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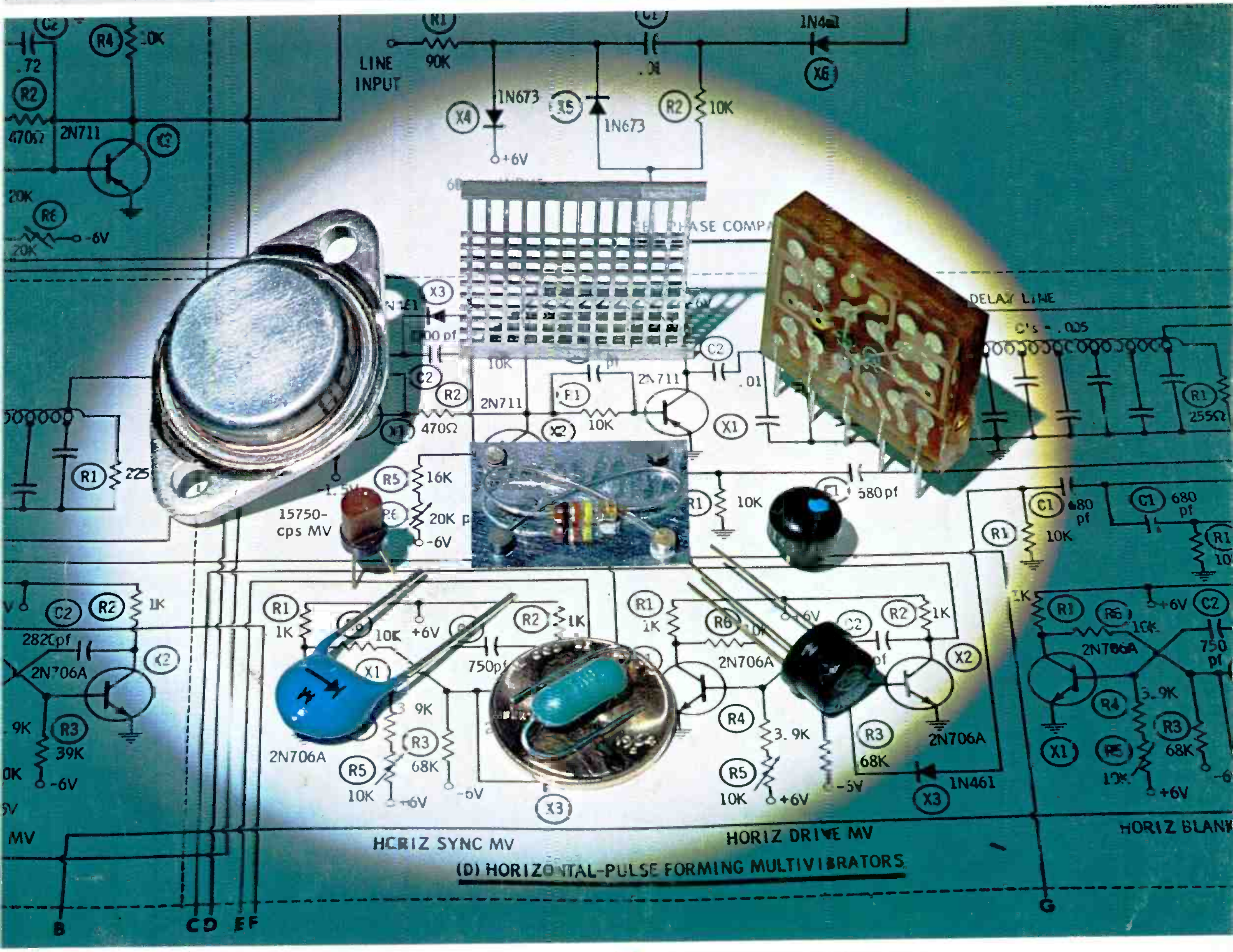

Special SOLID-STATE Issue

- Solid-State Circuits in Test Equipment
- Servicing Vertical Sweep in Transistor Sets
- Solid-State Relays for Industry
- Zeners, Tunnels, Mesas—so What's New?
- Plus other servicing features

SOLID STATE CIRCUITS in Test Equipment

Transistors play an ever-increasing role in servicing instruments.

by Forest H. Belt

With miniaturization and portability the watchwords in modern test equipment, progressive manufacturers are converting to solid-state. Not that semiconductors are anything new in test equipment—they have been used for years as power-supply and meter rectifiers. But modern units have solid-state devices in many other circuits.

Some service technicians hestitate to buy instruments built from transistors. Partly they don't trust transistors yet, but mainly they doubt their own ability to keep the instruments in repair and adjustment. They fear for stability or dependability.

Their hesitancy is unfounded. Properly designed transistorized instruments are not only as stable as their vacuum-tube counterparts but frequently display greater dependability under heavy or even abusive use. Calibration and maintenance procedures are almost identical with those in tube equipment. Only the circuits differ, and these we'll explore in this article.

Rectifier Circuits

Rectifiers are the most common and simple of solid-state circuits, so let's review a few variations of them before we progress into more sophisticated uses of solid-state devices.

Meter Rectifiers

In Fig. 1 are shown three basic rectifier circuits used in AC voltmeters. The multiple diodes in B and C are frequently combined into one unit; older selenium versions were simply open stacks, while modern germanium, selenium, or silicon units are apt to be potted, with only the leads protruding from an encapsulated case.

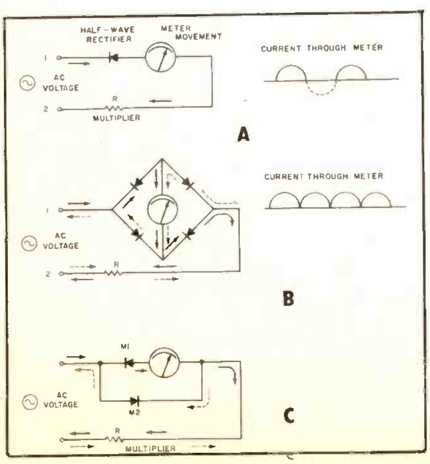

Fig. 1. Most common rectifier circuits.

The half-wave rectifier in Fig. 1A needs little explanation. The diode permits current to flow in only one direction, during one half-cycle of each AC excursion. The inherent slowness of the DC meter movement averages out the pulsating DC that results, causing a fairly steady reading. Some sensitive meters are bypassed with a large-value capacitor that helps smooth out tiny needle fluctuations. The multiplier resistor is chosen to limit current to whatever amount will swing the meter to full-scale when a particular AC voltage is applied at terminals 1 and 2.

The full-wave bridge in Fig. 1B, or a two-diode-two-resistor version of it, is popular in good-quality instruments because it provides smoother action. Current flow is shown during one half-cycle by solid arrows, during the other by dashed arrows. Current through the meter is in the same direction for both half-cycles—hence the name full-wave. A capacitor often bypasses ripple around the meter coil in this circuit, too, although it isn't as important as in the half-wave type, nor is as large a capacitance necessary.

One inefficiency of the simple half-wave design (1A) is overcome by the addition of a second diode—see Fig. 1C. The active half-cycle causes current to flow as usual, as indicated by solid arrows; the alternate excursion, represented by dashed arrows, is bypassed around through the added diode. Reverse current through the meter, caused by rectifier leakage, is thus eliminated.

Shown in simplified form in Fig. 2 is the two-diode-two-resistor version of a full-wave bridge circuit. The first half-cycle (solid arrows) pushes current through X2, the meter, R4, and back to the source. The alternate half-cycle (dashed arrows) of current flows through X1, the meter, R5, and returns to the source. The main course of current is through the meter in the same direction during both half-cycles. Because of R4 and R5, however, a very small reverse current reaches the meter during each half-cycle; this serves only to reduce efficiency slightly and can be allowed for when choosing multiplier resistor R1.

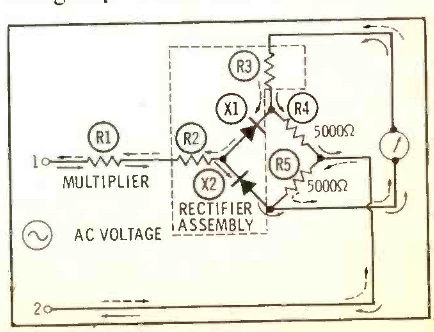

Fig. 2. Full-wave with only two diodes.

Power Supplies

The rectifier power supplies in Fig. 3 are familiar to most technicians. Some of the instruments described later will derive their main DC voltages from a supply like one of these. They are (A) a simple half-wave supply, (B) a full-wave supply, and (C) a negative-output full-wave supply. Rectifiers are either selenium or silicon, single or dual units.

The combination-type power supply used in one modern instrument is shown in Fig. 4. This circuit is a form of voltage tripler, but is easiest to understand if we consider it as a doubler plus an extra negative-output rectifier. C1 charges to the peak input voltage through X1 on one half-cycle; C2 charges through X2 on the next alternation and, since it is in series with already-charged C1, takes on a charge almost double the peak input voltage. Thus, nearly 300 volts DC is developed across R1 and R2. In the meantime, C3 has been charging every half-cycle, developing a DC voltage about equal to the peak input voltage but negative with respect to the junction of X1, C2, and R2; this −150 volts is developed across R3-R4. Since R1, R2, R3, and R4 are in series, 450 volts appears across the entire group—three times the input peak

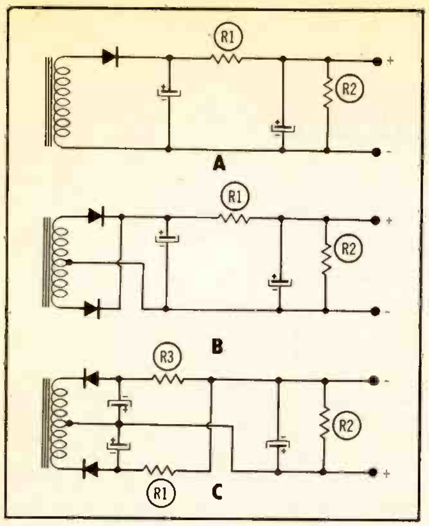

Fig. 3. Simple B- supply arrangement.

voltage. In this particular unit, the designer chose the junction of R3-R4 as the chassis ground point, so all supply voltages are measured with that point as reference.

