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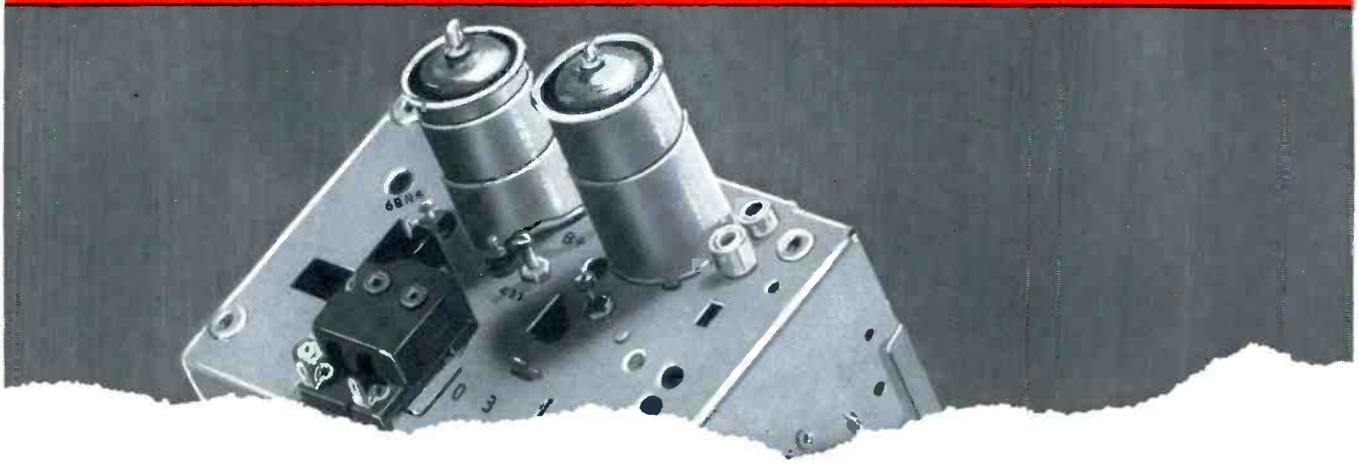

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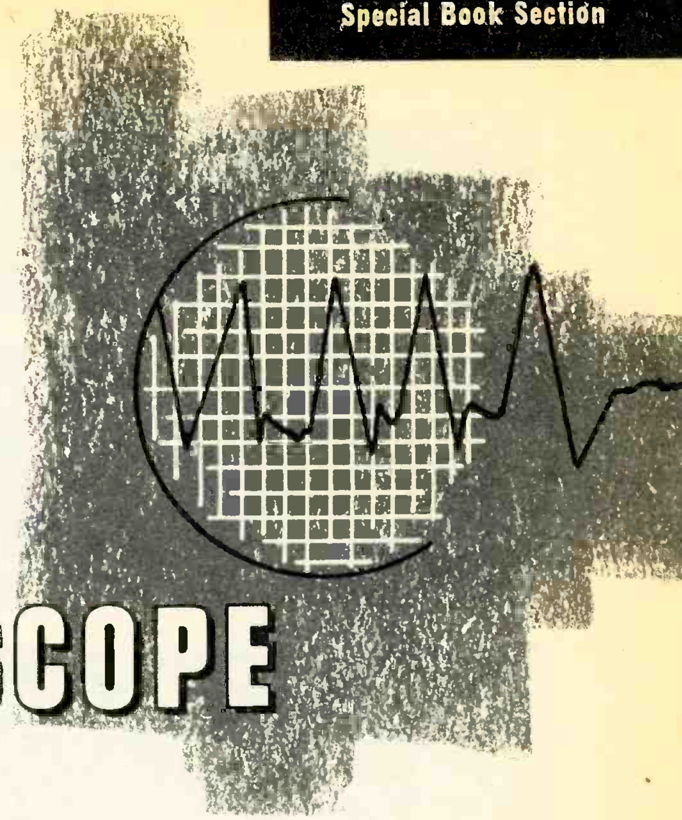
by Robert G. Middleton

GETTING THE MOST FROM YOUR SCOPE



To reap the full benefits of owning an oscilloscope, you need to be thoroughly familiar with what it is capable of doing, and alert to all opportunities for finding new ways to utilize this instrument. Another essential requirement is to keep your scope in top-notch operating condition, so you can rely on its ability to furnish distortion-free test results. A well-maintained oscilloscope in the hands of a skilled technician is a razor-sharp tool for cutting the toughest service problems down to size.

Amplifier Tests

Maintenance in oscilloscopes, as in TV receivers, is largely a matter of tube replacement; however, various circuit faults may also develop with continued use. A series of simple tests should periodically be made to uncover and localize any such defects. The following checks are especially useful:

Nonlinearity

A scope should be capable of providing full-screen deflection without producing nonlinearity of the trace due to overdriving of the amplifiers. To make an accurate check of linearity, connect any AC voltage source to both the vertical- and horizontal-input terminals of the scope, as shown in Fig. 1. The AC voltage may have a sine, square, or sawtooth waveform; identical test results will be obtained in any case. The frequency can be 60 cycles, or any frequency within the pass band of the scope amplifiers.

Advancing the vertical and horizontal gain controls causes an inclined line to appear on the scope screen.

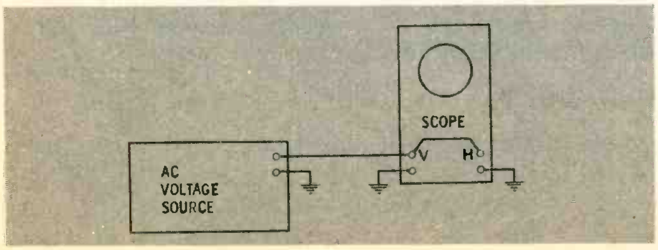


Fig. 1. Setup for simultaneously checking the linearity of vertical and horizontal amplifiers of an oscilloscope.

This line will be straight, as shown in Fig. 2A, if amplification is linear. As the gain controls are further advanced, the ends of the line may begin to curve (Fig. 2B), indicating that amplitude distortion is being introduced. The direction of curvature shown in this photo indicates overloading of the vertical amplifier; bending in the opposite direction would be evidence of overloading in the horizontal amplifier.

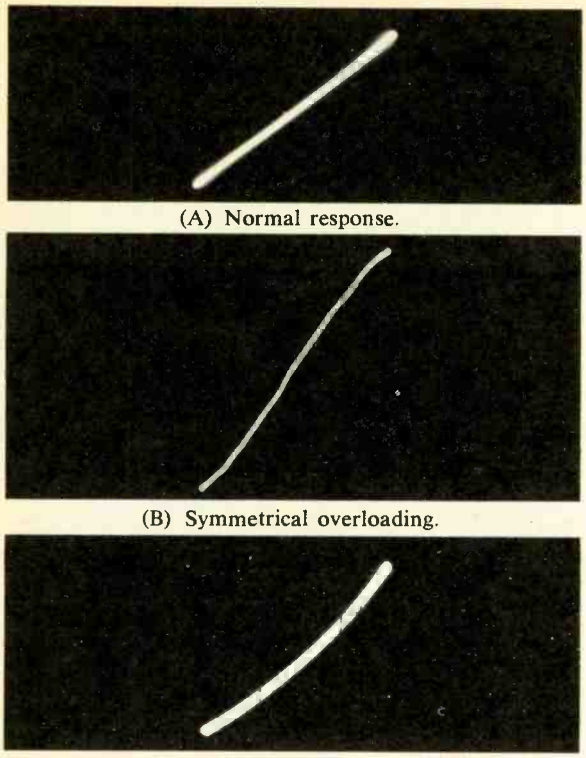
Nonlinear amplification is most likely to be caused by weak tubes, low B+ voltage, or incorrect tube bias due to a leaky coupling capacitor. A somewhat less probable cause is a decrease in value of an amplifier plate-load resistor.

If overloading cannot be avoided at the highest gain settings, the amplifiers should at least be operated so that the nonlinearity is symmetrical (with opposite curvatures at both ends of the trace, as in Fig. 2B). This is an assurance that the scope is providing the greatest possible amount of undistorted amplification. If the test line has a C-shaped curvature, as in Fig. 2C, nonsymmetrical overloading is indicated. This symptom indicates a defect such as a loss of bias on an amplifier, which introduces amplitude distortion into all but the lowest-level input signals.

Push-Pull Amplifier Balance

All vertical amplifiers used in scopes will *ring*, or produce damped oscillations, when driven with square waves having a sufficiently fast rise time. (See Fig. 3.) The ringing pattern shows whether the push-pull amplifiers in the scope are balanced for high-frequency response—in other words, whether the reaction to transient signal peaks is as good as it might be.

The ringing patterns in Fig. 3 are nonsymmetrical, indicating an unbalance in a push-pull vertical amplifier.



(A) Normal response.

(B) Symmetrical overloading.

(C) Nonsymmetrical distortion.

Fig. 2. Results of the amplifier-linearity test.

This condition can be caused by shorted turns in a peaking coil, or by incorrect inductance values. The same nonsymmetry is noticed if the plate-load resistors in a push-pull stage have widely different values.

Other Square-Wave Tests

Ringing without overshoot may be observed on square-wave tests, as illustrated in Fig. 4. Lack of overshoot indicates that plate-load resistors in successive stages have incorrect values. It is possible to obtain flat over-all frequency response in a vertical amplifier by compensating for a falling high-frequency response in one stage with a rising high-frequency response in the next stage. However, this results in rounded corners with "steps" in square-wave reproduction. Another disadvantage of staggering vertical-amplifier stages is that the stage with the falling high-frequency response will overload on high frequencies before it overloads on low frequencies. For instance, if a chroma (color-bar) waveform is displayed, the 3.58-mc component will show limiting distortion sooner than the 15,750-cycle component.

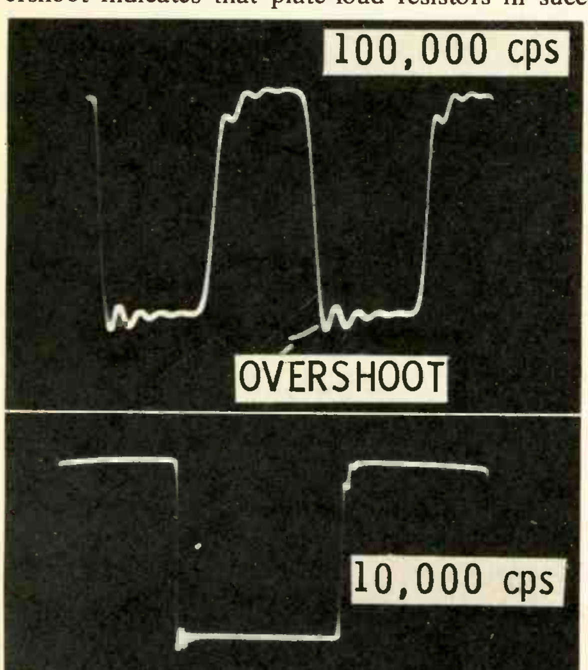


Fig. 3. This nonsymmetrical ringing pattern in square wave is an indication of unbalanced push-pull output stage.

Sometimes a low-frequency square-wave test of a vertical amplifier shows an unsymmetrical spiking with tilt, as seen in Fig. 5—an indication of poor low-frequency response. In such cases, look for a poor or open plate-bypass capacitor in the cathode-follower input stage. To provide the highly efficient bypassing needed at this point, an electrolytic filter capacitor is commonly used. When replacing this capacitor in a wide-band scope, make sure the new unit has a low inductance at high frequencies; otherwise, it will cause selective degeneration that will attenuate the high-frequency portions of the input signal. If square-wave or video-sweep generator tests of the vertical amplifier indicate a loss of response above 2 or 3 mc, try shunting a 1000-mmf mica or ceramic capacitor across the electrolytic unit to counteract its inductive effect.

Amplifier Phase Shift

If the vertical and horizontal amplifiers of an oscilloscope are both in good condition, neither of them should introduce any noticeable phase shift at frequencies within their region of flat response. However, certain defects in amplifier circuits can distort the signals by causing different degrees of phase shift at different frequencies.

To detect this condition, connect the output of a signal generator simultaneously to the vertical and horizontal input terminals of the scope, as was shown in Fig. 1. Make tests at several different frequencies which fall within the pass band of both amplifiers. At some setting of the horizontal and vertical gain controls, an inclined line similar to Fig. 2A should appear on the screen if there is no phase difference between the amplifier outputs. Any phase shift will cause an ellipse to appear in place of the line, as in Fig. 6.

If phase shifting is observed at low frequencies, check the coupling, bypass, decoupling, and grid-leak capacitors in the amplifiers. To find the cause of high-frequency phase shift, check the peaking coils, and consider the possibility of a change in stray capacitance due to faulty lead dress.

Astigmatism

A circular pattern, obtainable with the test setup shown in Fig. 7, can be used to determine whether the trace can be sharply focused at all points on the screen. If some parts of the trace are always fuzzier than others,

PF REPORTER for April, 1961, Vol. 11, No. 4. PF REPORTER is published monthly by Howard W. Sams & Co., Inc., 2201 E. 46th St., Indianapolis 6, Indiana. Second-class postage paid at Indianapolis, Indiana, 1, 2 & 3 year subscription prices: U.S.A., its possessions, and Canada: $4.00, $7.00, $9.00. All other countries: $5.00, $9.00, $12.00. Current single issues 35c each; back issues 50c each.

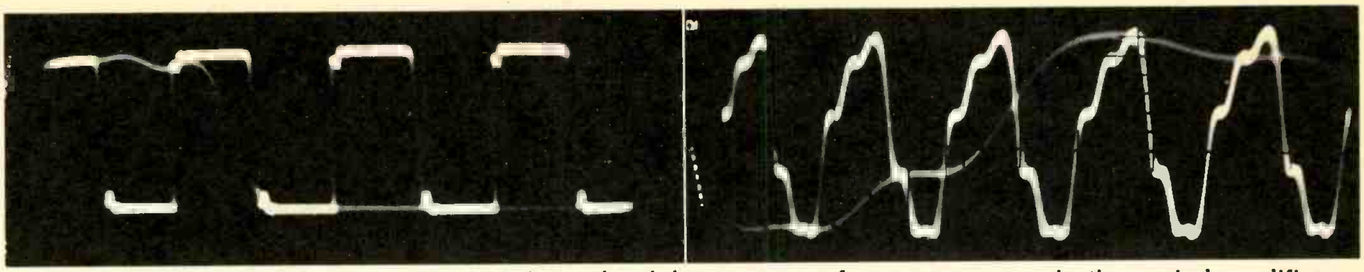


Fig. 4. "Stepped" effect in square wave is produced by an uneven frequency response in the vertical amplifier.

regardless of how the focus control is adjusted, the condition called *astigmatism* is present.

When single-ended deflection is used to drive the CRT, some astigmatic distortion is always present. The input signal is applied to only one deflecting plate, while the opposite plate remains at AC ground potential; consequently, the center of the "electrostatic lens" travels back and forth across the screen as the signal voltage varies. On the other hand, the electrostatic lens remains centered on the axis of the CRT gun in a double-end deflection system, because the average value of the push-pull drive signal in this system is zero regardless of the value of signal voltage. Therefore, double-ended deflection minimizes astigmatic distortion.

Some scopes contain an astigmatism control for minimizing focus variations. Since it interacts with the focus control, the two adjustments should be "rocked in" for the best over-all results.

Nonlinear Sweep

When a 60-cycle sine-wave display appears compressed at the right, as seen in Fig. 8, the sawtooth deflection waveform is being distorted by poor low-frequency response in the horizontal amplifier. As a rule, the trouble is easily corrected by using larger coupling capacitors. Note, however, that a nonlinear sweep can also result from lowered plate-supply voltage to the horizontal oscillator, which forces the oscillator tube to operate in its nonlinear region.

Heater-cathode leakage in the CRT puts AC on the cathode and causes intensity modulation of the electron beam. The trace appears as seen in Fig. 9.

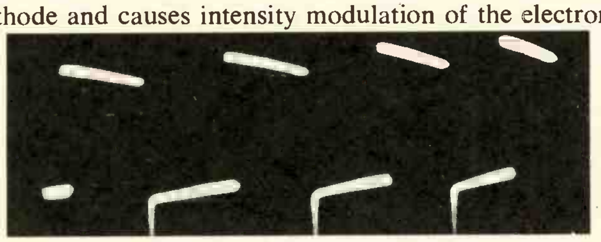


Fig. 5. Unsymmetrical spiking and tilted tops in this square wave are the result of low-frequency attenuation.

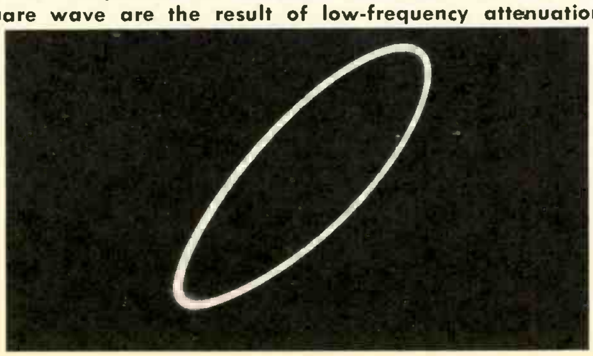


Fig. 6. In the amplifier test of Fig. 1, phase shift will cause an ellipse to appear in place of a straight line.

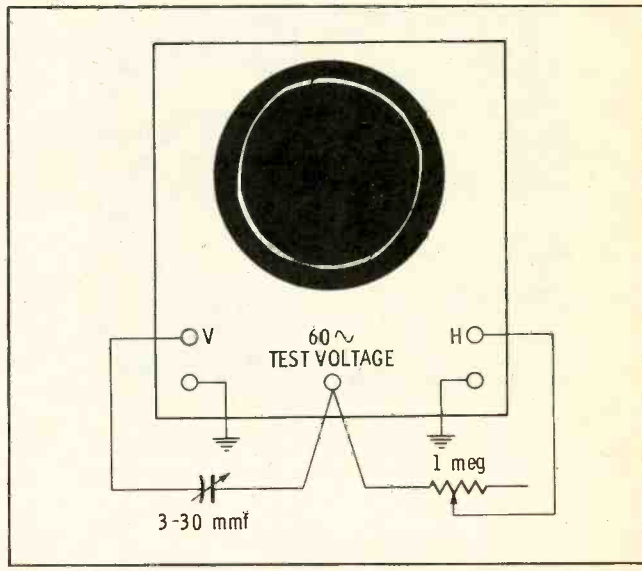


Fig. 7. To check for astigmatic distortion, put this circular trace on the CRT screen; check the focus all around.

Vertical Amplifier—Over-All Response

If a sweep generator covering the video-frequency range is available, it can be used to check the frequency response of a vertical amplifier. This test, which is especially valuable in wide-band scopes, follows the same procedure as for a response check of a video amplifier in a TV receiver. Fig. 10 shows a typical response curve as it would be displayed on the screen of

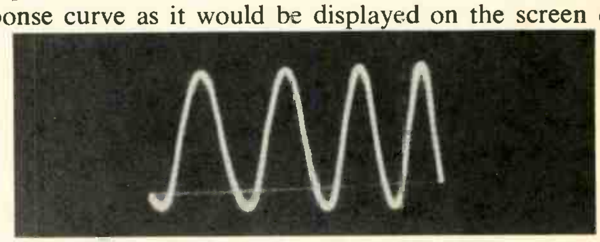


Fig. 8. When one side of waveform appears compressed, suspect nonlinearity in the horizontal sweep circuit.

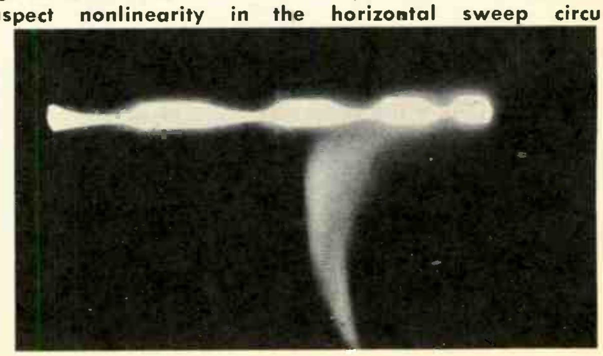
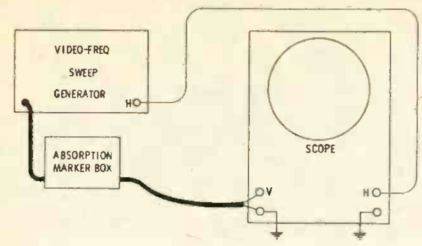
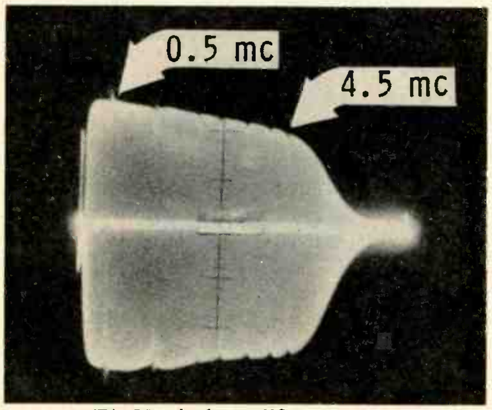


Fig. 9. Heater-to-cathode leakage occurring in cathode-ray tube commonly causes intensity modulation of the trace.



(A) Test-equipment connections.



(B) Vertical-amplifier pattern.

Fig. 10. Frequency-response check of amplifier.

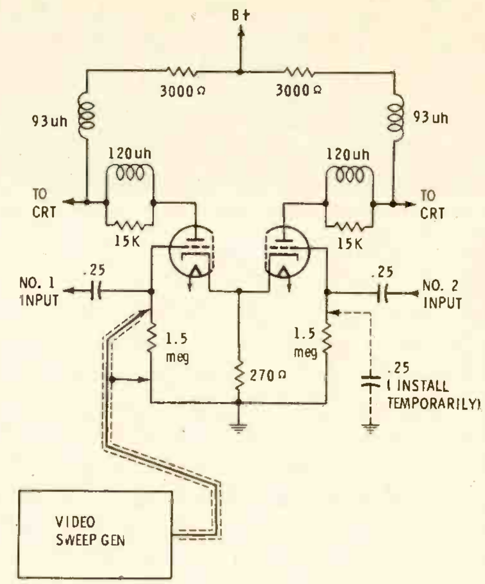


Fig. 11. Push-pull amplifier converted to single-ended drive to permit stage-by-stage frequency-response test.

the scope being tested.

Vertical Amplifier—Stage-By-Stage Check

Trouble in a vertical amplifier is often isolated most easily by making a stage-by-stage check of frequency response. This test usually requires driving a double-ended stage from a single-ended generator. However, this is readily done with the use of a bypass capacitor, as shown in Fig. 11.

The stage shown in the diagram normally receives two identical, but out-of-phase, input signals (Nos. 1 and 2) from the preceding stage. A temporary conversion to single-ended drive can be made by shunting a .25-mfd capacitor from the No. 2 grid to ground, and attaching the "hot" lead of the generator to the No. 1 grid—or vice versa. The common cathode resistor then provides paraphase inversion, and the stage operates as if it were being driven from a double-ended source.

Since the output from this type of sweep generator is generally limited to 0.1 or 0.2 volt, the test does not result in very much pattern height on the screen. However, even a quarter or half inch of deflection is sufficient to reveal whether the stage has an adequate frequency response or whether one side of the amplifier is defective.

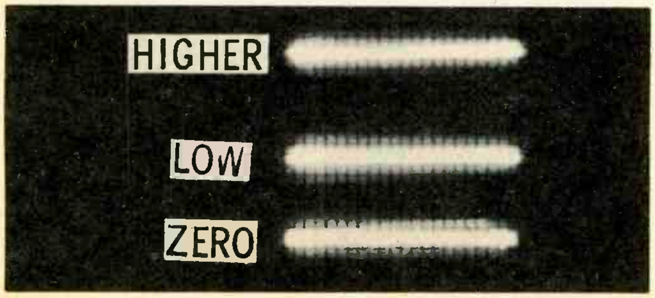


Fig. 12. In a DC scope, any change in input DC voltage level causes trace to be deflected either up or down.

DC-Amplifier Maintenance

"DC scopes" have no blocking capacitors anywhere in the path from the circuit under test to the vertical deflection plates; therefore, as Fig. 12 shows, the trace line will be deflected up or down by any DC voltage applied across the vertical input terminals of the scope. Because of this action, DC amplifiers require a little more attention than capacitively-coupled amplifiers.

Trouble in the power supply is more quickly apparent in a DC scope than in an AC scope. Since the direct-coupled amplifiers operate as a chain, with one stage obtaining operating voltages from the next stage, any deviation in supply voltage is likely to affect the centering of the trace. Similar behavior can result from defects such as off-value load resistors, which would have a much less noticeable effect on AC amplifiers.

You will often notice that the trace line in a DC scope will move up and down as the vertical-gain vernier control is turned. To provide a means of stabilizing the resting level of the CRT beam, scopes of this type usually include a vertical-balance potentiometer. This adjustment should be set in the following manner: First set the vertical-gain vernier at minimum, and use the vertical-centering control to bring the trace exactly

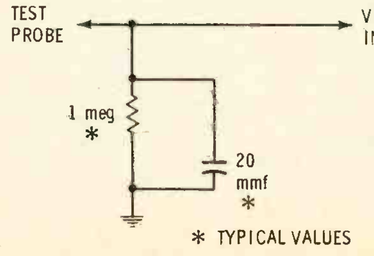


Fig. 13. Equivalent input circuit appearing across the vertical-amplifier terminals of a typical service scope.

to the middle of the screen. Then advance the gain vernier to maximum, and note how far the trace shifts up or down. Adjust the balance control, and again check the amount of trace shift occurring between maximum and minimum gain settings. Continue to operate the balance control until the shifting has been reduced to a minimum.

This adjustment should be made only after the scope has been warmed up to the point where the plate resistances of all vertical amplifier tubes have become stabilized. After installing new amplifier tubes, age them overnight before attempting to make balance adjustments. It is sometimes helpful to select tubes with extra care for use in DC scope amplifiers, since some tubes will be found to produce slight drifting even after they have been aged.

Up-and-down drifting of the trace line in an AC scope can be corrected much more easily—replacement of a leaky coupling capacitor will usually do the trick.

Input Attenuators for Wide-Band Scopes

To maintain linear amplitude calibration and flat frequency response in a scope, the role of the input circuit is as important as that of the vertical amplifier. Every scope has some input resistance and capacitance, which effectively shunt the vertical-input terminals (Fig. 13). These quantities should be held constant, with the resistance as high as possible and the capacitance as low as possible, in order to minimize *and standardize* the loading effect on the test circuit.

However, the input to the vertical amplifier must be variable to compensate for different strengths of input signal, and this complicates the problem of stabilizing the input resistance and capacitance. Some older scopes had a simple 1-megohm potentiometer (Fig. 14) to attenuate the input signal. This arrangement took care of the input-resistance problem, since the entire potentiometer was permanently wired across the probe terminals; however, the input capacitance still presented some difficulty. Stray wiring capacitances C1 and C2 across the upper and lower sections of the potentiometer remained practically constant, even though the resistance ratio between these sections could be changed at will. Then, for input-signal frequencies high enough to find a relatively low-impedance path through C1 and C2, the amount of attenuation provided by the input network would not be the same as for lower frequencies. This limitation on flat response made the circuit of Fig. 14 suitable only for scopes with narrow-band vertical amplifiers.

Step Attenuators

To provide better frequency compensation and other advantages, modern scopes generally use a switch-type step attenuator in combination with a limited-range vernier potentiometer. The simplest type of step attenuator, which provides either straight-through coupling of the signal or reduction by a factor of 10, is shown in Fig. 15. The total input resistance is still 1 megohm, but it is divided into 900K and 100K sections (R1 and R2) to give the desired 10-to-1 attenuation for low frequencies. Trimmer Ct can be adjusted so that the

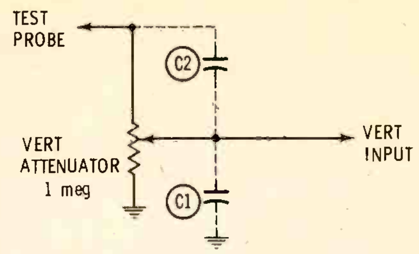
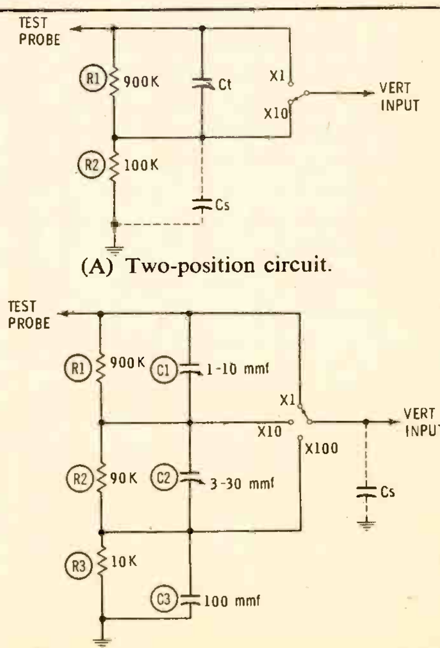


Fig. 14. Simple potentiometer-type vertical attenuator is suitable only for scope with narrow-band amplifier.

time constant of Ct and R1 is equal to that of stray capacitance Cs and R2; when this is accomplished, the attenuation ratio of 10:1 is maintained over an extended range of high frequencies. It is sometimes necessary to add a fixed capacitor in parallel with Cs to achieve the proper balance between the two time-constant circuits.

A more elaborate three-step circuit (Fig. 15B) offers attenuation factors of 10 and 100. The high-frequency attenuation is regulated by two trimmers in series. In practice, they are adjusted to obtain proper amplitude division of a high-frequency input signal, usually 100 kc; for the details of this procedure, the serviceman should consult the instruction manual for the particular scope in question. Since the trimmers tend to interact, they must be "rocked in" for best results.

The circuit of Fig. 15B cannot be adjusted for perfect high-frequency response, since the presence of stray capacitance Cs across the amplifier input tends to introduce an error. On the X10 range, note that Cs is in parallel with both C2 and C3, and in series with C1 only; on the X100 range, Cs is in parallel with C3 and in series with both C1 and C2. Because of this discrepancy, the settings of C1 and C2 are somewhat of a compromise.



(A) Two-position circuit.

(B) Three-position circuit.

Fig. 15. Simple step-type vertical attenuators.

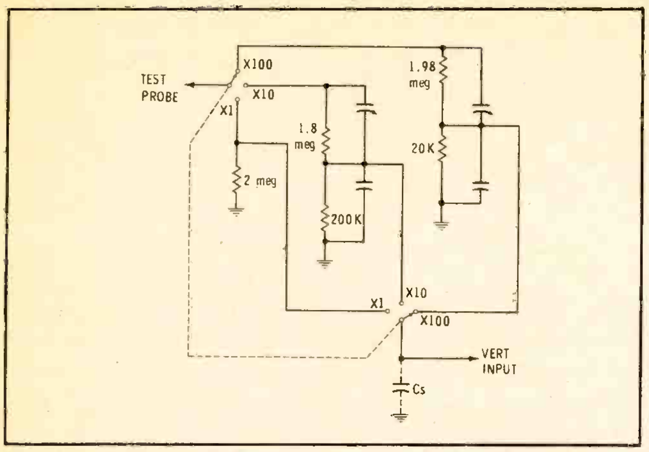


Fig. 16. A more elaborate version of the three-step attenuator, as used in the modern wide-band oscilloscopes.

A circuit often used in wide-band scopes (Fig. 16) overcomes this limitation by using an independent RC network for each range of the step attenuator. This allows full compensation for stray input capacitance on every switch position. In the circuit shown, note that an input resistance of 2 megohms is maintained at all times. The resistors customarily have 1% tolerance, and seldom change value *unless excessive input voltage is applied.*

In all of the above circuits, the shunt capacitance of the test cable does not affect the trimmer settings, because it does not contribute to the stray capacitance across *individual sections* of the attenuator. However, it must be taken into account in determining the overall input capacitance of the scope. Substituting straight wire leads in place of a coaxial cable will reduce the total input capacitance, but usually at the expense of introducing stray signal and hum pickup. Therefore, some sort of further isolation is necessary as a remedy for capacitive loading of critical high-frequency circuits.

Vernier Attenuators

Even when correct frequency response has been preserved all the way from the probe tip to the output of the vertical step attenuator, it can still be lost in passing through the vernier gain-control circuit that lies between the step attenuator and vertical amplifier. A high-resistance potentiometer is not suitable as a vernier in wide-band scopes, for the same reasons which were pointed out in connection with Fig. 14. The resistance must be kept low (only a few thousand ohms) to nullify the shunting effect of stray capacitance across the control at high frequencies. Accordingly, some means is needed for transforming the high-impedance output of the step attenuator into a low-impedance input for the vernier. A cathode follower is commonly used for this purpose.

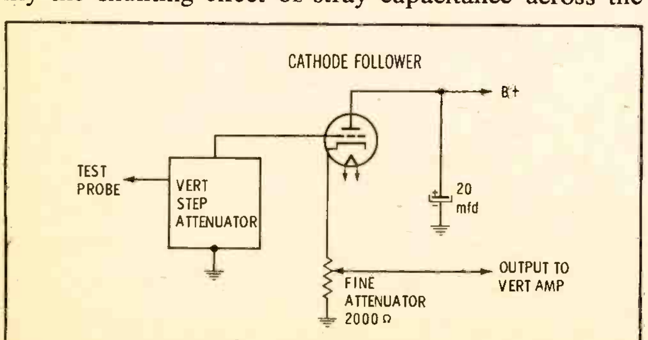


Fig. 17. Simplest version of cathode-follower circuit used as vertical vernier attenuator in oscilloscopes.

