer, or direct drive.

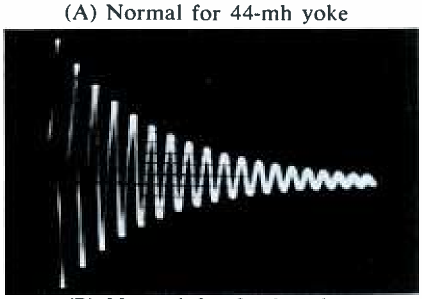
Fig. 4 tabulates the results typically obtained in these three common deflection circuits at a test frequency of 2600 cps. Note that different defects sometimes give nearly identical test results; however, the exact defect can be found by making further tests. For example, a shorted flyback and a shorted width coil usually produce quite similar ringing traces. If a check of the entire circuit indicates that either of these windings is possibly defective, it is a simple matter to pinpoint the offending part by merely disconnecting the width coil. If trace B remains, the width coil is apparently not the offender. Next, any capacitor that shunts a winding of the flyback should be disconnected, and finally the yoke itself should be taken out of the circuit. If any of these operations results in a normal trace, the last part disconnected is at fault. If trace B remains, there is scarcely any doubt left that the flyback is defective.

Checking Components Separately

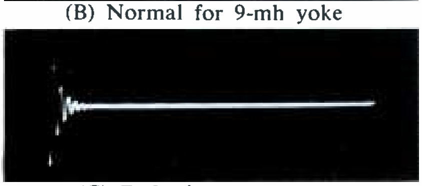
"Out-of-circuit" checks of individual components are equally simple, if standardized hookups and specific scope-sweep frequencies are consistently used. For flybacks, the condition of all windings can be determined by connecting the scope across the winding considered to be the transformer's "primary." That is, attach both the pulse-supply lead and the vertical-input lead to the plate wire of the horizontal output tube (not the high-voltage rectifier plate connection), and clip the scope's ground lead to the other end of this winding. On autotransformers, ground the bottom terminal. A representative trace obtained from a good flyback, using a sweep frequency of 2600 cps, is shown in Fig. 5A. Either a single-turn short or a high-resistance leakage within any winding, as well as shorts between separate windings, will show



(A) Normal for 44-mh yoke



(B) Normal for 9-mh yoke



(C) Defective—any type

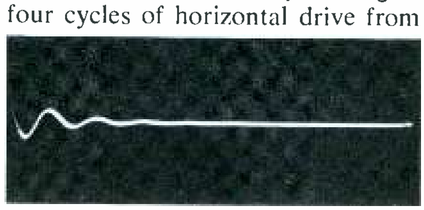
Fig. 6. Yoke ringing patterns.

up as in Fig. 5B. Results of this test are practically identical in nearly all flybacks, even those as dissimilar as the so-called "Flying Saucer" and the heavy, complex-cored types used in early receivers.

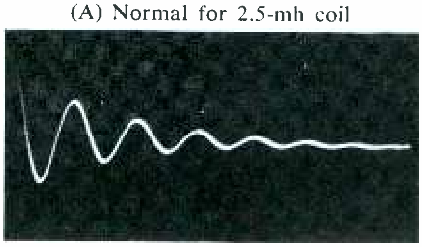
To check the horizontal windings of a yoke, attach the pulse and vertical-input leads of the scope to one end of the windings, and ground the other end. Again, use a 2600-cps sweep. Resultant traces will vary somewhat, depending upon the inductance of the windings. A high-inductance winding (44 mh) presents the rather fast-decaying trace in Fig. 6A, while a low-inductance (9-mh) yoke produces greater ringing (Fig. 6B). Only slight ringing, as pictured in Fig. 6C, indicates a defective yoke.

Defective linearity coils will not show up in the "entire-circuit" check, except in some very rare designs. A defect is easy to recognize, however, by merely adjusting the core. A good linearity coil will have an effect on raster linearity, width, or brightness, whereas a defective linearity coil will have no effect—regardless of how much its inductance is varied.

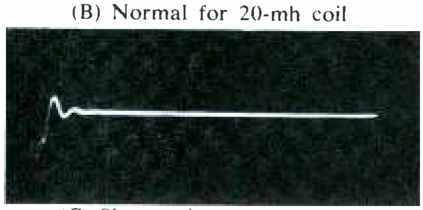
There may be times when a serviceman might want to give this coil a separate ringing test. It can be done, but the scope frequency is different from that used with other horizontal coils. The scope sweep should be set to approximately 4000 cps—recognized by locking in four cycles of horizontal drive from



(A) Normal for 2.5-mh coil



(B) Normal for 20-mh coil



(C) Short—either type of coil

Fig. 7. Linearity-coil ringing.