Demodulator Probes

Probes that are used with scopes and VTVM's, to measure the modulation envelope or the strength of RF signals, also use simple rectifier circuits. Whereas power supplies require high-power solid-state units and meter rectifiers need substantial current capabilities, diodes for RF probes must be extremely sensitive—as the signals involved may measure only a few millivolts or microvolts—and rarely need to carry much current. For detector or demodulator probes, germanium diodes are generally used.

Fig. 5 shows some typical RF probes. The type in Fig. 5A is used most often in service work. The configuration is the same for both scope and VTVM use, but parts values differ. Those values shown are for a scope probe; for a VTVM, the series capacitor would be larger (perhaps .005 mfd) and the resistor value much higher (to perhaps 4.7 meg). Fig. 5B shows a probe that can be used for extra sensitivity when measuring very weak signals; it is a voltage-doubling probe. Fig. 5C shows a probe designed

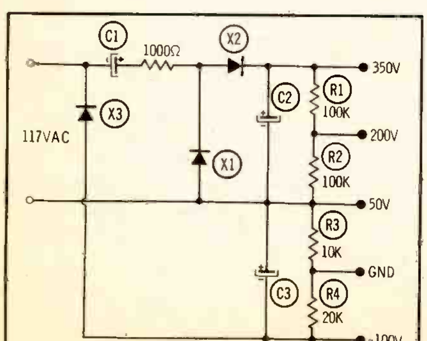

Fig. 4. Voltage tripler; note GND point.

for demodulation with balanced lines, such as 300-ohm television lead-in systems. The one shown is commonly used in running sweep-generator response curves of balanced antenna systems.

The outputs of the probes shown in Fig. 5 are negative-going; that is, they demodulate only the negative side of the modulation envelope and produce only negative DC from unmodulated RF signals. They can be made to produce positive-going outputs, however, merely by reversing the polarity of all the diodes.

Meter Protection

One interesting recent development in solid-state devices for test instruments is the *meter protector* that is becoming popular in modern multimeters. VOM's, lacking the overload-withstanding ability of VTVM's, are being fitted with semiconductor devices that prevent current overloads from burning out meter movements or bending pointers. These protectors take two brand forms: a dual-diode unit at the meter terminals protecting only the meter movement, and a transistor-and-relay arrangement that also prevents multiplier resistors from being burned by overloads.

The diode-type unit consists of two carefully matched silicon diodes from the zener family of regulators. The exact choice of zener breakdown voltage depends on the coil-movement sensitivity and resistance: For a typical 1800-ohm, 50-ua movement, .09 volt (90 mv) applied to the armature will bring the pointer to full scale; the coil can withstand several times that voltage without burning out, but the sudden application of a larger potential might bend the pointer. A .2-volt zener diode connected across the coil will limit voltage enough to prevent damage to the meter. If two such diodes are connected in parallel, and in opposite polarity, across the meter armature (Fig. 6A), they will prevent any type of surge above .2 volt from affecting the meter.

One factor about zener-diode protection circuits is worthy of mention. As long as the maximum current rating of the zener diode isn't exceeded, the diode will take care of the overload without overheating or damage. This means, however, that the source of the overloading voltage must have a certain amount of internal resistance that limits the current it can supply; if not, regulating action of the zener diode must depend on a series limiting resistor of some sort. In one VOM, the movement's own internal calibrating resistor is used as the regulating re-

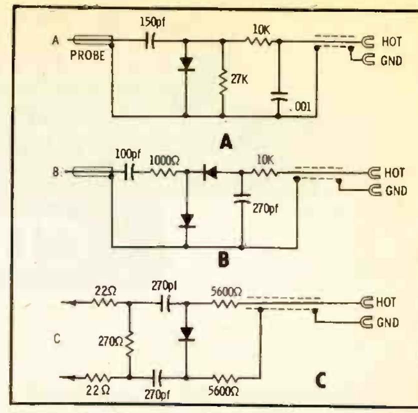

Fig. 5. Demod probes for scope, VTVM.

sistance; the tap is brought out to a third terminal on the meter case, and the protective diode unit is connected across the armature only. With this arrangement (Fig. 6B), greater surges can be withstood without damage to either the protector or the meter.

Since the two diodes are connected in opposite polarities, and are usually mounted as a sealed unit, the technique for testing them is slightly different from testing ordinary diodes. With one end of the diode unit disconnected from the meter, use your ohmmeter to measure the forward resistance of both—that is, connect the ohmmeter in one polarity, then in the other. Both units should measure within an ohm or so of one another and should exhibit forward resistance no less than 5 ohms nor more than 15 ohms. Normal readings tell you the diodes are not open. To be sure neither has excessive leakage, leave one end disconnected from the meter and apply a voltage (or current) to the VOM sufficient to bring the meter exactly to full scale; reconnect the diode unit and watch the pointer—if the change in reading is more than just barely perceptible, the unit should be replaced.

A more elaborate protection device uses a solid-state bridge rectifier, a transistor, and a relay to protect the entire VOM from overloads. Its circuit is shown in Fig. 7. Bridge stack X2 rectifies whatever voltage appears at the terminals of M1. PNP transistor X1 meanwhile is biased past cutoff by a negative voltage applied to the base through R2, and relay K1 is in its normally closed position.

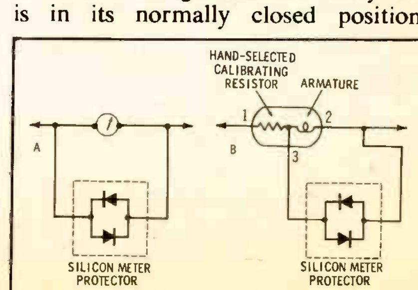

Fig. 6. Semiconductor saves meters.

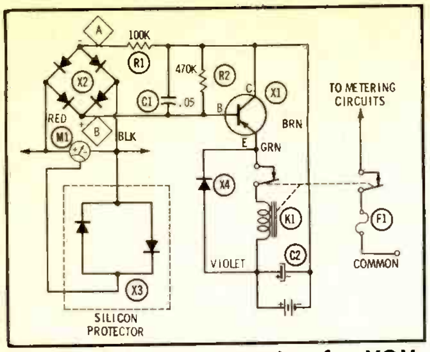

Fig. 7. Elaborate protection for VOM.

When an overload reaches the meter movement, X2 develops a positive output voltage between points B and A. This positive voltage is applied across R2 via R1, overriding the cut-off bias on the transistor. X1 conducts, K1 operates and opens its two contacts, and all connections to the COMMON jack are interrupted. K1 latches mechanically, holding the COMMON lead open and keeping power from the transistor. The overloading voltage obviously is removed and can do no damage to the meter or the range-multiplier circuits. When the overload is removed, K1 can be manually reset and operation of the meter resumed.

Being mechanical, the relay doesn't necessarily open the instant a surge is applied to the VOM. To protect the meter movement from transient voltages and during the first instant of any serious overload, a regular silicon protector diode (X3) is also used with the meter. X4 protects the transistor from surges induced by the relay coil when the contacts open.

Regulated Power Supplies

An important factor in the use of bench power supplies is the constancy of their output voltage. To keep the DC supply voltage constant under varying current demands, solid-state regulators are built into all except the least expensive of these bench power supplies.

Diode Types

Over a limited range of output currents, a zener diode can be used as a simple shunt regulator, as shown in Fig. 8A. Resistor R1 is chosen to allow the voltage at point A, with the zener diode disconnected, to remain slightly above the desired output level when a load is drawing the expected maximum current. The zener diode, when connected, draws enough additional current through R1 to drop the voltage to exactly the zener rating. If the load draws less than maximum current, the voltage at A tends to rise because the IR drop across R1 isn't as great; the zener then conducts more heavily to bring the voltage back down. If the load draws more current than the maximum rating of the supply, however, the voltage at A drops below the zener's breakdown level and the supply is no longer regulated because the zener stops conducting.

Fig. 8B shows a regulator that works with AC voltage; it consists of two zener diodes connected back-to-back. On the positive half-cycle, X1 is forward biased and conducts easily; X2, however, conducts only as long as the positive voltage at point A is above the zener rating, and then draws only enough current to keep the voltage at the zener level. During the negative half-cycle, X2 is forward-biased, while X1 provides zener action. The result is that during both halves of the cycle the voltage at A can rise only so high; the AC output that is obtained is clipped at a fixed level.

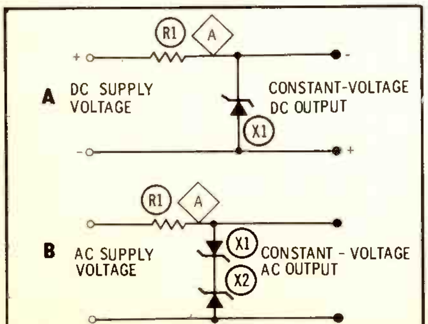

Fig. 8. Zeners, good shunt regulators.

Transistor Regulators

Another form of regulator for solid-state power supplies is the series type of transistor regulator, the simplest of which is shown in Fig. 9. Filtered DC input is from a supply like one of those in Fig. 3. Reference bias for PNP regulator transistor X1 is taken from the slider of R2, which thus controls the level of regulated DC output. Moving the slider more negative increases the forward bias on X1, lowers the collector-emitter resistance, and raises the output voltage at E (for any given load current). Moving the slider toward the positive end reduces the forward bias and thus increases the C-E resistance of X1; the result is lowered output voltage.

When the current drain increases at the output terminals, current through X1 rises, and the voltage at the emitter lowers because of IR drop in the transistor. Reduced negative (more positive) voltage at E means more forward bias; C-E resistance is reduced, and the voltage at E restabilizes at the normal value.