The simple attenuator circuit in Fig. 17 has good frequency response, but the amplitude loss in the cathode-follower circuit is considerable. Less signal is wasted if the value of the fine-attenuator control is increased, but the shunt capacitance then becomes a problem at higher frequencies. It is possible to compensate for this effect by adding a series peaking coil similar to those used in TV video amplifiers (Fig. 18A), but this compromise solution is not absolutely satisfactory because the high-frequency response tends to vary slightly with the vernier-control setting. Flatter response can be achieved by using a very low resistance, as in Fig. 17, and making up for the amplitude loss by using a higher-gain vertical amplifier.

One slight disadvantage of the simple circuit in Fig. 17 is that the waveform pattern tends to "bounce" whenever the vernier control is turned. The control carries the DC plate current of the cathode-follower tube as well as the signal current, and a DC surge is passed on to the vertical amplifier whenever the control setting is disturbed. This drawback can be overcome by using split AC and DC loads, as in Fig. 18B. Since only AC is present in the fine-attenuator control, no pattern bounce occurs. The only trouble with this arrangement is that the shunting effect of the DC-load resistor further increases the signal loss in the cathode follower. Once again, a reasonable compromise between amplitude and frequency response can be obtained by using a peaking coil in series with the output lead.

A number of troubles can develop in the cathode-follower circuit of a scope after long use. Here are some of the more common defects, with their remedies:

The electrolytic plate-bypass capacitor (Fig. 17) must maintain the plate at AC ground for all frequencies from 30 cps to 4 or 5 mc. When this unit loses capacitance or develops a high power factor, low frequencies will be attenuated; for symptoms of this trouble, refer again to Fig. 5.

The 25-mfd coupling capacitor in Fig. 18B must easily pass all frequencies within the pass band of the vertical amplifier, and also must have low DC leakage in order to avoid "pattern bounce."

If the pattern jitters as the fine-attenuator control is turned, the potentiometer is probably noisy and due for replacement. Erratic action is sometimes the fault of "cadmium growth," a condition in which the cadmium plating of the case or cover forms whiskerlike extensions which reach out and touch the resistance element.

Clipping or limiting of waveforms at low settings of the vernier control is a sign of overloading in the cathode-follower stage. The higher the plate-supply voltage to this circuit, the lower you can operate on the control range. To be on the safe side, however, it is a good practice to operate the fine-attenuator control at a relatively high setting, and use the step attenuator to reduce the signal strength as needed.

With the input attenuator networks properly maintained and calibrated, the amplifiers kept in trim to assure linear operation, and a suitable probe attached to the input terminals, your scope is ready to tackle any job you want it to do.

Special Scope Applications

The usefulness of the oscilloscope does not stop with signal-tracing and visual alignment, but extends to hundreds of additional specialized applications. In practically any situation calling for a measurement or comparison of AC voltage amplitudes and waveshapes, intelligent use of a scope can lighten the serviceman's work load and increase the accuracy of his test methods, One example will be sufficient to illustrate the wide range of advanced scope techniques that can be devised for use in the service shop.

Percentage of Modulation

A scope with a calibrated CRT scale provides a highly convenient means of checking amplitude-modulated RF signals to determine the percentage of modulation. One valuable application of this test is in maintenance of shop signal generators.

A service-type wide-band scope permits direct observation of carrier signals at frequencies up to 4 or 5 mc. When the scope is synchronized at some audio frequency which provides a clear view of the modulation envelope, as in Fig. 19, the approximate percentage of modulation can be quickly determined by comparing the amount of envelope fluctuation with the total RF-signal amplitude. (This assumes that the scope has a flat response, so it can provide equal gain for the RF and modulating signals.) Note that the positive and negative peaks in Fig. 19 are not symmetrical, indicating that the RF wave was modulated in a nonlinear manner. Less than perfect symmetry is acceptable for ordinary signal-injection and RF-IF alignment tests, as long as the over-all percentage of modulation is not reduced to a point where the audio output becomes too weak to use. However, an output as unsymmetrical as the "horrible examples" in Fig. 20 (taken from a shop-constructed RF generator at various frequencies) should not be tolerated.

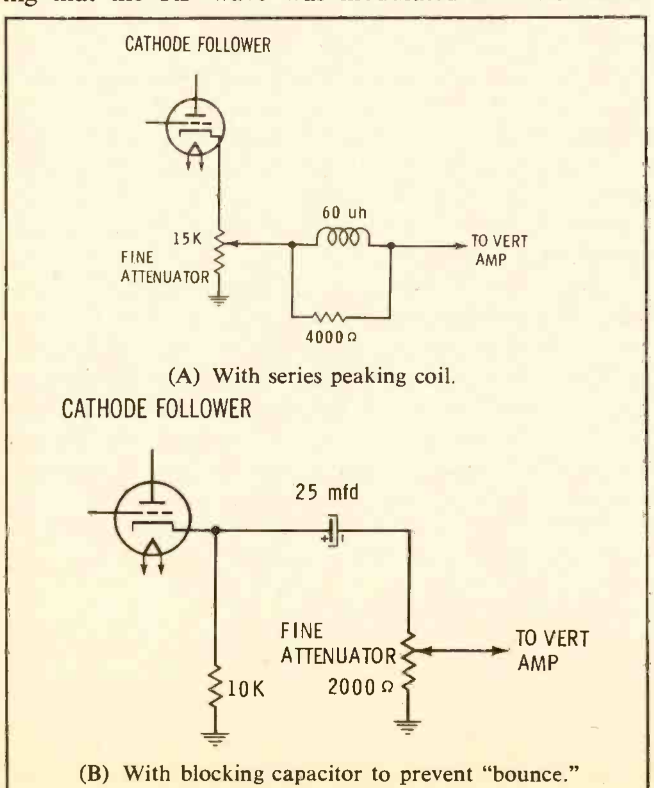


Fig. 18. Modified cathode-follower circuits.

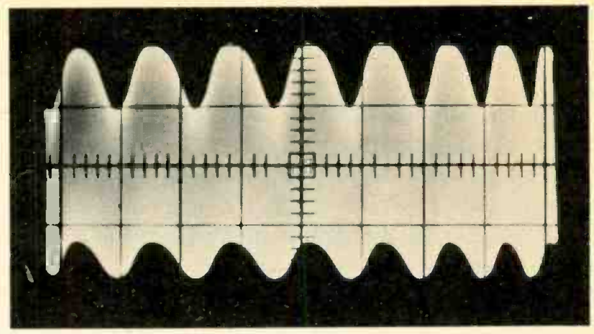


Fig. 19. Amplitude-modulated 455-kc signal viewed on a wide-band scope, using only a simple direct probe.

If the frequency of the RF signal you wish to check is too high to be viewed directly on a wide-band scope, you can still determine the percentage of modulation with the aid of a DC scope and a demodulator probe. (The response of some probes is virtually flat up to 150 mc or higher.) DC scope operation is specified in order to take advantage of the effect which was demonstrated in Fig. 12—a vertical shifting of the trace line according to changes in DC voltage.

As shown in Fig. 21, the audio-modulated RF input to the demodulator probe is rectified and filtered, and the resultant output is direct-coupled to the vertical amplifier of the scope. This signal has an AC compo-

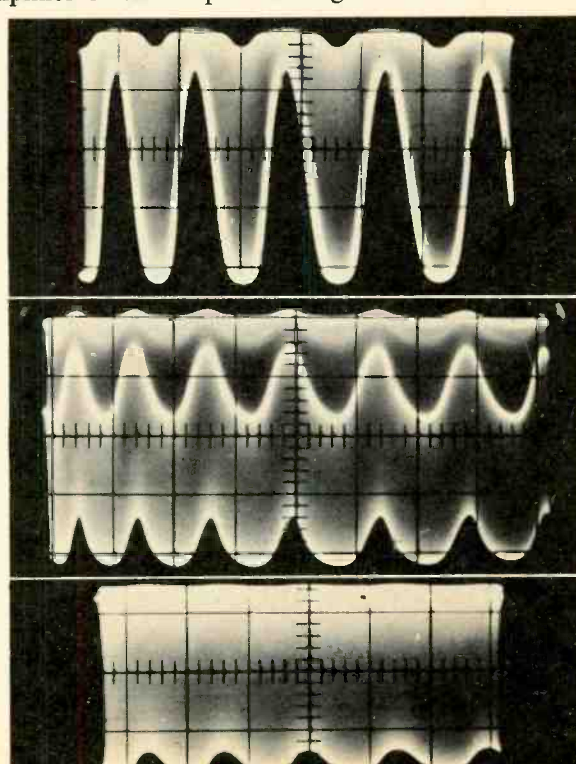


Fig. 20. Three examples of distortion in the amplitude-modulated output of a shop's homemade signal generator.

nent which represents the audio modulation, and also a DC component which corresponds to the average voltage.

With no signal applied to the scope, the trace comes to rest at some definite level, indicated by the zero line in Fig. 22A. Then, if the demodulator probe recovers the positive half cycles of an RF signal, the positive DC component of the output deflects the entire trace upward from the original zero level (Fig. 22B). The percentage of modulation can then be determined by noting the position of the negative peaks in the AC waveform with respect to both the present and former DC levels. In Fig. 22B, the peaks are midway between the old and new levels, so the downward deflection produced on the negative half-cycles of AC voltage equals 50% of the DC voltage. This corresponds to 50% modulation. If the negative peaks reached down all the way to the zero level (Fig. 22C), 100% modulation would be indicated. Other percentages can be determined by careful attention to the scale on the scope screen; for instance, if the DC level rises by 10 squares, and the negative AC peaks extend only two squares below this level, the percentage of modulation is 20%.

The negative half of the RF waveform can be recovered in a similar way, by merely reversing the polarity of the crystal diode in the demodulator probe. Interchanging the probe leads will *not* give satisfactory results, since the probe and the RF generator are both single-ended circuits (with one side grounded). If you have any suspicion that the modulation has poor symmetry, it would be advisable to check both the positive and negative portions of the envelope.

This modulation-percentage check can be used to good advantage in TV troubleshooting, to analyze the cause of buzz in the sound. Theoretically, no amplitude modulation is present in the 4.5-mc FM signal fed to the sound detector, but practical circuits do contain a greater or lesser amount of AM. Most of it consists of sync-pulse information which was incompletely suppressed by the sound take-off circuit; thus, amplitude modulation is recognized by "sync buzz."

When the input signal of the sound detector is checked with a demodulator probe and DC scope, the trace will rise or fall to indicate the average signal level; in addition, vertical sync pulses may be visible if an appreciable amount of AM is present (see Fig. 23). Most types of sound detectors will further suppress these pulses, but the amount of buzz from the speaker will still be proportional to the amount of AM entering the detector. The pulse amplitude can be minimized by properly aligning the video and sound IF stages, correctly adjusting the fine tuning, and making sure that the antenna is not distorting the input signal to emphasize frequencies in the video-carrier region.

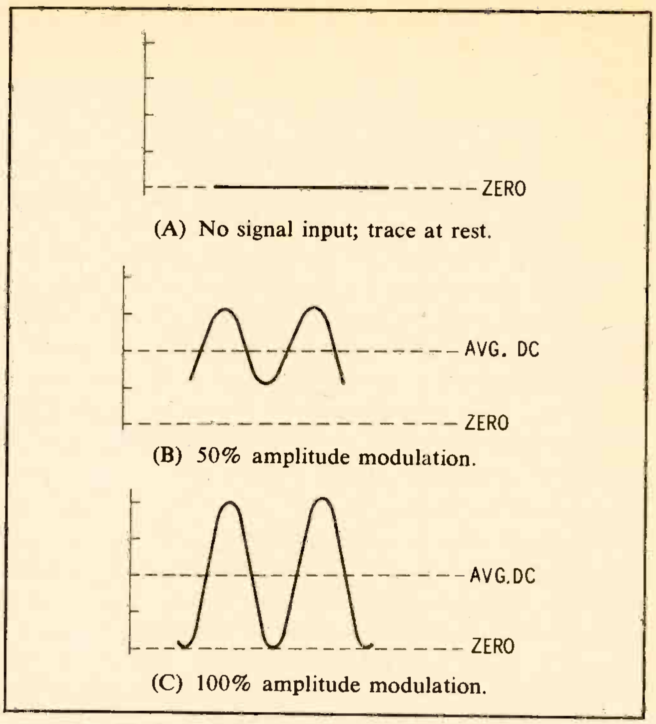


Fig. 22. Modulation-percentage readings on CRT.

The "buzz pulses" usually extend *toward* the original zero-volt level, indicating a decrease in the percentage of modulation. In some receivers, turning the contrast control will cause the pulses to collapse and then extend in the other direction—away from the zero-volt level. This indicates overloading in the video amplifier. At one critical point, the "downward" pulse modulation introduced in the video detector is exactly cancelled by "upward" modulation due to increasingly nonlinear operation of the video amplifier, resulting in momentary relief from buzz. However, the picture quality is not acceptable at this point, and repairs are needed. Correcting the tendency to overload may take care of the buzz; if not, further testing and alignment should be attempted.

This test for percentage of modulation may be a "new wrinkle" in scope use to many readers, but it is only a small sample of what this versatile instrument can do if given a chance. The servicemen who are getting their money's worth from scopes are not content to check for the presence of waveforms at standard test points—they are investing time in figuring out new ways to speed troubleshooting. ▲

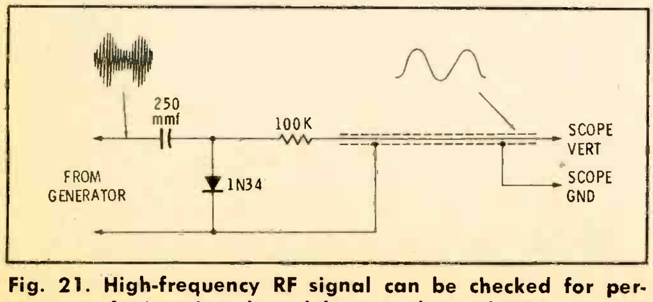


Fig. 21. High-frequency RF signal can be checked for percentage of AM using demodulator probe and DC scope.

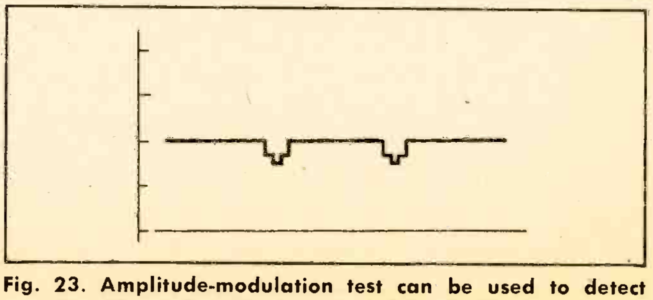
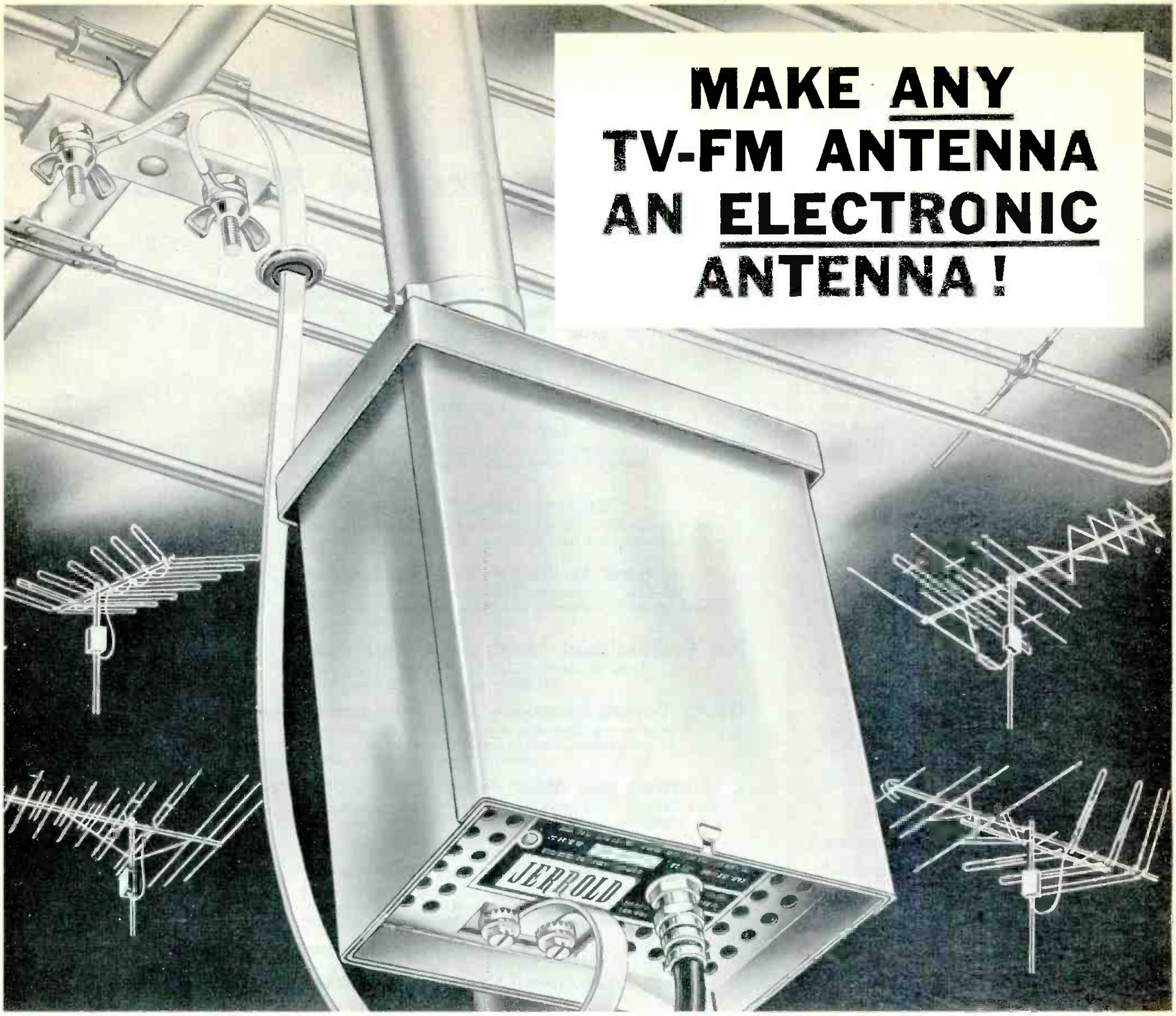


Fig. 23. Amplitude-modulation test can be used to detect presence of sync buzz in TV sound-detector input.



New Jerrold DE-SNOWER® Model 202

Increases Gain of Any Antenna 10 TIMES!

Out of the Jerrold laboratories, where the famous DSA-132 was born, comes the ultimate in signal preamplifiers for all channel TV (VHF) and FM reception. By combining *two* frame grid 6DJ8 dual triodes in a special low noise circuit, Jerrold's new DSA-202 develops *minimum* 20 db gain (10 times) on all TV channels and 8db (min.) on FM . . . *triple* the gain developed when using one 6DJ8. Also featured is a new lightweight iridite-aluminum weatherproof housing; no-strip twin lead terminals; and sliding access panel. All new high output remote power supply reduces a 117v AC to a safe 22 volts which goes up same cable that amplified signal comes down.

Only Jerrold assures you of proven reliability and unequaled performance based on more than a decade of designing and producing mast mounted preamplifiers . . . more Jerrold De-Snowers are in use today than all other makes combined.

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Includes new power supply model 407-P. Has "on-off" switch and handy cable compensating control.

Output uses shielded coax. to eliminate antenna feed-back and interference pick-up on down-lead.

Two 6DJ8 tubes develop 20 db gain (minimum) on all TV (VHF) and FM channels. →

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

PF REPORTER

including Electronic Servicing

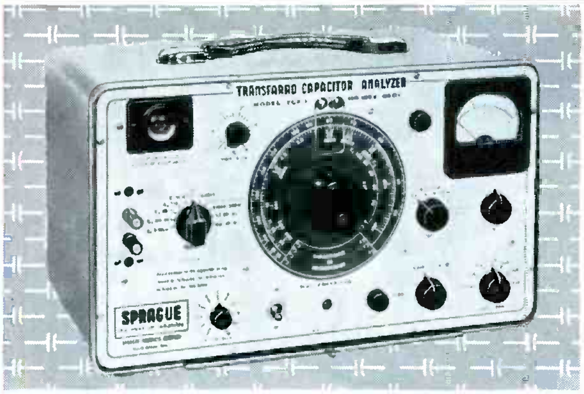
VOLUME 11, No. 4 — APRIL, 1961

CONTENTS

ABOUT THE COVER

Making effective use of test equipment is a key factor in efficient electronics servicing. With this point in mind, we've prepared a special issue covering the gamut of selecting, understanding, using, and maintaining all types of test instruments for practically all electronics servicing activities. Every feature, from the special 8-page oscilloscope section to "The Troubleshooter," is specifically planned to help you gain maximum benefits from your test equipment.

TEST EQUIPMENT by SPRAGUE® WORLD'S LARGEST CAPACITOR MANUFACTURER



The Sprague TCA-1 is specifically designed to safely test capacitors such as tantalum capacitors, low-leakage aluminum electrolytic miniatures, low voltage ceramics and low voltage paper and film capacitors used in transistor and other low voltage circuits. No industrial laboratory or modern electronic service shop can afford to be without one!

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- **CAPACITANCE BRIDGE** measures 1μμF to 2000μF in five overlapping ranges. Only 0.5 volt is applied to the bridge from a continuously adjustable power supply. The voltage across the capacitor is less than this applied voltage, the amplitude depending on the capacitance being measured. No possibility of overheating or deforming any low voltage capacitor during measurements.
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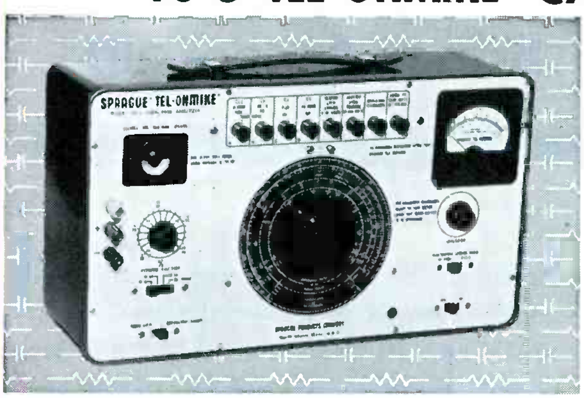
- **LEAKAGE CURRENT** measured directly on meter at exact rated d-c voltage of capacitor. Sensitive circuit makes full scale measurements from 0.6 μa to 600μa in seven ranges.
- **POWER FACTOR** measured by Wien bridge from 0 to 50 per cent.
- **MAGIC EYE** null detector in high-gain amplifier has sensitivity control permitting accurate measurement of small capacitors.
- **SHORT-TIME STABILITY** is assured by dual regulation of the power supply. Specially processed etched circuits and complete encapsulation of the critical bridge-null amplifier insure long-time stability.
- **BINDING POSTS** are shielded against strays, assuring greater accuracy during low capacitance measurements.
- **FOR SAFETY** the capacitor under test is automatically discharged after testing. Three wire line cord grounds instrument case.
- **OPERATING PROCEDURES** are clearly shown on convenient pull-out slide.

TO-5 TEL-OHMIKE® CAPACITOR ANALYZER



The TO-5 TEL-OHMIKE capacitor analyzer is a must for checking all capacitors except special low voltage transistor types. The TO-5 is a moderately priced instrument with laboratory quality and accuracy—the highest accuracy of any instrument of its type available to the service trade!

MODEL TO-5RM FOR RACK MOUNTING

Electrically identical with the standard instrument, Model TO-5RM has a standard 19" wide x 10½" high panel so that it can be mounted in standard relay racks.

Model TO-5RM......$102.50

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- **INSULATION RESISTANCE** directly read on large meter up to 20,000 megohms for papers, ceramics, and micas. No guessing with neon lamps.
- **LEAKAGE CURRENT** of electrolytics measured directly on meter, with exact rated voltage up to 600v. applied from continuously adjustable power supply. Two ranges: 0-6-60 ma. No guessing on eye-width or counting lamp blinks!
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MODEL TO-5..........115 VAC/50-60 cy..........$92.50 net

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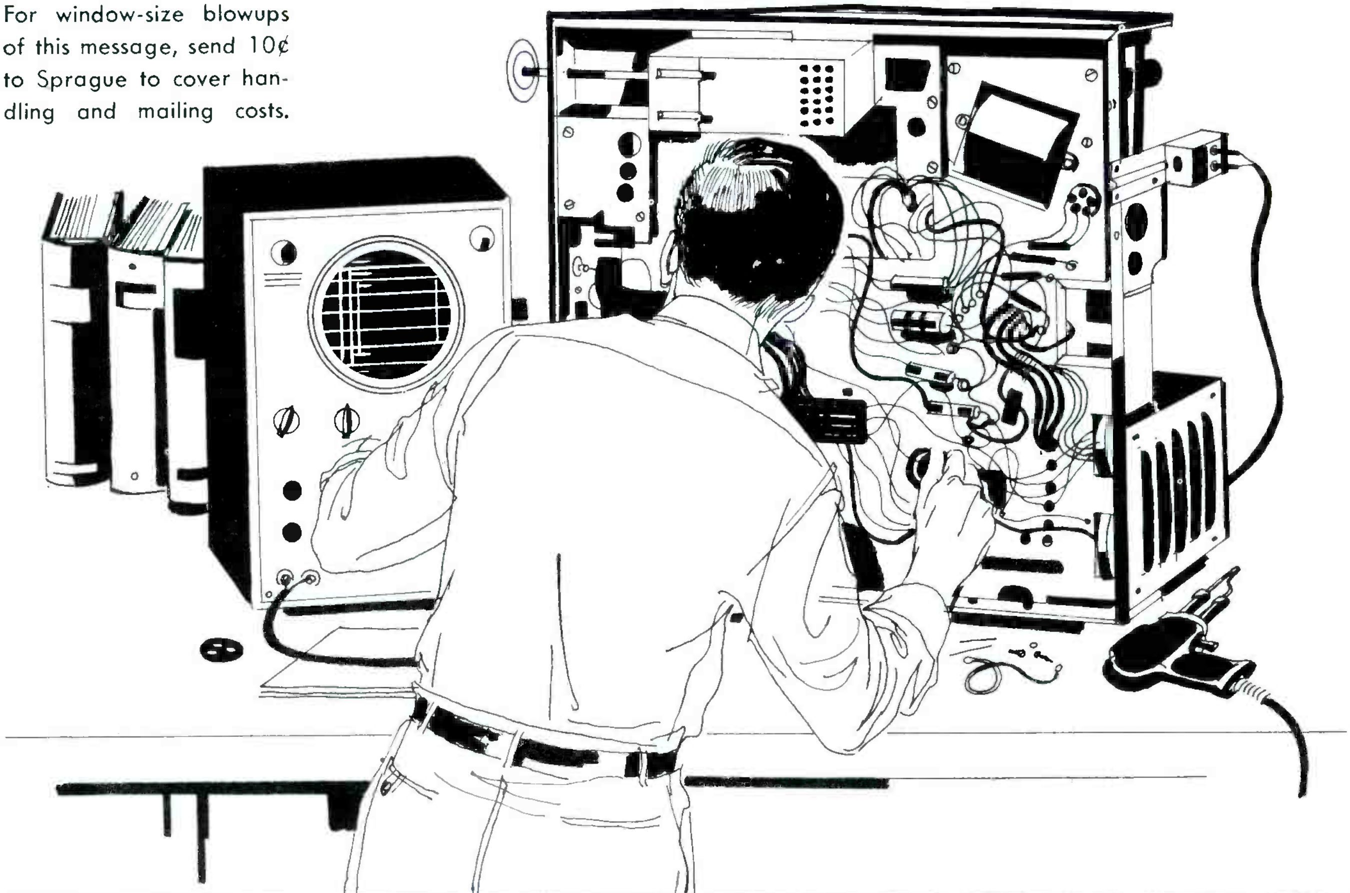
For window-size blowups of this message, send 10¢ to Sprague to cover handling and mailing costs.



More than 5600 ft. of circuitry . . . 590 parts . . . and he has to know how to fix 'em all!

YOUR TV SET is the most complicated piece of equipment you've ever owned. It represents a considerable investment of money. It provides your family with a wealth of entertainment pleasure. You value it highly.

Nobody is more aware of these facts than your neighborhood TV-Radio technician. And because he stakes his reputation on your satisfaction, *he strives to be worthy of your trust in him.* He achieves this by years of training and practice in electronic theory and application. He equips himself with expensive but essential test equipment, tools, and service manuals. He spends countless hours keeping up-to-date on new developments, new circuits, new trouble-shooting techniques.

His training and experience qualify him as a modern, professional expert. As such, he asks a fair, professional price for his services. Since he will not use cut-rate methods or cut-rate parts in your TV set, he cannot offer cut-rate prices. *Remember, you get only your money's worth in TV-Radio service. When you are taken in by a "bargain-type" offer, you can expect to get "bargain-type" service. BEWARE THE SERVICE BARGAIN!*

THIS MESSAGE WAS PREPARED BY SPRAGUE PRODUCTS COMPANY,
DISTRIBUTORS' SUPPLY SUBSIDIARY OF SPRAGUE ELECTRIC CO., NORTH ADAMS, MASS., FOR

YOUR NEIGHBORHOOD TV-RADIO TECHNICIAN

LETTERS TO THE EDITOR

Dear Editor:

If the entire series of 60 ads in your "Service-Keyed Advertising Program" are available at this time, please advise me of this fact. I think these are the best advertising ideas to come along in some time, and I'd like the entire series without delay.

R. D. SANFORD

Bob's Radio-TV-Appliance
Oxnard, Calif.

You were the first, but by no means the only reader to request the entire series, Bob. Yes, indeed, you can obtain the entire 60 ads at one time—at the special reduced price of only $25.00 for both ad mats and reproduction proofs.—Ed.

Dear Editor:

First of all, your publication is the "most," to say the least. We have been on your regular list since your publication was first issued, so you can call us old-timers. We've relocated a few times—Michigan, Florida, Michigan, and Florida—but PF followed us all the time. We have subscribed to four other trade journals at various times, but did not renew the subscriptions. Do you know why? We found in PF REPORTER all the assorted articles, information, and news we wanted. That is why we're with you.

J. J. CIERESEWSKI

Cheri's Television
Fort Lauderdale, Fla.

Thanks, Cheri. With all that back-and-forth moving, we had a time keeping up with you for awhile—but "we're still with you."—Ed.

Dear Editor:

Glad to see that Editors are human, too! I refer to the flub on page 70 of your March issue.

Although our client, Blonder-Tongue certainly has no objection to being associated with a fine corporation like Motorola, transposing the pictures for the two product write-ups (43Z and 45Z) is going a bit far.

SANFORD J. DURST

Director of Public Relations
Gilbert & Felix, Inc.
New York, N. Y.

It's lucky for us a TV/FM signal amplifier doesn't look anything like a kit of transistors, or distributors would be getting calls for some mighty peculiar products!—Ed.

Dear Editor:

I found the February article, "You Can Fix Small Radios," very helpful. I have only one question. Mr. Davis suggests substituting a 25L6 for the 35Z5 when a semiconductor is used to take over the rectifier function. Wouldn't a 35L6 work better?

A. MARTINO

Martino TV
Chicago, Ill.

Yes, a 35L6 would work better, since its heater requirements are exactly the same as for a 35Z5. Incidentally, don't forget to open the connection to pin 5 of the socket; this is the plate connection for the 35Z5, but the grid connection for the 'L6. Since pin 8 is the cathode connection for both tubes, failure to observe this precaution will ruin the 'L6 grid structure (although it won't affect the heater circuit).—Ed.

Dear Editor:

Congratulations on the 10-year index in the January issue. It will be a big time-saver for the technician who knows that somewhere in the large stable of publications accumulated over the last several years, there is an article with valuable information concerning problems at hand.

We are in somewhat the same position as a lawyer who has a vast library in his office. He doesn't have the location of all the information "stored in his head," but he has an index that guides him to the desired information.

CLYDE H. BALDWIN

Dallas, Texas

Thanks. Hope you "win every case."
—Ed.

Dear Editor:

I would like to have all the subject reference indexes for the PF REPORTER so that I would not have to search for two days for something needed to refresh my memory.

I am setting up my issues as a reference library, and the indexes would sure save me a lot of time. I have issues dating back to the very first — January, 1951 — although I missed a few along the way. One of these days, I'm going to order the missing copies to complete my library. How much would it cost me if I ordered 24 at once?

WILLARD R. ROBERTS

Radio & Television Service
Jacksonville, Ark.

Better order those back issues right now, Willard: many of them are in short supply, and some are completely out of stock. For orders of 6 copies or more, you earn the special bulk discount of 10c off the regular price of 50c per copy. (See page 76 of this issue.)

Annual indexes for the years 1951 through 1956 appeared in the corresponding December issues. Indexes for 1957, 1958, and 1959 were published separately, and are on their way to you. No separate index was published for 1960, having been incorporated in the Cumulative 10-year index included in the January, 1961 issue. This 16-page index is available alone, or as part of the January issue — as long as they last — for 50c per copy.—Ed.