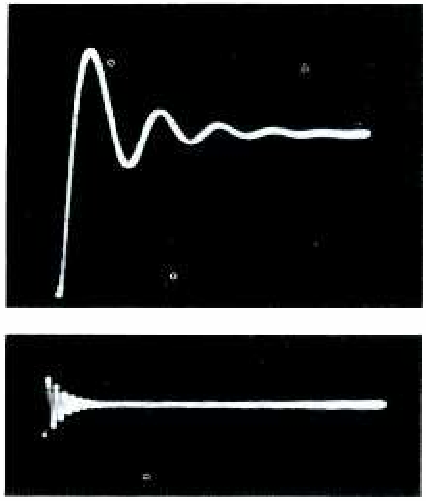


Fig. 8. Good and bad vertical output transformers—scope frequency 800 cps.

an operating receiver. Apply the test leads across the full winding on tapped units, or across the largest winding on multiple-wound units. Resultant traces for typical coils are shown in Fig. 7.

Vertical Sweep Coils

For vertical deflection components, use a hookup like Fig. 2A across the largest winding of the component (primary of output transformer, or secondary of blocking-oscillator transformer); use a sweep frequency of 800 cps. As mentioned earlier, these iron-core units do not have a very high Q; therefore, even a good unit will ring for only a few cycles. Nevertheless, the difference between normal and abnormal patterns is still obvious, as demonstrated in Fig. 8.

Choice of Frequency

The frequency of the shock-excited oscillations in a ringing test depends not only on the characteristics of the coil being tested, but also on the shunt capacitance introduced by the scope connections. Since test conditions may vary to a considerable degree, some servicemen may find it necessary to use scope-sweep frequencies somewhat different from those which have been mentioned.

The easiest method of finding the proper frequencies for your scope would be to make ringing tests on a number of known good coils at various sweep rates, and standardize on the frequencies at which the damped wave trains appear similar to the ones illustrated in this article. ▲

Stereo FM

(Continued from page 33)

only the multiplex section, but also the RF tuner and IF's for a symmetrical wide-band response.

Alignment Equipment

If misalignment is responsible for improper operation of the stereo FM multiplex unit, make sure you have the proper test equipment. You'll need a stereo signal generator, an oscilloscope, and an AC VTVM. You may need an audio oscillator, too, depending on which stereo generator you use.

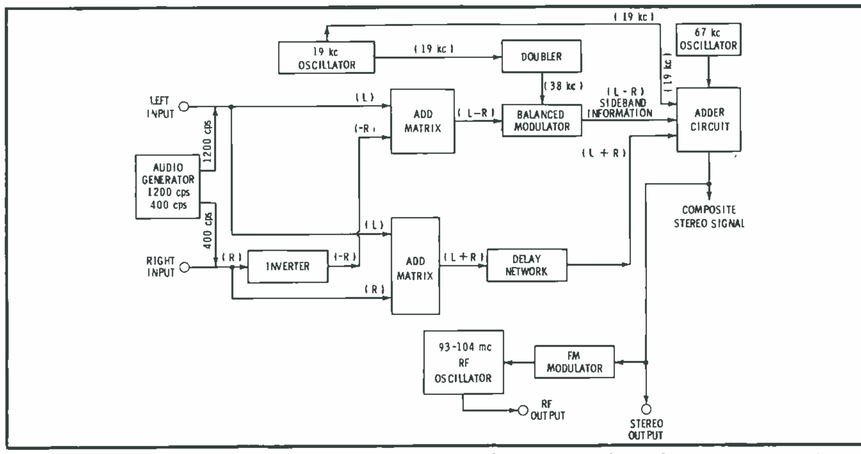


Fig. 3. Multiplex generator produces all essentials of stereo-FM signal.

Basically, there are several types of stereo-FM signal generators available. One type has no internal RF generator, and must be coupled directly to the multiplex section; others are RF types that can feed a signal into the stereo receiver's antenna terminals. Some generators have built-in audio oscillators, while others require an external audio generator as an accessory. The functions of all types are similar, once the equipment is set up for operation.