The same system to some degree

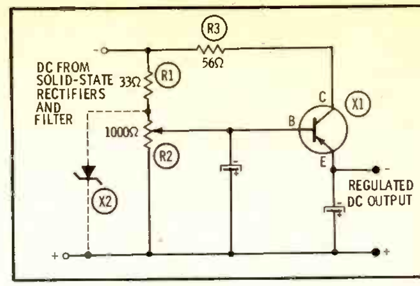

Fig. 9. Simplest-form series regulator.

takes care of fluctuations in the supply received from the rectifiers. A lower input voltage reflects a considerably greater drop at E than at B. Forward bias is thus actually increased, reducing the C-E resistance of X1 and allowing E to return to normal voltage. This system of handling input fluctuations isn't as effective as might be wished, since the variation across R2 tends to cancel regulation slightly. To eliminate this tendency, zener diode X2 is added to some circuits to keep the reference voltage constant despite input variations.

A more elaborate series regulator is shown in Fig. 10. This circuit, with variations, is used in several popular regulated supplies. The R1-R2-R3 chain, with zener diode X4, develops reference voltage for the base of NPN transistor X1, which is also connected across the input voltage in series with R4 and R7. The voltage developed at the collector (C) of X1 affects conduction of PNP transistor X2, an emitter-follower DC amplifier. The voltage at C of X2 controls internal resistance of X3, the PNP series regulator.

Here's how R3 determines the regulated output voltage: If the slider is moved toward the positive end (toward R2), forward bias is increased on NPN transistor X1. Increased conduction through X1 and R4 reduces the positive voltage at C of X1, and thus at the base-emitter junction of X2. Less positive voltage at its base increases conduction in PNP transistor X2, with a less-positive voltage being developed at its emitter (across R5). Reduced positive voltage at B of X3, the PNP regulator, increases

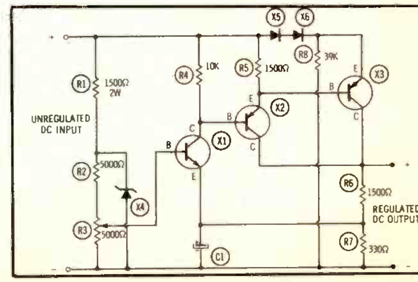

Fig. 10. Some types are more complex.

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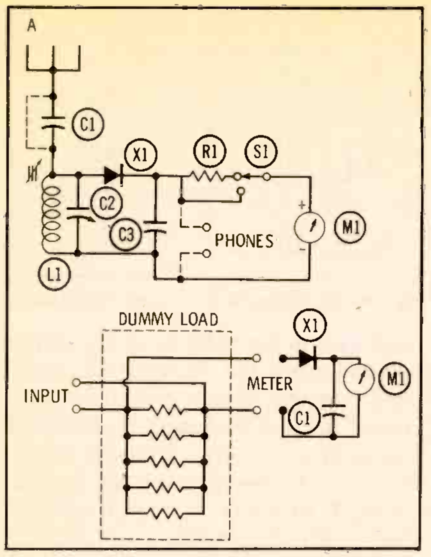

Fig. 11. Field-strength meter and power meter are basically same circuit type.

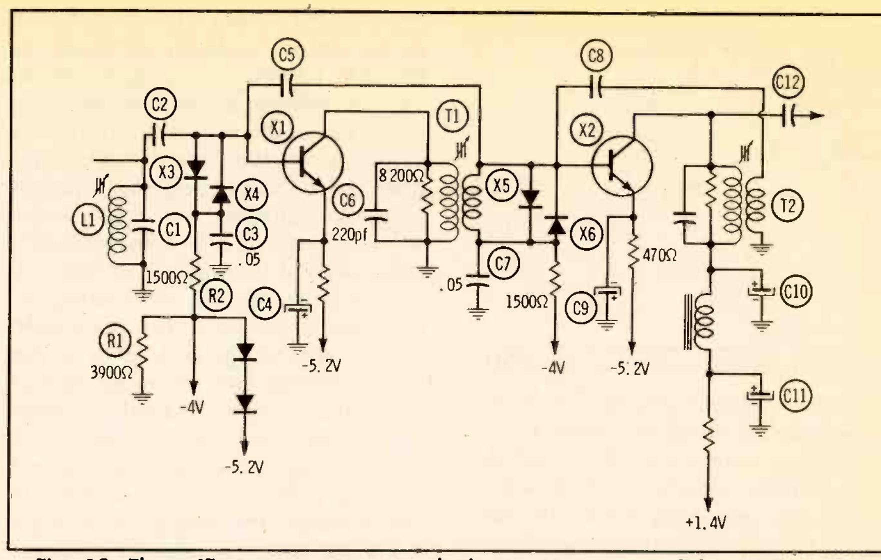

Fig. 13. These IF stages operate much the same as any solid-state RF amp.

conduction and lowers internal resistance; the output voltage is thus increased. When the slider of R3 is moved toward the negative end, the actions are opposite and the output voltage is reduced.

The primary sensing element for changes in output voltage is the R6-R7 network. Reduced voltage across R7 is fed back to the emitter of X1 as a less-positive reaction. Since X1 is NPN, the result is greater forward bias. Action thereafter is the same as when the slider of R3 is moved to increase forward bias: X1 conducts more, X2 conduction rises, and the internal resistance of X3 is reduced; the output voltage rises to normal. A reduced output load allows the regulated voltage to rise. Fed back from R7 to emittter of X1, the positive shift causes X1 and X2 conduction to diminish, which in turn raises the internal resistance of X3; output voltage returns to its proper level.

Variations of this DC-amplified regulator circuit use similar arrangements, although they operate the same. X3 sometimes consists of more than one transistor in parallel to handle greater currents. PNP units may be used throughout, or perhaps all NPN units. Further, the regulator may be connected so that the positive side is common, and regulation takes place in the negative leg. Other variations affect the way of handling the reference voltage: a decade switch may take the place of a potentiometer; some means other than a zener diode may be used for stabilizing.

Signal-Measuring Devices

Simple solid-state components have been used for years in signal-measuring devices. Power meters, field-strength meters, demodulator probes (already discussed)—all use a rectifier to convert signal energy to DC so it can be read on a DC meter. Here are a few circuits you'll encounter in instruments you may already own.

Field-Strength Meter

The simplest field-strength meter is the same as an RF probe; Fig. 5 shows some examples. The schematic in Fig. 11A is an ordinary unamplified FSM. Readings are in relative terms instead of calibrated microvolts. L1-C2 are a tuned tank, which helps prevent erroneous readings caused by signals other than the desired one; further, tank-circuit action provides some increased sensitivity over that of a simple antenna-wire pickup. In some instruments, C1 is omitted. C3 bypasses the remaining RF, while R1—with switch S1—permits reducing instrument sensitivity in the presence of a strong signal.

In more sophisticated units, transistor stages often amplify the RF signal before rectification, and some use DC amplifiers to raise the level of detected DC before it is applied to the meter movement. In the former, ordinary RF amplifiers are used; in the latter, ordinary DC amplifiers. We'll discuss RF amplifiers in other instruments shortly, and DC amplifiers are similar to X1 or X2 in Fig. 10.

RF Power Measurement

Power meters for service work are usually simple devices that merely rectify and measure the signal developed by a transmitter across a standard dummy load—Fig. 11B. For measuring low power levels (fractional to 5 watts), the dummy load is usually part of the instrument. For higher powers, the load itself may be housed in a finned or louvered box for cooling, with RF voltage developed across the resistance and brought out through a jack to the rectifier, meter, and range multipliers. Such a power-measuring setup can be calibrated with a standard or with an accurate RF voltmeter — remembering that $P = E^2/R$.

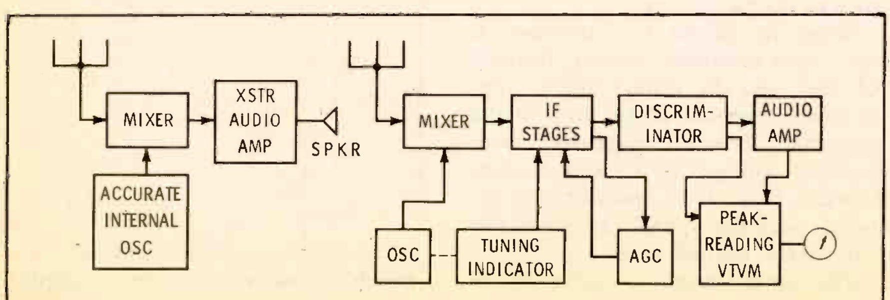

Fig. 12. Simple and elaborate frequency meters using heterodyne principle.

Frequency Meters

Used primarily by communications technicians for checking transmitters that have been adjusted or repaired, frequency meters take several forms. The most popular is the heterodyne type. Not many frequency meters are transistorized, because of the difficulty until recently of procuring transistors that are stable at the frequencies required for commercial frequency measurements. The heterodyne meter, however, particularly the type that feeds the harmonics of a local oscillator into a mixer along with the signal to be measured, doesn't need high-frequency transistors. Fig. 12A shows a simple heterodyne frequency meter that uses ordinary audio transistors to amplify the beat note. The mixing diode is a germanium-type signal crystal.

More elaborate frequency meters, particularly those combined with FM deviation monitors, are superhet FM receivers with calibrated discriminators—a block layout is shown in Fig. 12B.

RF Amplifiers

With high-frequency transistors now practical, RF circuits in some recent instruments are transistorized. The schematic in Fig. 13 is of IF circuits in one RF frequency meter; these stages are typical of solid-state RF amplifiers in other instruments.

The RF signal preselected by tank L1-C1 is fed through capacitor C2 to the base of NPN transistor X1. The power-supply path is R2, with R1 as a stabilizing bleeder. Diodes X3 and X4 load the input of the transistor, since they present a low impedance across the tuned circuit. X5 and X6, connected directly across the secondary of T1, demonstrate this even better.

Notice the neutralization added by C5 and C8. They add degenerative feedback that overcomes the tendency of the stages to self-oscillate at the frequency of the tuned circuits. X2 is neutralized from the secondary winding of T2, even though the secondary isn't used for coupling the signal to the following stages; C12 is the output coupling device for X2.