Dear Editor:

With what issue did you begin the practice of including the monthly subject reference index on the Catalog & Literature card? I consider this an excellent idea, and wonder if you could print cards for

FIRST CHOICE WITH SERVICE TECHNICIANS . . . EVERYWHERE!

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ELMENCO

DIPPED MYLAR*- PAPER CAPACITOR

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LOOK FOR THE "EM" ON ALL dp UNITS

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- OPERATES AT 125°C. WITHOUT DERATING
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Available at every REPUTABLE distributor throughout the country!

ARCO electronics inc.

Community Drive, Great Neck, New York • Branches: Dallas 7, Los Angeles 35

Write for Catalog dp 110.

issues published in the last couple of years.

The January 10-year index section was excellent. Is this available separately? Incidentally, I much appreciate Sams PHOTOFACT Folders.

JAMES J. SALDA
Oklahoma City, Okla.

The monthly index card first appeared in the September, 1960 issue; none are available for prior issues.—Ed.

Dear Editor:

I'd like to comment on reader Koehler's form letter, published in your February issue.

If a service shop arbitrarily sets a time limit on accepting responsibility for storage of repaired sets, without regard for the laws of his state, he's in for trouble.

Indiana's law, set up back in the 1860's, states that if an item is not claimed within 90 days, and the owner has been notified that it is ready, the item may be advertised and sold at a public auction.

Each state, however, has its own laws, and the shop owner should know what they are. I don't know if Indiana permits storage charges for unclaimed items. Perhaps PF REPORTER could shed some light on the subject.

JAMES O. WOODWARD
Woodward TV & Changer Repair
New Castle, Ind.

Thanks, Jim. We'll look into the matter and see if we can't come up with some information on the subject.—Ed.

Dear Editor:

We think the article, "Let the Customer Have Your Way" in your February issue was swell. After reading it, we thought of passing along an idea we find very effective in the field of customer relations.

When called by a new customer, we present the enclosed article to him as we go to work on the TV set. This keeps even the do-it-yourself customers off our neck while we work, since they stay busy reading. As you will note, the article comes right to the point and answers a lot of the questions a new customer might ask, without either of us saying a word!

GEORGE E. MOLSON
Manager
Eastern Electronics
Albany, N. Y.

> This is not an advertisement. It is an introduction, presenting some facts about us—our service policy and views.
>
> We specialize in servicing TV sets only. In fact, we think, talk and live—TV. We have ample experience and equipment to say that we are qualified to serve you. Our list of satisfied customers can verify this.
>
> We are in business to *make* money—not *take* it. Our policy is to be honest and fair. We do not like to settle for less and expect to be treated in the same way.
>
> To us servicing TV sets is not a business deal alone. It is also a personal affair in that we will take a personal interest in your TV problems and try to solve them as if they were our very own. We will work with you—and hope you will work with us.

• *Please turn to page 20*

DOUBLES YOUR EFFECTIVE MANPOWER

Fix "Tough Dogs" Fast!

Save Half Your Time!

Step Up Your Profit!

B&K NEW
MODEL 1076

TELEVISION ANALYST

for Black & White and Color

Check all circuits-Pinpoint any TV trouble...in minutes

By Easy Point-to-Point Signal Injection, You See the Trouble on the TV Screen and Correct it—Twice as Fast and Easy!

There's no longer any need to "lose your shirt" (and customers)—and worry about the lost hours you never recover—on "tough dogs" or even intermittents. *The remarkable B&K Analyst* enables you to inject your own TV signal at any point and watch the resulting test pattern on the picture tube itself. *Makes it quick and easy to isolate, pinpoint, and correct TV trouble in any stage* throughout the video, audio, r.f., i.f., sync, and sweep sections of black & white and color television sets—*including intermittents.* Makes external scope or wave-form interpretation unnecessary. Most useful instrument in TV servicing! Its basic technique has been proved by thousands of successful servicemen the world over.

The Analyst enables any serviceman to cut servicing time in half, service more TV sets in less time, really satisfy more customers, *and make more money.*

Model 1076. Net, **$299.95**

Available on Budget Terms. As low as $30.00 down.

See Your B&K Distributor or Write for Bulletin AP17-R

Combines all the features of both the Model 1075 and Model A107

- COMPLETE R.F. and I.F.
- VIDEO TEST PATTERN
- COMPOSITE SYNC
- FM MODULATED AUDIO
- COLOR PATTERNS
- HORIZONTAL and VERTICAL PLATE and GRID DRIVE
- B+ BOOST INDICATOR
- HI-VOLT INDICATOR
- YOKE and HI-VOLTAGE TRANSFORMER TEST

Also Now Provides:

- SWITCH-TYPE TUNER
- NEGATIVE BIAS SUPPLY
- AGC KEYING PULSE
- PICTURE TUBE MODULATION

B&K

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1801 W. BELLE PLAINE AVE • CHICAGO 13, ILL.
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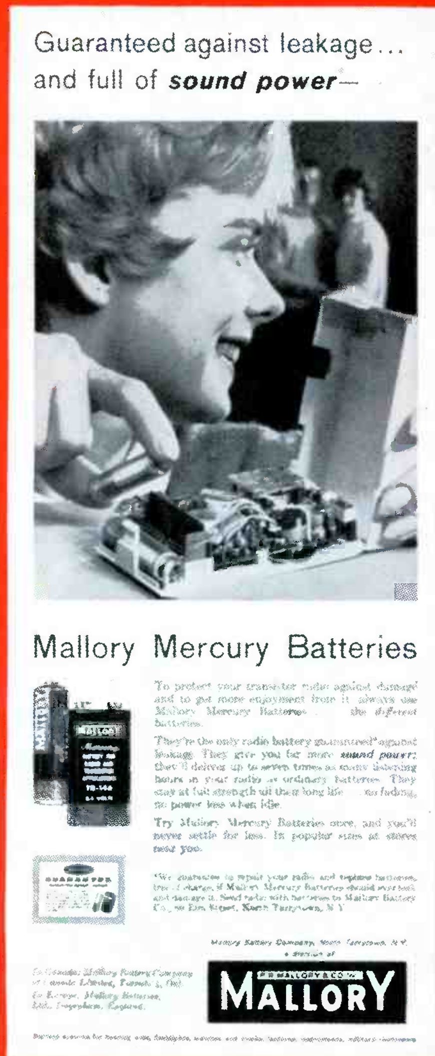
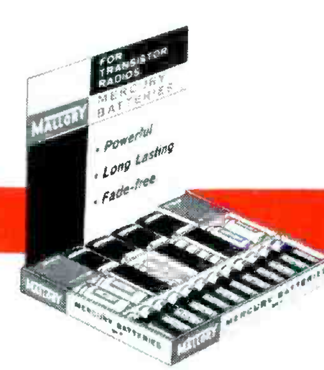


Step up your battery profits

BRING PROSPECTS INSIDE . . .
with this bold window streamer.

BRING 'EM TO THE POINT OF SALE . . .
with store and window display material.



THEN SELL 'EM . . .
from this new counter-top dispenser. A service-selected assortment of Mallory Mercury Batteries . . . a line to fit all popular transistor radios.

ADVERTISED IN

LIFE

LIFE ADS REACHING 34 MILLION PROSPECTS

Consistent Mallory advertising in LIFE—telling them . . . and selling them.

Mallory Mercury Batteries . . . the ***sound power**** battery . . . now come to you with a new *salespower program* to help you cash in on the booming transistor radio battery business. It's a big market . . . over 15 million transistor portables in use today, thousands more every month. And Mallory Mercury Batteries have the performance . . . the promotion . . . and the profitability . . . that lead the field.

New national advertising that pre-sells millions of customers this *different* battery.

New guarantee against leakage, unique in radio batteries . . . heavily promoted in national advertising.

New promotional materials—store banners, window displays, dealer ad mats, counter cards.

A new point-of-sale merchandiser—puts every dealer in the Mercury Battery business . . . balanced inventory . . . minimum investment . . . attractive display.

Plus . . . the unequalled performance of the most powerful batteries on the market. Up to seven times more sound power. Non-fading performance. Two years or more storage life.

And . . . high profit per sale . . . several times that of ordinary batteries.

See your Mallory distributor now. Get ready for the big battery selling season . . . with the fastest growing battery line! *T.M.

with the Mallory '61 Program

Distributor Division
Indianapolis 6, Indiana

P. R. MALLORY & CO. Inc.
MALLORY

AND KEEP 'EM SOLD . . .
Attach this sticker inside each radio. It reminds customers that you've replaced with Mallory Mercury Batteries . . . and reminds them to come back to you.

NEW GUARANTEE AGAINST LEAKAGE . . .
Display the Mallory guarantee that protects your customers. We guarantee to repair the radio and replace the batteries, free of charge, if Mallory Mercury Batteries should ever leak and damage a radio set.

Letters

(Continued from page 16)

We will make every attempt to repair a TV at the location, for we know that removing the set to our shop will result in a higher repair bill. Our shop contains the necessary, modern electronic test equipment and information that we know how to use in order to provide the best possible service at the lowest cost.

We will install only the parts you need at the time. However, if other defects or symptoms of future trouble are discovered, it is our policy to let you know so that a complete repair may be made in the interest of longer, trouble-free operation. If we should fail to make a satisfactory repair on our first attempt, with the same trouble condition remaining or returning, please do not let the trouble go on or call someone else! We insist that you call us back! If the trouble is from another source and not our recent repair, we will charge you as usual. But if the trouble is due to a failure on our part, we will not charge again for labor.

When you call us for TV service, your problems become ours and even with the best in knowledge and equipment, a troubled TV can give us a hard time. In such cases, we only ask that you understand our position, whereby a TV set is a complex and delicate instrument. With this understanding, we can best solve the problem together, in time.

Our service charges are fair, we believe, considering that we have the necessary expenses that go with operating an established business. With this in mind, you can realize that service charges must be paid upon completion of work.

To satisfy us—we must satisfy you. We can do this, if given a fair chance!

A serviceman friend of ours says you'd have to write a whole book to keep some of his customers busy! All the same, George, we like your idea.—Ed.

Dear Editor:

I have eagerly read all your articles on repairing transistor radios, but I have yet to read anything about the time-consuming job of unsoldering, testing, and re-soldering tiny transistors on a printed board which is often only 2″ or 3″ square.

We have decided, for the time being, to sell only radios which use plug-in type transistors, since they are much easier to service.

I intend to make a gold-plated garbage can and use it to show customers what they might as well do with soldered-in transistor radios they expect to have repaired for \$3 or \$4. Let's have a *really* good article on how to check soldered-in transistors without all the unsoldering.

G. SAGE VIEHE

V's TV Sales & Service
Eau Gallie, Fla.

How about the article on repairing transistor radios which appeared on pages 24 and 25 of last month's issue? We'll whip up more sometime soon.—Ed.

SPECIAL ANALYZERS

FOR TV TROUBLESHOOTING

Signal-substitution testing adds flexibility to your bench-servicing technique.

Since we can now place maneuverable earth satellites in orbit, and "electronic brains" can solve unbelievably complex problems in the wink of an eye, it isn't difficult to imagine the possibilities of a "Troubleshoot-O-Matic"—a miraculous piece of test equipment that automatically tells you which component is causing the trouble in a TV set. It sounds like the answer to a serviceman's dream, until you realize that it would enable *anybody* to service TV—and then where would the service industry be?

Fortunately, troubleshooting has not yet advanced to the push-button stage, but there are already some ingenious test instruments which can transform many of the servicer's mega-problems into micro-problems. They still require the mental efforts of a skilled technician; but if the techniques of their use are properly mastered, they can supply information not readily obtainable in any other way.

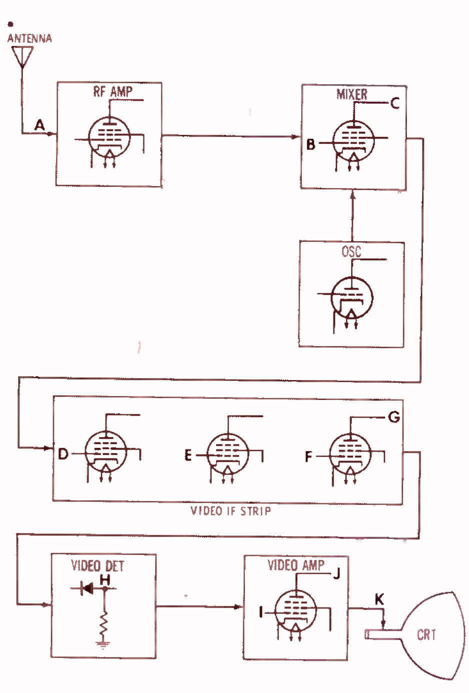


Fig. 1. Basic check points for analyzer tests of RF, IF, and video stages.

These pieces of equipment perform a multitude of tests, and they can be classified in many ways; for example, various units generate test signals, monitor test results in a unique yet simple manner, or feature expedient methods of signal-tracing or substitution. However, we can consider them all in the broad group of "special analyzers"—either because they permit making tests which are not possible with conventional test equipment (scope, VTVM, etc.) or because they perform familiar tests in a different manner from conventional equipment.

To give you an over-all picture of the types of analyzers currently on the market and how they operate, let's examine a TV receiver in sections and discuss some of the specific troubleshooting applications of these special instruments.

RF-IF-Video

The television signal, in passing from antenna to picture tube, goes through a long chain of RF, IF, and video circuits. To help localize trouble in these various stages in a minimum amount of time, several different types of analyzers have been developed. They range from large signal generators to small probes that can be held in your hand.

One of the most elaborate analyzers for this purpose is the flying-spot scanner. Functioning as a portable TV transmitter, the instrument provides a choice of RF, IF, or video output with modulation representing complete picture, sound, and sync signals. Troubleshooting is accomplished by following a signal-substitution procedure, using the receiver picture tube or an oscilloscope as an indicating device.

To isolate trouble in a tuner, the generator section of the analyzer is adjusted for a modulated RF output, and both instrument and receiver are tuned to the same channel. In some instances, the test signal will be applied to an output cable by a flip of a switch, while in others, the output cable must be connected to a particular jack on the instrument.

The RF test signal may be injected at either A or B in Fig. 1. Using the picture tube as a test monitor, or viewing results with a scope at any point along the signal path, you can determine if the RF circuitry of the tuner is working properly. By changing the output of the analyzer from RF to IF and including test point C, you can also see if all stages following the mixer are functioning.

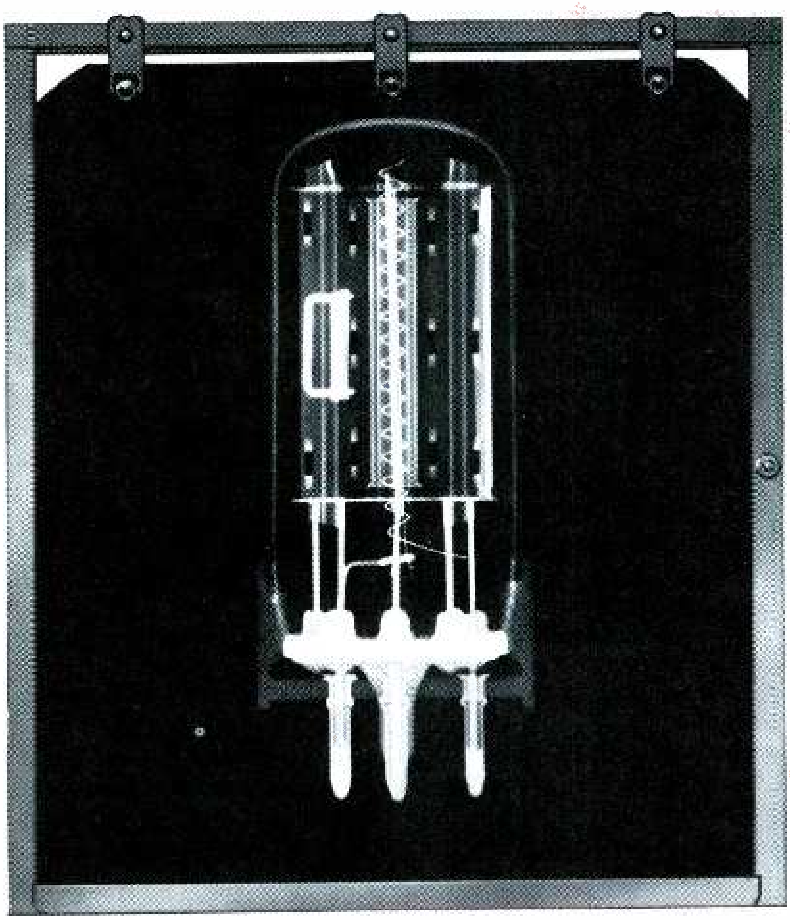
In addition to these more complex instruments, simple harmonic generators are also useful in this section of the receiver. These portable units may supply a fixed output that can be applied to all picture-signal stages, or they may be equipped with an RF/IF-AUDIO/VIDEO selector and output attenuator. Instruments of this nature are usually moderately priced and self-powered by a battery.

Probe-type analyzers are also employed for either stage substitution or signal sampling. For example, one lead from the probe may be attached to the RF amplifier grid (point A in Fig. 1), and another to the mixer grid (point B). The self-contained amplifier of the probe

• *Please turn to page 73*

damper tube exhibits tolerance of high voltages

Thorough examination of the subject reveals physical characteristics conducive to exceptional longevity. Immunity to the high voltage ailments that plague so many less rugged damper tubes is due mainly to unusual care attending the tubes' formative stages. Outstanding qualities are noted in electrophoretically coated heater peaks and insulator coils; a "cool" running cathode; a copper core plate designed for maximum dissipation and less back emission. All of these minimize arcing. In addition, the electrically isolated insulator coil maintains high voltage insulation with the shortest possible warm-up time. In every respect, the Tung-Sol damper tube exhibits structural standards that approach an ideal far above more common types. Tubes of this family are certain to prove fully reliable under the most adverse conditions.



JUST WHAT THE DOCTOR ORDERED

All modern damper tubes trace their genealogy directly to improved designs created by Tung-Sol. Where diagnosis of a customer's TV set indicates damper tube replacement, be sure to prescribe Tung-Sol. These are some of the more popular Tung-Sol damper tubes:

6/12AF3	6DA4A
6/12/17AX4GTB	6DE4
6/19AU4GTA	6V3A
6/25W4GT	12D4A

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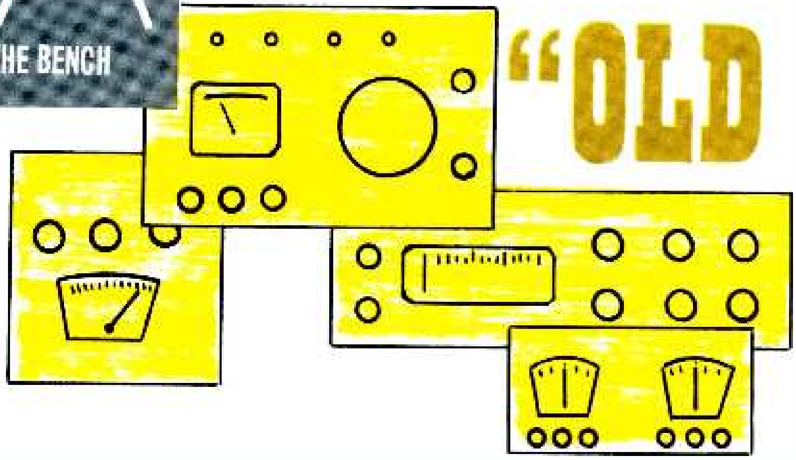
DAMPER TUBES

TUNG-SOL ELECTRIC INC., NEWARK 4, N. J.

ACROSS THE BENCH



"OLD FAITHFULS" of the bench

Rapid expansion in the field of electronics has placed unparalleled demands upon the servicing end of the industry. The radioman of old has met challenges, not only to his technical competence, but also to his ability to devise new troubleshooting techniques. In addition, there has been a constant flow of "new blood" into the service industry; it has attracted men with alert minds, having no preconceived notions that troubles must be traced in a certain way. This, in turn, has resulted in the development of a wide variety of new test instruments to help today's radio-TV-electronics technician do his job more easily. However, the "old faithfuls" of the bench still contribute a fair share toward pinpointing troubles quickly and efficiently.

Tube testers, for example, can put the finger on tube faults—confirming suspicions aroused by substitution testing. When a new tube eliminates horizontal pulling, increases gain, or otherwise improves performance, a tube check will usually confirm that a defect existed in the old tube. Testers are useful, too, in obtaining an idea of how a tube will function when no substitute is readily available. When a tube tester is used by a technician fully aware of its capabilities and limitations, it can save a lot of time and eliminate many trial-and-error procedures.

An offspring of the tube tester, the transistor tester, has also proved its worth on the bench. It already belongs in the category of "old faithfuls," even though it is a rather new development. When troubleshooting transistorized equipment, servicemen often waste considerable time in trying to determine if a transistor is good or bad before actually testing it—simply because it's soldered into the circuit. Some of the newer transistor testers have overcome this obstacle to some degree by providing limited in-circuit tests. In any case, you'll find it time-saving to test the transistor when preliminary checks indicate it is bad; whatever the results, you'll be able to take appropriate action.

Another "old faithful" designed to evaluate specific components is the capacitor tester. This instrument often saves the user from making mass capacitor substitutions and replacements. Capacitors checked with one of these units may prove to be off-value, leaky, open, or shorted, thereby confirming previous suspicions.

Capacitor testers are probably most useful in tracking down intermittent troubles. Take a radio with intermittent motorboating, for example. There's a good chance the motorboating will stop when a meter probe is touched to a B+ point, or when a substitute capacitor is hooked in anywhere along the B+ line; then it may take hours or days of playing for the trouble to develop again. Normally, the trouble centers in C1B of Fig. 1, an electrolytic unit which sometimes develops a high impedance to RF signals. Making a power-factor test of this unit can therefore save you a lot of time and trouble.

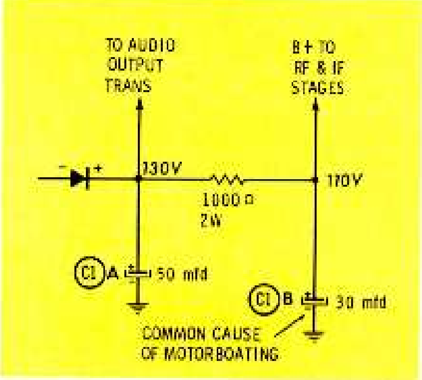


Fig. 1. High power factor in the filter capacitor often causes motorboating.

Many of the "dogs" in TV are caused by capacitors that develop a slight amount of leakage, or change from their rated value, as the operating temperature increases. Applying heat to such capacitors often provides a quick and decisive test that can save countless hours, dollars, and gray hairs.

While we're on the subject of intermittents, this is a good time to mention using an adjustable isolation transformer to vary the input voltage. Simulating AC-line variations is the fastest way to localize intermittent problems in three-way portables. Quite often the trouble is in the B+ or filament power-supply circuits (Fig. 2). Reducing the input voltage to 100 volts soon lets you know if the intermittent condition is due to some section of the receiver

• *Please turn to page 66*

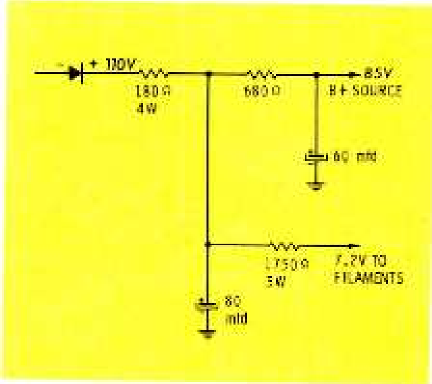


Fig. 2. Check the power supply at reduced line voltage to spot intermittents.

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How to Select Test Equipment

by Les Deane

Once the decision has been made to add a piece of test equipment to existing radio-TV-electronics servicing facilities, the technician faces the problem of selecting a specific instrument. This involves many considerations other than, "Will it fit into the budget?" There is a wide variety of instruments from which to choose, and the demands which will be placed on the instrument must be carefully evaluated before the final choice is made. Personal habits and techniques often have as much of a bearing on the selection as the electrical characteristics of an instrument; therefore, many physical properties of different units should receive consideration. For that matter, all available information on a given unit deserves the attention of the prospective buyer. The main objective of this article is to point out how specifications can be interpreted to aid in selecting the proper piece of test equipment to meet a specific servicing requirement.

VOM

The old granddaddy of test instruments, the volt-ohm-milliammeter, has been employed in just about every phase of electronics from checking the continuity of a fuse to making measurements in complex computer systems. When selecting a multimeter of this nature, one should first consider where it is to be used.

As the name itself implies, the instrument is primarily designed for the measurement of volts, ohms, and milliamps. Most of these meters have provisions for measuring AC and DC voltages, resistance, and a wide range of DC current; some also measure AC power on scales calibrated in db. In most applications it isn't necessary for a VOM to provide *all* of these indications. The proposed use of the meter dictates the provisions it should have.

The limits or ranges of the various functions should be given due consideration in selecting a VOM. For general radio and TV work, it should be capable of measuring AC and DC voltages up to 1000 volts, DC currents up to 500 ma, and resistance values up to 10 or 20 megohms. However, if the meter is intended for use in servicing color TV and transistorized equipment, both higher and lower ranges may be required. High-voltage and high-frequency probes can often be used to extend certain ranges. Meters that read signal power in db are useful in audio and hi-fi work. Specifications clearly state the various functions and their inclusive ranges; therefore, it should be easy to understand exactly what a meter offers in these respects.

Once the basic type of VOM has been determined, sensitivity must be considered. This characteristic is stated in terms of ohms per volt for both AC and DC functions. Typical sensitivities range from 1000 to 100,000 ohms/volt; for example, the representative "spec sheet" in Fig. 1 indicates a rating of 20,000 ohms/volt DC, or 5000 ohms/volt AC. For voltage measurements, the meter-input resistance in ohms will equal this ohms-per-volt figure times the full-scale indication of the voltage range selected. Thus, on the 100-volt DC range, in the example of Fig. 1, the input resistance equals 20,000 x 100, or 2 megohms. On the 100-volt AC range, the input resistance equals 500,000 ohms.

Sensitivity specifications need to be considered because the input resistance of the meter shunts the circuit under test during voltage measurements; the higher the shunt value, the lower will be the loading. Consequently, for voltage measurements in a high-impedance circuit, greater accuracy can be attained by using a meter with a higher ohms/volt rating.

Speaking of accuracy, this specification is usually expressed in a percentage of full-scale deflection. Hence, if a VOM has an accuracy of

Sensitivity —
20,000 ohms/volt DC
5000 ohms/volt AC
Ranges —
DC volts: 0-6000 in 6 steps; full-scale markings 3, 6, 12.
AC volts: 0-6000 in 6 steps; full-scale markings 3, 6, 12.
Resistance: 0-100 megohms in 4 steps.
Direct Current: 0-10 amps in 6 steps.
Volume level (zero db equal to 1 milliwatt across 600 ohms): –20 to +50 db in 4 steps.
Other Features —
Polarity-reversing switch.
Accuracy 3% DC to 1200 volts.

Fig. 1. Typical list of specifications for common 20,000 ohm-per-volt VOM.

Frequency Response —
Vert.—DC to 4.5 mc, ± 1 db; usable to 6 mc.
Horiz.—Flat 10 cps to 200 kc, –4db at 500 kc.
Deflection Sensitivity —
Vert.—20 mv rms/inch.
Horiz.—250 mv rms/inch.
Input Impedance —
Vert.—1 meg, 35 mmf.
Horiz.—500K, 22 mmf.
Sweep Frequency —
14-100 kc in 4 ranges; preset "V" and "H" positions.
Other Features —
Retrace blanking; 10-volt peak-to-peak calibration voltage; expanded sweep provision.

Fig. 2. Typical specifications for a scope sutable for color TV servicing.

2%, and we consider the 500-volt range, accuracy under these conditions would be 2% of 500, or within ±10 volts of the value indicated by the meter needle. Of course, accuracy requirements will depend on such factors as circuit tolerances in the apparatus being tested.

Physical size is another consideration—especially if the instrument is to be mounted in a panel or carried in a tool box or tube caddy. Portability and length of test leads may be important if test points in the equipment to be serviced are hard to reach. A polarity-reversal switch, meter-burnout protection, and the readability of meter scales are just a few other points to keep in mind when choosing a VOM.

VTVM

Vacuum-tube voltmeters offer virtually all the functions of the VOM, and generally more diversified ranges. In some applications, the accuracy of the readings obtained on a VTVM may not be quite as good as those of a VOM. Nevertheless, taking into account the frequency compensation and constant input impedance characteristics of a VTVM, its over-all accuracy may exceed that of the average VOM. Thus, the former unit finds wide application in every phase of electronics servicing.

Most VTVM's are AC-operated; however, some are powered by batteries. Quite a few models indicate AC voltages in peak or full peak-to-peak values, as well as in rms values. When the AC features include a broad db range, the VTVM suits most audio and hi-fi specialists to a "T."

The high input resistance or impedance of a VTVM makes it possible to measure very low voltages in relatively high-impedance circuits; for instance, the radio-TV serviceman finds it easy to read small grid-bias potentials with a VTVM because it neither seriously loads nor detunes the stage being checked.

VTVM's have a constant high input DC resistance on all ranges—generally from 10 to 20 megohms. The input for AC functions of the instrument is expressed in values of impedance—such and such resistance shunted by so many mmf of

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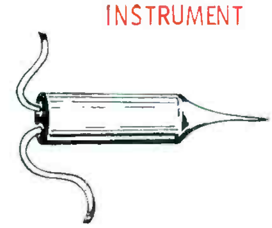
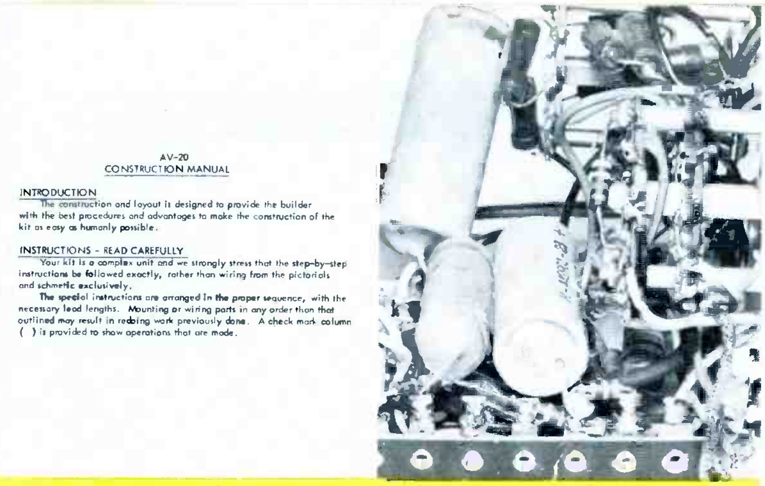
TEST EQUIPMENT AVAILABILITY CHART



MANUFACTURER / INSTRUMENT	Audio Generators	Capacitor Testers	Color Bar Generators	Oscilloscopes	Pattern Generators	RF Signal Generators	Sweep Generators	Transistor Testers	Tube Testers	VOM's	VTVM's
Aerovox		●									
Anchor									●[1]		●
Anko								●[2]	●		
Arkay	●[3]	●				●				●	●
B & K	●[4]	●[5]	●[4]		●[4]	●[4]		●	●	●	
Ballantine										●	●
Central Electronics									●[1]		
Cornell-Dubilier	●										●
Doss	●[6]										
Eby	●[6]							●[7]		●	
EICO	●	●[5]		●		●	●	●	●	●	●
General Cement								●[2]	●	●	
Hewlett-Packard	●			●		●	●			●	●
Hickok	●	●[5]	●	●	●	●	●	●	●	●	●
Jackson	●	●	●	●	●		●		●		●
Kay Electric						●	●				
Mercury		●[5]						●	●	●	
Motorola	●[6]							●			
Paco	●[3]	●		●		●		●	●	●	●
Precise	●[3]			●		●		●[2]	●		●
Precision Apparatus	●		●	●	●	●	●	●[2]	●	●	●
Precision Electronics											●
Pyramid		●									
RCA	●		●	●	●	●	●		●	●	●
Seco								●	●		●
SENCORE	●[6]							●	●		
Shell									●		
Simpson	●[3]	●	●	●	●		●	●[7]	●	●	●
Sprague		●									
Superior	●[3]	●[5]			●[4]	●[4]		●	●	●	●
Tektronix	●	●		●		●					
Triplett	●[3]		●	●	●	●	●	●	●	●	●
Waterman				●							
Weston									●	●	●
winston	●		●		●			●			

1 - Cathode-ray tubes only.
2 - Additional function of tube tester.
3 - Output from RF signal generator.
4 - Function of special instrument.
5 - Additional function of voltmeter.
6 - Noise or harmonic signal generator.
7 - Requires indicating device.



AV-20
CONSTRUCTION MANUAL

INTRODUCTION

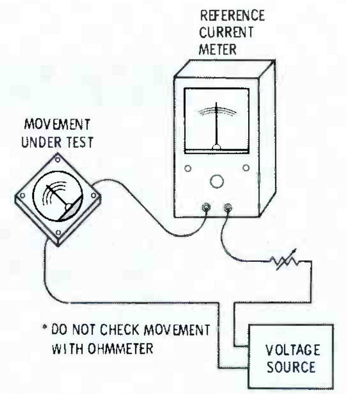
The construction and layout is designed to provide the builder with the best procedures and advantages to make the construction of the kit as easy as humanly possible.