Fig. 3 shows a typical stereo-FM signal generator. Let's analyze the block diagram, to see where and how the alignment signals are developed.

The left-channel audio (L) and the right-channel audio (R) information are combined in the add matrix networks. However, before being applied to the L − R matrix circuit, the right-channel audio information is inverted in phase so proper mixing will take place. The output of the L − R add matrix is fed into a balanced modulator along with an internally generated 38-kc signal. The balanced modulator suppresses the 38-kc subcarrier, and the output contains only the L − R sidebands. This information is sent to another adder circuit for mixing with the L + R signal and the 19-kc pilot carrier.

The L + R signal must pass through a delay circuit so it will arrive at the adder exactly in phase with the L − R sideband information. To insure that the sideband information recovered at the receiver will maintain a proper phase relationship with the L + R signal, the generator provides a 19-kc subcarrier for the 38-kc reinsertion-signal oscillator to "lock in" upon.

Provisions are made in some generators for supplying the adder circuit with a 67-kc signal for use in aligning the receiver traps that attenuate SCA interference. Some instruments include a 67-kc oscillator, while others provide only a jack where the SCA signal can be injected. The 67-kc signal, the 19-kc signal, and the L − R sideband information can usually be switched on and off, for testing multiplex units under various signal conditions.

From the adder circuit, the composite stereo signal is coupled to the stereo output jack. The unit being discussed also incorporates an RF generator having a tunable frequency range from 92 to 104 mc. With this type of generator, you can simulate an actual stereo-FM broadcast, with the output being coupled loosely or directly to the antenna terminals of a stereo-FM receiver; if desired, a stereo tape or phono recording can be used for program material, instead of the internal audio oscillators.

To show the variety of facilities included in stereo-FM signal generators, Chart I lists several key specifications for most of the service-type units now available.

Alignment Setups

The detector output level of the FM receiver is very important. Multiplex circuits may require anywhere from .2 volts to 2 volts rms for normal operation, and the stereo signal generator must be set for an output level sufficient to "drive" them. Distortion and motorboating can be caused by insufficient signal voltage at the multiplex input, since the 19-kc pilot signal may be too weak to synchronize the demodulator system. On the other hand, too much signal voltage can cause distortion, poor separation, and spurious responses. To determine the correct level (if you don't already know), you can use your scope to observe the detector output of the receiver, while it is tuned to a station broadcasting stereo. Then connect the leads from the multiplex generator to the scope and adjust the signal level for the same approximate peak-to-peak deflection.

For aligning the 19-kc oscillator

coil, simply disable all L and R signals in (or to) the generator, and be sure no 67-kc signal is present; thus, you'll end up with only the 19-kc portion of the composite stereo signal. Connect the generator to the input of the multiplex circuitry—or, if it is an RF type, to the receiver-antenna terminals. Hook the scope (or AC VTVM) at some convenient point between the demodulator and the coil to be adjusted. The 19-kc signal source can also be used to align the 38-kc coil or transformer. Once the scope has been set for two cycles of 19-kc signal, a four-cycle display will appear when the 38-kc doubler is in proper adjustment.

For checking and aligning the separation between the left and right channels, the ideal setup can be accomplished by using the signal generator to feed the composite signal to the input of the adapter, and connecting a two-channel scope to the left and right outputs. The same effect can be had by using two AC VTVM's in place of the scope. By this arrangement, you can monitor both channels without switching leads. However, you can get excellent results by using a single scope or AC VTVM connected to one channel at a time; it just takes longer to complete the job.

Another alignment technique involves using both the horizontal input and vertical input circuits of your scope. Connect the horizontal input of the scope to an accurate 38-kc signal, and connect the vertical input to the 38-kc test point on the adapter. With the scope set for external sync, adjust the 19-kc oscillator coil until a circular pattern is observed on the scope screen. The 38-kc doubler coils or transformers can be peaked with this same setup.

Conclusion

Stereo-FM alignment isn't complicated, as you can see from the foregoing; neither is the test equipment difficult to understand. And when you become familiar with the instruments and techniques of stereo alignment, spread the word among your audio and hi-fi customers who are in range of stereo broadcasts. You'll be surprised how your stereo business will pick up! ▲

PRODUCT report

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

Ceramic Microphone (51X)

A compact, high-output microphone, the **Euphonics** Model C47 "Hot Head," is designed for Citizens - band, amateur, marine, and other communications applications. The unit has an average output level of –48 db, and a frequency range of 300-4000 cps. Other features include a DPDT push-to-talk switch, and a high-impact case. The unit will operate over a temperature range of 0° to 200° F. List price of the microphone is $16.00.