Deviation Meter

You will frequently find an FM modulation meter combined with a VHF frequency meter, since much commercial two-way radio is narrow-band FM. Fig. 14 shows some of the circuits used in one solid-state deviation meter. The audio from a frequency-counting type of discriminator (shown extracted and redrawn in Fig. 15 for easy understanding) is coupled through a delay line to a three-stage fixed-gain transistor amplifier. The amplifier is standard in many respects; the main differences are the feedback loop around all three stages, which assures constant gain, and the use of bias cells (B1 and B2) to stabilize base voltages on X6 and X7.

The audio is fed to a peak-reading transistorized voltmeter along with reference information filtered directly from the discriminator diodes. The two signals mix in stage X8 to produce a meter reading proportional to average frequency deviations in the incoming signal. In modern versions, a scale switch sets the full-scale meter range for either 15-kc or 7.5-kc deviation readings.

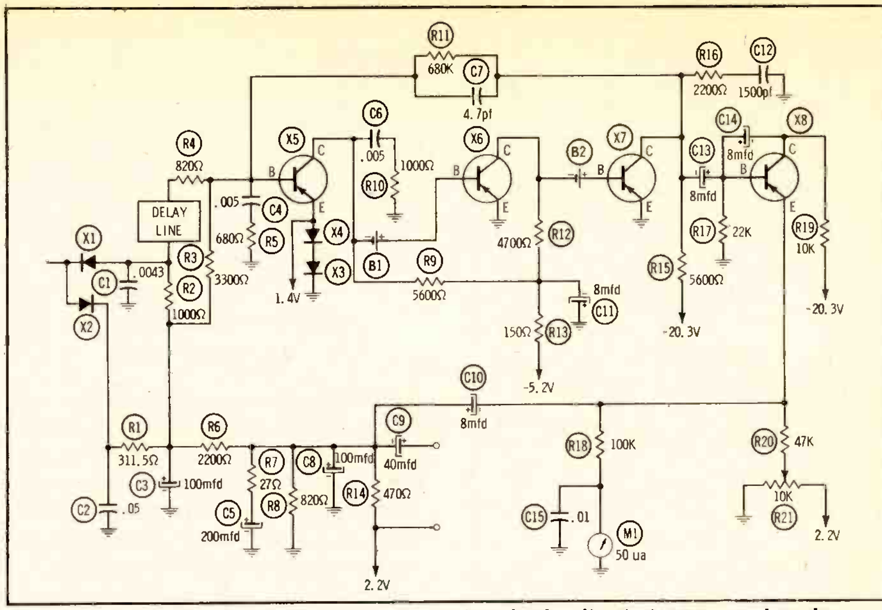

Fig. 14. Deviation-reading section contains both discriminator and voltmeter.

Voltmeters

That most popular instrument, the volt-ohm-millameter, uses semiconductors as meter rectifiers—as we've already pointed out. There are, however, additional uses for solid-state devices in VOM's. The vacuum tube has been used for years to increase the sensitivity of voltmeters; now solid-state devices perform this and other functions in transistorized voltmeters. Fig. 16 shows a simple DC voltmeter using transistors. A switch selects the correct multiplier resistor for the maximum voltage to be measured, and the NPN-type first transistor is a DC amplifier and impedance-matching device. The second transistor, a PNP unit, is one leg of a bridge-type amplifying circuit—redrawn for simplicity in Fig. 16B. The 5000-ohm potentiometer balances the bridge when no voltage is applied, thus serving as an electronic zero control. With a rectifying device, and an appropriate change of multiplier values, this basic DC voltmeter can also be used to measure AC.

A more sensitive bridge-type instrument is shown in Fig. 17. This circuit is sometimes called a differential amplifier because the transistors amplify the voltage difference caused by any change in current through R1. The high sensitivity of this arrangement combines with a sensitive meter movement to make the instrument capable of measuring even very tiny currents. As shown in the inset of Fig. 17, a battery can be inserted in series with the probe to measure resistance. A differential setup like this one can be calibrated with extreme precision. Note also the use of meter-protection diode X3 (this one to prevent damage during reverse-current situations).

An elaborate transistor voltmeter for measuring audio voltages is shown in Fig. 18. The basic block diagram (Fig. 18A) shows how the amplifiers can also be used to feed a speaker; the signal progresses from the final fixed-gain stage to a power stage and thence to the output terminals.

At 18B is shown the preamplifier circuit—which is similar in some respects to the DC voltage amplifier in Fig. 16. In this preamp, however, a

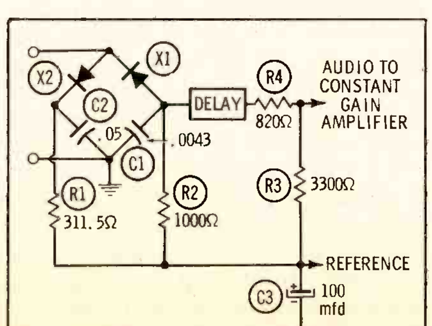

Fig. 15. Discriminator is like bridge.

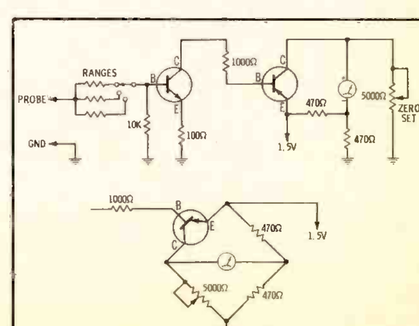

Fig. 16. Simplest transistor voltmeter.

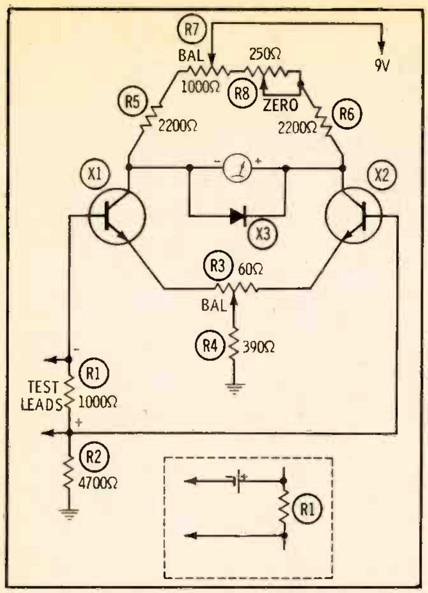

Fig. 17. A bridge-type voltmeter that uses differential-amplifier principles.

more elaborate supply-voltage system is used to furnish bias to the base of X1: R6 and R2 form a DC divider, while their high values, and bypass capacitor C1, prevent audio feedback. Diodes X3 and X4 act as limiters.

The amplifier section (Fig. 18C) uses six stages of transistor amplification, with plain audio amplifiers similar to those in Fig. 14. The first four stages are paired. That is, X3 and X4 are DC-coupled, collector-to-base, with a capacitive feedback loop to assure constant gain; X5 and X6 are the same. Coupling between the pairs is capacitive, collector-to-base, as is coupling to the fifth stage. X7 has two outputs: a direct collector connection to the base of X8, and a capacitive emitter-follower connection to the power output transistor. X8 is coupled through a capacitor to the rectifier-and-meter circuit.

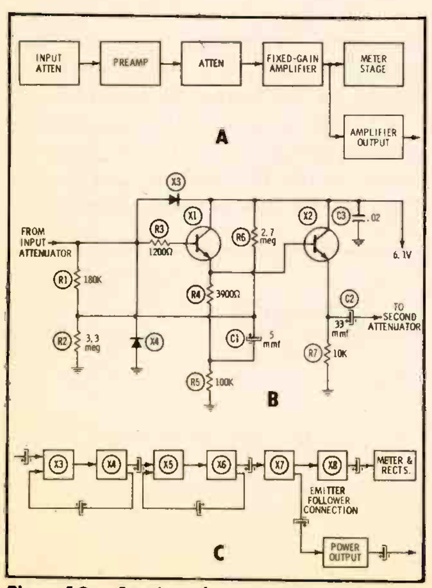

Fig. 18. Sectional arrangement and preamp schematic of audio voltmeter.

A voltmeter of this elaborate configuration is a precision instrument and will be calibrated very closely. One similar elaboration is a precision DC voltmeter with five push-pull stages and no preamp—a total of ten transistors; this unit is so sensitive it can be used for measuring potentials as tiny as fractions of a microvolt.

Solid-State Circuits Can Be Combined

From the foregoing, you can see the way basic circuit arrangements can be used, with or without elaboration and modification, for performing a multiplicity of test-instrument functions. You will find this similarity among many types of instruments.

The circuits used to test transistors and other solid-state devices provide a good example. The transistor is placed in some simple configuration—such as an amplifier or oscillator—and its performance evaluated under controlled conditions. The circuits are standard, and conditions are similar to those under which the transistor might be used.

Fig. 19 shows the arrangement used in one instrument. Transistors are used to generate the RF and audio test signal, and others are used as amplifiers to make the meter more sensitive for measurements with small-signal transistors. The amplifiers are similar to those in Figs. 14, 16, and 18B and C. The oscillators are similar to some we'll be showing in the section on oscillators and generators. The meter rectifying circuits we've already examined (Figs. 1 and 2), and DC supply voltages come from systems such as you saw in Figs 3 and 4. A protection diode (Figs. 6, 7) may be used across the meter movement. Thus you see how basic circuits can be put together in different combinations to perform almost any desired group of functions.

Generating Signals

Up to this point, we've discussed metering and measuring circuits predominantly. The fact is, however, that the newest uses for solid-state devices in test instruments are in generators that supply special signals the modern technician needs to test and adjust unusual types of equipment.

Signal generators of all types are being designed (or redesigned) to use transistors and other solid-state devices wherever possible. We'll now examine some of the basic circuits in these instruments, keeping in mind that many are used in more than one unit—often even in more than one brand.