INSTRUCTIONS – READ CAREFULLY

Your kit is a complex unit and we strongly stress that the step-by-step instructions be followed exactly, rather than wiring from the pictorials and schmetic exclusively.

The special instructions are arranged in the proper sequence, with the necessary lead lengths. Mounting or wiring parts in any order than that outlined may result in redoing work previously done. A check mark column ( ) is provided to show operations that are made.

Even if you've been repairing sets since you were knee-high to a portable, in the long run it's better to follow kit-building instructions step by step. It conserves time, makes work easier to check, and ultimately results in an accurate trustworthy instrument. Random wiring may lead to needless unsoldering and resoldering, or to errors that virtually beckon trouble. When parts are literally stacked in a confined area it's only logical to build from the bottom up.

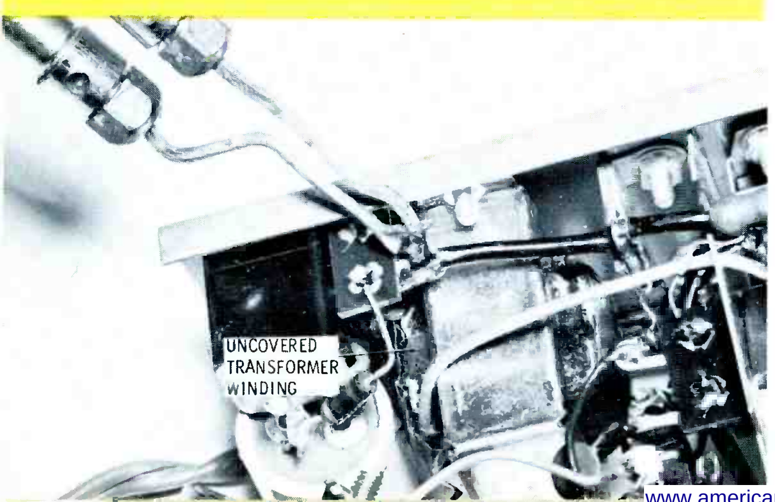


On any assembly line, parts are spot-checked before taking their places in the end product. When building a kit, you should be equally careful to inspect the individual components before wiring them together — it's easier than troubleshooting the completed unit! In addition to pretesting meter movements and switches, check for shorts and opens in transformers, controls, and other major components, and visually inspect all fragile parts.

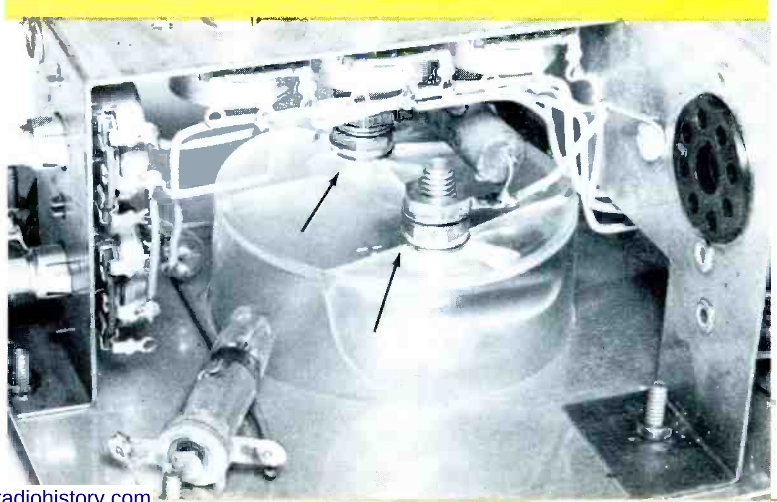
Now hear this — all would-be kit builders! Whether you've yet to construct your first kit, or you're an old hand at the game, this GI (general itinerary) on kit construction will help you do a better job of assembling test equipment kits.

The Professional

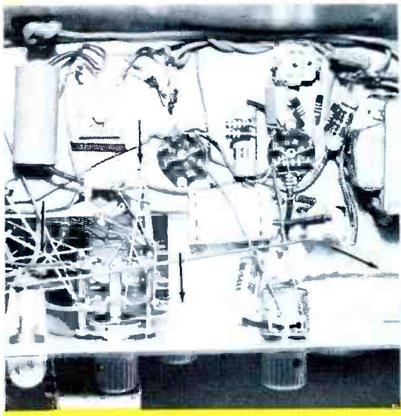
Kit builders sometimes come to grief by slighting these basic soldering principles in their hurry to finish: (1) All terminals and leads must be perfectly clean before soldering. (2) Never work above any part that can be damaged by drops of hot solder. (3) Use only the type of solder recommended; acid-core solder or paste flux may void the guarantee. (4) Solder individual connections according to instructions; in "mass-production" soldering, you might miss a few joints.



The cracked meter case shown in the photo vividly illustrates what can happen when you apply too much muscle in one of the mechanical steps of kit building. When crimping or tightening an object, bring it up snug (especially where an electrical connection is involved), but don't go beyond the point of firm contact. You can very easily strip threads, break a plastic case or housing, crack a knob held by a set screw, or damage a switch wafer, with "just one more turn."



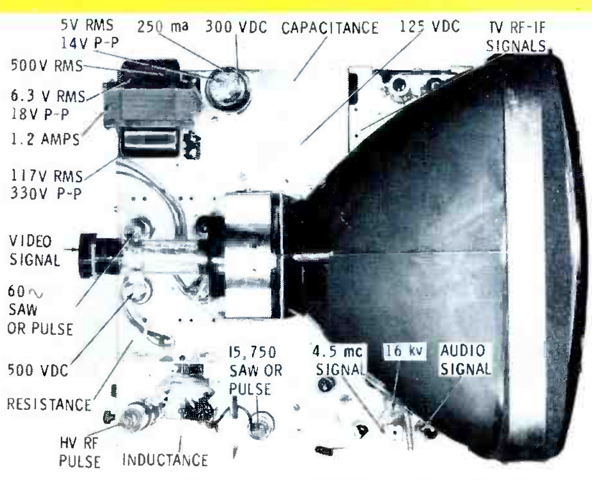
If you want to avoid a stubborn intermittent symptom after the kit is completed, remember to remove the enamel coating carefully from the ends of certain wires — such as the transformer leads shown here — before soldering. It's also advisable to tin these wires prior to making the physical connections. By the way, a pair of wire strippers is a big time-saver for removing the insulation from all hook-up wire in a kit.



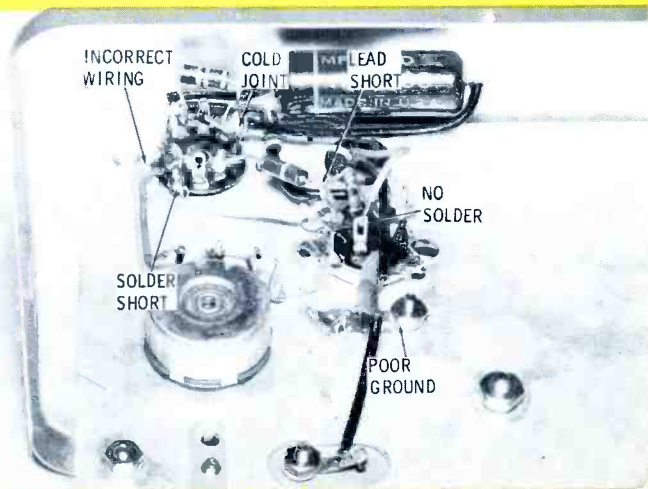
Every step in the construction procedure is important — and this includes cutting component leads to specified dimensions. Improperly-trimmed leads make it impossible to follow lead-dress or component-placement patterns. This may result in undue strain on a lead and terminal, overheating of a critical part, or undesirable stray coupling which may be responsible for parasitic oscillations, detuning, or degeneration in high-frequency circuits.

Touch in Kit Building

To test or calibrate a finished kit with complete accuracy, you may need special equipment; however, you can quickly check the performance of a newly-completed unit with the aid of some common, easy-to-obtain device such as a receiver. An ordinary AM or FM radio, for example, can be used to check a signal generator. The accompanying illustration calls your attention to the wide selection of signals, voltage sources, and other standards available in a typical TV chassis.



Regardless of how simple or insignificant a wiring step may seem, take your time and complete each operation accurately. In addition to avoiding the common errors pointed out here, be very careful not to overheat coax leads or printed wiring; also, make it a point to check continuity of test prods or cables, and be sure to observe the polarity markings on meter terminals, crystal diodes, capacitors, and solid-state rectifiers.



USING COMMUNICATIONS

These are the facilities you need for bench and field

With the rapid growth of private mobile communications systems, more and more service technicians are becoming interested in this fascinating and profitable field.

A typical two-way communications system is composed of a permanently-located base station, in addition to several mobile stations. The latter may be mounted in autos, trucks, planes, or boats, or may even consist of hand-carried portable equipment. Both types of stations usually include a crystal-controlled transmitter and receiver, although there are variations in antennas and power supplies to suit different requirements. The Federal Communications Commission requires that each transmitter be checked every six months by an FCC-licensed technician for proper frequency, modulation deviation, and input power to the final amplifier. In addition, these points must be checked each time any work is performed on the transmitter. Proper and legal servicing or checking of mobile radios requires specialized test instruments.

Frequency Meters

The actual operating frequency of a transmitter under test can be very accurately measured with a frequency meter. Some of these instruments incorporate a sensitive receiver which enables them to check transmitters from a remote location. Normally, however, the simpler heterodyne-type frequency meter is used. This type of meter must be placed reasonably close to the transmitter being tested, as shown in Fig. 1. A simple antenna picks up a sample of the transmitted signal and mixes it with a very stable, accurately-calibrated internal oscillator. The point is then found where the mixing of these two signals provides a zero beat or null; the meter dial reading is then noted, and the operating frequency of the transmitter is determined from a calibration chart supplied with the frequency meter.

Modulation Meters

Frequency-modulation meters are designed to indicate the amount of deviation of an FM signal, in terms of kilocycles above and below the center frequency. Some systems are limited to a maximum deviation of ±15 kc for 100% modulation, whereas many newer systems fall under a regulation which limits maximum deviation to only 5 kc. Certain manufacturers of communications test instruments combine a modulation meter and a frequency meter into one versatile instrument.

The modulation meter is an FM receiver specially designed to measure the peaks of deviation at the discriminator. Again, as in the case of the frequency meter, some of these instruments can be used at some distance from the transmitter being tested, while others must be used in close proximity (Fig. 1).

The first step in using a modulation meter is to adjust its discriminator for a zero indication while receiving an unmodulated signal from the transmitter. To measure modulation deviation, many technicians use a loud "ah-h-h" sound to modulate the transmitter via the microphone. The modulation level of the transmitter is then adjusted so that the deviation does not exceed the specified limit of 5 or 15 kc, no matter how loud the sound. A whistle is sometimes used, but this is not as satisfactory as the "ah-h-h."

Wattmeters

Two types of wattmeters are in general use—the terminating or load type, and the in-line or feed-through type. Either is very satisfactory for measuring output power of the transmitter, and the feed-through type also has certain other uses.

The terminating or load-type wattmeter is merely connected to the output of the transmitter via a short piece of transmission line. The instrument is designed to offer the proper load to the final amplifier stage for normal operation. When the transmitter is actuated, or keyed, output power is indicated directly on the wattmeter. Input power to the final stage can be approximated from this reading. Since efficiencies of about 50% can be expected at VHF, when the stage is properly adjusted, the input power will be approximately twice the output power.

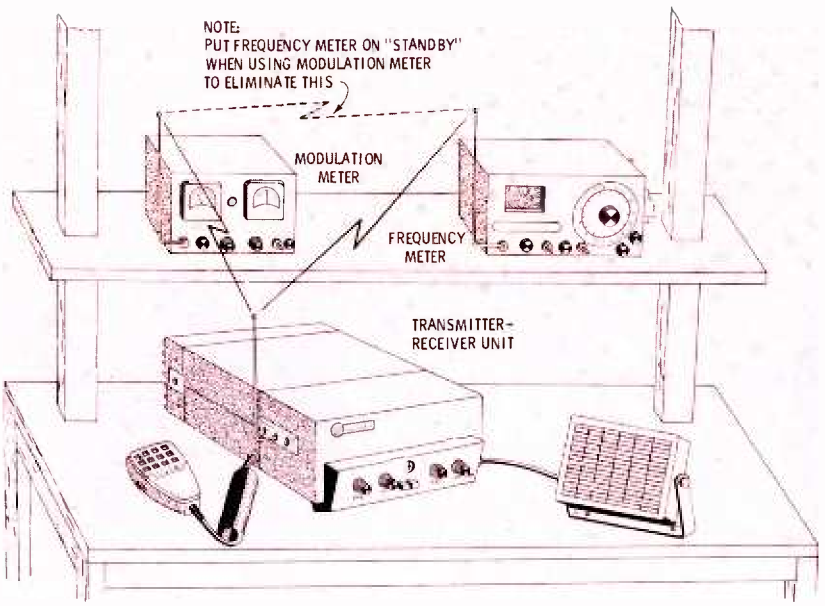


Fig. 1. Frequency and modulation meters pick up RF output of transmitter.

TEST EQUIPMENT

testing of two-way mobile radios . . . by Forest Belt

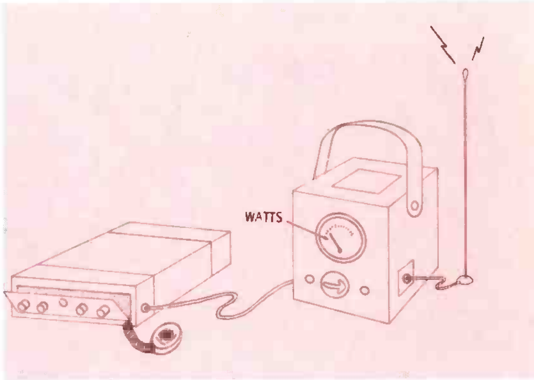


Fig. 2. An in-line wattmeter connected in series with transmitter antenna.

To use the feed-through type of wattmeter, a suitable external load must be provided. The wattmeter is connected as in Fig. 2 by using a piece of transmission line from the transmitter to the instrument, and another length of transmission line from the wattmeter to the load. Either a dummy load or the system antenna can be used, but the latter is preferable.

Notice that the in-line wattmeter has a provision for reading power in either direction. By choosing the proper direction of reading, it is possible to measure the power being sent to the load by the transmitter, or the power reflected from the load back toward the transmitter. In case the load is the system antenna and transmission line, this reflected-power reading would indicate power being generated, but not being radiated into space. This can be translated into a standing-wave ratio for technicians more familiar with that term; at any rate, the reflected-power reading is useful in measuring the efficiency of the antenna system. It is interesting to note that a defective transmission line would give a reading of almost the same power in both directions; on the other hand, a broken antenna element would cause only some reduction in reverse reading.

The reflected-power meter is similar to the in-line wattmeter. The difference lies in the fact that the reflected-power meter is not calibrated in watts, but relies upon relative readings. The instrument is connected the same as the in-line wattmeter of Fig. 2. The selector is set to read forward power, or that going from the transmitter to the antenna. The sensitivity control is adjusted to bring the meter needle to some reference point, such as a line marked "100%." The selector is then set for a reverse or reflected-power reading, and the meter deflection shows the percentage of available power which is not being radiated by the antenna. Some of these instruments are calibrated directly in terms of standing-wave ratio.

These measurements can be made in other ways, and with more accurate results in some cases, but the aforementioned methods are simpler and much quicker from a practical standpoint.

Signal Generators

A typical VHF communications receiver (see block diagram, Fig. 3) uses a double superheterodyne circuit. The incoming signal is converted to a first intermediate frequency of 5.5 mc and then mixed with a second oscillator signal to create a second IF of 455 kc. Double conversion is used for two important reasons: First, because it gives the set better selectivity and image rejection, and second, because the bandwidth of the set is more easily controlled at 455 kc than at higher frequencies.

Obviously, a stable RF generator capable of covering both intermediate frequencies is needed for servicing communications receivers. A good-quality generator such as used for radio servicing will suffice if the frequency calibrations in the vicinity of 455 kc are accurate. A frequency range of 100 kc to 10 mc is ample for this generator—accuracy is its most important requirement.

One of the more important uses for the RF generator is to permit calibration of the receiver discriminator. When an accurate 455-kc signal is injected at point A in Fig. 3, the discriminator output at point C must read exactly zero volts. This alignment affects all other frequency adjustments, so it must be made accurately and carefully. While the generator is hooked to point A, the second IF and limiter stages can also be aligned.

One fundamental requirement of a communications receiver is extremely good sensitivity—often 0.5 microvolt or better. Sensitivity is measured by determining the amount of receiver-input signal which will provide 20-db quieting of the inherent circuit noise in the receiver. This job requires a special signal generator with the following qualifica-

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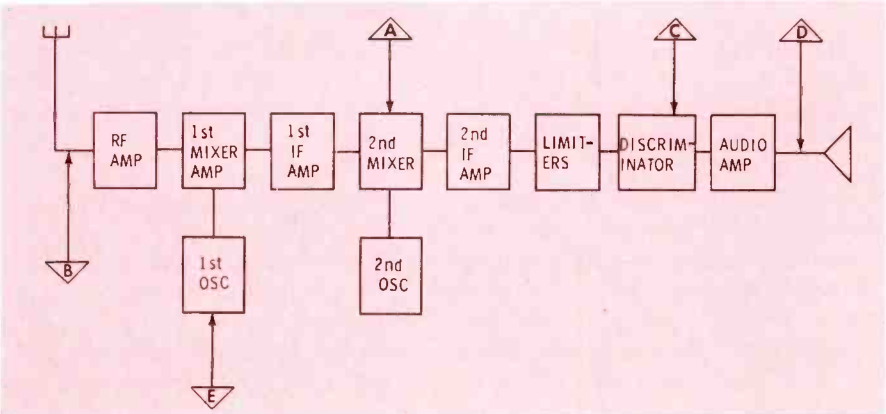
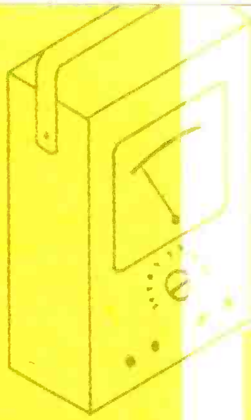


Fig. 3. FM mobile communications receiver of double superheterodyne type.

Shop Talk

By Marvin Tepper



Getting the most from your VTVM

The VTVM is one of the first test instruments a serviceman learns to operate, and he soon reaches the point where he feels "lost" without it. Paradoxically, this familiarity may tend to limit the usefulness of the meter. Many servicemen continue to use the test procedures they learned as novices, without ever getting around to explore the further capabilities of their VTVM's; also, in many cases, they are not sure what to do about a VTVM that "goes on the blink." Better and more effective use of this instrument can be achieved by simply gaining a clearer understanding of its inner workings.

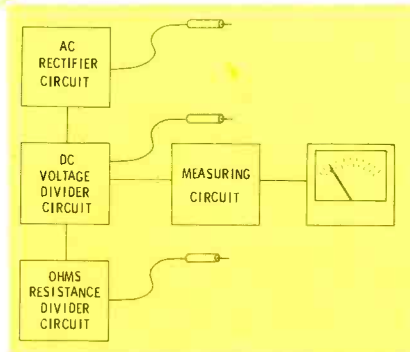


Fig. 1. DC voltage is fed to VTVM measuring circuit for all functions.

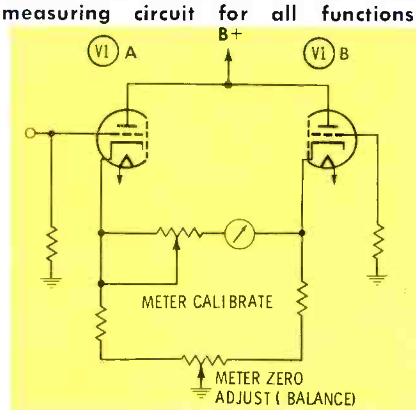


Fig. 2. Basic measuring circuit uses the balanced sections of twin triode.

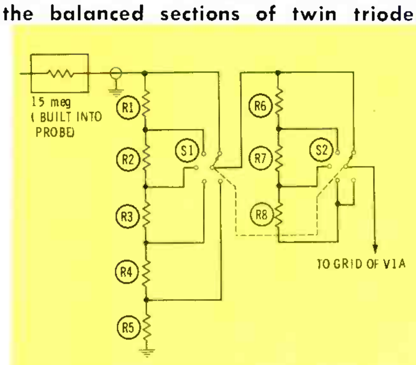


Fig. 3. Switching S1A to lower tap places meter on higher DC range.

Basic Measuring Circuit

The block diagram of a typical VTVM circuit is shown in Fig. 1. Discussing the circuits of the instrument one block at a time will make it easier for you to understand each individual one.

The basic measuring circuit used in many meters is shown in Fig. 2. Applying a negative-going signal to the grid of V1A will cause the plate current of this tube section to decrease, resulting in a reduced voltage drop across the cathode resistor. This places the cathode of V1A at a lower potential than that of V1B, and current then flows from the cathode of V1A through the meter to the cathode of V1B. The circuit is usually designed so that a current of 1 ma will produce full-scale deflection. A potentiometer is inserted in series with the meter to limit the current to 1 ma for calibration purposes. Individual calibration controls are used for each measuring block—AC, DC, and ohms. In addition to the calibration controls, a potentiometer is inserted in series with the two cathode resistors to permit accurate balancing of the circuit. By moving the control arm, the value of cathode resistance for each tube is varied until the cathode voltages are exactly equal. With each cathode at the same potential, no current will flow through the meter, and it will read zero. To insure that the current through the meter will be in the proper direction, a polarity-reversing switch is included as part of the front-panel function-selector switch (+DC and –DC voltage positions).

DC Voltage Divider

The DC voltage-divider circuit is shown in Fig. 3. The voltage is applied through a 15-megohm isolating resistor and is developed across a string of resistors, R1 through R5. With the range switch set to the lowest value, the total voltage developed across the string of resistors is applied directly to the grid of V1A in the measuring circuit.

As the arm of range switch S1A is moved closer to ground, the meter range will be increased by the voltage-divider action of R1 through R5. Since the resistance from the arm of S1A to ground is lowered, S1B inserts series resistors to maintain a constant input impedance to V1. There will be no voltage drop across R6, R7, and R8, since there is no current flow in the grid circuit of V1A.

AC Rectifier Circuit

The AC rectifier circuit is shown in Fig. 4. The use of a single diode

• *Please turn to page 69*

Table I — VTVM Trouble Analysis

Measuring-Circuit and General Problems

SYMPTOM	CORRECTION PROCEDURE
Pilot light is not lit; instrument does not operate.	Check line cord for breaks, especially at plug. Test on-off switch and power-transformer primary for continuity.
Intermittent operation.	Look for faulty ground return of probes, bad switch contacts, defective solder connections, or bad tubes. On kit using solid hook-up wire, flexing may have caused wire to break inside insulation; use insulated probe to ferret out this problem by probing at wires.
Tubes and pilot light are lit, but instrument does not operate.	Examine for continuity of ground or common circuit inside instrument. Check for defective tubes or meter movement. Inspect all test leads for open circuit. Measure voltages to be sure they are present and correct.
Meter pointer sticking.	Examine meter movement when out of case; if pointer still sticks, bearings are probably defective, or coil may be rubbing on pole piece or magnet. If pointer is rubbing against case, bend **carefully** away from obstruction.
Meter pointer is "pegging" left or right.	Check for intermittent switch contacts. Test tube in measuring circuit, and check continuity of both grid circuits; open condition in either one will peg meter.
Inaccurate voltage readings on both AC and DC.	Examine DC voltage-divider network for correct resistor values.

DC Voltage-Divider Circuit

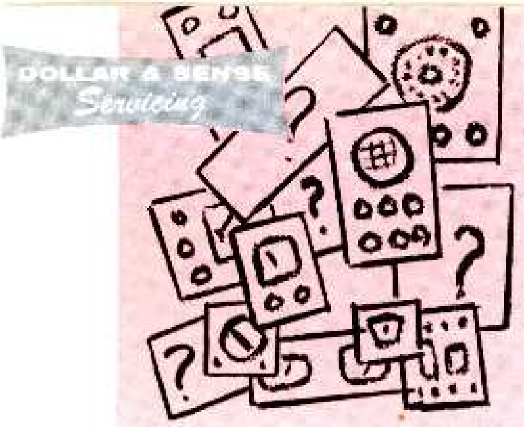
SYMPTOM	CORRECTION PROCEDURE
Instrument operates normally on one polarity setting of function switch, but is inoperative on other polarity setting.	Check for open switch contact, or for open circuit in + or – DC-calibrating potentiometers.
Instrument does not operate on DC, but operates normally on AC and ohms.	Check for open DC probe lead, isolating resistor, switch contact, or ground-return circuit.
Inaccurate readings of DC voltages, but accurate AC readings.	Recalibrate + and – DC-calibrating potentiometers as directed in instrument manual. Check for changed value of isolation resistor in DC probe.

AC Rectifier Circuit

SYMPTOM	CORRECTION PROCEDURE
Meter-pointer setting varies to large extent from zero as range switch is changed.	Test AC-rectifier and measuring-circuit tubes. Check resistance values of AC-zero potentiometer and contact-potential bucking circuit. Recalibrate AC voltmeter circuit as directed in instrument manual.
Inaccurate readings of AC voltages, but accurate DC readings.	Test AC-rectifier and measuring-circuit tubes. Examine range switch for poor contact, or for leakage in areas of salt water or high humidity. Test contact-potential bucking resistors for changed values. Check for defective input coupling or bypass capacitors.
Inaccurate readings of AC voltage, but normal operation on DC and ohms.	Check for open circuit in function switch or in AC zero-adjust potentiometer, and for defective AC-rectifier tube.

Ohms Circuit

SYMPTOM	CORRECTION PROCEDURE
Ohms-adjust control cannot place pointer at maximum reading.	Check for weak battery or cell, defective ohms-adjust potentiometer, or bad tube in measuring circuit.
Need for frequent retouching of ohms-adjust setting as range switch is turned.	Test measuring-circuit tube for gas. In areas of salt water or high humidity, check for leakage between switch contacts.
Ohms function inoperative, but instrument gives normal AC and DC voltage readings.	Check for disconnected or dead battery or cell, bad contact on function switch, or open circuit in resistance-divider network.
Inaccurate resistance readings.	See if divider resistor has changed value; this may result from erroneous application of voltage while instrument is set to read ohms.



Do you *really* have the TEST EQUIPMENT you need?

by Joe A. Groves

The "screwdriver mechanic" is on his way out. This means, among other things, that to succeed, you must be more competent, more efficient, more dependable than your competitor down the street. The public is impressed by professionalism, and a good part of being professional is not only knowing *how* to do the job, but having the equipment to do it quickly and efficiently, at a competitive price.

Having the right equipment is therefore a means to an end. However, there's no sense spending good money for instruments that will only stand idle in some remote corner of the shop! Even the most elaborate array of equipment is nothing more than display material when you don't know when or how to use it. By the same token, a good technical man's performance is limited without the proper equipment. What, then, are the test instruments you need? The answer, of course, depends on what you service, and to some extent on the volume of work you handle. Since TV servicing represents the largest single source of revenue for most independent shops, let's concentrate on this area.

There is no question that the scope, VTVM and VOM, and sweep and marker generators are considered as the basic TV servicing instruments. A scope is necessary for making alignment checks and analyzing signal waveforms. And even though more modern instruments such as signal-substitution units often provide a more efficient means of isolating troubles, there are numerous occasions where a scope either becomes a downright necessity or provides a more accurate analysis.

Without a doubt, VTVM's and VOM's are absolute musts for every TV bench. As a matter of fact, most circuit troubles could not be analyzed without the use of one or both of these instruments. Usually, they are the ones most relied upon to isolate troubles to specific components. In addition, they are the only instruments needed for many of the simpler jobs.

Sweep and marker generators, on the other hand, are generally needed only for alignment work, although they can be very helpful in signal-tracing RF, IF, video, AGC, and sound troubles. Marker-adder units, while not absolutely essential, help increase efficiency and accuracy of alignment checks and adjustments.

While tube testers were not mentioned above in the category of basic instruments, any first-rate service shop should be able to boast of owning at least one. In fact, the public practically demands that you own one—having been exposed to the idea of "drug-store" testing. Thus, the customer-conscious serviceman not only invites consumers to come to *him* for free tube testing, but also uses a portable tester on home calls to prove the necessity for tube replacements. In the eyes of his customers, this man is "professional" *because he is equipped to do the job.*

At this point, some of you may feel that if you had *just* the instruments mentioned thus far, you'd be equipped to tackle any TV service job that might come along. If so, what will you do when you want to observe an RF or IF signal, and find yourself in need of a demodulator probe? And what about the other probes needed for accurate voltage measurements in high-impedance, low-capacitance, and high-voltage circuits? If you're earnestly in the TV service business, you'll need them, also. Furthermore, you'll find that other instruments such as capacitor testers, circuit analyzers, signal- and component-substitution units, and bias-voltage supplies can help you turn out more work in less time. If you make antenna installations, a field-strength meter is often helpful in selecting the proper site. You can also use it to check the attenuation in lead-in wire or cable, and to troubleshoot master antenna systems.

You say you have all this equipment? Wonderful! If you know how to use it efficiently, you *really* have all you need—for servicing black-and-white TV sets, at least. Being so well equipped, however, you've no doubt received at least a few requests to service color TV sets—and as an expert, you didn't turn them down (we hope). If you've handled more than just a few, you learned of the necessity for some specialized equipment. Dot or crosshatch pattern generators are essential for making convergence adjustments; color-bar generators provide needed test signals for checking color-reproduction problems, and special scope probes and preamplifiers are sometimes necessary for troubleshooting chrominance circuits. Degaussing coils, while not considered test instruments in the strictest sense, are a must for correcting color-purity problems.

Now, how about radio servicing? Perhaps you'd rather not bother with it, but if you don't you stand a good chance of losing a lot of your regular TV customers. (Who ever heard of an expert TV serviceman who couldn't fix a "li'l ol' radio"?) Table models, transistor portables, AM-FM combos, clock and auto radios . . . what next will the man who claims to be a TV expert be servicing? Fortunately, some of your basic TV servicing instruments—VTVM or VOM, tube tester, and

• *Please turn to page 38*

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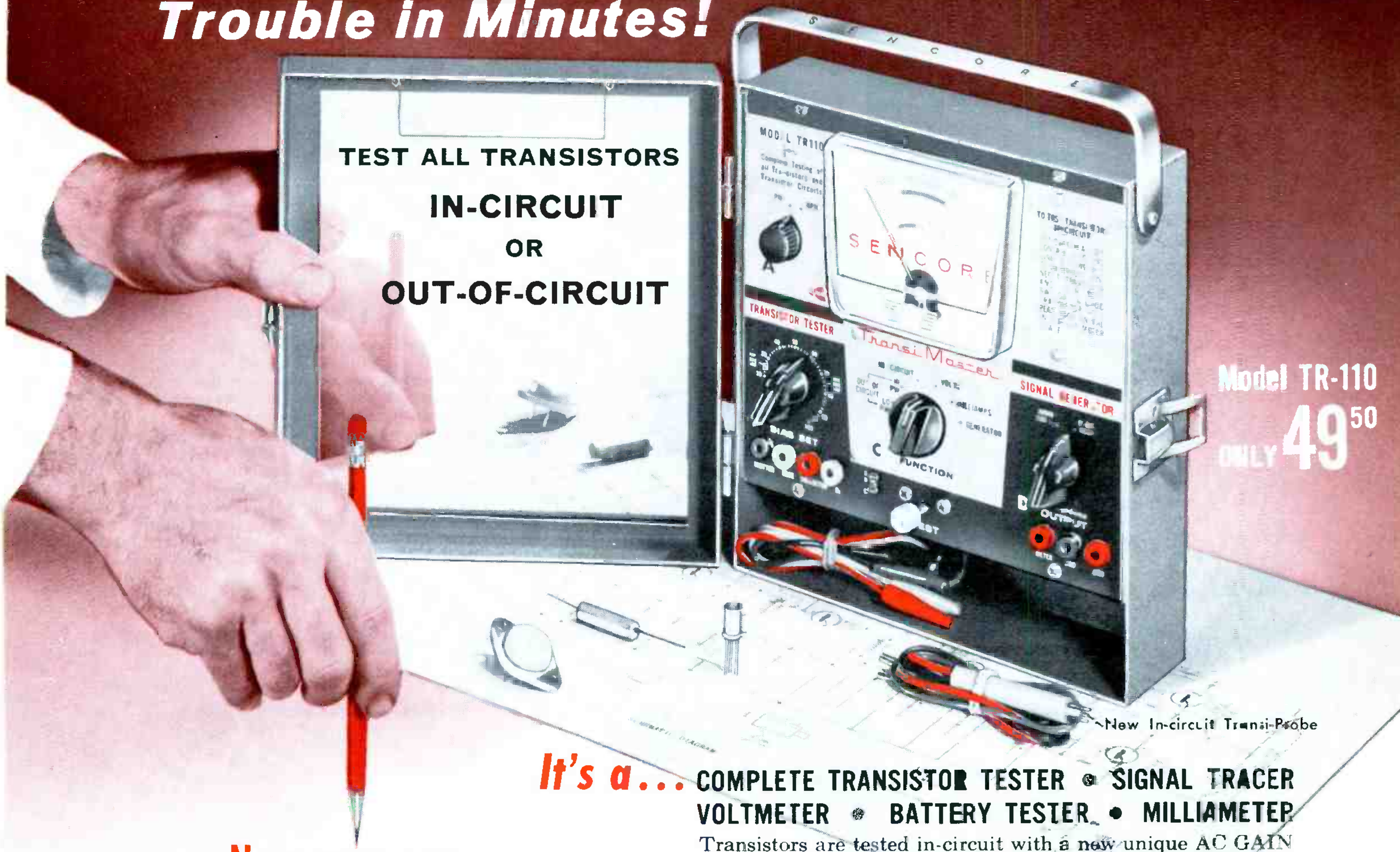

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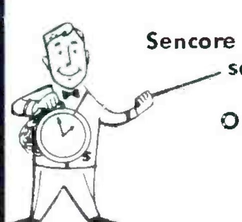

Sencore Sam says, "You'll save hours servicing transistor circuits. Only 49.50, see it at your distributor."