Contact Cleaner (52X)

A new spray solution, "Contact Kleen," can be used to restore smooth action to relays, controls, switches, attenuators, thermostats, and prongs. The cleaner is available from **Chemtronics** in an 8-oz. aerosol spray can, equipped with a stainless steel spray-extension tube. The price for each can is $1.49.

Nuvistor (53X)

Another addition to the growing nuvistor line — the 13CW4 —is similar to its companion types 2CW4 and 6CW4, except for a 13.5-volt, 60-ma heater. This high-mu **RCA** unit was designed for use as a grounded-cathode RF amplifier in multiple-antenna systems and in antenna-booster amplifiers.

Broadband Antenna (54X)

Providing a gain of at least 10.5 db within the high TV band, and 8.5 db within the low band, the **TACO** Model C-33 "Color Guard" is a broadband antenna designed for color-TV reception. The elements are manufactured of a chrome-aluminum alloy with a corrosion-proof golden conductive coating, and are designed for high mechanical strength to resist ice and wind loading. The antenna has a list price of $17.95.

Sweep Oscillator (55X)

The "Sona-Sweep" 1141-A beat-frequency sweep oscillator, designed for testing and aligning ultrasonic amplifiers, is a recent development of **Kay Electric**. The unit covers frequencies from 20 cps to 200 kc, with sweep widths of 0 to 2 kc and 100 cps to 20 kc; the sweep rate can be manually varied from 5 to 25 cps, or locked at 30 cps. Crystal-controlled markers of 50, 100, and 200 kc, which may be used simultaneously or separately, are also available. The sweep output is a sawtooth, synchronized by the sweeping oscillator, and has an amplitude of approximately 7 volts.

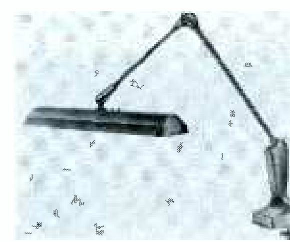
Universal Replacement Knobs (56X)

A kit of two-part TV and radio tuning knobs, **Colman** stock number 1179, contains 12 knob heads and 48 stems that can be assembled into more than 2700 different replacement knobs. The new heads are color-matched to existing universal two-part knobs, and will fit all stems presently in use. The kit has a list price of $15.56.

Record Cleaner (57X)

A chemically-treated sponge, useful for removing grit and dirt from phonograph records, is being offered by **Fidelitone.** Periodic use of the sponge to clean the playing surface of records will keep them free from dust and lint; this helps to reduce wear on both the stylus and the record. The "Foam-Coat" sponge is packaged in a plastic box and is priced at 69¢.

Desk Lamp (58X)



This new fluorescent desk lamp, available in either neutral brown or office grey, is made by **Acme.** Designated as the Model 404G, the unit comes with either a standard 26″ arm or an extra-long 33″ arm. A double-bolt clamp holds the wide base securely to a desk or table; a pad on the clamp prevents damage to the furniture. The lamp may also be secured to the desk with screws, to provide a permanent installation.

Scratch Remover (59X)

Technicians looking for a compound to remove fine scratches and abrasions from plastic material will be interested in "Surefire." Developed by **Wilco,** this nonflammable, nonabrasive compound can be used to remove scratch marks from any type of plastic—picture-tube safety shields and plastic cabinets, for example. "Surefire" will not scratch plastic surfaces, and is harmless to hands and skin.

CB Microphone (60X)

The Model 356C microphone, for Citizens-band use, being marketed by **Turner,** has a frequency range of 80-7000 cps and an output of –53 db. The microphone, complete with a 5′ coiled cord, comes wired for push-to-talk operation. A hanger button and a dash bracket are included. List price is $12.50.

Electric Antenna (61X)

No clips or springs are necessary with the **Tenna** "C-Bam" power-driven AM/FM/CB auto antenna, a pushbutton-operated unit that extends to 55″ and retracts to 9½″. Its collapsibility reduces chances of damage from low garage doors, washracks, and vandalism. The "C-Bam" is top-loaded and can be installed in most conventional locations on a vehicle. Any 12-volt battery will power the unit.