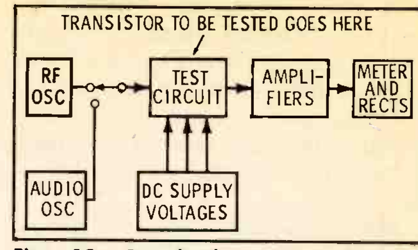

Fig. 19. Standard transistor circuits can be used to test other transistors.

RF Oscillators

One of the oldest and most basic RF oscillators is the *Hartley*. Fig. 20 shows two transistorized versions. A is the usual configuration, in which the emitter is connected to a tap and the lower end of the coil is at RF ground (C4); B shows a modified Hartley, in which the center tap and emitter are still tied together, but at RF ground (C4 for the tap). The circuit at B is simpler, because the bias and supply requirements aren't quite so elaborate —as with the conventional Hartley. Either of these configurations, and other NPN variations, may be found as RF oscillators operating all the way to VHF. The circuit is stable and requires few parts. One drawback of the A version is that both stator and rotor of the tuning capacitor are above ground, complicating mounting problems.

For low-frequency RF applications, especially for fixed-frequency requirements, the *Colpitts* oscillator (Fig. 21) is stable and practical. The configuration is suggestive of the Hartley, except that the feedback tap, connected to the emitter, is between two capaci-

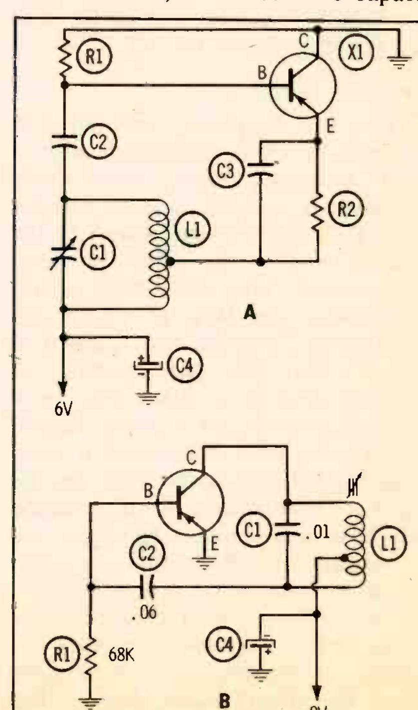

Fig. 20. PNP versions of the "old faithful" Hartley. NPN can also be used.

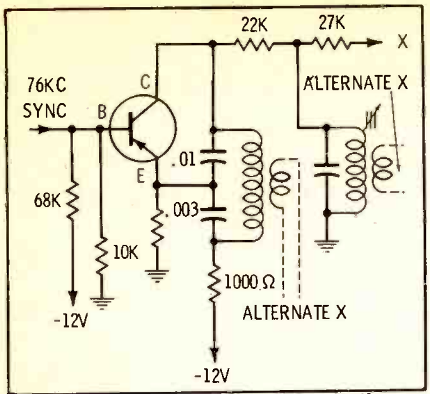

Fig. 21. Colpitts oscillator is similar to Hartley, except the tap is capacitive.

tors instead of two inductance windings. In the circuit shown (a 19-kc pilot-frequency oscillator in a stereo generator), a synchronizing signal is fed to the transistor base to lock the phase with other circuits in the instrument. Oscillator output is taken from point X across a second 19-kc tuned tank. Alternatively, some circuits have their output taken from a secondary winding. As with the Hartley, the Colpitts oscillator has variations, but the one in Fig. 21 is popular.

For signals of extremely accurate frequency, *crystal-controlled* oscillators are necessary. At the fixed frequencies of 3.58 mc (color subcarrier), 4.5 mc (sound carrier), 189 kc (color-bar generator base timer), and 76 kc (multiplex generator base timer), crystal oscillators are widely used.

Fig. 22 shows three common versions found in modern signal generators. All are variations of the Pierce circuit and use both PNP and NPN transistors. Feedback is from collector to base, controlled by the natural frequency of the oscillator crystal. With other transistors, different component values might be used. Output (X) is taken from capacitive dividers for impedance-matching purposes. In Fig. 22B, the capacitive divider is part of a tuned output tank; tuned tanks are used only occasionally in crystal-controlled circuits of this direct-drive variety (on the other hand, overtone crystal oscillators. which operate on the second or third harmonic of a crystal, regularly use a tuned collector tank to assure stability at the overtone frequency). One other feature of the circuit in Fig. 22B is the extra output; primary output X is fed to down-counting multivibrators, while secondary output Y feeds a vertical-line-forming stage.

In the generators used for servicing modern FM and TV equipment, you'll also find VHF oscillators so that the test signal can be fed into the FM or TV tuner directly. Fig. 23 depicts two popular transistor varieties (many transistorized instruments still use tubes in these critical stages).

The circuit in Fig. 23A uses C to B capacitance coupling for oscillation, which transistor RF stages are prone to do anyway if they're not neutralized. In fact, the 6.8-pf capacitor introduces degenerative feedback to keep the oscillator from squegging. L1 is a permeability-tuned coil that resonates with its own distributed capacitance. Output is at X.

Fig. 23B is essentially the same as Fig. 23A, except that the connection for modulation is shown, along with inductive output coupling instead of capacitive.

Audio Oscillators

Solid-state audio oscillator circuits are usually simple. The stage in Fig. 24 is an example—a form of Hartley circuit. T1 resonate with the .5-mfd. capacitor to set the frequency, with R2, R1, and the .01-mfd capacitor having small effects. R1 sets the point of oscillation by controlling bias for X1. Sometimes, instead of a transformer, an iron-core choke is used; in that type of circuit, output coupling is through a capacitor.

Not so simple is the oscillator shown in Fig. 25, a modified form of *Wien-bridge* oscillator with a gain-stabilized feedback arrangement. The bridge output is applied to the amplifier through X1. The amplifier has three output branches: directly to the attenuator and output, direct feedback to one junction of the bridge, and constant-amplitude feedback through X2 to the opposite junction of the bridge. The ranges of frequencies are set by different values of C1 and C2; R1 and R2 tune the frequencies within each range. A circuit this elaborate is used only in precision audio oscillators, where extreme stability and accuracy are requisite.

The circuit in Fig. 26 is unusual in

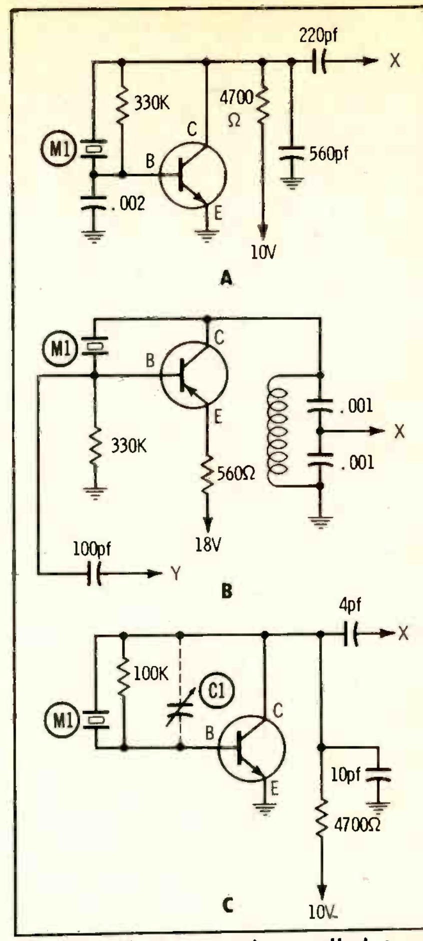

Fig. 22. Three crystal-controlled transistor oscillators of the Pierce variety.

that it is actually two oscillators: In the A position of the switch, it operates as a phase-shift oscillator at 1000 cps, and in position B it is a 67-kc Colpitts oscillator similar to Fig. 21. This makes one transistor do the job of two, which is fine since only one of the signals is ever needed at one time. In switch position A, the output of the transistor is shifted 180° in phase, 60° by each section of the phase-shift network, and applied to the base. Amplified and inverted 180° by normal ac-

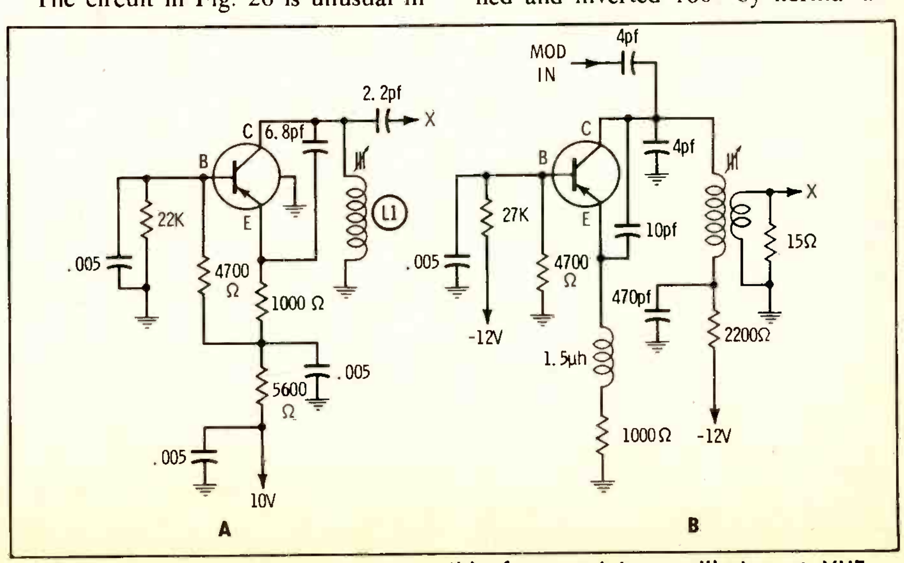

Fig. 23. C—B capacitance is responsible for sustaining oscillation at VHF.