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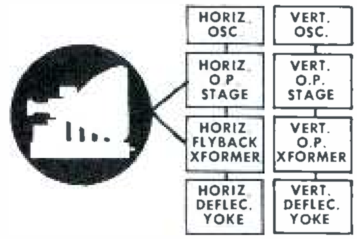

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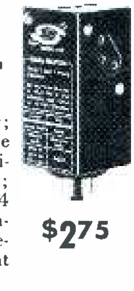

Plugs into any tube checker; ideal for use with LC3 or the Mighty Mite. To check 6v. vibrators, set for 6AX4 or 6SN7; for 12 v. vibrators, set for 12AX4 or 12SN7. Two No. 51 lamps indicate whether vibrator needs replacing. Instructions on front panel. Steel case.

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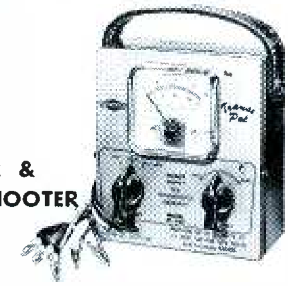

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Replaces Batteries During Repair . . . Replaces batteries during repair time of transistor radios and helps trouble shoot, too. For transistor radio servicing, experimenting and to charge nickel cadmium batteries. Dial output voltage from 0 to 24 volts DC and read on meter. Low ripple insures no hum or feedback problem. Meter reads from 0 to 100 MA. Shorted stage will cause current to read high as indicated on PF schematics; open stage will cause current to read low. To align transistor radio, tune in station signal and adjust IF slugs for maximum current. The PS103 is the only supply that will operate radios with tapped battery supplies; such as Philco, Sylvania, Motorola, etc.

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Substitute for Electrolytic Capacitors . . . Complete, safe substitution . . . from the smallest electrolytics used in transistor radios to the largest used in costly Hi-Fi amplifiers. Contains 10 electrolytics from 4 to 350 mfd. Select correct value with the flick of a switch. Features automatic discharge, surge protector circuit. Prevents accidental "healing" of capacitor being bridged. Completely safe—no arc or spark when connecting or disconnecting. Usable from 2 to 450 volts, DC.

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RECTIFIER TROUBLE-SHOOTER

$12.75

Locate faulty Rectifiers, Diodes . . . This unique substitution unit simplifies trouble shooting rectifiers and diodes, gives you a positive check every time. Substitute for suspected rectifier or diode, watch picture or listen to sound and you'll know in seconds whether or not the rectifier or diode should be replaced. No guess work, soldering mess or time lost. The RS106 costs less than having loose rectifiers and diodes in the shop for testing and is worth many times more. A must for servicing voltage doubler circuits. Protected by a ½ amp. Slow Blow Fuse.

All 3 Time Savers shown above in handsome display carton carrying case

MODEL SL108

$41.45

SENCORE BE3 "ALIGN-O-PAK"

Eliminates messy batteries in TV service work. Handy for alignment, AGC trouble-shooting or checking gated sync circuits. Dial the voltage you need, 0-18 volts, positive or negative. Completely isolated DC supply, less than 0.1% ripple. Covers all voltages recommended by TV set manufacturers and in Photo Fact schematics For 110-120V, 60 cycle AC.

$7.85

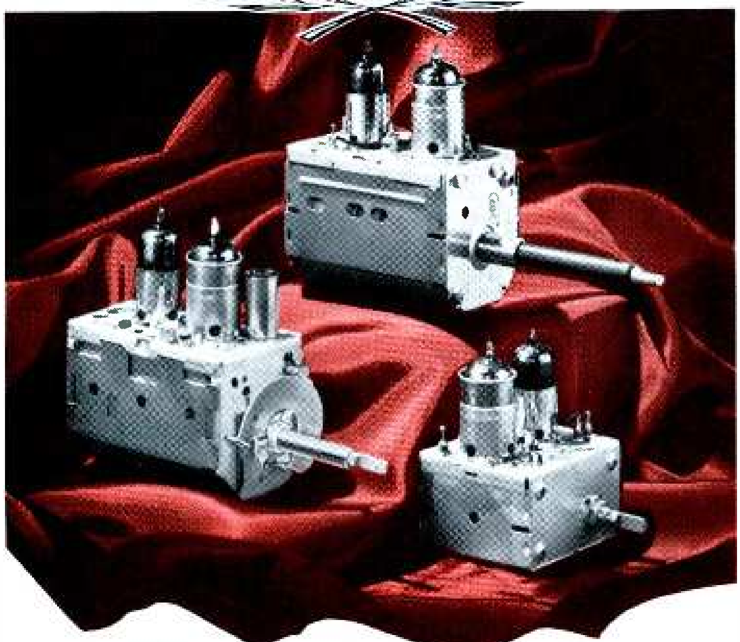
See your Parts Distributor

NEW! POWER RESISTOR SUBSTITUTION SENCORE BIG 20 MODEL PR111

For all resistors up to 20 watts from 2.5 to 15,000 ohms. Covers all power resistors encountered in Radio, Hi-Fi and TV circuitry.

$12.75

Substitute for all questionable power resistors; determine values of burned out 2 and 4 watt carbon resistors, wire wound potentiometers, fuse resistors and resistor value in a hundred and one places in servicing and engineering. A great time saver in restoring circuit to normal fast so that you find the actual defective component. Each resistor stands up to 20 watts normal testing time. The Big 20 pays for itself the first month in time saved.



Test Equipment You Need

(Continued from page 34)

signal generator (if it has audio and broadcast-band IF frequencies)—will stand you in fairly good stead. But, of course, you'll soon find yourself in need of a transistor tester, and there's not much sense in tackling an auto radio without a DC supply to power it. If your TV signal generator doesn't supply the proper IF and audio signals, and you're not ready to invest in one that does, your best bet is to buy an inexpensive harmonic generator for signal-tracing purposes.

As long as you've gone this far, you might as well consider taking on some hi-fi work. If you do, however, go after all the business you can to support the required investment in equipment. Sensitive AC VTVM's, sine- and square-wave generators, and harmonic- and intermodulation-distortion analyzers are the major additional instruments you'll need. Special strobe discs, head demagnetizers, gram scales, and test records and tapes are accessories that will serve you well in phonograph and tape-recorder work.

Many radio-TV-electronics service dealers add small appliances to the list of services they render. Much of the troubleshooting can be handled with no more than a VOM, but wattmeters, special thermal indicators, and continuity testers are also helpful in tracking down certain troubles and making adjustments.

Where do we go from here? Well, if you have all the instruments described in this brief resume, you *really* have what you need for servicing home electronics equipment. But this doesn't preclude the necessity for additional instruments in time to come—especially if you decide to expand your services into industrial or communications work. But even if you don't, tomorrow's receivers may require the use of test instruments as yet not even on the drawing board, and who knows what unique and more efficient instruments will be developed for your benefit?

In the electronics service business, acquiring new and additional test equipment is a never-ending process. The man who acquires his equipment wisely, and learns how to use it most efficiently, is well on his way to success. ▲

SYLVANIA 6SN7GTB
with 3-point plate support "builds up" your PROFIT PICTURE

Sylvania extras mean built-in stability, higher performance and extra-long life – profit-protection for you!

Take, for instance, the new structure that supports each plate at three points to substantially reduce microphonics. Or consider how the triode sections are obliquely mounted to reduce catastrophic failure of both sections due to physical shock. Too, Sylvania 6SN7GTB's are built with specially treated micas to reduce interelement leakage; extra-clean welds to cut down on the possibilities of internal shorts.

The technique of grid mounting plus the use of selected alloys for support provides excellent heat dissipation, increased tube reliability. *All this plus:*

- Sylvania "Automount" construction for precise, tight, uniform assembling of tube elements
- a "batch" of 100% tests to assure tube quality
- tapered pins for fast servicing.

The Sylvania profit "build-up" can work for you. Next time you replace a defective 6SN7GTB, make sure it's with a new . . . superior . . . Sylvania 6SN7GTB. Order them today from your local Sylvania tube distributor.

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SYLVANIA

Subsidiary of **GENERAL TELEPHONE & ELECTRONICS**

The Electronic Scanner

Now It's Official

Sencore, a trade name which has become well known throughout the industry, also officially became the name of the company recently. President **Herb Bowden,** at the firm's annual sales meeting, said that the change from Service Instruments Corp. to **Sencore, Inc.** provided better identification between the company and its products, and eliminated confusion between "like sounding" names in the industry. The sales meeting in itself was unique in that manufacturer's representatives for the company went through a 3-day program on TV and radio servicing. Purpose of the seminar, held in the new 10,000 square foot addition to the plant, was to school the reps on how to help the distributor help the service dealers with their technical problems.

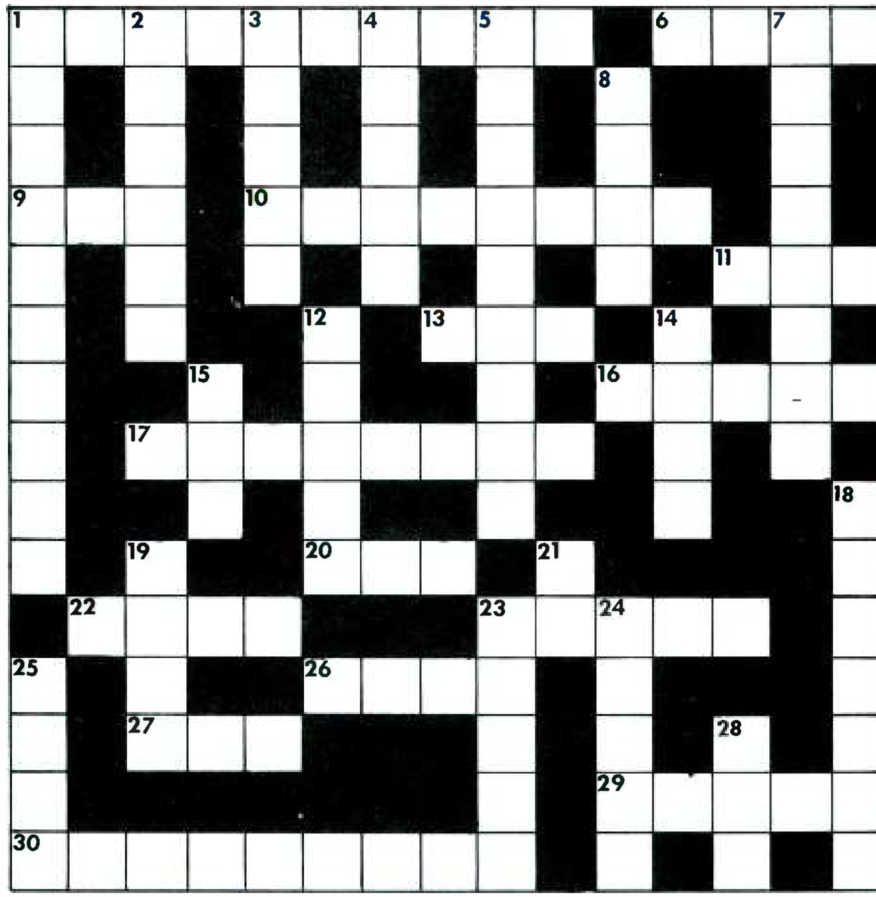
Test Equipment Trolley

Received the accompanying photo at press time from **Fred Voorhaar** at **TACO,** who felt our readers would be interested in the unique arrangement of bench test equipment in use at **Nick's Electronic Service,** Alta Vista, Va. If you can take your eyes off the **TACO** antenna being demonstrated by **Jerry White,** you'll notice that all the test instruments have been mounted in a rack which is suspended from an overhead trolley. This arrangement permits the equipment to be moved from one bench position to another with an easy pull on the rope. **Ford Nichols,** owner of the shop, is shown at left center, and **J. Pratt Winston,** distributor salesman, is at the far left. Not only is the idea good, but it's a natural for this special test equipment issue!

Esprit de Corps

For the first time in the nine-year history of the **General Electric** sponsored Edison Radio Amateur Award, given for outstanding public service, was won jointly by two "hams." It is also the first time the award has been made for scientific achievement. Winners **John T. Chambers,** W6NLZ, and **Ralph E. Thomas,** KH6UK, (right and center, respectively) are shown receiving their trophies from **L. Berkley Davis, General Electric** vice-president. The two radio amateurs were chosen on the basis of their experiments with tropospheric ducting radio propagation phenomena, culminating in a communications distance record of 2540 miles on the 432-mc band. Special citations were also granted to **Francis Ireland,** K4UUO, and **Albert Parker,** W4BAW, for outstanding service during the Hurricane Donna communications emergency; **Cesare Cavadini,** W6GYH, for message relaying on behalf of service personnel in the Far East; **Donald Johnson,** W6QIE, for educational services to novices and for leadership in organizing CD communications; and **Harry Phillips, Jr.,** W6CKV, for leadership in message handling despite a serious physical handicap. The judges further agreed that **Mario Lagos,** CE7BC, should receive special commendation for emergency communications operations during the Chilean earthquake disaster.

Test-Equipment Crossword Puzzle



ACROSS

1. Type of TV test pattern resembling wire screen.
6. The metal point of a test lead.
9. An intermediate connecting point.
10. Polarity of ungrounded lead from AGC bias box.
11. Common shape for tip of alignment tool.
13. Abbreviation for cathode-ray oscilloscope.
16. An electrical measuring instrument.
17. A mechanism used in a meter.
20. Visible marker signal.
22. A lamp used in tube testers for the purpose of indicating shorts.
23. Many test instruments are________for overload protection.
26. Each time you change VTVM ranges, ________ the meter.
27. A grid- ________ oscillator is used in some wavemeters.
29. A test-instrument accessory.
30. Figures observed on an oscilloscope screen when signals are applied to both horizontal and vertical inputs.

DOWN

1. An ohmmeter is useful in making ______ checks.
2. In some alignment setups, VTVM's are used as ______ indicators.
3. Resistor used to multiply range of a meter.
4. To bring circuits into tune.
5. Control you would adjust to position a waveform on a scope screen.
7. A resistance-measuring instrument.
8. Abbreviation for a voltmeter using vacuum tubes.
12. A special type of signal generator.
14. Maximum instantaneous value of an AC voltage.
15. Volt-ohmmeter (abbr.).
18. The indicating needle of a meter.
19. A wire supplied with a test instrument.
21. A type of meter calibrated to read audio-frequency power levels.
23. The oscilloscope control that regulates electron-beam spot size.
24. Short for oscilloscope.
25. A ______ occurs when the meter indication dips to zero.
28. Type of color-TV test pattern.

(Solution on page 68)

QUICKER SERVICING

WHAT? A Wattmeter for TV Servicing?

A simple wattmeter can be a very useful and effective test instrument in the hands of a skilled serviceman. Sporting no test leads or knobs to confuse the customer, it can serve as a powerful public-relations weapon to prove your wizardry as a TV technician. Imagine your customer's amazement when you pinpoint a trouble without ever removing the back of the set. You can do it! If you hit the nail on the head, play it up big. If you come close, say so. If you miss the boat, skip it and *get some more practice!*

Of course, you must be a master at interpreting wattmeter readings if you're to prove your magical skills; it's no game for a novice. If you really know your way around a TV, though, it's a simpler, faster trouble-shooting technique than you may imagine.

Successful application of this technique depends on a thorough understanding of the power requirements of various circuits in a TV. First, you must be reasonably well versed regarding the normal power consumption of various receivers. Normally, a set will draw from 150 to 300 watts, depending on size. A 12-tube set with a 70° or 90° sweep circuit will draw around 150 watts. Another 12-tube set with 110° sweep will consume about 200 watts, and larger sets with 17 to 20 tubes and 114° deflection will use close to 300 watts.

The wattage rating may be indicated on the back cover, or if you can check the service data for the set, this will give you the exact wattage requirements. If you have no indication of what the total wattage should be, you're flying by the seat of your pants. In this case, you'd better remove the back cover and get some idea of what kind of a chassis you're up against before making the initial analysis. Once you know what the total wattage should be, you can apply your knowledge of power distribution to the reading obtained with the wattmeter, and be well on your way toward tracking down the trouble.

Figuring the Percentages

Fig. 1 shows that the AC power (to filaments) accounts for approximately 50% of the total wattage, and DC power (B+) accounts for the other 50%. Expressing the DC-power requirements of specific circuits in relation to total wattage gives us some rather unwieldy percentage figures, so it is easier to divide the rated power in half and think of individual circuit requirements as proportions of the DC-power drain only.

Taking a closer look at Fig. 1, we see that the three power-output stages consume two-thirds of the DC power. The horizontal output stage accounts for one-third, while the vertical and audio output circuits each consume roughly one-sixth of the total DC power. The vertical circuit holds a slight edge, except in those receivers where the audio output stage also serves as a voltage divider. In these cases, the situation reverses, and the audio output draws roughly one-fourth of the DC power. The rest is pretty evenly distributed among the remaining circuits.

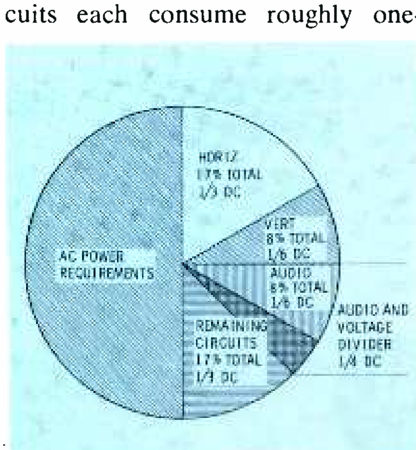


Fig. 1. Proportions of total wattage required by different TV circuits.

Putting the Facts to Work

Just what's the use of all of these percentages? Well, let's connect up the wattmeter and see what we can learn from some typical examples.

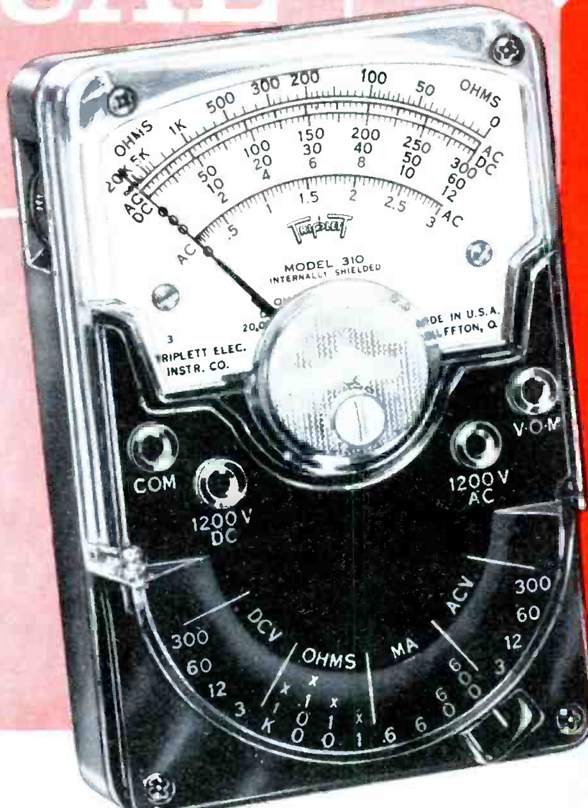
Suppose the wattmeter pointer leaps, quivers, and falls back to zero when the set is first turned on. You can, with authority, announce to the customer that he has a burned-out tube—and you can tell him so within 15 seconds after turning on the switch.

Here's why you can be so sure. This particular symptom is peculiar to series-string sets in which the filament circuit has opened. The instantaneous swing of the needle shows that the switch is OK, and that AC current is surging through the rectifiers to charge the B+ filters. But with no filament current, the tubes do not conduct, and there is no drain on the B+ supply. Therefore, as soon as the filters have become charged, the wattmeter returns to zero. Simple, huh?

Before going any farther, let's consider what a wattmeter will show when a normally-operating set is first turned on. Generally, the initial surge of current will produce an instantaneous reading of from 500 to 1500 watts. The meter will quickly drop to an indication of 70 to 100 watts and slowly creep up until just

TRIPLETT

ACTUAL SIZE



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VOLT-OHM-MILLIAMMETER

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POCKET SIZE V-O-M

FEATURES:

1 Hand size and lightweight, but with the features of a full-size V-O-M.

2 20,000 ohms per volt DC; 5,000 AC.

3 EXCLUSIVE SINGLE SELECTOR SWITCH speeds circuit and range settings. The first miniature V-O-M with this exclusive feature for quick, fool-proof selection of all ranges.

SELF-SHIELDED Bar-Ring instrument; permits checking in strong magnetic fields • Fitting interchangeable test prod tip into top of tester makes it the common probe, thereby freeing one hand • UNBREAKABLE plastic meter window • BANANA-TYPE JACKS—positive connection and long life.

■ Price—only **$34.50;** leather case **$3.20.**

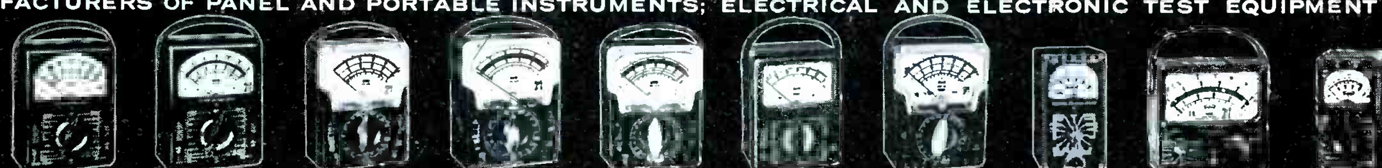
Available For Immediate Delivery From Your Triplett Distributor's Stock

MODEL 100

The most comprehensive test set in the Triplett line is Model 100 V-O-M Clamp-On-Ammeter Kit, now available at distributors. The world's most versatile instrument—**a complete accurate V-O-M plus a clamp-on-ammeter** with which you can take measurements without stripping the wires. Handsome, triple-purpose carton holds and displays all the components: Model 310 miniaturized V-O-M, Model 10 Clamp-On-Ammeter, Model 101 Line Separator, No. 311 Extension leads, and a leather carrying case, which neatly accommodates all the components. Model 101 literally makes it possible to separate the two sides of the line when using Model 10. Extension leads permit use of Model 10 at a distance from the V-O-M. Complete Model 100 is only **$59.50**

THE TRIPLETT ELECTRICAL INSTRUMENT COMPANY, BLUFFTON, OHIO

MANUFACTURERS OF PANEL AND PORTABLE INSTRUMENTS; ELECTRICAL AND ELECTRONIC TEST EQUIPMENT



630 630-A 630-PL 630-APL 630-NA 630-T 631 666-HH 625-NA 666-R

FOR EVERY PURPOSE—THE WORLD'S MOST COMPLETE LINE OF V-O-M'S before the instant the raster appears. Then, as the horizontal circuit begins to operate, the wattage will rapidly climb to its normal value.

A few exceptions to this normal behavior must be noted. For one thing, transformerless sets equipped with silicon rectifiers will have greater initial surge currents as a result of the low forward resistance of the rectifiers. On the other hand, chassis employing temperature-compensating resistors for controlled tube warm-up will have a much lower initial surge, and a more gradual rise toward normal drain. Receivers which incorporate a delayed B+ circuit will also show lower "drop-back" wattage levels; when the delay device "kicks in," a pronounced rise in the wattage indication will be noticed.

Now, let's see how we can put this knowledge to work. We have already cited an example of an open filament in a transformerless set, but suppose the tubes are OK, and the trouble is somewhere in the B+ circuit.

Open B+ protective devices, rectifiers, and filters result in a lower initial surge of power, and after the reading has stabilized, the total consumption will be about half the normal value. When you obtain an indication such as this, you can tell the customer he has power-supply troubles—in a matter of seconds.

Excessive B+ drain, on the other hand, will cause the wattmeter reading to surge upward and stay there. It's time to pull the plug and explain to the customer that you're going to have to track down a short in his set.

Suppose there is no raster. You know there is horizontal trouble, but where? You try to draw an arc from the high-voltage rectifier and get nothing. A higher-than-normal indication on the wattmeter shows that the horizontal output tube may be drawing excessive current. Taking the plate cap off the horizontal output tube should reduce the drain to about 85% of its normal value; if it doesn't, the excessive current is going somewhere other than through the output tube. If the wattage was originally 85% of normal, you can be reasonably certain the horizontal output stage isn't functioning.

Look at a vertical problem for a moment. Loss of sweep offers two possible trouble areas—the oscillator or the output circuit. If the oscillator is at fault, the wattage will read nearly normal. On the other hand, if the wattage is down appreciably, the trouble is probably in the higher-current vertical output stage. Troubles in the audio circuits will give similar indications.

Video, RF, IF, AGC, and sync problems won't give as much of an indication as the troubles we've already mentioned. However, if excessive AGC voltage is biasing all the RF and IF stages to cutoff, there will be a noticeable reduction in power consumption. In sets with a power transformer, an inoperative stage can be pinpointed by pulling tubes, one at a time, while watching the wattmeter. When you find one that doesn't cause a change in the reading, you'll have pinpointed the trouble to a specific stage.

In Conclusion

We've only outlined some of the salient features of tracing TV troubles with a wattmeter. If you adopt this troubleshooting technique, you'll soon discover many other meaningful clues which will direct you to the source of trouble. The system is fast, since you obtain definite indications in a hurry—and with little effort. ▲

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SAVE $8.15

ON PYRAMID'S FAMOUS RC-1

Checks electrolytics* in Transistor Radios,

Color, Black and white TV, miniaturized equipment as well as in all radios and other electronic equipment and gear.

*plus all other types of capacitors

FORMER PRICE: $44.95

BURTON BROWNE/New York

For Checking Miniaturized Equipment, Pyramid's Model RC-1 New Resistance-Capacity-Ratio Bridge Tester. Budget priced . . . outstanding quality instrument . . . the RC-1 saves you both time and money. Precision-engineered, Pyramid's new model RC-1, Resistance-Capacity-Ratio Bridge Tester has a special low voltage bridge and stable vacuum tube amplifier for safe testing low voltage electrolytics such as commonly used in transistorized receivers.

Pyramid's RC-1, Resistance-Capacity-Ratio Bridge Tester is a functionally designed, sturdy, compact, lightweight unit, ideal for use by technicians, servicemen and engineers in radio, television (color as well as black and white), industrial electronics and all related fields.

PYRAMID MODEL RC-1 FEATURES:

- Special 3 volt amplifier for checking low voltage electrolytics used in miniaturized equipment such as transistor radios, etc.
- Capacity Ranges—from 10 mmfd. to 2000 mfd.
- Resistance—from .5 ohms to 200 megohms in 4 ranges.
- Ratio Test—provides quick reactance or resistance ratio between any two capacitors, inductors or resistors —range: .05 to 1 and 20 to 1. It can be used also to determine turns ratio of transformer windings within this range.
- Leakage Tests—handles all types of capacitors at rated voltages between 0 and 500V DC.
- Power Factor—0 to 60% (on capacitors from .1 mfd to 2000 mfd).
- Capacitor Test Voltages—variable between 0 and 500V DC in 17 steps.

PRICE: Dealer Net—$44.95

For further information about the RC-1 see your Pyramid distributor or write for complete technical data to: Pyramid Electric Company, Union City, N. J. EXPORT: 458 Broadway, N. Y. 13, N. Y. • CANADA: Wm. Cohen, Ltd.—7000 Park Ave., Montreal.

PYRAMID ELECTRIC CO.

PITFALLS OF METER READINGS

Why and how much the shunting effect of your VOM and VTVM affects the accurcy of voltage tests.

Of all the test instruments you own, your VOM and VTVM probably get the hardest workout. This isn't surprising when you stop to consider the versatility of these instruments. Nothing is more adept at supplying basic information about the operation of a circuit. One thing should be remembered, though; the voltages used for analysis purposes are *relative* indications. Having "learned to live with errors," most technicians do an amazing job of tracking down trouble. You can do even better if you're aware of what happens to a circuit when a meter is connected to it.

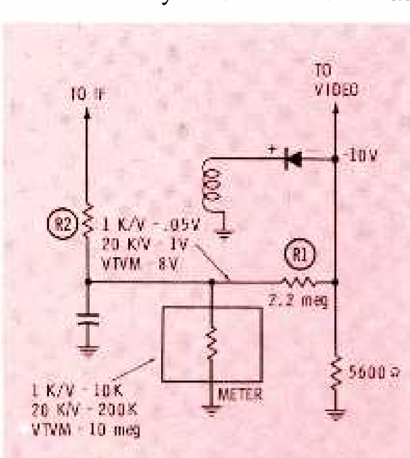

Fig. 1. Equivalent circuit explains meter errors when making voltage tests.

Voltage Readings

DC voltage measurements are not only the most common, but also the most misinterpreted tests made with a VOM or VTVM. In this application the technician is really connecting a resistor (the meter) in series or parallel with one or more resistors in the equipment being serviced. The reading obtained is the voltage drop across the meter resistance, a far cry from the actual voltage present at the test point.

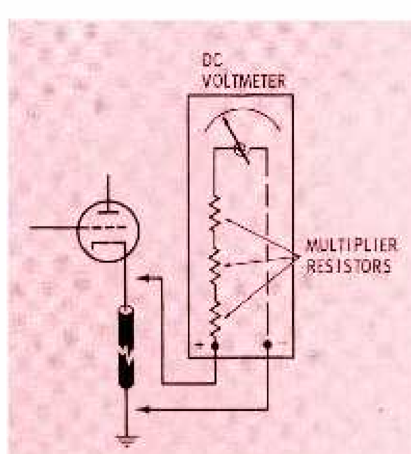

Fig. 2. Open cathode will give wrong voltage reading — may damage meter.

To be fully aware of the discrepancies you may encounter when making voltage measurements, take a look at the simplified AGC circuit shown in Fig. 1. Here we've shown the equivalent circuit of a voltmeter connected to measure the voltage present on the IF side of AGC filter resistor R1. To the right of the meter are listed the meter resistances for the common 1000-ohm/volt, 20,000-ohm/volt, and VTVM types when they are set on the 10-volt scale. For convenience, we've assumed the potential at the AGC source to be –10 volts. Above each meter is the reading it would give—not a full 10-volt deflection in any case. Since we know there should be no current flowing in an AGC circuit, we're likely to misinterpret the lower-than-expected meter reading as being the result of a leaky capacitor or IF-tube grid current. Still lower voltage readings are obtained on the IF side of R2, providing further "proof" of current flowing through the AGC network. Current is flowing, all right, but it is passing through the voltage-divider network consisting of R1 and the added meter resistance. Therefore, an erroneous condition is being created by the meter itself. Failure to realize this may send us on a wild goose chase in an attempt to locate a nonexistent trouble.

You can easily obtain the same type of false impression when testing any circuit containing high-value resistors. While the VTVM gives the most accurate reading in such cases, don't overlook the fact that it's not indicating the exact voltage present. On high ranges, your VOM may even be more accurate than your VTVM. This is true because the input impedance of a VOM increases with the scale used, while the impedance of a VTVM is always the same. For example, a 20,000-ohm/volt VOM, on the 1000-volt scale, has an impedance of 20 megohms. Most VTVM's, on the other hand, have an impedance of 10 or 11 megohms. Therefore, your VOM is more accurate on the 1000-volt scale.

It was mentioned earlier that *relative* readings are used in troubleshooting. By now this should be obvious. But what about the readings provided in service data? Aren't they relative, too? Of course they

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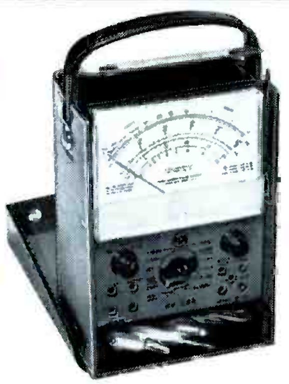
Only $43.95* complete with probes, leads, instructions. (RCA VoltOhmyst Kit only $29.95*).



WV-38A VOLT-OHM-MILLIAMMETER
THE V-O-M WITH THE EXTRAS!

Compare this superlative RCA V-O-M against the model you may have been thinking of buying. See if it doesn't check out better in these extra features:

- EXTRA! 1.0 volt and 0.25 volt ranges DC!
- EXTRA! Big easy-to-read 5¼" meter!
- EXTRA! Non-breakable plastic case; no glass to crack or shatter!
- EXTRA! Smart attractive modern styling—the V-O-M of the future!
- EXTRA! Red test lead has probe and slip-on alligator clip for added versatility!
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- EXTRA! Spring clips on handle to hold test leads!
- EXTRA! DB scales clearly marked: no squinting!
- EXTRA! Rugged, scuff-proof, stain-resistant laminated vinyl carrying case, only $4.95* extra!