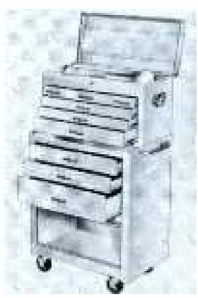
Miniature Microphone (62X)

A rugged miniature microphone, the **Shure** Model CA5A, weighs only ¾ of a gram. The tiny size of this high-impedance unit (1" x .250" x .100") makes it ideal for use in hearing aids, small head-worn microphones, hand-held transmitters, pocket tape recorders, and dictating machines. It has a frequency range of 50 to 5000 cps, and an output level of –73 db.

Transistorized Tape Recorder (63X)

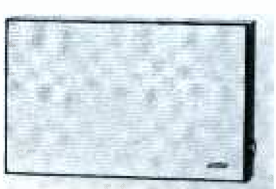
A new transistorized portable tape recorder, weighing only 5½ lbs., and able to provide two hours of playing time, is available from **Citroen.** The Model 660 comes equipped with leather carrying case, remote-control microphone, earphone, batteries, telephone pickup, reel of tape, and take-up reel. The recorder has a list price of $149.50.

Tool Chest (64X)



Tools and parts are easily moved from one working area to another with the **Owatonna** Model 105 rolling tool chest. Constructed of 18-gauge steel with a blue baked-enamel finish, the chest has three drawers plus a lower storage compartment. The front casters are equipped with locking toe brakes. An AC outlet attachment, to provide a source of power for test equipment and other tools, is available at extra cost; also, a matching two- or six-drawer service chest may be purchased if extra drawer space is required.

Speaker Enclosure (65X)



For use as a supplementary speaker system, the **Mercury** Model CH-2 "Challenger" is a slim enclosure with dimensions of 18" x 12" x 3½". It contains two 6" x 9" speakers and a 4" tweeter, a crossover network, and a side-panel knob that can be used to adjust the sound-output level. Available in a walnut finish, with a user price of $29.75, the unit has a peak power capacity of 15 watts.

Receiving Tubes (66X)

Two new tubes, the 6HA5/-EC900 RF triode amplifier and the 6GJ7/ECF801 oscillator-mixer for use in UHF and VHF television tuners, were recently announced by **Amperex.** When incorporated in future sets using the popular 6EH7 and 6EJ7 in a two-stage IF system, these new types will improve set sensitivity considerably. Both tubes feature frame-grid construction.

Stereo/Mono Needle (67X)

A new kind of needle, capable of playing stereo records on a monophonic changer, has been added to the **Jensen** line. This offers the hi-fi fan an opportunity to start his stereo collection, even though he doesn't yet have a stereo phonograph. The needle is specially designed to "give" when it encounters the "hills and dales" found only in stereo records, thus avoiding damage to cartridge or record.

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1X. *ANTENNACRAFT*—Brochure on anodized aluminum UHF antennas, Models SA-1483 (channels 14-83) and SA-7083 (channels 70-83), guaranteed for black-and-white or color reception.

4X. *GAM* — Specifications on miniaturized TG-2-R VHF mobile antenna—mounts on top of vehicle or in other restricted spaces. *See ad page 90.*

5X. *JFD*—Brochures on LPV log-periodic TV antennas and *Transis-tenna;* also bulletins and catalogs showing entire line of TV-FM indoor and outdoor antennas and accessories.

6X. *WARD PRODUCTS*—Catalog 614 listing full replacement line of auto-radio and mobile communications antennas and accessories.

7X. *WINEGARD*—Complete technical data, schematic, and service tips on new "Red-Head" transistorized antenna preamplifier. *See ads pages 26, 52.*

AUDIO & HI-FI

8X. *ATLAS SOUND, Div. of American Trading & Production Corp.*—Catalog and specification sheet describing new Model EC-10 paging speaker and T-4 line-matching transformers. *See ad page 66.*

9X. *CBS LABORATORIES* — Information on STR-100 test record for professional audio technicians.

10X. *EICO*—New 32-page catalog of kits and wired equipment: stereo and monophonic hi-fi, test equipment, Citizens-band transceivers, ham gear, and transistor radios. Also 'Stereo Hi-Fi Guide" and 'Short Course for Novice License." *See ad page 93.*

11X. *FISHER*—40-page booklet giving authoritative answers to most frequently asked questions on stereo hi-fi; also list of available equipment.

12X. *HARMAN-KARDON*—Brochure on new line of mobile, portable, and general-purpose public address equipment.