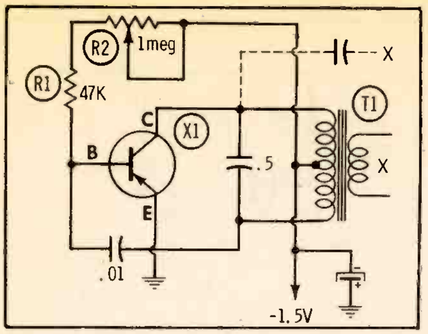

Fig. 24. Hartley form of audio oscillator uses tapped choke or transformer.

tion of the transistor, the signal energy is self-sustaining—a requirement for oscillation. Note that output is via a capacitor at X for phase-shift operation, with capacitor C1 as an emitter bypass. For 67-kc oscillation, C1 is switched to the 67-kc output line, and the stage acts as an emitter follower.

Multivibrators

In a way, a multivibrator can be thought of as one form of audio oscillator. In present-day instruments, however, multivibrators are used more commonly as frequency dividers or counters—they "count down" a signal from one frequency to some submultiple.

The circuit in Fig. 27 is a bistable multivibrator used as a 2-to-1 divider in a stereo generator; with a 76-kc input, the outputs at X and Y are each 38 kc. The usual cross-feedback arrangement is used, with triggering applied via two 220-pf input coupling capacitors. Diodes X3 and X4 prevent bias on X1 and X2 from ever exceeding zero; thus both transistors are kept cut off except when triggered by appropriate input and feedback signals. Since input and feedback signals occur in adding phase only every second cycle of the 76-kc input, the natural frequency of this multivibrator is 38 kc.

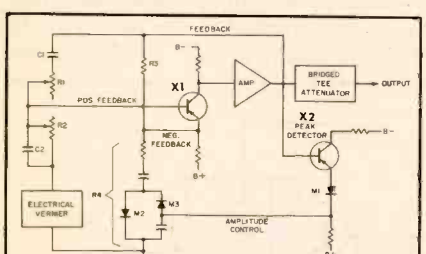

Fig. 25. A Wien-bridge oscillator with added circuit to stablize output level.

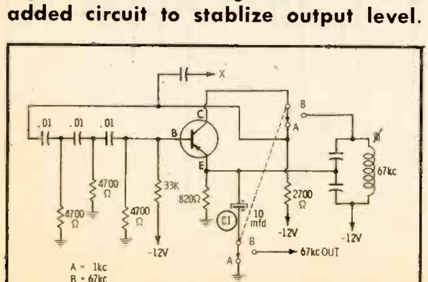

Fig. 26. Unusual combination makes circuit either Colpitts or phase-shift.

Other Counters

The advent of competitively priced and dependable *unijunction* transistors has made possible a greatly simplified counting arrangement for dividing frequencies with solid-state devices. Whereas a multivibrator requires two transistors for each count-down stage, a single unijunction transistor can do the same job. Thus it has become practical to improve stability even while counting down in larger increments (dividing by a larger number).

Fig. 28 shows one basic form of unijunction counter or divider, using two stages. Let's examine the operation of X1, the first stage. The unijunction transistor is cut off, how deeply depending on the setting of R1. Every time a cycle of the 189-kc signal is applied to C1, the capacitor charges slightly; the time constant of C1, R2, R1, and R3 determine how rapidly C1 can charge, and thus how much it charges during one cycle. In adjusting this particular stage, R1 is set so that emitter bias is just enough that the charge on C1 overrides it when six cycles of the input signal have been applied. Thus, X1 effectively counts the cycles of 189-kc signal and produces one output pulse for every six input cycles; the output, taken from base 1 of the transistor, across a 100-ohm resistor, is at a frequency of 31,500 cps.

Looking at stage X2, we see a similar operation. This time, the emitter-circuit time constant has been altered —by changing the value of C2 and the setting of R4—so the circuit counts only five pulses of input signal before firing. X2 therefore divides its input signal to an output frequency of 6300 cps.

Notice also that a second output point is taken from the resistor at base 1 of transistor X1. With 100-ohm resistor R7 for isolation, the same 31,500-cps signal can be used to trigger

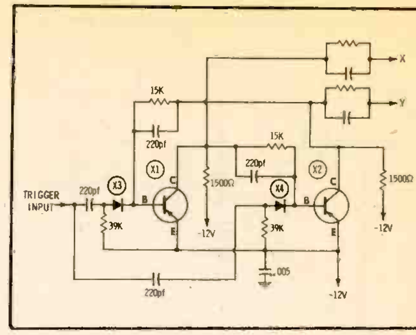

Fig. 27. Bistable multivibrator is cut off during every second cycle of input.

another counter to develop some other frequency.

Miscellaneous Circuits

Other semiconductor stages are used in modern signal generators, especially in color-bar and stereo generators. Most such stages, however, are ordinary amplifiers with special operating characteristics to perform some special job.

Keep in mind the normal action of the particular solid-state device, and you can usually figure out its function in a circuit, even if you're not familiar with the instrument. Study the schematic; consider polarity of the device and of the normal DC voltages around it; notice what other components are connected to it. Circuits you will encounter in most modern generators will be similar to those we've discussed.

Keeping in Touch

After this comprehensive analysis of solid-state circuits in test equipment, you should feel at home with most of the instruments presently available. But solid-state technology isn't standing still. Once you are familiar with the circuits we've outlined here, you have a built stepping-stone to an understanding of later developments. Keep in touch with these developments, and make sure you're servicing with the best equipment available. ▲

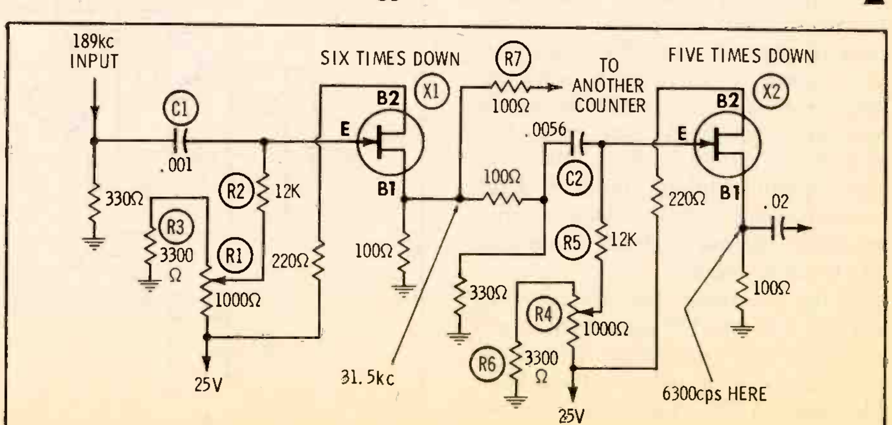

Fig. 28. Latest development for counting circuits is the unijunction transistor.

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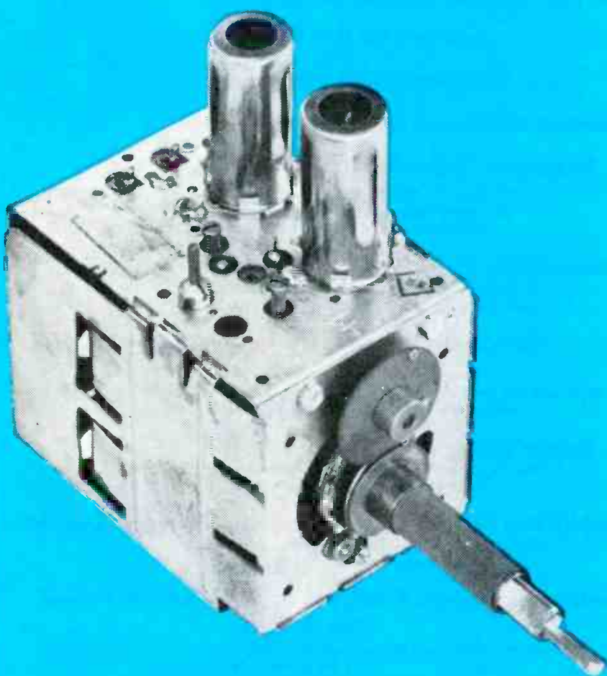

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PF Reporter™

PHOTOFACT

the magazine of electronic servicing

VOLUME, 15, No. 6 *JUNE, 1965*

CONTENTS

ABOUT THE COVER

This month the spotlight is on solid-state devices. It no longer can be said that you'll need to know about transistors to service tomorrow's sets—you need to know about them *today*. Throughout this issue, you'll find informative articles that tell you what's new and interesting in the way of diodes and transistors. Join us on this special tour of the world of semiconductors.

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Take your automobile for instance. Tuning up the motor today is no guarantee against a tire blowout tomorrow!

Such a thing is easier to understand because most of us are more familiar with automobiles than with today's highly complicated TV and radio sets. But such unconnected troubles occur in TV and radio nevertheless—and because they are so hard to explain in non-technical terms, it is always embarrassing to your service technician when they do.

His continued business existence is based on gaining the full confidence of you and other set owners like you. He isn't in business to "gyp" you or to overcharge you. His success is based on doing each and every job to the level best of his ability, at a fair price for his skilled labor. It's only when you patronize the shops that feature "bargains" at ridiculously low prices that you need worry. Good radio and TV service can't be bought on the bargain counter! Set owners who recognize this aren't likely to get "gypped."

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Letters to the Editor

Dear Editor:

Your new COLOR TV GUIDEBOOK was read with a great deal of interest. In the article "Coax for Color TV," however, the author neglected to differentiate between "flat" twin-lead and twin-lead that is specifically designed for color and UHF TV. The use of encapsulated twin-lead will completely change the performance comparisons that are stated in the article. All that glitters isn't gold, and all twin-lead isn't flat.

JOHN BARTHELMY
Manager, Advertising and
Sales Promotion
Belden Manufacturing Company

We appreciate this correction, John. Passing it on to our readers gives us the chance to tell them how well accepted the Guidebook has been. Distributor stocks that have sold out already will be replenished as soon as we can get more of them off the press.—Ed.

Dear Editor:

As a long-time subscriber to both PHOTOFACT and PF REPORTER, I thought other readers might be interested in this method of converting old car radios. I have found that it is a very good shot in the arm for summertime income.