Only $43.95* complete with batteries, instruction book and all probes, clips and cables. (RCA V-O-M Kit only $29.95*).

NEW! WV-98B
SENIOR VOLTOHMYST®

Measures AC and DC voltages (3% accuracy); resistance from 0 to 1,000 megohms. Measures peak-to-peak values of complex waveforms. Rugged cast aluminum case, big 6½" meter. **Only $79.50*** with leads, clips, instructions. Also available in economical kit form.

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***AUTOMATIC* ELECTRON TUBE TESTER**

Especially designed for TV and general service testing of electron tubes. Uses automatic punched-card selection of correct test conditions on wide variety of tubes. Checks vacuum-tube rectifiers under high-current conditions. **$199.50*** complete with 263 punched cards, 24 blank cards, card punch, instruction book.

SCOPES

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5-INCH COLOR-TV OSCILLOSCOPE

High-performance, wide-band oscilloscope ideally suited for color-TV, black-and-white TV, and other electronic applications. Dual bandwidth (4.5 Mc, 0.053 volts rms/in. and 1.5 Mc, 0.018 volts rms/in.). Internal calibrating voltage and calibrated graph screen. Includes special direct/low-cap shielded probe and cable.

Only $239.50* complete with ground cable, insulated clip, instruction book.

NEW! WO-33A
SUPER-PORTABLE OSCILLOSCOPE

A low-cost all-purpose scope you can carry anywhere—only 14 pounds—ideal for in-the-home servicing of black-and-white and color-TV, audio and ultrasonic equipment. High gain and wide bandwidth to handle the tough jobs! Rugged and compact—scaled 3" graph screen.

Only $129.95* complete with low-cap direct input probe, cable, power cord, cord-carrying brackets, instructions. (RCA Super-Portable Oscilloscope Kit, only $79.95*).

GENERATORS

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AUDIO GENERATOR

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SIGNAL GENERATOR

For alignment and signal tracing of AM/FM receivers, low-frequency signal tracing and alignment of TV vf/if amplifiers. Six ranges—85 Kc to 30 Mc. Internal 400 cps modulation. Low rf signal leakage!

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For visual alignment and troubleshooting of TV rf/if/vf circuits and other electronic equipment IF/video frequency ranges 50 Kc to 50 Mc, TV channels 2 to 13, plus FM range—88-108 Mc. Sweep width continuously adjustable to 12 Mc or more.

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To supply a fundamental frequency rf carrier of crystal accuracy for aligning and troubleshooting color-TV, black-and-white TV, FM receivers and other electronic equipment operating in 19 Mc to 260 Mc range. **Only $242.50*** complete with output cable, two phone tips, instruction book.

There's an RCA test instrument to help you do every job better, and easier—and to save you valuable time. A comprehensive line of test accessories: video multi-markers, TV isotaps and bias supplies, probes and cables. See your Authorized RCA Electronic Instrument Distributor for complete information.

RCA Electron Tube Division, Harrison, N.J.

*User Price (Optional)

The Most Trusted Name in Electronics
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are. The biggest pitfall of all faces the technician who tries to compare one standard of relative readings with a completely different standard —VOM readings with VTVM readings, for example. Service information for many of the older sets contains voltage readings taken with a 20,000-ohm/volt VOM. If you try to compare VTVM readings with these, you're heading for trouble. The same is true if you try to compare VOM measurements with the readings shown in newer service literature. Always be sure to observe the notes which tell you what type of meter was used to obtain the reference voltages!

Measuring the cathode voltages to determine how a stage is functioning is a very good troubleshooting technique. However, it can cause you grief. When the cathode resistor is open (Fig. 2) the internal resistance of a meter connected between cathode and ground replaces the resistor. Not only does this give an erroneous reading (about the same as at the plate), but it also may cause damage to your meter. Excessive current through the multiplier resistors may cause them to change value or burn out. Therefore, it's always advisable to merely touch the meter probe to the cathode so you can remove it quickly if you get the wrong indication. Better still, measure between plate and cathode before you measure from cathode to ground; if the cathode resistor is open, you'll get no reading at all.

Ohmmeter Readings

Weak batteries are a common source of erroneous ohmmeter indications. It's a good practice to check their condition periodically by testing them under load. An easy way to do this is to connect a 10-ohm resistor between the ohmmeter leads and measure the voltage across the resistor with another voltmeter.

This test has a second advantage in that it makes you aware of the voltage and polarity at the ohmmeter terminals. Check it on all ranges while you're at it. Most VOM's will have two different ohmmeter test voltages, while most VTVM's have only one. VOM voltages may range from 1.5 volts to 45 volts or higher. VTVM voltages, on the other hand, will normally be 1.5 or 3 volts.

It's important that you know the voltage and polarity of your instruments in order to obtain meaningful indications when checking the forward and reverse resistances of semiconductor diodes, rectifiers, and transistors. Excessive voltages can damage these components, and associated parts in transistorized equipment, so be safe—not sorry.

No test instrument is handier than a VOM or VTVM. Both have their place on every bench. Take some time to increase your understanding of what they have to tell you and you'll find your work will become easier and can be completed faster. ▲

"I said look for a capacitor leak, I don't care how they check tires!"

BURGESS New Product Promotion NEWS

SPRING 1961

Burgess Distributors' Salesmen Offer New Full-Range Profit Opportunities

FREEPORT, ILL., (BNS) . . . Burgess Distributors' Salesmen have hit the road with the newest, most complete portable radio battery sales program in industry history.

NEW PROMOTIONS

The all-new 1961 campaign provides radio-tv servicemen and appliance dealers from coast to coast with everything they need to rack up the biggest portable radio battery sales ever.

NEW PRODUCTS

Leading the way are new products. Burgess now offers magnetic recording tape and a complete line of Mer-

(continued in next column)

cury batteries, in addition to their world famous line of zinc-carbon batteries and their sealed nickel-cadmium rechargeable batteries.

GREATER SALES

Servicemen and dealers everywhere will be given the complete story by Burgess Distributors' Salesmen. These men will explain how to sell more batteries with the Burgess full-range sales program.

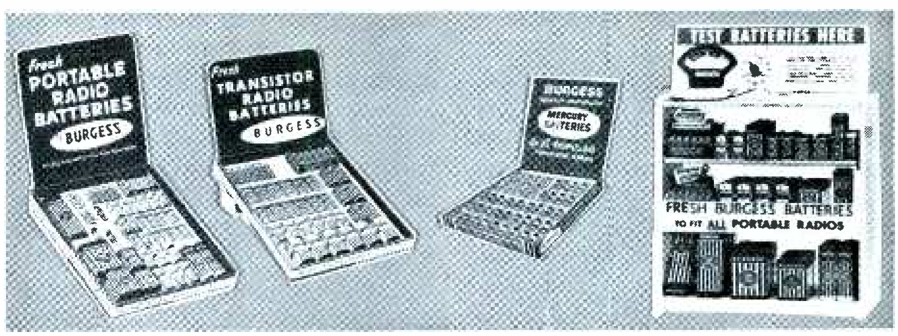
This new, eye-appealing label design identifies the expanded full line of Burgess Quality-Controlled Mercury Activators.

Big Dramatic BURGESS Ads Scheduled for '61

Burgess Portable Radio Batteries will again be pre-sold in 1961 to literally millions of portable radio owners!

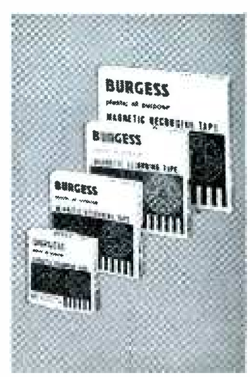
Big, colorful advertisements such as this full page Saturday Evening Post color ad will be seen by millions of readers in top-ranking national magazines.

New BURGESS *Selling Aids Announced*



Burgess has unveiled a sales-building line of compact, complete displays to fit every merchandising need. Servicemen and dealers are asked to contact their distributor salesman for full information on how they can get these dynamic, new displays!

New BURGESS Magnetic Recording Tape *Now Available*



40 years of successful developments in acoustics, coatings, coating processes, and solid state physics, have enabled Burgess engineers to produce a superlative magnetic tape characterized by these quality features: SUPERB FREQUENCY RESPONSES; LOW NOISE LEVEL; HIGH SENSITIVITY; UNIFORM TROUBLE-FREE PERFORMANCES ASSURED BY BURGESS QUALITY CONTROL.

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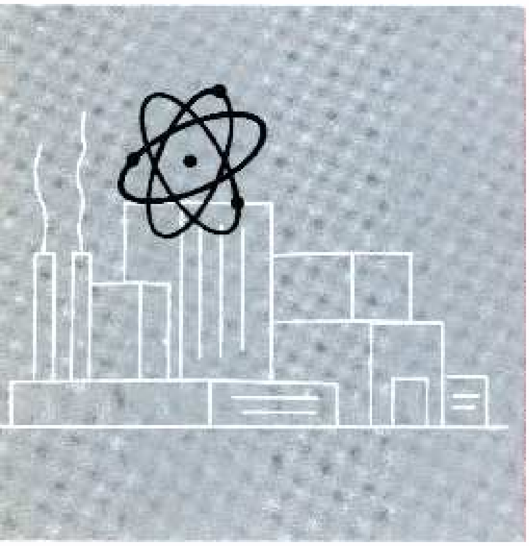
INDUSTRIAL ELECTRONIC TEST EQUIPMENT

Uses and characteristics of the instruments with the broadest application in industrial servicing . . . By Alan Andrews



The term *industrial electronic test equipment* can have several meanings. As used in this article, it refers specifically to instruments for testing and troubleshooting electronic equipment in industry, rather than those for other purposes such as monitoring a production process.

No matter what area of electronics servicing we consider, we find a few instruments in daily use everywhere. These include the VTVM, VOM or multitester, oscilloscope, tube tester, and signal generator. Although special design features may be incorporated into a particular unit of test equipment to make it more useful in a given type of work, the basic instrument remains the same. In many cases, a single piece of equipment can be utilized in several different phases of service activity without any modification.

Take the VOM and VTVM for example. Both basic instruments have applications in industrial servicing. Just as in any other branch of electronics, there are "right" times and places for using each instrument. It's best to use the VOM whenever there are strong magnetic fields or RF noises present. Such conditions are common around power-control circuitry, which has sufficiently low input and output impedances that the VOM does not produce excessive loading. However, sequence and routing circuits have input impedances high enough to require a VTVM. The latter instrument also finds application in measuring the output of sensing devices which develop a small output voltage across a high impedance.

Various types of signal generators are used in industrial servicing. Sine- and square-wave generators supply signals for checking gain, frequency response, distortion, and other circuit characteristics. Pulse generators are used to calibrate equipment and to check frequency response, timing, etc. Double-pulse generators find usage in checking various types of frequency-producing and frequency-measuring equipment. As the name implies, they produce two pulses for each cycle. In these units, the pulse width and spacing are variable, as is the frequency.

A wide variety of oscilloscopes are used in industrial servicing. Bandwidth and sensitivity requirements vary greatly, depending on the type of equipment to be checked. For making power-factor corrections, time - interval adjustments, troubleshooting welding equipment, etc., a scope with .1 volt-per-inch sensitivity and a frequency response of from a few cycles to 100 kc will do a fine job. In fact, the characteristics of this scope are such that the observed waveform will have less distortion than with a higher-gain, higher-frequency scope. Portability is an important consideration in scopes of this type.

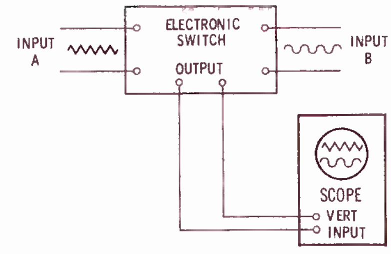


Fig. 1. The electronic switch permits comparison of two signals on a scope.

Scopes with higher frequency responses are often referred to as research or lab-type oscilloscopes. These instruments may have a frequency response up to 1000 mc, and may even incorporate plug-in units to offer completely different scope circuitry. Many special probes and cables are available to make these instruments highly flexible in their application.

Calibration is one of the outstanding differences between industrial scopes and those found on the average TV bench. Most industrial scopes are calibrated in microseconds and centimeters, and some have automatic triggering circuits to lock in the waveform when the appropriate range setting is selected.

Scope Accessories

In some industrial servicing applications it is desirable to observe two different scope waveforms at the same time to compare frequencies, phases, waveshapes, or signal amplitudes. This may be done by applying two signals to an electronic switch, the output of which is connected to the vertical or Y input of an oscilloscope (Fig. 1). Actually, the waveforms are produced on the scope at different times, but due to

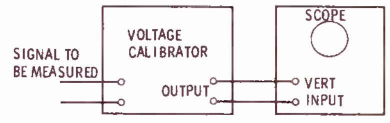


Fig. 2. Peak-to-peak voltages are determined with a voltage calibrator.

the persistence of the phosphor on the scope screen, they are both visible.

The two signals are applied to separate terminals (A and B) and channeled through separate amplifiers which are alternately keyed into conduction. Keying is done by supplying the A and B circuits with square waves of voltage, 180° out of phase. Each amplifier has its own gain control to regulate the amplitude of the signal applied to the scope input. The distance between the two waveforms on the scope is determined by a balance control in the control- or screen-grid circuit of the amplifiers. As the balance voltage on one stage is increased, that of the other is decreased, and the scope traces are separated; if the balance voltages on both amplifiers are equal, the two signals are superimposed. For frequency or phase measurements, the superimposed trace is normally easier to use; for waveform comparison, however, separated traces are preferred.

A voltage calibrator is a handy unit used to measure the peak-to-peak amplitude of a scope waveform. It produces a square wave of voltage with a definite, accurately-controllable amplitude, which can be compared to a signal of unknown amplitude appearing on the scope. Fig. 2 shows the normal hook-up for calibration. A selector switch on the calibrator unit connects either the signal to be measured or the calibrating voltage to the vertical input terminals of the scope. The calibration-signal voltage is adjusted to produce a deflection equal to that of the unknown signal, and the amplitude is read from the calibrator dial. The unit is especially advantageous for measuring signal amplitudes over a wide voltage range, since it eliminates changing the vertical gain of the scope for every reading.

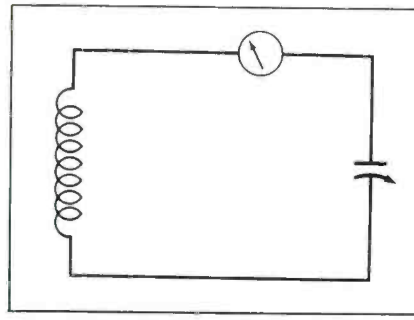
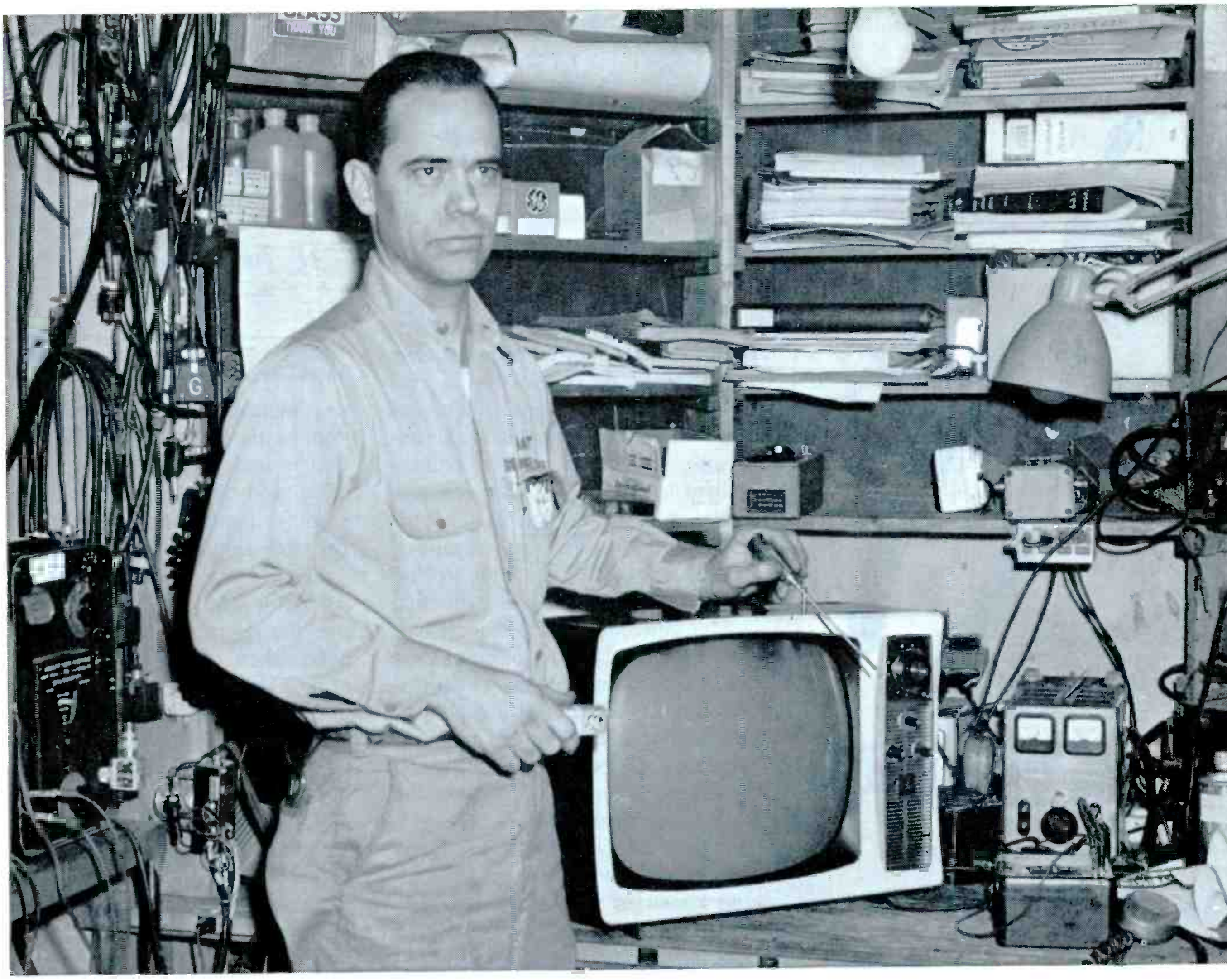


Fig. 3. Basic circuit of wavemeter uses milliammeter to read the tank current.

Frequency Meters

Frequency meters have many uses in industrial servicing. One of the more common applications is for measuring the frequencies of oscillating devices such as RF heaters. Most of this equipment must meet FCC frequency requirements; thus, it is mandatory that the operating frequencies be accurately measured and adjusted. Also, many industrial technicians work with two-way ra-

"Hello, Ed's TV? This is the Hilton Motels. We have 35 sets here and they all need repair."



"We *like* to service General Electric TV"

says Royal Alvis, A.A.T. Service Co., 68 Winham St., Staten Island, N.Y.

■ "We appreciate General Electric's high standards of quality design and quality control. As far as we can see, General Electric has made the most outstanding advances in engineering and serviceability. ■ The 'Designer' particularly is a great favorite with us. It's the simplest set to work on that we've ever come across. And we can tell from what our customers say that when a General Electric 'Designer' is sold—it stays sold!" ■ The reasons Royal Alvis and so many others who service TV are sold on the "Designer" are these: Tubes are directly replaceable, fuses readily accessible, and you easily get at the check points. Another thing: the painted schematic on the boards helps you find your way around more quickly. All this means more calls per day—more earning power for you. ■ "Designer" TV—it's called the easiest-to-service set in television! General Electric Co., Television Receiver Dept., Syracuse, N.Y.

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dio, which requires periodic transmitter-frequency checks. There are several ways to measure frequency, but some methods require equipment much too cumbersome for general use. The instruments most likely to be used in practical work are absorption wavemeters, grid-dip meters, and heterodyne frequency meters.

The simplest of these, although not the most accurate, is the absorption wavemeter—often called simply a wavemeter. It consists of a coil and a capacitor in parallel. One of these components (normally the capacitor) is variable, and a pointer attached to its shaft moves across a calibrated scale or dial on the outside of the case. The basic circuit of a simple wavemeter is shown in Fig. 3. In the most accurate instruments, a meter movement is connected in series with the L and C components to read maximum current developed in the circuit. Some units use a flashlight bulb or neon lamp in place of the meter; others have no indicator, but depend on indications from the circuit being measured.

In use, the wavemeter is placed close enough to the tank circuit being measured to form an inductive coupling. For best results, the degree of coupling should be as low as possible to still obtain a reading, since excessive coupling may load the tank and change the circuit frequency. As the wavemeter is tuned to the same frequency as the tank circuit, it absorbs energy and increases the plate current of the stage being measured. When the meter has been tuned for maximum plate current, the frequency can be read from the wavemeter dial.

Most wavemeters have different inductances which may be plugged or switched into the circuit to change the range of the meter. The dial is usually calibrated from 0 to 100, and frequency is then read from a calibration chart provided for each range.

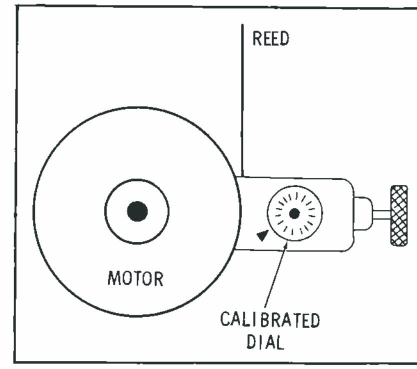

Fig. 4. A reed and calibrated dial shows cycles per minute of a vibration.

A grid-dip meter, with its own oscillator and indicator, can measure the frequency of a tank circuit even when the circuit is not operating. Although grid-dip meters generate their own test signal, the method of using them closely parallels that of the simple wavemeter.

Using a heterodyne frequency meter and an accurate reference standard is a more accurate method of determining frequency. A signal from a reference oscillator (signal generator) is mixed with a signal of the frequency being measured. Heterodyning the two signals produces an audible beat or difference frequency which can be monitored by a pair of earphones or a meter. The reference oscillator is adjusted for a zero beat or meter null, and the frequency read either directly from the dial or from a conversion chart.

Vibration Test Equipment

Motors, machines, and other devices which vibrate unnecessarily are a contributing factor in poor workmanship, excessive wear on parts,

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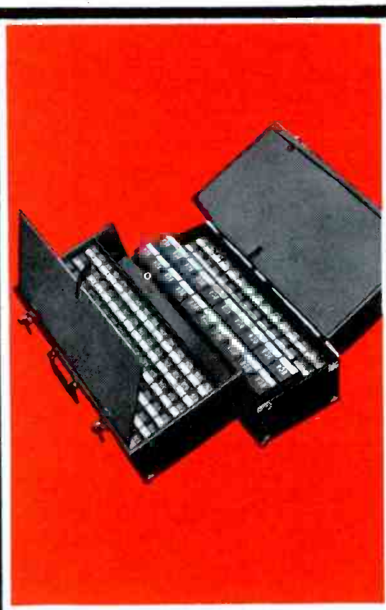

RCA "TREASURE CHEST" TUBE CADDY

"Presto! And now you see the ever-popular RCA *'Treasure Chest' Tube Caddy*. It's exceptionally strong yet lightweight, and holds over 260 tubes."

RCA "QUICK CALL" TUBE CADDY

"And now, the younger brother of the 'Treasure Chest': the handy *RCA 'Quick-Call' Tube Caddy!* It's attractive, rugged, compact, and holds 162 tubes —just right for quick service jobs."

RCA TV-TOTER TABLE

"Behold the *RCA TV-Toter Table*—that enables you to roll a chassis from place to place. Gives you more work and storage space in the shop."

RCA TV-TOTER HANDTRUCK

"And finally, the *RCA TV-Toter Handtruck,* for safe handling of chassis or sets in shop or home. It's light and rugged ...a real time and back-saver!"

"Remember, these valuable RCA Service aids are designed to make your work faster and easier—and you know that fast service means satisfied customers. To find out how you can get these helpful items, check with your Authorized RCA Electron Tube Distributor. And tell him the Wizard sent you!"

RCA Electron Tube Division, Harrison, New Jersey

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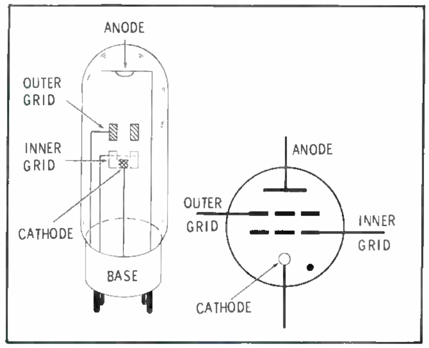

Fig. 5. Pictorial diagram and schematic symbol of tube used in stroboscope.

and high noise levels. Special instruments, designed to measure vibration frequency, velocity, and displacement, are helpful in locating the cause of vibrations and evaluating corrective measures.

One of the simplest instruments used to determine the frequency of a vibration consists of a reed that can be varied in length by means of a knob (Fig. 4). The reed is extended until a point of maximum vibration is reached, and a reading of frequency per minute is read from a dial geared to the reed. Once the frequency of the vibration is known, the search for its source can be restricted to the machines and equipment operating at this basic speed.

Several sound-pickup and amplifier devices are available for determining the severity of vibrations. Sensitive sound pickups are placed in direct contact with motors, machines, and even floors, to detect the amplitude of vibrations. The output of the sound head is fed to an amplier having enough gain to control some form of indicating meter.

Stroboscopes are used to measure the speed of rotating or reciprocating machinery, and also to permit slow-motion study of any vibrations or erratic operation of a piece of equipment. A primary advantage of the stroboscope is that it makes these observations possible under actual operating conditions with no electrical or mechanical connections to the equipment. Essentially, the stroboscope produces extremely short flashes of light at a controlled rate. Projecting this light on the machine, and adjusting the flash rate until the moving unit seems to stand still, gives a measurement of machine speed. If the strobe rate is set slightly higher or lower than the machine rate, the machine appears to be turning very slowly, allowing slow-motion study.

The light is produced by a tube known as a strobotron (Fig. 5)—a cold-cathode tube that does not require warm-up time before operation. Neon gas is used in the tube, causing a characteristic red glow each time there is sufficient difference of potential between the grids to produce glow discharge.

In operation, the anode and one grid (usually the outer) are supplied with fixed positive voltages. The other grid is driven by negative pulses, causing a glow each time a pulse is applied. Firing pulses are obtained from a built-in pulse generator or from some external source.

Strain gauges can also be used to check vibration, as well as stress or pull. By use of a resistance bridge, the variations in the resistance of the strain gauge can be translated into meaningful indications of vibration.

Bridge circuits are used in a wide variety of instruments to measure impedance, capacitance, resistance, inductance, voltage, etc. To attempt to discuss all of the various pieces of test equipment built around the bridge circuit would fill a book. However, studying only the common portable potentiometer will provide a basic idea of bridge operation.

In these instruments, a sensitive galvanometer is in series with an unknown voltage and the arm of a linear potentiometer. The potentiometer is connected across a calibrated voltage standard. When the voltage between ground and the slider arm equals the unknown voltage, the galvanometer will read zero and the value of the unknown voltage can be read from a calibrated dial.

A wide selection of meter shunts and reference-voltage sources makes the portable potentiometer a versatile test instrument. One of its most common uses is that of measuring the output from thermocouples and other pickup devices that produce very low voltage outputs.

In addition to the test equipment discussed here, literally hundreds of specialized instruments are used daily in industrial servicing. However, we have discussed only the most widely-used instruments, citing some of their applications, and informing you of the tools of the industrial electronics service trade. ▲

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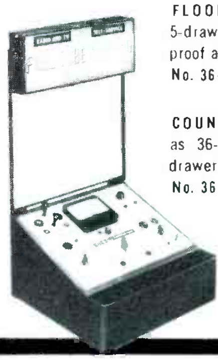

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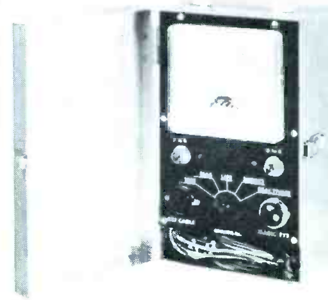

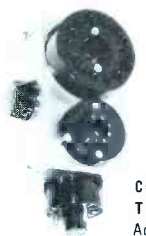

COLOR & 110° TUBE ADAPTER
Adapts 36-506 for latest test needs.
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Pocket-size unit checks for burned out tubes without waiting for warm-up. Just plug in and get instant filament check.
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NEW Color & Black-and-White
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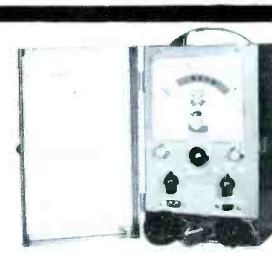

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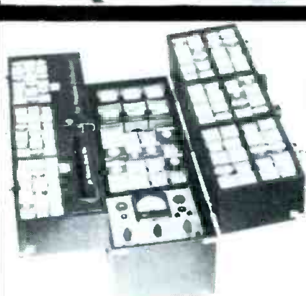

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Gone—But Not Forgotten

I have a Solar capacitor tester with a shorted power transformer. I've written to the company, but my letters have been returned for incomplete address. None of my catalogs list any of their products, so maybe they are out of business. Can you furnish any information about where replacement parts can be obtained.

R. P. LOESCH

Pittsburgh, Pa.

Solar is out of business, and has been for a number of years. However, many of their capacitor testers are still around. Transformer breakdown seems to be common in these units. Stancor lists part number P-6459 as an exact replacement for Solar Model CF-160; perhaps this will solve the problem for you.

Creeps Out of Sight

My wide-band scope is giving me trouble. The whole trace gradually drifts toward the top of the tube, and after about 30 minutes it drifts completely beyond the range of the vertical positioning control. Any suggestions of how to solve this problem will be greatly appreciated.

GEORGE D. ENGLE

Miami, Fla.

The trouble is probably the result of a gradual change in the DC balance of the push-pull vertical output amplifier. Since the fault takes 30 minutes to develop, the most likely suspects are a gassy tube, a leaky capacitor, a resistor increasing in value, or a defective positioning control.

The fault undoubtedly lies somewhere between the input grid circuit of the push-pull output stage and the vertical deflection plates of the CRT. To correct the trouble, first try tube replacement in this section. If this doesn't correct the fault, check the grid-coupling capacitors for leakage, and check all resistor values in the output stage (both hot and cold). Since there may be series peaking coils in the output plate circuit, also check them for continuity after the instrument has warmed up.

Eliminator Buzz?

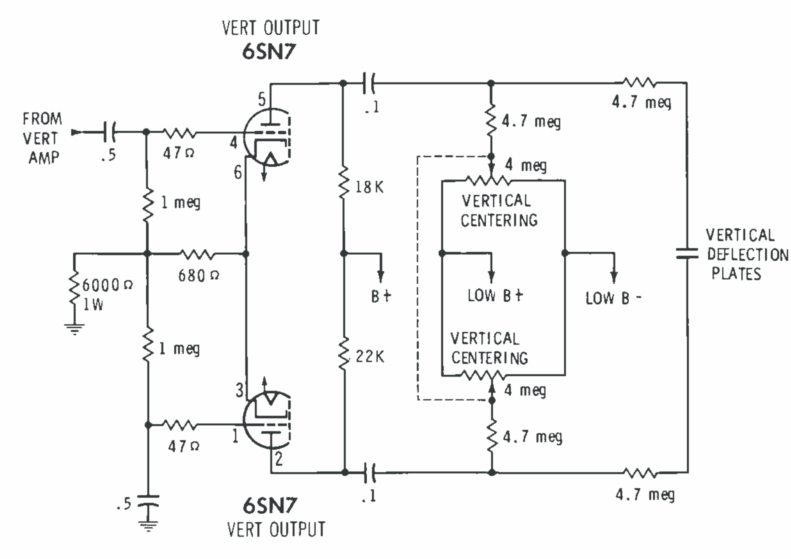
Some of the auto radios I service have a loud buzz in the speaker when operated on the bench, yet operate perfectly in the car. Is my battery eliminator causing the trouble, or what? How can the problem be solved?

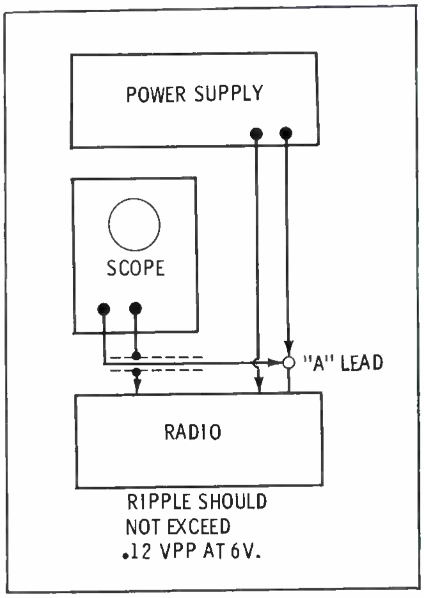
THOMAS R. MIZE

Penns Grove, N. J.

Several things could be causing your troubles. It's doubtful if your battery eliminator is at fault, since the trouble appears only on some sets. To find out for sure, simply use your scope to measure the peak-to-peak amplitude of the ripple from the power supply. Make your test when the trouble is present, and compare your findings with the ripple specifications given in the operating manual of the eliminator.

If the ripple is excessive, check the current drain of the supply. If it's near the upper limit, you must anticipate hum due





to improper regulation. Be certain the receiver isn't drawing more current than it should as a result of a partial short or leakage path in the filament circuit. Heater-cathode leakage in one of the tubes may be the cause of your trouble. If the ripple is present when the current drain is well within limits, check the components in the LC filter circuits for an off-value filter capacitor.