13X. *OAKTRON*—8-page catalog of speakers, enclosures, wall and ceiling baffles, line transformers, auto rear-seat speaker kits, and accessories.

14X. *QUALITONE*—"Needle Wall Chart" cross-reference of cartridge numbers and replacement needles.

15X. *QUAM-NICHOLS* — Detailed information on full-fidelity hi-fi loudspeakers. *See ad page 71.*

17X. *SONOTONE* — Specification sheet on Model WR8-BH "New Sonotone Sound" wide-range hi-fi speaker.

18X. *UTAH*—Conversion data to allow using constant-voltage line transformers in constant-impedance systems; catalog sheet on baffles and line transformers. *See ad page 58.*

COMPONENTS

19X. *BUSSMANN*—Information on new GBB fast-opening fuse for protecting solid-state devices, such as semiconductor rectifiers. *See ad page 18-19.*

20X. *CENTRALAB*—6-page booklet describing "Fastatch" II replacement control system, and FRK-100 dealer kit.

22X. *LITTELFUSE* — Form L-562 showing prices and specifications on complete line of fuses, fuse holders, and merchandising aids. *See ad 4th cover.*

23X. *SPRAGUE*—Chart C-457 (designed to hang on wall) showing all popular TV/radio/hi-fi replacement components. *See ad page 12.*

24X. *SWITCHCRAFT*—Specifications on new *NF-Lite* and *Littel-Lite* miniature illuminated push-button switches.

SERVICE AIDS

25X. *CASTLE*—Leaflet describing fast over-haul service on television tuners of all makes and models; also illustrated lists of universal and original-equipment tuners. *See ad page 43.*

26X. *ELECTRONIC CHEMICAL* — Catalog and brochure listing electronic-chemical line, including formula EC-44 for cleaning and lubricating contacts.

27X. *GC ELECTRONICS*—48-page new-products supplement FR-62-S for general catalog FR-62; lists replacement antennas, test equipment, and service aids. *See ad page 49.*

28X. *PRECISION TUNER*—Information on repair and alignment service for any TV tuner. *See ad page 62.*

29X. *STANDARD KOLLSMAN* — Catalog sheet on UHF converters.

SPECIAL EQUIPMENT & SERVICES

30X. *ACME*—Specifications and applications for control-type magnetic amplifiers with capacities from 5-1000 watts and voltage ranges from 24-160 volts. *See ad page 82.*

31X. *ATR*—Literature on 1963 *Karadios*, including tube-equipped and transistorized versions. All sets available as "universal" or "customized." *See ad page 14.*

32X. *GREYHOUND* — Complete information on Greyhound Package Express, including rates and routes. *See ad page 47.*

33X. *TERADO*—Catalog sheet 5999 describing complete line of converters, battery chargers, and relays. *See ad page 90.*

34X. *VOLKSWAGEN* — 60-pge illustrated booklet, "The Owner's Viewpoint," describing how various business enterprises use VW trucks; complete specifications on truck line. *See ad page 65.*

TECHNICAL PUBLICATIONS

35X. *CLEVELAND INSTITUTE OF ELECTRONICS*—"Pocket Electronics Data Guides" with conversion factors, formulas, tables, and color codes. Also, folder "Choose Your Career In Electronics" describing home-study electronics training programs, including FCC-license preparation. *See ad page 95.*

36X. *HOWARD W. SAMS* — Literature describing all current publications on radio, TV, communications, audio/hi-fi, and industrial electronics, including Fall-Winter 1962 Book Catalog and descriptive flyer on 1962 *Test Equipment Annual. See ads pages 70, 75, 94.*

TEST EQUIPMENT

37X. *B & K*—Catalog AP20-R, giving data and information on Model 850 *Color Analyst*, Model 960 *Transistor Radio Analyst*, Model 1076 *Television Analyst*, *Dyna-matic* 375 VTVM, *V-O-Matic* 360, Model 625 *Dyna-Tester*, Models 600 and 700 *Dyna-Quik* tube testers, Model 420 and 440 CRT Tester-Reactivators, and Model 1070 *Dyna-Sweep* Circuit Analyzer. *See ads pages 45, 46, 55, 56, 57, 61, 73.*

38X. *HICKOK*—Information about specifications of new Model 677 Wide Band Oscilloscope; also "Scope Facts." *See ad page 67.*