First, select a filament transformer having sufficient capacity to handle the total current required by all the tubes in the set. One side of the transformer secondary is soldered to ground, and the other side is soldered to the "hot" filament lead.

Modifying the B+ supply is probably the easiest part of the whole conversion process. By soldering a 5- or 6-lug terminal strip at any convenient location inside the chassis, you can arrange all the added wires and small components neatly.

You can use any small silicon rectifier, such as the 1N2094, and 30-mfd, 150 WVDC electrolytic capacitors to construct a simple voltage-doubling B+ supply. The old vibrator and rectifier tube should be removed entirely. No change has to be made in the filtering circuits beyond. One must be sure that the on/off switch is left in the circuit, and proper grounding procedures must be taken. Any piece of wire can be used for an antenna.

Besides creating more work at the bench, such conversions can lead to new sales of old tubes such as the 6SA7, 6SK7, 6SQ7, etc.

FRED HUBER
Lemmon, S. Dakota

This could be a good source of some extra income, Fred. We'd like to emphasize the part about proper grounding procedures; a hot chassis can be very dangerous in a garage, basement, etc. It would be best to use such a radio with polarized (3-prong) plugs and receptacles. Or the chassis could be put in a fully insulated box or cabinet.—Ed.

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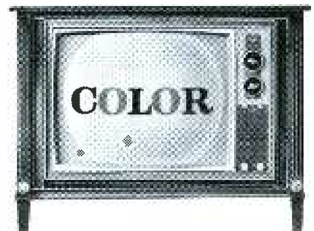

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news of the servicing industry

Expansion Extends to East Coast

An east-coast warehouse and service facility has been opened in White Plains, New York, by **LTV University,** a division of Ling-Temco-Vought, Inc. This is the fifth such facility to be opened in this country by the company. The other locations are Portland, Oregon; Los Angeles; San Francisco; and Chicago. The new 30,000-square-foot facility is located in the former headquarters of LTV University at 80 South Kensico Avenue. It will serve 15 North and Mid Atlantic States, which include New England, New York, New Jersey, Pennsylvania, Maryland, Washington, D.C., Delaware, West Virginia, Virginia, North Carolina, and eastern Ohio (Cleveland, Akron, Youngstown, Canton, and neighboring cities).

Five-Year Cartridge Warranty

Solid-state techniques have now been applied to the stereo phonograph cartridge by **Admiral Corp.** and **Euphonics Corp.** The SM-1 solid-state semiconductor cartridge utilizes silicon elements more minute than the tip of a diamond stylus to generate 100 times the power of a ceramic cartridge and up to several thousand times the output of a magnetic cartridge. Because of the high reliability of solid-state devices, the new cartridge is covered by a warranty for five years—the same term as the transistorized chassis.

New Tape Factory

A magnetic tape manufacturing plant is being built at Hayes, Middlesex, England, by the **Tape Manufacturing Company Ltd.,** a jointly owned subsidiary of **Electric & Musical Industries Ltd.** and **Philips Electrical Industries Ltd.** Both EMI and Philips will sell the new plant's finished products under their own trade names. The plant will contain 75,000 square feet of space. It is being equipped with entirely new machinery for the production of computer and video tapes in addition to the manufacture of audio tape. EMI already is a producer of magnetic tape for entertainment, instrument, and computer industries, and uses the products in many of the 26 recording companies which it owns throughout the world, including Capitol Records, Inc., in the U.S.

Triples Quarters

The Central Regional office of **Sony Corporation of America** has been relocated at 5551 North Milton Parkway, Rosemont, Ill. The new quarters, with facilities for warehousing, service and administrative offices, will triple the size of Sony's present Chicago location.

New Service Plan

A Qualified Service plan has been designed by **Philco Corporation** to ensure the availability of high-quality independent service to owners of Philco products.

The new program calls for the selection and certification of proficient independent service outlets in every Philco market area. Under the terms of the Philco Qualified Service program, the company clearly defines the caliber of organizations it will accept into its certified service network and provides service-store and vehicle identification materials. Philco distributors select and appoint the Philco Qualified Service Centers and implement and administer the program in each market. Prospective service outlets are now being surveyed.

User instruction booklets, being packed with all Philco products shipped from the factory, include a special service section highlighting the Philco Qualified Service plan and recommending that owners contact only those service outlets displaying the Qualified Service insignia. As a result of this and other publicity programs, it is expected that a much greater share of Philco's product installations, adjustments, and repairs will be directed to the new PQS outlets.

• *Please turn to page 20*

The new Amphenol 860 Color Commander cuts alignment time in half!

Ever finish a convergence job to find the raster off center. Lose convergence when you re-centered? Can't happen with the new Amphenol Color Commander, battery-powered, solid-state color generator. A special, single-crossbar pattern consists of one horizontal and one vertical line, crossing just where the center of the raster should be. No need to guess when centering the raster with this new pattern.

See dots before your eyes when you want only one to start static convergence? The 860 gives you that single dot, right at center screen. You'll be switching back to this important dot during dynamic adjustment to make sure you haven't gone off the track.

Even the old patterns offer something new. Line spacing in the crosshatch pattern is rigidly maintained for the 4:3 aspect ratio. You can rely on it for linearity, height, and width adjustments. The pattern gives you finely etched line width at normal brightness levels. What good is perfect convergence at reduced brightness if you lose it when the set's readjusted for normal viewing? This special crosshatch also eliminates receiver

fine-tuning error. Among the 860's nine useful patterns (most color generators have 5 or 6) are: multiple-dot, single vertical line, single horizontal line, vertical lines only, and horizontal lines only.

Finally, the Color Commander's unique color bar pattern (just three bars–R-Y, B-Y and–R-Y) simplify color adjustments. First you can get a rapid, overall check of color circuits. Then you can adjust color demodulator phase or pre-set the hue control and check its operating range. In each step, you know precisely how the color bars should look and how they should change during adjustment.

A new timing circuit eliminates instability and loss-of-sync problems. Silicon transistors maintain built-in precision and stability indefinitely. RF output is on channel 3 or 4, switch selected. An attenuator simulates weak-signal conditions. It has gun killer circuit. With 9 penlight cells, the Color Commander weighs 3½ lbs. In compact, leatherette carrying case, only $149.95.

The new solid-state Amphenol CRT Commander, Model 855, checks all black-and-white or color CRT's with the same techniques used by tube manufacturers. Variable G-2 voltage and choice of bias voltages permit you to simulate conditions found in TV receivers. Adjust electron guns to exact cut-off characteristics, check for emission, continuity, shorts, gas, and expected tube life. In color tubes, check for gun balance. The 855 rejuvenates CRTs where others fail. Features–AC operated, completely portable in matching leatherette case. Built-in burnout-proof voltmeter uses 50-μa d'Arsonval movement. Screen and plate voltage and B+ distribution can be measured with direct probe on 1000-volt scale. Optional probe measures 2nd anode voltage to 50,000 volts. Filament voltage range, in 11 steps: 2.2 to 20 volts. Versatile 5-socket cable accommodates 7 different sockets, handles virtually every CRT without adapters. Complete with CRT Test Chart, $89.95. See Color Commander test instruments at your Amphenol distributor.

Amphenol ®

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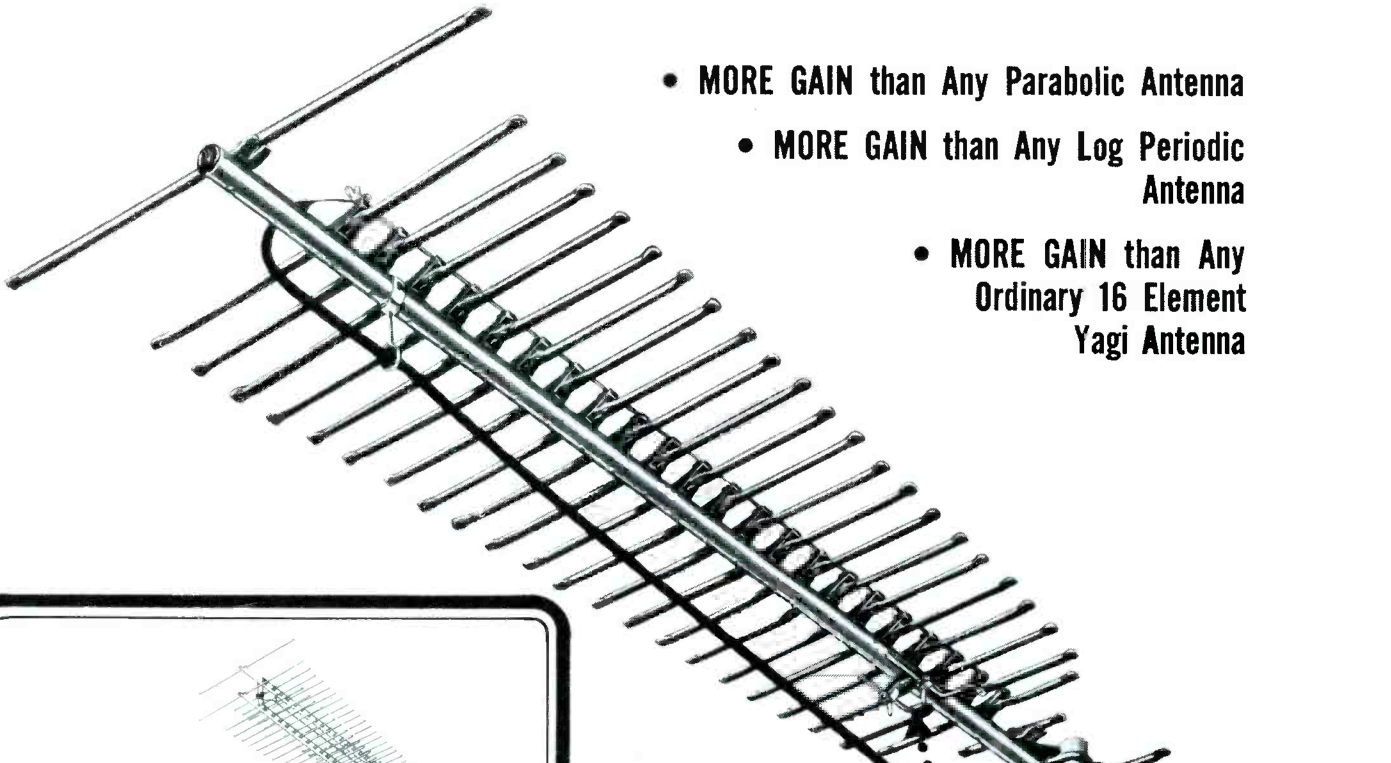
amphenol • borg electronics corporation
2875 S. 25th Ave., Broadview, Ill. 60155

Circle 9 on literature card

FIRST ALL-CHANNEL UHF ANTENNA BUILT



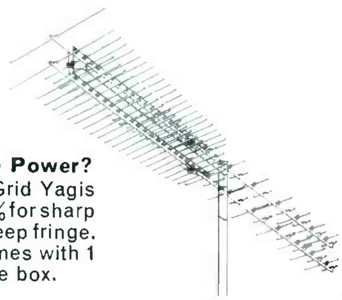
- MORE GAIN than Any Parabolic Antenna
- MORE GAIN than Any Log Periodic Antenna
- MORE GAIN than Any Ordinary 16 Element Yagi Antenna

Want to Couple VHF, UHF and FM? Super-efficient VHF-FM coupler is built right in . . . you work with just 1 down lead!