A more likely cause for your trouble is radiated interference picked up by your shop antenna. The RF circuits of many auto radios are quite sensitive, and radiated AC hum will often be picked up by the antenna and given high-gain amplification by the radio. A condition such as this is more apt to happen if you have fluorescent lamps over the bench. Try repositioning the antenna lead, or completely disconnect it, the next time you encounter the trouble.

To Test New Tubes

My tube tester is so old that I can't obtain setup data for checking some of the newer tubes. However, I like the tester and don't want to give it up. Is there any way of determining what the setup adjustments should be?

JULIAN KUPELRESKI

Jackson Heights, N. Y.

Yes, it's possible for you to develop your own tube tester setup in order to check newly-developed tube types. You must know what the tube basing is, and if possible, the transconductance rating.

The first thing to do is compare the new tube to an older type for which you already have test information. For example, suppose you want to determine the setup for the rather new 6GN8 video amplifier-sync separator tube. Three other types (the 6AU8, 6AW8, and 6EB8) can be temporarily substituted for the 6GN8, and the setup data for any of these tubes should suit the requiremens of the 6GN8 closely enough to give you a workable test. Of course, Gm or emission readings may not be valid, because of differences in transconductance between newer and older types.

If no substitution data is available, studying the setup adjustments for a tube *with similar basing will permit you to identify the control on your tube tester which connects the various tube elements into the test circuit. A little more study will show what the switch sequence is. (You may be able to determine these points directly from your tube-tester operating manual.) With this information at hand, you can transpose tube-basing data from the schematic directly into tube-tester settings. This will become easier after you've done it a few times.*

With the proper tube connections set up on your tester, you can plug in a known good tube of the type you want to test. Of course, you will have already adjusted the filament-selector switch to provide the proper filament voltage. As the tube is being tested, the bias adjustment on your tube tester can be varied to give the proper transconductance or "good-bad" indication.

The bias level required to obtain the reading should then be recorded. Test as many tubes of the same type as you can, and come up with an average bias level for testing each section of the tube. By following this procedure for every tube section and recording the results, you'll obtain all data necessary for future tests of the new tube type.

Meter Shunts

I have a panel meter with a 1-mil movement. I'd like to build up a special setup and monitor current drains of up to 50 amps. Is there any way I could use my meter to accomplish this?

W. P. STETTER

Pacoima, Calif.

I'm afraid not. You'll never find a suitable shunt to increase the range of a meter with a one-milliamp movement so it will have a range of 50 amps.

In order to increase the range of an ammeter, a shunt must be connected in parallel. The resistance of the shunt must be lower than that of the meter, and the ratio of the resistances must be such that the rated current will pass through the meter movement to obtain full-scale deflection. This, of course, brings up the question, "What is the resistance of the meter movement?" For one-milliamp meters, it may range from about 40 ohms to as high as 1000 ohms.

When the resistance of the meter and the maximum current through it are known, the voltage drop across the meter can be computed. This same voltage also appears across the shunt. Therefore, since we know the current that must pass through the shunt, we can determine the required resistance. To understand more clearly why the use of a meter is limited to a specific range, let's figure out how a one-mil meter with a resistance of 1000 ohms would have to be shunted to extend its range to 50 amps full scale.

The voltage drop across the meter at full-scale deflection would be one volt. Dividing this value by 50 amps shows that the shunt would need to have a resistance of .02-ohms—and it would have to pass 49.999 amps of current. Just where such a shunt could be found is hard to say. However, with this information, perhaps you can find some other suitable uses for your spare panel meter.

Service Dealer Advertising Program No. 4 in a Series

Response to the unique PF REPORTER advertising program has proved beyond any doubt that such a service is needed. This response is a healthy sign that the radio-TV electronics service industry is aware of the necessity for *good* advertising copy.

The PF REPORTER program has been planned and executed by men intimately aware of your needs. Some of the messages are seasonal; others emphasize specialized services on hi-fi, color TV, auto radios, antenna systems, etc., while several are designed for special offers.

To make sure these ads will get results, the program has been carefully developed and field-tested. As a service to our readers, each month's selection of 5 ads is available *at cost* in two forms—durable newspaper mats at $1.75 per set, or high-quality reproduction proofs at only $1.00 per set. The latter will serve as finished artwork for offset printing of handbills, postcards, doorknob hangers, direct-mail pieces, etc. To obtain your set of this month's ads, use the convenient order form on page 84. Your ads will be sent to you postpaid.

ES-5: 1⅞" x 4⅛"
Here's an ad that puts your potential customer in a good mood even *before* he calls you — promises you'll fix his set promptly and economically.

ES-12: 1⅞" x 3⅞"
Want to get in a real pitch for your radio service? This ad will do the trick. It also points out you're available for TV and hi-fi service.

ES-22: 3¾" x 2¼"
Cartoons are always attention getters. This one teams up with a powerful selling message that plugs your TV, radio hi-fi, auto- and transistor-radio service.

ES-26: 1⅞" x 3"
The sinking TV is sending out a last, desperate S.O.S. Naturally, you're the one who will answer the distress call in a hurry.

ES-30: 1⅞" x 4¾"
This ad will draw potential customers to you when they want a "bright, rock-steady picture in a jiffy."

Communications

(Continued from page 31)

tions: (a) Frequency range covering that of the equipment being serviced, 5-470 mc being adequate for most systems encountered; (b) excellent frequency stability; (c) positive suppression of RF radiation from the generator, except via the output cable; (d) accurate amplitude control and microvolt calibration of the generator output; (e) frequency calibration accurate enough so the technician can obtain the proper frequency with ease.

Fig. 4 shows the test setup for measuring receiver sensitivity. An output meter is connected to the speaker terminals (point D) to read the amount of circuit noise inherent in the set. With the receiver operating, the volume control is adjusted to produce some reference reading of noise on the output meter, say 10 volts. The signal generator is then connected to the input of the receiver at point B. The generator-output control is set for about 100 microvolts, and the frequency is adjusted to that of the receiver. The most accurate method of tuning the generator to the exact frequency is to measure the DC voltage at the discriminator (point C) and adjust the generator-frequency dial until the receiver discriminator reads exactly zero volts. This quiets receiver noise through limiter action, and reduces the output-meter reading to zero or nearly so. The generator output can then be reduced until the receiver noise reading is exactly 1/10 the reference value chosen earlier—in this case, 1 volt. Stating it another way, the noise output is 20 db below the original level, so 20 db of quieting has been produced in the receiver. Checking the microvolt output of the generator gives a direct reading of receiver sensitivity.

Volt-Ohm-Milliammeters

Although communications equipment can be serviced with the same type of VOM used in the repair of other electronic devices, a more sensitive meter with a 50-ua movement comes in very handy for making tests of certain key points in many sets.

Field-Service Instruments

Some of the above-mentioned instruments are designed for portable use in the field, and several addi-

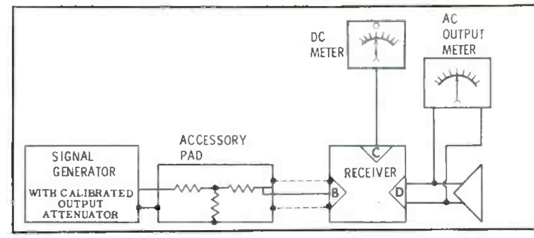


Fig. 4. Test setup for measuring the sensitivity of communications receiver.

tional items are available to simplify and speed field-service activities. Probably the most useful of these is the test set intended for use with a particular model of radio. Most modern transmitter/receivers have several leads from key test points brought out to a common metering socket or sockets, designed for direct plug-in connection to a test set. Switching arrangements provide for instant metering of various points—thereby cutting down the time consumed in checking circuit operation, over-all performance, and results of adjustments. Many test sets also provide additional features (built-in signal generators, field-strength meters, microphone testers, wattmeters, VOM ranges, etc.)

Supplementary Test Instruments

Many other useful pieces of equipment are available to make the job of troubleshooting and adjustment easier for the busy communications technician. Some of these deserve brief mention.

RF field-strength meters are handy to have around for field adjustment of antenna-coupling circuits and the final stages of transmitters. Relative readings obtained from a meter placed near the transmitter antenna provide sufficiently accurate readings to obtain optimum coupling and output tuning.

Audio generators are useful for testing the audio amplifier circuits in receivers and the microphone amplifiers in transmitters. Stages can be checked for gain and distortion by

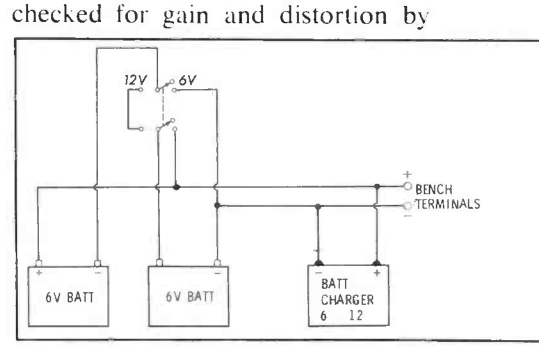


Fig. 5. A simple, well-regulated DC supply — two batteries with charger.

injecting the audio signal at a suitable level and noting the results. Remember, however, that the audio circuits of all transmitters and most receivers are designed to amplify only frequencies between 300 and 3000 cps.

An oscilloscope is useful in checking audio circuits, as well as in checking power-supply circuits for proper decoupling, hash elimination, and filtering. Familiarity with vibrator waveforms, and the waveforms generated by transistor power supplies, will assist in detecting and pinpointing possible defects in these circuits.

When used in conjunction with a sweep generator, an oscilloscope serves to check the receiver discriminator for a proper S-curve, the same as in any FM receiver. In this application, scopes offer definite clues for spotting any stage which may be failing to respond properly to adjustment. This is a good way to track down IF coils which have shifted frequency or lost Q. Bandwidth can also be checked to see if the bandpass filters are functioning properly. Most television alignment generators will do nicely for performing these chores.

Much of the newer communications equipment uses transistors; therefore, a transistor tester can help to relieve some of the strain on the harried technician by speeding the discovery of trouble spots.

For bench-testing mobile equipment, a dependable source of 6- and 12-volt DC is a necessity. The supply must have excellent regulation because of the wide difference in current requirements between "receive" and "transmit" conditions. One of the best setups for bench power consists of two 6-volt batteries interconnected with a battery eliminator as in Fig. 5. The batteries maintain excellent voltage regulation, while the eliminator provides the current to bring the batteries back to full charge after being used on a transmitter.

A collection of alignment tools and the usual assortment of coupling clips, pads, jumpers, and input and isolating gimmicks (already in daily use by most technicians) complete the test-instrument requirements for professional-grade maintenance of mobile radio communications systems. ▲

Old Faithfuls

(Continued from page 24)

being "power-starved." This trick of the trade is just as applicable to TV sets, or any other electronic device, as it is to portable radios.

Besides its usefulness in troubleshooting intermittents, the isolation transformer is indispensable for servicing transformerless equipment —as if this fact needed mentioning. Many "bites" could have been avoided if an isolation transformer had been put to work in the first place. Even more important than avoidance of accidental shocks is the protection an isolation transformer gives to the receiver under test. For instance, think of the balun coils that have been burned up in "hot-chassis" TV sets when a grounded antenna was accidentally connected on the wrong side of the antenna-isolation network—and baluns are *so* hard to replace.

DC Power Supplies

Variable DC supplies (6/12-volt battery eliminators or transistor power supplies) are as helpful as their AC counterparts. Their well-regulated outputs eliminate any shadow of doubt as to whether or not a unit under test is receiving proper input power. The majority of DC power supplies are equipped with panel meters to indicate voltage and/or current output. When the set under test is first turned on, the immediate indication given by these meters often suggests where to look for trouble. In vibrator-powered equipment, such as older auto radios

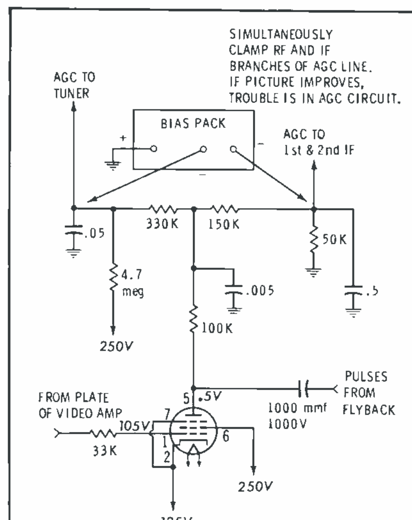


Fig. 3. Dual bias pack clamps both sections of AGC line in keyed system.

and mobile PA amplifiers, these immediate meter readings can provide clues to shorts and similar troubles before the fuse has a chance to blow. Stuck vibrators or power-tuning units, as well as shorted filament leads or spark plates, will often peg the ammeter hand—calling for immediate removal of power until other tests are made.

In servicing transistor radios, the meters built into the power supplies provide useful clues in localizing inoperative stages and tracing the causes of excessive current drain. Simply shorting the base of a transistor to the emitter should produce a specific decrease in total current if the stage is operative. If there is no noticeable change in current when this test is performed, the stage may be assumed to be dead. If there's a radical change, you can be sure the stage under test is drawing excessive current.

Variable DC supplies are also helpful in tracking down intermittent troubles. One example is the way reduced input voltage causes a weak 0Z4 tube to show its true colors.

Bias packs are not normally considered as "DC power supplies," but in a sense, they can be regarded as such. These units normally offer one to four DC outputs which are variable from zero to around 15 volts. The output impedance of the supply is quite low, so it can simulate the circuit-loading characteristics of a battery.

Clamping AGC lines at a fixed voltage is the main use for bias packs (Fig. 3). This procedure offers one of the surest ways of determining if an AGC trouble exists, and also provides a handy voltage source for establishing proper bias during alignment. Since the bias supply has such a low output impedance, and AGC circuits have such limited power, connecting the bias pack automatically disables or overrides the action of the AGC system. Thus, the bias pack can compensate for excessive, as well as insufficient, AGC voltage. When the bias supply has been adjusted to provide the proper value of negative voltage, normal troubleshooting techniques can be employed to trace the trouble to its source.

Component-Substitution Boxes

Among the handiest things to have at the bench are substitution units for temporary replacement of components. Decade boxes provide substitute parts with values adjustable in graduations of 10; other replacement units offer a variety of EIA standard values. Either way, a suspected component can be substitution-checked by the flick of a switch and the attachment of test leads.

Back in the old days, when you wanted a useful little substitution unit, you took the time to assemble a handful of capacitors, resistors, and a rotary switch or two. Since then, however, many manufactured substitution units have become available for a wide variety of applications.

Now it's possible to substitute for almost any value of resistance—and several wattages are available. Substitution units for capacitors are also made, covering a wide range of values; some that include electrolytics even have a test switch to discharge the 'lytic when the test is completed. While capacitor-substitution units are extremely versatile, small-value capacitors aren't included because of the additional stray capacitance of the test leads.

Other component - substitution units are available for quick checks of semiconductor diodes and rectifiers, speakers and/or audio output transformers, deflection yokes, and even picture tubes.

Picture-tube substitution units, often referred to as check tubes, are useful in determining the true condition of a suspicious-acting CRT, or in taking the place of a cabinet-mounted picture tube for bench servicing. The growing trend for TV manufacturers to mount the picture tube in the cabinet promises to make the check tube more popular as time goes by.

One of the newer instruments, the flyback and yoke tester, has already saved many an hour in servicing. This specialized component tester offers "proof positive" of the condition of a flyback or yoke. Unfortunately, some servicemen have been reluctant to trust the answers obtained with this type of tester, regarding them as "maybe not right." A man may be tempted to adopt this attitude when he hasn't been able to pin down a difficult horizontal sweep problem, and hopes without hope that the flyback is at fault. This often results in an unnecessary flyback replacement that fails to solve the problem.

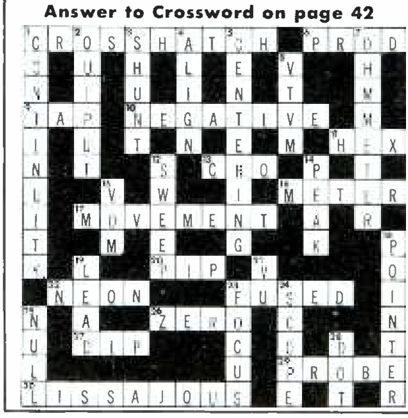
Radio Signal Tracer

For many of you who are new to radio, you'll find the old faithful signal tracer mighty handy to have on the bench. The simplest of these units consists of a demodulator probe feeding an audio amplifier that has sufficient gain to amplify a signal detected at the radio antenna. Beginning at this point, and tracing through the RF, IF, and audio circuits, you should pick up a steadily increasing signal until you reach a dead stage—where the signal will be lost.

Since the signal tracer is a sensitive signal amplifier, it is very useful in tracing hum modulation. When the offending modulation is entering the circuit via a radiation path, the probe of the signal tracer will often "pick the signal out of the air" and direct your attention to improper shielding or lead dress.

Of course, several other "old faithfuls" found on nearly every bench are still to be mentioned—panel meters, volt-ohm-milliammeters, VTVM's, signal generators, scopes, etc. In this article, however, we've made a point of concentrating on the items that seldom gain attention, but still are used day in and day out to improve efficiency. The reason for considering these instruments is to make the newcomer more aware of the various types of equipment used to speed troubleshooting, and at the same time remind the "old pro" to get some of these instruments down, dust them off, and restore them to their rightful place on the radio-TV-electronics service bench. ▲

Answer to Crossword on page 42



VTVM

(Continued from page 33)

rectifier results in a problem. With no signal applied, the few electrons breaking away from the space charge about the cathode will pass through the plate circuit and develop a voltage drop across the rectifier load resistor. This undesired voltage is *contact potential*, and its value may rise to as high as one volt. To overcome this problem, two diodes are used. With no signal applied, the polarity of the contact current of diode V2A is developed across R1 in the direction shown by the arrow. The contact current of diode V2B flows through R1 in the opposite direction, as indicated by a second arrow. By adjusting R2 to the correct value, the contact current of V2B can be made equal and opposite to that of V2A, cancelling any contact potential. R2 is called the AC BALANCE or AC ZERO adjustment. The rectified output is then handled as a DC signal by the DC voltage-divider circuit.

Ohmmeter Circuit

To use the measuring circuit as an ohmmeter, a known voltage is placed in series with a known value of resistance. The unknown-value resistor is then placed in series with both, and the resulting voltage division is read by the measuring circuit. The resistance-divider circuit is shown in Fig. 5. Shorting the input terminals places the grid of V1A at ground, or zero potential. Placing an unknown resistor across the input terminals causes the voltage of the 1.5-volt cell to divide between the series resistor of the selected range and the unknown resistor. The measuring circuit then reads the value of voltage across the unknown resistor. As the value of this resistor is increased, the voltage drop across it will increase proportionately, and this will be indicated by a higher reading on the meter. By calibrating the dial scale in ohms instead of volts, the resistance value may be read directly from the meter face, with maximum resistance readings on the right-hand edge of the scale and zero at the left. When the value of the unknown resistor becomes too large in proportion to the value of the known resistor, a larger value of known resistance is switched in place. By using multiples of 10,

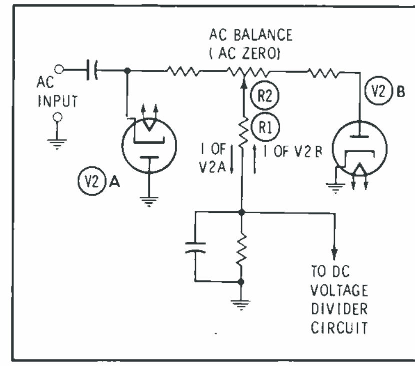


Fig. 4. Extra diode V2B prevents a contact-potential error on AC scales.

100, etc., the dial scale is simplified to one resistance calibration, and only the correct number of zeros need be added to readings on the higher ranges.

VTVM Troubleshooting

Even if there is no sign of trouble, the technician should periodically test the instrument and provide preventive maintenance. It is important to keep a close check on probes, which are a constant source of difficulty because they are handled so often. A broken center conductor in the shielded lead where it connects to the DC isolating resistor is a typical fault. Poor connections to the ground lead or AC-OHMS test prod are also common problems.

On some instruments, separate test jacks are used for each plug-in test lead; these often come loose from the instrument panel. A loose test jack will cause difficulty if the jack is part of the ground circuit. To prevent an intermittent ground because of this loose mounting, a lead from the test jack to an internal chassis ground is a good safety feature. Speaking of safety—is the VTVM anchored? Too many times someone has tripped over hanging test leads, pulling the instrument off the bench.

When circuit trouble develops in a VTVM, it is usually of a straightforward nature, and can be readily localized. A typical problem is a VTVM which is inoperative on all ranges and functions. Frequently, the pilot lamp does not even glow. The obvious location of the defect is in the power supply, which is common to the entire instrument. Since the power-supply circuit is simple, the serviceman usually has no difficulty—if he has another meter to check the VTVM.

When a defective tube other than

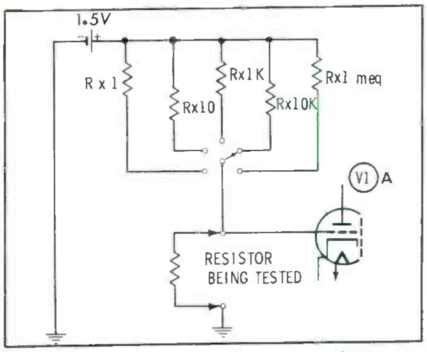


Fig. 5. Known and unknown resistances are placed in series across battery.

a power-supply rectifier needs replacing, it is good policy to age the tube before recalibrating the meter. The length of time required for aging the average tube is about 30 hours. If a tube is not aged before calibration, the meter will probably have to be recalibrated within a week. A tube with high gas content, although aged, may cause the zero setting of the pointer to shift when switching ranges.

When the meter pointer will not deflect to full scale on the ohmmeter range with an open circuit across the test leads, the battery in the ohmmeter circuit is probably weak and needs replacing. This should be done just as soon as this trouble is noticed, since a weak battery, if left unattended, may leak and/or corrode. When replacing the battery, be sure to observe the correct polarity. If the instrument uses spring contacts instead of soldered leads, be sure the contacts are clean. A slight burnishing with fine sandpaper is a good precaution. In addition, the tension of the spring contacts should be checked.

Although not a common problem, dirty switch contacts may cause intermittent difficulties. These can be cleaned by the same methods used on TV tuner switch contacts—employing a chemical which leaves a thin film of special corrosion-resistant lubricant.

Voltage Overloads

It is almost impossible to burn out a meter movement in the circuit of Fig. 2. It is quite common, however, to have voltage overloads damage the divider circuits by changing the values of the precision resistors. This trouble is commonly caused by attempting to measure voltage with the function selector set to ohms.

When checking a suspected divider resistor for correct value, bear in mind that the accuracy tolerance of the meter you are using may be broader than the value tolerance prescribed for the resistor. A laboratory-type bridge circuit should be used for accurate testing. If a bridge is not available, check the reading obtained with a 1% resistor of the same value against that produced by the resistor in question.

Meter Movement

Should the meter movement itself be under suspicion, don't check it with an ohmmeter; the battery voltage in the ohmmeter circuit may be high enough to burn out the meter movement. For test purposes, temporarily substitute another movement of equal value. If this can't be done, play safe and return the movement to the manufacturer or someone else known to be qualified to test and repair it.

With the power to the VTVM turned off, check the meter pointer to be sure it is resting at zero. If not, a mechanical adjustment can be made by turning the positioning screw located on the front of the meter at the base of the pointer. Be sure to make this adjustment with care, as it does not require a "heavy hand." If the pointer will not return to zero, return the meter to the manufacturer.

If you should be brave enough to take the meter movement out of its case, proceed with caution. Be sure to do this anywhere but at the service bench. The magnet of the meter movement has an unhappy faculty for picking up stray pieces of metal seemingly from nowhere. Take the meter movement apart over a large, clean, solid sheet of blank paper. This will enable you to keep track of all mounting screws and to keep iron filings, etc., out of the meter movement. If the case is plastic, it will probably have an antistatic coating. If this needs replenishing, and no antistatic solution is available, a detergent such as that used in home laundry machines may be substituted. After washing the case with the detergent, be sure to allow sufficient time for drying.

More complete suggestions for troubleshooting a defective VTVM, summarized in Table I, touch on practically every defect which might develop in this type of instrument.▲

Analyzers

(Continued from page 22)

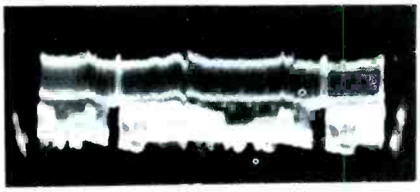


Fig. 2. Signals in RF or IF section can be viewed with waveform analyzer.

then substitutes for the RF stage, and indications are observed on the picture-tube screen. In a like manner, you can "bridge" the mixer stage by connecting the probe's test leads across points B and C.

Another type of analyzer from the probe family can be used with a scope to sample the television signal at various stages. The amplifier in this type of probe may also be tunable to cover the RF, IF, and video frequencies. For example, the signal may be picked off at the output of the tuner, passed through the probe where it is amplified and detected, and then fed to the vertical input of the scope for visual inspection.

When you check the IF stages of the receiver using one of the elaborate generator-type analyzers, you'll find that the troubleshooting procedure remains about the same, except now the output carrier frequencies are in either the 20- or 40-mc band. Here, test points D, E, F, and G of Fig. 1 are involved, and various patterns from the scanner can be monitored on the picture-tube screen. Incidentally, these analyzers will usually provide control over both output level and percentage of modulation.

When troubleshooting with a probe instrument in this section of the receiver, you again use either the stage-substitution or signal-sampling method. As you gain experience with the sampling type of analyzer, you'll find that you can even perform stage-by-stage alignments.

Letters H, I, J, and K in Fig. 1 represent key test points for check-

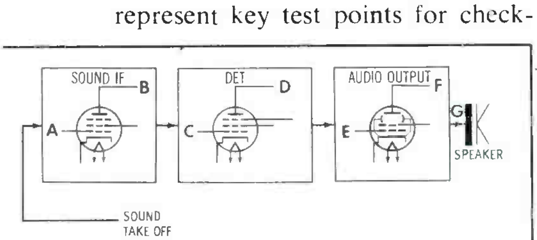


Fig. 3. Analyzer test points in sound-reproducing system of a TV receiver.

ing the video stages of a receiver. If you use one of the flying-spot scanners to analyze this section, you merely switch over to a video-signal output. You'll find that the instrument will provide an output with either positive- or negative-going sync pulses. The polarity to be selected will depend, of course, upon the point of signal injection. Through the use of transparent slides, the flying-spot scanner can generate almost any pattern you need for troubleshooting—a standard TV test pattern, white dots, bars, crosshatch, etc.—on the screen of any normally-operating receiver. These features also permit the analyzer to be used for convergence adjustments and signal-tracing in color receivers.

One interesting approach to localizing a defect in the video section is to use a stage-substitution type of probe. One lead from the analyzer is clipped to the plate of the vertical output tube, while the probe tip is placed at the video detector load (point H in Fig. 1). If the video amplifier is operating, a hum bar (60-cycle modulation) should appear on the CRT.

A different approach is to use the speaker in the receiver as an indicating device. For example, one probe lead is attached to the ungrounded end of the volume control, and the probe tip is touched to the plate of the video output tube (test point J). With the sound IF stage disabled, sync buzz should be heard in the speaker if the composite video signal is reaching point J.

Another special analyzer permits observation of signal waveforms from the top side of the TV chassis. Basically, this instrument is either a highly sensitive scope in itself or a preamplifier for use with an oscilloscope. It makes use of special probe adapters capable of sampling signals from the glass envelope of both single-stage and multipurpose tubes. This type of analyzer is especially useful in high-frequency, low-level circuits. Since the input of the instrument features tuned amplifier stages similar to a conventional TV tuner plus a detector network, you'll find it possible to view the composite video signal anywhere from the antenna to the driven element of the picture tube. To illustrate what you can do with one of these analyzers, Fig. 2 is the demodulated waveform obtained by sampling the signal at a second IF amplifier stage with a ring-type pickup probe slipped over the tube envelope.

Before we leave this section of the receiver, let's look at the AGC system. Since trouble in this circuit can produce so many different symptoms affecting both picture and sound, there is a real need for a rapid and systematic method of troubleshooting the entire AGC network. Several instruments needed for this job are all combined in one type of special analyzer including an RF signal generator, VTVM, and small DC power supply. With these built-in features, you can check AGC action at different RF signal levels, monitor AGC voltage (including the high peak-to-peak pulse present on a keyer tube), and substitute for AGC bias at any point. Small bias units designed for the express purpose of clamping the AGC line with a fixed voltage are also available; these are especially useful for quickly confirming a diagnosis of AGC trouble, as well as for alignment work.

Sound IF-Audio

The major problem in trouble-

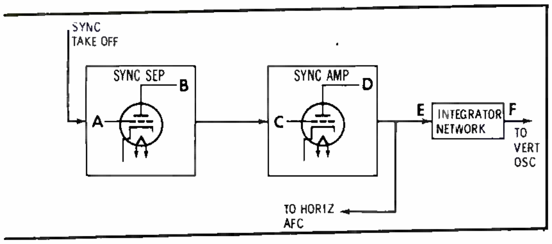


Fig. 4. Some analyzers also permit a stage-by-stage check of sync circuits.

shooting audio circuits arises when you attempt to pin down the fault to one particular stage. Here again, special analyzers come to the rescue. Radio signal tracers, harmonic signal or noise generators, and signal-substitution probes are well suited for troubleshooting the sound section. Signal-tracer instruments will usually include a detector probe, built-in test speaker, and output jacks for monitoring a signal using an external indicator (earphones, a VTVM, or a scope). In some designs, the VTVM may be a built-in feature.

Since the sound IF and detector stages are designed for FM operation, you may find it necessary to use an auxiliary generator in connection with the signal-tracer type of analyzer. In the case of an intercarrier sound system, the audio-modulated output of a generator tuned to 4.5 mc is injected into the grid of the sound IF stage at point A (Fig. 3). The signal-tracing probe is then placed on the plate of that stage, or point B. Providing the stage is operating, the AM test signal should be heard in the instrument's speaker. This test may not be entirely conclusive, since the detector is not actually responding to a frequency-modulated signal. However, if the stages preceding and following the detector check out okay, you can assume that any difficulty must be originating in the detector circuit itself. For the audio section of the receiver, the signal tracer can be employed as in conventional radio circuits. The built-in AF amplifier and speaker system of the analyzer reproduce the TV sound signal from test points D, E, F, and G shown in Fig. 3.

A noise generator can also be successfully used to troubleshoot the TV sound section. The output is usually an audio-frequency square wave, with harmonics extending well up into the RF range. When injected into a sound IF circuit, this signal

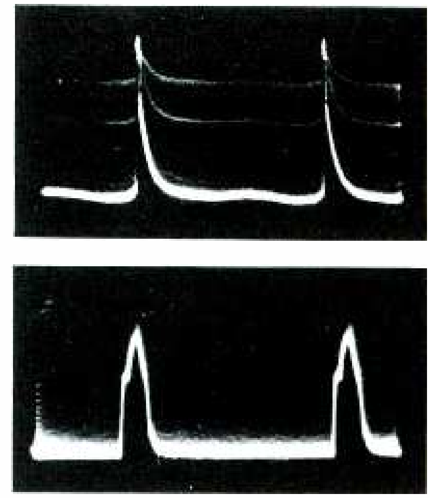


Fig. 5. Vertical and horizontal sync signals from a flying-spot scanner.

behaves as if the RF harmonics were modulated by the basic audio frequency; thus, it can pass through the 4.5-mc tuned circuits, and can produce sufficient output from the detector to be heard in the speaker.

An input for signal-injection testing of the audio section can also be obtained from the vertical sweep circuits of the receiver, using a signal-substitution probe in much the same way as described for testing the video amplifier.

Recent models of flying-spot scanners have a frequency-modulated 4.5-mc output for signal-tracing sound IF and detector stages of intercarrier receivers. Troubleshooting information can also be obtained from the above-chassis waveform analyzers which sample signals from the tube envelopes.

Sync

Several recently-developed special analyzers incorporate test facilities expressly for the sync circuits of TV receivers. These instruments range in design from complex generators to small signal-substitution probes. A sweep-circuit analyzer, for example, might include a separate output jack for a composite signal of both vertical and horizontal sync pulses. In some units, this signal is made available in either a positive or negative polarity. In other types of analyzers, separate adapters are necessary to convert sawtooth drive pulses into usable sync signals.

Using the sync pulses generated by this type of analyzer, you can inject the signal into the various test points illustrated in Fig. 4. Since it's almost impossible to synchronize the generator with a TV-station signal accurately enough to get a stable picture, you'll find it more convenient to monitor the signals passed by each stage on a scope rather than viewing the TV screen. An output signal from a flying-spot scanner can be used in this same manner, provided video modulation is switched off. The signals do not have precisely the same waveshape as those originating from a TV station, but they come close enough to do the job. Examples of these sync waveforms are presented in Fig. 5.

About the simplest probe analyzer available for sync troubleshooting is the type that merely samples the sync signal and applies it to the audio section. If the particular tube or circuit being checked is passing vertical sync, a buzz will be heard in the speaker.