39X. *KARG*—Data sheet and instruction booklet for MX-1G Stereo Multiplex Signal Generator; also "Alignment and Adjustment of Stereo FM Tuners And Adapters." *See ad page 68.*

40X. *MERCURY* — 8-page catalog of tube testers, component substitutors, CRT tester, and other service test equipment. *See ad page 85.*

42X. *SECO*—Complete information on three new 0-30 volt power supplies, all featuring transistor-regulated voltage. *See ad page 15.*

43X. *SENCORE*—Brochure answering questions about SENCORE color test equipment. *See ads pages 22-23, 89.*

44X. *TRIPLETT* — Catalog 44-T containing specifications of new test equipment. *See ad pages 1-2.*

TOOLS

45X. *BERNS*—Data on 3-in-1 picture tube repair tools, on *Audio Pin-Plug Crimper* that lets you make pin-plug and ground connections for shielded cable without soldering, and on ION adjustable "beam bender." *See ad page 58.*

46X. *EVERSOLE*—Description and price list of *DeSod* desoldering tools for use on printed-circuit boards, including new tip for compactron sockets. *See ad page 60.*

47X. *XCELITE* — Bulletin P562 describing "Service Master" 99SM and other electronics service kits containing interchangeable handles, nutdriver and screw-driver blades, pliers, and wrenches.

TUBES & TRANSISTORS

48X. *ADMIRAL*—Wall-chart "Picture Tube Substitution Guide" for tube sizes ranging from 7" to 27".

49X. *AMPEREX*—33-page catalog with numerical index, descriptions, and basic specifications on tube line.

50X. *SYLVANIA*—Specifications and characteristics of NPN large-signal silicon epitaxial mesa transistors.

Latest Jackson Tube Test Data

JACKSON MODEL 648

Tube Type	Fil.	D.	E.	Plate Test
6DL4	6.3	A125	AC47	42V
6FM7◆	6.3	C6	AC79	19XZ
	Nor -S switch in S position			
		C5	AC89	39VW
6FY7◆	6.3	AC5	AC29	43VW
		AC6	AC79	59XZ
	Nor -S switch in S position			
6HE5◆	6.3	AC3	B124	31W
8106	Set line to 80% mark			
	12.6	A125	C349	28V

JACKSON MODEL 658

Tube Type	Sec.	Circuit: Heater	H-K	P-G	Plate	Grid Test	Heater Current
6DL4	T	6.4J	125	ac47	25R	6WY•	
6FM7◆	T	6.4K	C6	ac78	15Q	10XY•	
	T	"	C5	ac90	17R	70VY•	
6FY7◆	T	6.4L	C5	ac29	20R	70VY•	
	T	"	C6	ac78	20Q	10XY•	
6HE5◆	P	6.4L	C3	b124	24Q	85VY•	
8106	P	13.6M	125	c349	30R	25VY•	

JACKSON MODEL 598

Tube Type	A.	B.	C.	Fil. Cont.	D.	E.	F.	G.
6DL4	6.3	4YZ	3679	5	8	1		55
8106	Set line to 75% mark							
	12.6	4	8	5	1	7	2	44

Get the All-New RCA Institutes Color TV Home Study Course
FREE with Your Purchases of Dependable RCA Receiving Tubes

Make no mistake about it: the future of electronic servicing is in Color TV! . . . And here's how RCA—pioneer of the compatible Color TV system in use today—can put you in the color picture.

The RCA Electron Tube Division offers you the RCA Institutes brand-new, completely up-dated Color TV Home Study Course FREE with your purchases of RCA entertainment receiving tubes. This practical course, filled with the latest up-to-the-minute information, will help equip you to trouble-shoot and repair all modern color receivers regardless of brand.

Because Color TV is already such big business (approaching $300 million a year), this course can start making money for you as soon as you complete it—and for many years to come. Don't miss this major opportunity for a more profitable future. Ask your participating Authorized RCA Tube Distributor for full details right away.

The Most Trusted Name in Television

WHAT YOU GET

4 Study Groups, 8 Graded Lessons. This is an **all-new course**, never before offered. Covers the most modern Color TV circuits. Even if you've taken a previous color course you'll still benefit from this one.

Handsome, durable 3-ring binder to keep all lessons and examinations in a permanent reference file.

RCA Institutes Color TV Graduation Certificate on completion of course—plus all regular RCA Institutes educational services to students. Graded examinations on every lesson.

RCA ELECTRON TUBE DIVISION, HARRISON, N. J.