Another analyzer in the probe family contains built-in vertical and horizontal oscillator circuits for substitution testing of those in the receiver. This instrument also provides sync pulses for controlling the frequency of each oscillator, thus making it suitable for checking sync-circuit operation.

Vertical Sweep

When confronted with a trouble symptom involving the loss or distortion of vertical sweep, we naturally welcome any device that will help us isolate the fault to either the oscillator circuit, output stage, or deflection yoke. Several modern-day instruments include test methods for checking this section of the receiver by signal substitution. Certain sweep analyzers, for example, provide a grid-drive signal for the vertical output stage. If sweep returns to the screen when signal is applied between point A (Fig. 6) and ground, you can assume that the vertical oscillator circuit is at fault. If sweep is not restored, the trouble must be somewhere between point A and the vertical yoke winding.

In addition to this grid signal, some special analyzers include plate-

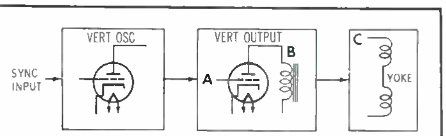


Fig. 6. Vertical sweep section and its three basic analyzer check points.

and yoke-drive pulses which can be used to localize trouble to either the output transformer or the vertical windings of the deflection yoke. These signals are applied to points B and C (Fig. 6). Here again, the indicating device for such tests is the TV screen itself. It's interesting to note, however, that the signal used to test the deflection capability of the yoke is likely to produce a raster resembling Fig. 7, rather than a linear sweep. This is due to the fact that the driving signal from many analyzers is a sine wave rather than the normal sawtooth.

Simple probe-type analyzers have also been developed for troubleshooting this section of the receiver. For instance, one such instrument makes use of the sound system in the set as an indicating device. A lead is attached to the volume-control arm, while the probe samples the signal at the vertical oscillator or output stage. If a 60-cycle buzz is heard in the speaker, this indicates that the vertical signal is at least present.

A stage-substitution probe is another type of analyzer useful in pinpointing a faulty stage in the vertical system. This particular kind of unit features a built-in oscillator circuit which may be substituted for the receiver oscillator. Component analyzers for testing transformers and yokes are also of considerable value in servicing this section.

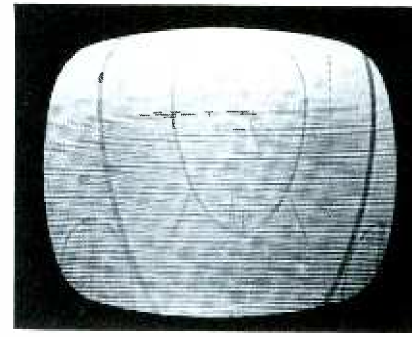


Fig. 7. Raster produced by sine-wave signal fed to grid of vertical output.

Horizontal Sweep

The horizontal sweep and high-voltage section is the "hot spot" of the TV chassis, with high DC and pulse voltages that tend to produce a high failure rate of components. Test-equipment manufacturers, aware of the serviceman's problems in this area, have developed numerous analyzers especially for the horizontal section. Many of these are self-contained instruments that employ a signal-substitution method of tracking down trouble. Most such units include a built-in signal generator plus a circuit for testing flyback transformers and yokes. From the generator, a grid-drive signal may be applied to the horizontal output stage between points B and C in Fig. 8. If the output tube and flyback system are working properly, high voltage and a raster should be obtained. The analyzer may also provide a pulse for directly driving the flyback transformer. In this case, the test signal is applied between points D and C.

Tests of the flyback or yoke are usually made with the component partially disconnected from the circuit. This type of analyzer will generally employ a panel meter or a tuning-eye tube as an indicating device, and some even include features for testing capacitors.

More specialized instruments for troubleshooting the horizontal section not only isolate the faulty stage, but are also capable of measuring various circuit parameters. Through the use of panel switches and tube-socket adapters, a built-in meter

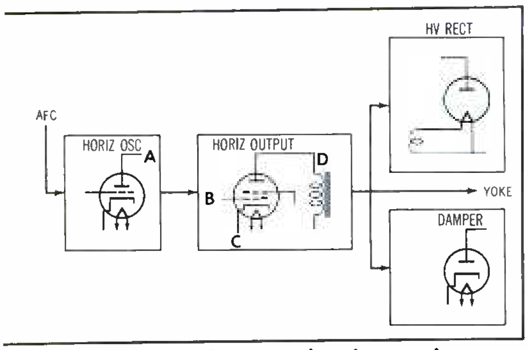


Fig. 8. Diagram showing major analyzer check points in horizontal section.

can be rapidly set up to read voltage, current, resistance, and peak signal values. These more or less automatic measurements naturally save a tremendous amount of time in localizing trouble to the oscillator, output, B+, damper or high-voltage circuit. This variety of analyzer may not always include an internal switching arrangement; it may instead provide test jacks on a tube-socket adapter so that conventional tube-pin measurements can be made from the tube side of the chassis.

Special flyback and yoke checkers, without drive-signal test facilities, also find application in servicing horizontal sweep systems. In addition, the previously-mentioned top-of-chassis waveform analyzers, as well as signal- or stage-substitution probes, can also be of great help in solving horizontal sweep problems.

Summary

In addition to the many specialized instruments just discussed in relation to specific sections of the television receiver, there are also other devices which fall into the "analyzer" category. These include intermittent-trouble locators, various component analyzers, and combination units capable of signal-tracing more than one certain section or troubleshooting both sweep circuits. It might be well to point out here that most analyzers are designed primarily for speedy localization of a defective stage or network. To pinpoint a faulty component, conventional instruments like the voltohmmeter will usually take over where analyzers leave off.

This general discussion of analyzers has barely scratched the surface of the subject. However, it will serve to illustrate how you can vary your troubleshooting tactics to save time for greater profits in servicing. ▲

Select Test Equipment

(Continued from page 27)

capacitance. Therefore, the loading effect may differ for DC, rms AC, and peak-to-peak AC measurements. These factors should be borne in mind by anyone using the various functions of the VTVM.

In work demanding accurate signal-level measurements, frequency response and the type of AC test circuit employed (full- or half-wave rectifier) must also be considered. Unusually sensitive DC - voltage ranges are certainly advantageous if the instrument is to be used to service transistorized circuits.

Provision for polarity reversal is standard on a VTVM; a couple of other convenient features, found on many but not all meters, are probes with selector switches for either AC or DC functions, and a scale with a zero-center indication. The availability of accessory high-voltage and RF probes for extending the ordinary ranges of a VTVM may influence the decision between different units.

Scope

The oscilloscope is now practically indispensable in all branches of the electronics servicing industry. Its most important job is to convert signal voltages into a visual display to be analyzed for shape, amplitude, and frequency. The faithfulness with which it accomplishes this depends upon a number of characteristics. The specifications of a scope express its capabilities, but they may be somewhat difficult to interpret or evaluate.

Sensitivity and frequency response are among the first features of a scope to be considered, but one is normally attained at the expense of the other. Some instruments, on the other hand, may provide a selector switch that offers either high-sensitivity or wide-band operation.

Frequency response of both deflection systems in the scope may be given, but generally the vertical is of greater significance. The typical specification, "DC to 4.5 mc, ± 1 db," as given in Fig. 2, means that, for input signals between the frequency limits of 0 and 4.5 mc, the gain characteristic of the vertical amplifier section is flat—except for variations within 1 db above or below an average gain level. Specifications may also state that this same instrument is useful to some higher frequency (for example, 6 mc). This indicates that the scope can furnish sufficient amplification to allow signals between 4.5 and 6 mc to be reproduced, but only relative amplitudes can be measured. A wide-band response is not always essential; the scope bandwidth needed for a specific job depends on the frequency of the signals to be viewed.

Deflection sensitivity must be evaluated from specifications such as 30 mv/in rms, or 10 mv/cm, etc. These ratings tell how much signal is required to produce a certain deflection. Thus, "30 millivolts per inch" means that an input signal of .03 volts rms will result in a 1-inch trace on the CRT screen. From this it can be seen that lower mv/in ratings signify higher-gain scopes. Generally speaking, the horizontal sensitivity needs to be considered only when applications call for external sweep-driving signals.

Characteristics such as sweep-frequency ranges, rise time, writing speed, etc., can also qualify a scope for certain specialized jobs. The maximum sweep frequency, of course, governs the number of individual cycles which can be reproduced on the scope screen; if the upper limit is relatively low, it becomes impossible to view one or two cycles of a relatively high-frequency signal. Rise time is the period required for the vertical amplifiers to respond to an input signal that instantaneously changes from approximately 10% to 90% of its over-all peak value; the shorter this time, the more accurately the scope can reproduce square waves and sharp pulses. Writing speed indicates how fast the CRT beam can trace across the screen, and is rated in terms of microseconds per inch. This rating is helpful in determining the amount of pulse detail that can be observed.

Writing speed depends on both the horizontal sweep frequency and the horizontal gain. For example, assume the writing speed of a scope is rated at .25 microseconds per inch, and the scope has a maximum sweep rate in excess of 1 mc. When one cycle of a 1-mc signal is locked in, it will spread across four inches of the screen. With the scope set in this manner, a 3.58-mc color burst signal will be slightly over 1" wide and quite distinguishable.

"Additional Features" listed in scope specifications may influence the choice of an instrument. For example, expanded sweep provisions make it possible to view pulse details with greater clarity in certain critical tests. Some scopes have 30- and 7875-cps sweep-selection positions that enable the operator to lock in TV signals with the flick of a switch. Built-in calibration systems simplify making peak-to-peak voltage measurements, while retrace-blanking, sweep-phasing, and intensity-modulation features can be used to provide clearer presentations of alignment response curves and marker indications.

Scopes with vertical-amplifier frequency responses rated in kilocycles, and a numerically high vertical-sensitivity rating, are satisfactory for radio and hi-fi work. They can be used to service TV, but greater detail is obtained with scopes having vertical-response figures in the megacycle range. Color-TV service requires a minimum response rating of 4 mc. Many scopes classified as industrial or research types have such features as automatic lock-in regardless of range, higher frequency response, increased sweep rates, and high writing speeds, which appeal to some radio-TV-electronics service shops.

When choosing a scope, however, remember not to overlook elementary features such as screen size, portability, and availability of accessory probes for the instrument.

RF Generator

Most RF signal generators can also be described as AM generators; i.e., their continuous-wave RF output can be amplitude-modulated by either an internal or external signal of lower frequency. Specifications stating the output signals and frequency ranges of these instruments are fairly self-explanatory (see Fig. 3). The frequency coverage is divided into a certain number of bands. Signal-output levels are generally specified in voltage (e.g., .1

volt rms within 1 db) either for the whole frequency range or for certain bands.

In selecting a generator for a particular job, the main question to be answered is, "What test signals are needed — standard AM or FM broadcast, VHF, or UHF?" Most generators cover certain RF bands, and furnish IF signals which are commonly associated with these RF frequencies.

Accuracy and stability are imperative in a signal generator, especially when it's to be used for tuned-stage alignment or as a marker source. To this end, instruments with crystal-controlled oscillators, regulated power supplies, large calibrated dials, and hairline pointers offer certain advantages. Another feature to consider is the provision for modulation. Many units afford a choice of unmodulated RF, internal modulation, or modulation by an external source. The low-frequency modulating signal, usually 400 cps, is almost always available at a jack on the front panel so that it can be used alone as an audio test signal.

In addition to furnishing RF and IF signals, a generator for use in the

RF Outputs —
AM: 110 kc to 110 mc in 7 ranges;
FM: 100 kc to 160 mc in 7 ranges;
all bands fundamental;
.1 volt rms ± 1 db all ranges;
0-60% modulation control;
70-ohm output cable provided.
AF Output —
0 - 3 volts, 400-cycle tone for internal modulation and to external output jack.
Other Features —
Hairline pointer and illuminated scale.

Fig. 3. Example of specification list for shop-type RF signal generator.

color-TV field should also cover frequencies in the range from .5 to 4.5 mc for use as an accurate marker source in checking the response of video stages.

Sweep Generator

The sweep-signal generator is unlike conventional RF generators in that it supplies an output signal which changes frequency at a constant rate and over a selected range. When this piece of equipment is employed in conjunction with an oscilloscope, it's possible to obtain a visual representation of the voltage response for any frequency-sensitive circuit within the range of the generator.

The most important characteristics of a sweep generator are sweep-frequency ranges, output-signal amplitude, and sweep width. Specifications show the frequency limits of the unit, which may include RF, IF, and video bands. In the case of most TV generators, the RF ranges may cover VHF, UHF, and IF bands; however, some units provide only partial coverage. Signal-output level is generally expressed in rms voltage for either all frequency ranges or certain specified bands. High output ratings assure sufficient signal strength for performing RF alignments.

Sweep width is normally variable by means of a step-type selector switch or a continuous control. As an example of what might be required for various applications, a sweep width of only 450 kc is often used in FM alignments, while directions for aligning a TV set will usually recommend a width of from 6 to 10 mc.

The generator should have a relatively flat response over all bands.

Output impedance of the instrument should be noted so the output cable can be properly terminated and matched to the load circuit. If this is ignored, both response and signal level may suffer. Settings for the center sweep frequency need not be extremely accurate; however, if the instrument incorporates a built-in marker generator, its dial calibration must be very precise.

Some sweep generators have additional features which may influence the selection of a certain instrument to fit specific demands. Blanking provisions add a base line to the scope presentation, providing a zero level for the response curve. Sweep-reversal switches can convert the curve to a "mirror image" in order to match figures shown in service literature. Crystal-calibration features are found on some sweep generators that include a marker generator; this permits accurate adjustment of marker frequencies. Horizontal - sweep driving signals and phasing controls are helpful in obtaining a steadier pattern on the scope. A few units include bias supplies for clamping AGC lines during alignment; still others have low sweep ranges to facilitate checking video circuits as well as bandpass amplifiers and demodulators in color sets.

Pattern Generator

Falling into the category of pattern generators are several units designed for either black-and-white or color TV applications. Such instruments have output signals capable of producing dot, bar, crosshatch, or Indian-head test patterns. These patterns are convenient for signal tracing, linearity adjustments, response checks, color convergence, etc. Specialized generators falling into this category may simulate a closed-circuit TV transmitter and furnish complete signals (modulated RF or composite video) for injection into RF, IF, or video-amplifier sections of a receiver.

Specifications for a typical pattern generator will usually list all available output patterns in a straightforward, unabbreviated form. A separate heading, "Other Features," tells whether the instrument provides only a modulated RF output, or gives a selection of RF, IF, and video signals. The latter naturally provides greater flexibility in the use of the instrument. Tuning ranges of the RF output, and the availability of both positive and negative video signals, are factors to be considered.

In certain instances, provisions for varying the size and number of dots or bars produced by the generator may be advantageous. Specifications normally state this feature if it exists. Either dark patterns on a white background or white patterns on a dark background may be afforded by the instrument. For color-convergence adjustments, white dots and bars of relatively small diameter or thickness are mandatory. A provision for external synchronization is also desirable in many applications.

When choosing a pattern generator, be sure to consider what types of patterns are needed, which frequencies are available, whether a portable unit would be desirable, and how well the instrument is equipped with properly-matched output cables.

Color-Bar Generator

Another piece of equipment designed strictly for television servicing is the color-bar generator, an indispensable unit for checking, troubleshooting, and adjusting color-TV circuitry. These instruments are generally classified into either rainbow or keyed-rainbow types, or those capable of producing an NTSC color-bar pattern.

Servicemen experienced in color television will find that the specifications are as easy to understand as those for any conventional pattern generator. Some of the terms that might be a little unfamiliar are: NTSC — National Television Systems Committee; R-Y, B-Y, G-Y, I, and Q — different types of color signals minus brightness modulation, and demodulated signals; phases — the angle of phase separation between various signals.

A color-bar generator should provide standard color outputs for RF, IF, and ± video, in addition to color-subcarrier signals in phases necessary to check the operation of demodulator circuits. It's best to have all output signals crystal-controlled for greater accuracy.

Audio Generator

As the name implies, the audio generator is used to analyze or troubleshoot sound systems. Tests for harmonic distortion, frequency response, intermodulation distortion, and power gain require an audio generator of some type. Such generators also find use in testing and determining resonant frequencies of individual components, impedance matching, signal tracing, and other applications where relatively low frequencies are required.

The instruments are available as harmonic generators, pure sine-wave generators, pure square-wave generators, and combined sine- and square-wave generators. Their specifications generally include frequency range, output level with respect to frequency and load, and sometimes maximum hum and distortion given either as a percentage of the output signal or in db attenuation. For a unit with a square-wave output, the figures might also include rise time (as mentioned for oscilloscopes), percentage of tilt or rounding of the output wave within certain frequency limits, and provisions for symmetry adjustment.

Intermodulation - distortion tests require two separate signal outputs within the audio range. One must be of higher frequency than the other; a typical combination is 3000 and 60 cycles. In some commercial units, the regular variable output may be used for the higher frequency, while the lower is supplied from a line-frequency source within the instrument.

Almost every audio generator now on the market covers an adequate range of frequencies and provides a suitable output level for just about any application in the field of audio. The characteristic of utmost concern, however, is the output purity or fidelity. If the generator signals are distorted, and are accompanied by excessive hum or interference, the instrument can be of little value in analyzing hi-fi equipment.

Summary

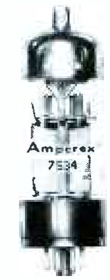
The usefulness of various instruments can be expanded by gaining a better understanding of their capabilities. Troubleshooting techniques can then be tailored to utilize instruments to their fullest potentialities. For the servicemen selecting new test equipment, the following rules should serve as a guide to assure that the right instrument is chosen.

1. Decide on the general type of instrument needed to meet the demands of the test work to be done.
2. Study specifications for various instruments in this general category.
3. Single out the important characteristics that apply only to the operations to be performed.
4. After weighing features of the various instruments and considering price, size, etc., choose a unit — confident that the choice is wise. ▲

PRODUCT report

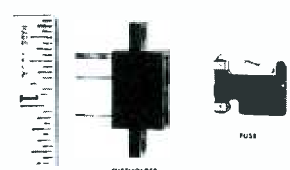
For further information on any of the following items, circle the associated number on the Catalog & Literature Card.

Industrial Pentode (40A)



Both the control and screen grids of the **Amperex** Type 7534 power pentode are of frame-grid construction. One result is an exceptionally low screen current (4 ma) in comparison with a cathode current of 300 ma and Gm of 25,000. This tube is designed for up to 10,000 hours of service in exacting industrial applications such as wide-band amplifiers, series regulators, and Class B push-pull output circuits.

Indicating Fuse Holders (41A)



When a **Bussmann** Type GMT fuse blows, a colored flag springs out to call attention to the open circuit. Fuse failure also closes a set of contacts which can be connected into an external or remote alarm circuit. These subminiature fuses, with matching type HLT holders, are available in many sizes up to 10 amps.

Transformers and Coils (42A)

The **Walsco** "Koil-Pik" display rack holds 44 different types of exact-replacement transformers, coils, and capacitors — particularly featuring ratio-detector and discriminator transformers, radio-TV IF cans, and low-voltage electrolytic capacitors for printed-circuit portable radios. Each component is individually "skin-packaged" on a card labeled with full part-number, model-usage, and price information.

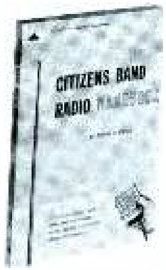
Communications Radio Tubes (43A)

The twin pentode sections of the **RCA** Type 6939 RF power amplifier have a common cathode and screen grid, frame-type control grids, and built-in neutralizing capacitors between sections. Another new tube for mobile communications is the 4604 beam-power type, which is similar to the 6146, but has a quick-heating filament so that it need be operated only during actual transmission in "push to talk" service.

Citizens Band Antenna (44A)

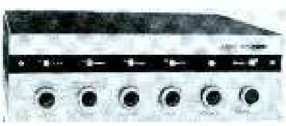
A vertical, two-section, half-wave dipole antenna for Class-D Citizens band base stations, **G-C** Cat. No. 29-734, is "end-fed." The bottom of the lower dipole arm (a high-impedance point) is connected to the lead-in cable through a quarter-wave section of RG-8/U coax, which matches the antenna to a 50-ohm transceiver. Gain is about 1 db over a standard plane antenna with 9′ radials. Made of aluminum, the antenna is 17′ long; list price is $36.60.

Book on Citizens Radio (45A)



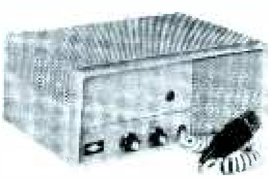
The "Citizens Band Radio Handbook," by David E. Hicks, published by **Howard W. Sams & Co.,** is an introduction to all phases of Citizens band communications — receiver and transmitter circuits, antenna systems, base and mobile station installations, equipment maintenance, and operating procedure. An appendix contains the text of Part 19, "FCC Rules and Regulations," governing the Citizens band. Price is $2.95.

Stereo Amplifier Kits (46A)



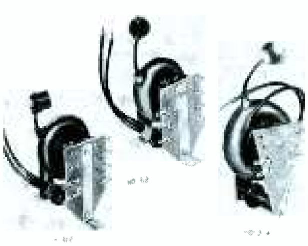
Two newly-styled types of integrated stereo preamp-power amplifier units have been introduced by **EICO.** The ST70 (kit, $94.95—wired, $144.95) has a cathode-coupled phase-inverter circuit driving a pair of 35-watt output stages, while the ST40 (kit, $79.95 — wired, $124.95) features a split-load phase inverter and Williamson-type 20-watt output stages.

Business Radio Transceiver (47A)



For use in the Business Radio Service (two-way AM transmission of business messages in the 150-174 mc band), **Gonset** has introduced the G-150 "Business Communicator." This 5" × 12½" × 8½" unit is usable in either fixed or mobile installations; the power source may be 6V, 12V, or 24V DC, or 117V AC. The transmitter has a power input of 18 watts, and the receiver is a double-conversion superhet.

Flyback Transformers (48A)



Five more exact-replacement horizontal output transformers have been announced by **Chicago Standard.** Type HO-315 replaces Olympic part number TR-3599-5; HO-316 is a replacement for Olympic TR-5598/B; HO-317 replaces Admiral parts 79B77-6, 79D77-6, and 79E77-6; HO-318 replaces Admiral 79B77-7, 79D77-7, 79-E77-7, and 79D77-22; and HO-319 replaces Admiral 79D83-1 and 79D83-2.

Capacitance Slide Rule (49A)

A pocket-size (7" x 2⅝") slide rule, the **Ohmite** "Capacitor Calculator," helps solve problems involving capacitive reactance, power factor, equivalent series resistance, impedance, etc. Important formulas, comparison charts of capacitor types, and conventional A,B,C, and D slide-rule scales are included. The calculator is made of heavy, varnished cardboard and is priced at 25c.

Transistorized Two-Way Radio (50A)

The pocket-sized **Motorola** "Handie - Talkie" transmitter and companion receiver operate on the standard two-way mobile communications bands of 25-54 and 132-174 mc. Measuring 5½" x 2½" x 1⅛" and weighing 14½ oz., the transmitter contains 11 transistors and provides an RF power output of 500 mw. Rechargeable nickel-cadmium batteries can operate for up to 9 hours per charge on a 10% duty cycle, or replaceable mercury cells will give about 80 hours of service under the same conditions.

INDEX TO ADVERTISERS

April, 1961

Latest Jackson Tube Test Data

MODEL 648

Tube Type	Fil.	D.	E.	Plate Test
5DJ4	5.0	13	5	18 W
	"	13	8	18 W
6CQ4	6.3	234	6	14 W
6GW6	6.3	123	AB569	17 W
6HG8	6.3	A1234	B567	40 YZ
	"	123	AC89	15 XZ
15EA7	15.	A238	AC56	75 YZ
	"	234	A17	13 WZ

SUPPLEMENTS LATEST ROLL CHART 648-24

MODEL 598

A.	B.	C.	Fil Cont.	D.	E.	F.	G.
5.0	2	1357	8	4			18
"	2	"		6			18
6.3	8		7	5			17
6.3	2		7	0	5	4Y	19
6.3	4YZ		5	8	2	9	68
"	4Z			7	6		35
15.	7Z		8	5	4		65
"	7			2	1		18

SUPPLEMENTS LATEST ROLL CHART 598-3

MODEL 658

Tube Type	Sec.	Heater	Circuit H-K	Circuit P-G	Plate	Grid Test	Heater Current
5DJ4	D	6.4F	13	5	20R	V	
	D	"	13	8	"	V	
6CQ4	D	6.4L	234	6	18U	V	
6GW6	P	6.4M	123	ah560	20R	70VY•	
6HG8	P	6.4J	1234	b567	30R	10WY•	
	T	"	123	ac89	16S	15WY•	
15EA7	T	18.6E	238	ac56	60Q	10WY•	A22 J Z450
	T	"	234	a17	18R	80VY•	

SUPPLEMENTS LATEST ROLL CHART 658-4

"For further information, see Tube Test Data in PHOTOFACT Folder No. 528"

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ANTENNAS AND ACCESSORIES

1A. *JERROLD*—"Products For Better Televiewing," a 12-page catalog of home TV reception aids, TV distribution systems, antenna-system test equipment, and accessories. *See ad page 9.*

2A. *JFD*—New 1961 *Exact-Replacement Antenna Guide Wallchart for Portable and Toteable TV Sets.* Gives TV-receiver model number, manufacturer's antenna part number, and model number of corresponding JFD exact-replacement antenna. Also Form 940 dealer catalog illustrating and describing 1961 line of natural silver- and gold-anodized *Hi-Fi* TV antennas, mounts, masts, TV tables, and accessories. *See ad page 13.*

3A. *WINEGARD* — 6-page dealer brochure (WPT-3) and envelope-stuffer for consumer advertising (WPS) providing detailed information on *Powertron* electronic antennas. *See ads pages 58, 86.*

AUDIO AND HI-FI

4A. *EICO*—New 28-page catalog of kits and wired equipment for stereo and monophonic hi-fi, test instruments, "ham" gear, Citizens band transceivers, and transistor radios. Also "Stereo Hi-Fi Guide" and "Short Course for Novice License." *See ad page 40.*

5A. *SONOTONE*—8-page 1961 catalog of audio and electronic products, including cartridges, tone arms, tape heads, equalizers, microphones, speakers, and vacuum tubes. *See ad page 65.*

6A. *SWITCHCRAFT*—New Product Bulletin 107 describing two new adapters: No. 370 *Tini-Plug* finger output to phono-jack input, and No. 371 *Thick Panel Phono Jack Adapter.*

BUSINESS AIDS

7A. *OELRICH* — Catalog sheet giving description of No. 1800 *Profit Guard* simplified bookkeeping system (with spiral-bound record book) and No. 1805 accounts-receivable ledger file.

COMMUNICATIONS

8A. *COMMUNICATIONS CO.* — Literature on 680 *Basecom,* a base station for 25-50 and 144-174 mc FM two-way communications; also data on 680 *Fleetcom* mobile unit. *See ad page 54.*

9A. *MOTOROLA* — Complete brochure describing Motorola Training Institute course on two-way radio communications. *See ad page 79.*

COMPONENTS

10A. *ARCO*—Circular describing new *Elmenco* Disc Ceramic Kit No. C120, featuring 5 exact-replacement capacitors in each of 24 values. *See ad page 15.*

11A. *BUSSMANN*—Bulletin EFA on two new fuse assortments in new-style metal display stand which incorporates a special inventory feature. Stand may be hung on wall or stood on service bench. *See ad page 41.*

12A. *LITTELFUSE*—Illustrated price list on entire range of fuses and fuse holders. *See ad 4th cover.*

13A. *PYRAMID* — No. J-19 "hang-on-wall" capacitor-replacement catalog, and *Hook On to Pyramid* leaflet giving details of capacitor kits available to dealers. *See ad page 47.*

14A. *SEMITRONICS*—Replacement and interchangeability charts covering domestic and Japanese transistors, in addition to selenium and silicon power rectifiers.

15A. *SPRAGUE*—New 44-page Catalog C-614, showing complete listings of all stock parts for TV and radio replacement use, as well as *Transfarad* and *Tel-Ohmike* capacitor analyzers. *See ad pages 11-12.*

RADIOS

16A. *ATR*—Complete descriptive literature on *Customized Karadios* to fit imported and compact American cars, featuring 8-tube performance with excellent sensitivity, tone, and volume. *See ad page 14.*

SERVICE AIDS

17A. *ARNOLD LABS.*—Literature on *Formula 99 Furniture-Restoring Kit* for removing scars and blemishes from cabinets, etc., by simple method that requires no sandpapering.

18A. *BERNS*—Data on 3-in-1 picture-tube repair tool, 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 62.*

19A. *CASTLE*—Leaflet describing fast overhauling service on television tuners of all makes and models. *See ad page 67.*

20A. *JW ELECTRONICS* — Dealer leaflet outlining complete tuner repair and alignment service for all makes and models of UHF and VHF tuners. *See ad page 87.*

21A. *PERMA-POWER* — *Britener Selector Guide* and supplement, listing the correct britener choice for every picture tube in general use. *See ad page 68.*

22A. *PRECISION TUNER* — Information on repair and alignment service available for any type of TV tuner. *See ad page 56.*

23A. *VIDAIRE*—Flyer on Model LR-10 *Line Voltage Regulator* for increasing or decreasing AC line voltage fed to TV sets and other equipment rated at up to 350 watts; also data on Model UC-234 *Universal TV and FM Coupler* for connecting several sets to one antenna. *See ad page 84.*

24A. *YEATS*—Information about dolly for delivering TV and hi-fi sets or appliances. and about padded TV, radio and appliance covers. *See ad page 82.*

TECHNICAL PUBLICATIONS

25A. *HOWARD W. SAMS* — Literature describing all current publications on radio, TV, communications, audio and hi-fi, and industrial electronics servicing. *See ads pages 42, 60, 61, 70.*

26A. *SYLVANIA* (Home Electronics Div.)—Information on availability of service literature on television, radio, and high fidelity, and monthly *Service Digest. See ad page 20.*

TEST EQUIPMENT

27A. *B. & K*—Catalog AP17-R giving information on new *V O Matic 360 Automatic Volt-Ohm-Milliammeter,* new Model 600 *Dyna-Quik* tube tester, Model 1076 *Television Analyst,* Models 1070 and A107 *Dyna-Sweep Circuit Analyzers,* Models 550, 650, and 675 *Dyna-Quik* mutual-conductance tube testers, Model 610 test panel, Model 160 transistor tester, and Model 440 CRT rejuvenator-tester. *See ads pages 17, 21, 25, 50.*

28A. *B & M* — 4-page folder describing *Inductive Winding Tester* and electronic switch. *See ad page 70.*

29A. *HICKOK*—Form TT611 describing new Model 890 in-circuit transistor tester and complete line of other transistor testers. *See ad page 63.*

30A. *I. H. MFG.*—Brochure, "How to Use *Telecheck* for Quick Servicing." *See ad page 76.*

31A. *JACKSON* — Catalog sheet describing Model 600 wide-band, high-sensitivity laboratory-type oscilloscope. *See ads pages 69, 88.*

32A. *MERCURY*—Bulletin 500, giving complete specifications on new Model 500 *Component Substitutor* and full information on other test equipment in line. *See ad page 71.*

33A. *PACOTRONICS, INC.*—Product Literature on PACO Model G-34 sine-square wave generator, Model G-32 sweep generator, and Model ST-25 FM tuner kit; also on Precision Model 990 in-circuit transistor tester and Model 58 AC millivoltmeter. *See ad page 53.*

34A. *RCA*—New Catalog 1Q1018 describes full line of electronic instruments, including calibrated test instruments, test-instrument kits, test-equipment probes, and accessories. *See ads pages 49, 73.*

35A. *SECO*—New 16-page booklet illustrating tube testers, dynamic transistor checker, two-way radio test set, and several time-saving service aids. *See ad page 83.*

36A. *SENCORE*—New booklet, *How to Use the SS105 Sweep Circuit Troubleshooter,* plus brochure on complete line of *time-saver* instruments. *See ads pages 35, 36-37.*

TOOLS

37A. *CHAMPION DeARMENT*—New Catalog No. 361, listing *Long Reach* pliers, *Little Champ* precision pliers, *HeatSorb Clamp* (heat sink), and other tools; also Form SA-1 brochure on sales aids and displays. *See ad page 56.*

38A. *VACO*—New 16-page illustrated *Buyer's Guide* covering all types of screwdrivers, nut drivers, pliers, and wrenches. *See ad page 87.*

39A. *XCELITE*—Condensed catalog pages on line of tools for the electronics service industry. *See ad page 64.*

THIS LITTLE TUBE WENT TO MARKET...AND THIS LITTLE TUBE STAYED HOME

Only the RCA tube on the left—which has passed one of the toughest series of quality-control tests in the industry—can be classified "Ready for Shipment."

The tube on the right failed only a single test. You can see that RCA made sure it will never end up on your shelf.

RCA quality-control testing is done automatically on a unique machine *which can perform 14 basic tests.* Tubes failing a single test are automatically rejected, and these are exhaustively analyzed to determine the cause of failure, so corrective action can be taken. *Then they are destroyed!* That's why there's no such thing as an RCA "second".

Automatic testing is but one phase of RCA quality control. In addition, large samples are taken from each production run and subjected to thorough life, quality, and rating checks. No production run can be released until the samples meet specifications.

RCA's extra care in quality control is your assurance that you can depend on RCA replacement tubes. Give yourself this extra advantage on every service job, and help reduce customer call-backs. Call your Authorized RCA Tube Distributor today. *RCA Electron Tube Division, Harrison, New Jersey.*

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