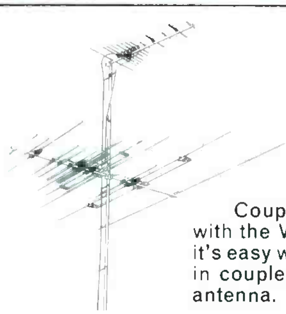
Model No. U-990
Only $29.95 list

GOLD VINYLIZED

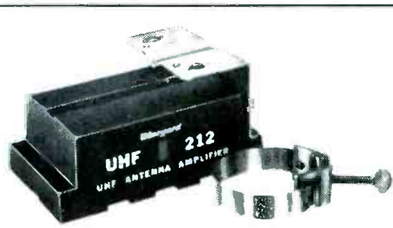
PATENT PENDING



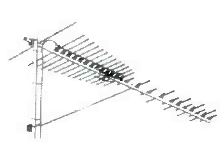
Need Even More Power?
Stacking Planar-Grid Yagis increases gain 41% for sharp pictures even in deep fringe. Every antenna comes with 1 stacking bar in the box.



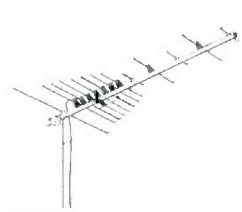
For perfect UHF and VHF reception.
Couple a Planar-Grid Yagi with the Winegard Colortron . . . it's easy with Planar-Grid's built-in coupler. Couples to any VHF antenna.



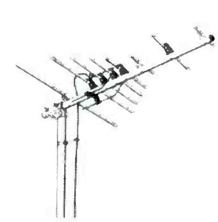
Pull in more UHF stations!
Use the Winegard UHF-212 antenna amplifier . . . Only $44.95 list.



Model No. U-980
Only $19.95 list



Model No. U-970
Only $11.95 list



Model No. U-960
Only $7.95 list

FOR THE CRITICAL DEMANDS OF COLOR TV

Winegard
Planar-Grid
FULL WAVE YAGIS

Unquestionably the Most Powerful All Channel UHF Antennas Ever Made!

- **First Antenna Ever Designed Using the Full Wave Planar-Grid Principle**
- **First Antenna With Progressive Gain Accumulation Across the Entire UHF Band from 14 to 83**

Planar-Grid UHF antennas have arrived . . . a most significant advancement in UHF antenna design. These new UHF antennas have the power and critical characteristics necessary for consistently perfect color reception. And of course, the TV antennas that are best for color are best for black and white, too.

Here's how the new Planar-Grid Yagis eliminate the disadvantages of all existing UHF antennas! Examples:

THE 4-BAY BOW-TIE—and Collinear antennas lack bandwidth. They require at least two separate antennas tuned to opposite ends of the band to give good gain across the entire UHF band. Increasing the gain by stacking of a 4-Bay Bow-Tie is equally impractical because it further reduces bandwidth which is already inadequate. With Winegard's new Planar-Grid Yagis, you get the *highest gain* UHF antenna on the market *PLUS* complete bandwidth.

ORDINARY HALF-WAVE UHF YAGIS, while having high gain, are frequency sensitive and normally maintain top gain over only six or so channels. Winegard Planar-Grid Yagis are made a *full wave wide* to double the capture area. They give very high gain over *all 70 channels.*

PARABOLIC ANTENNAS, by increasing size, can theoretically increase gain, but a parabolic type comparable to the U-990 Planar-Grid Yagi would require an antenna of at least 10 ft. in dia. Parabolics are inefficient and impractical because of size, cost, high wind resistance.

CORNER REFLECTOR ANTENNAS are medium gain antennas and, unlike most basic antenna designs, an increase in size does not appreciably increase the gain. The gain of the Planar-Grid Yagis is directly proportional to size.

Circle 10 on literature card

LOG PERIODIC AND "V" TYPE ANTENNAS, regardless of large size and total number of connected elements, have no more than two or three of their elements working on any one channel. This puts a low ceiling on the available gain for these types of antennas although they do have adequate bandwidth. Another disadvantage is the multiple lobe patterns, especially those antennas employing "V'd" elements working on the third and fifth harmonic mode. This type antenna is unable to reject interfering signals from the side because of these side lobes and can easily degrade picture quality—especially in color.

PLANAR-GRID YAGIS, in comparison, have the sharp uni-directional characteristics to insure clean, sharp pictures and perfect color. On the Planar-Grid Yagi, all parts of the antenna work together on every channel (Progressive Gain Accumulation Principle) giving it the highest gain and greatest bandwidth of any UHF antenna for a given size.

Highest Gain, Complete Bandwidth, Precision 300 ohm Impedance Match across the entire UHF band and Pinpoint Directivity—are characteristic of the brand new Planar-Grid Yagis from Winegard . . . these are really color-quality UHF antennas.

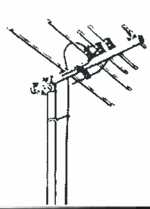
WINEGARD CONSTRUCTION, TOO... Features include Winegard's exclusive wrap-around mast clamp, complete factory preassembly and our new Gold Vinylized finish to protect against weather wear.

Enter the era of UHF now with the color-quality UHF antennas—Winegard Planar-Grid Yagis! Ask your distributor or write for spec sheets today.

Winegard Co.

ANTENNA SYSTEMS

3009G Kirkwood • Burlington, Iowa



Model No. U-950
Only $5.95 list

Electronics Tomorrow

Electronics in the home of tomorrow will not be limited to entertainment devices, W. Walter Watts, group vice president of **RCA,** stated in an address to the Northern California Electrical Bureau. Many of the materials and devices being developed for the military and space programs can be translated into products which will turn the home of tomorrow into a marvel of convenience, cleanliness, and comfort.

As envisioned by some electronic engineers, the miracle home will be run by a "household electronic center" which will virtually take over all daily chores. By pushing a few buttons in this center, you will be able to set up the entire household schedule in advance on magnetic tape. Probably preceding the home electronic center by a number of years will be a home computer, a scaled-down version of those now used by industry.

Mr. Watts predicted that in 10 or 20 years the bulb-like picture tube of today's television set should give way to a thin screen, one or two inches thick, that hangs on the wall like a picture—or fits in a pocket. Personal entertainment, he feels, will continue to grow, and every member of the family will have his own small-screen portable.

The home video tape recorder will open up an entire new business for the home-entertainment retailers. The day will come when the owner of a home video-tape player will be able to walk into a store and rent a color tape of the latest Broadway musical and invite friends in to enjoy it.

Another optional extra to the living room TV set of the future could be a device similar to today's facsimile receivers. It would deliver the latest news and pictures in printed form so you could read about the latest worldwide developments over the breakfast table minutes after the news had taken place. Also in the area of TV, Watts said small closed-circuit systems in the home will enable the housewife to see who is at the door or keep a close check on the baby in his carriage.

Personal communications is another area that will expand

Contest Winners

The grand-prize winner in the recent nationwide "New Ideas" contest, sponsored by the **Hallicrafters Company,** was Robert J. Scott, W8DJD, of St. Clairsville, Ohio. He will receive Hallicrafters amateur radio equipment valued at over $1000. Mr. Scott has been licensed as an amateur radio operator since 1931 and holds the amateur extra class license. The contest required that entrants complete, in 50 words or less, the sentence "My ideas for contributing to amateur radio are. . . ." Over 7500 amateurs submitted entries, and Mr. Scott's suggestions were considered the most creative and practical by a panel of judges composed of Hallicrafters executives and sales personnel.

Regional winners in the contest were: Albert J. Whetter, WA9HQJ, of Chicago; Daniel R. Dorsey, Jr., K4UVT, of Norfolk, Virginia; Roy C. Hejhall, K7QWR, of Scottsdale, Arizona; Wallace P. Beck, W8QQL, of Lansing, Michigan; and Homer F. Borst, W0ACG, Brookings, South Dakota. Each of the regional winners received a Hallicrafters SR-160 transceiver.

further in the future through lower manufacturing costs. Farmers, outdoorsmen, golfers and even straying children could maintain contact with home through a more refined version of today's Citizens band with an expanded number of channels.

Plant Expanded

13,000 square feet of additional plant space has been added at **Utah Electronics** in Huntington, Indiana. This is the fourth plant expansion for the company since the loss of the previous building in a $2,000,000 fire in June of 1962. The recent addition of another assembly line, plus the company's entry into the assembly of large, furniture-type speaker systems forced the present expansion. The additional area will permit stocking a larger inventory of distributor merchandise for faster filling of orders.

CATV School

Entron's first three-day course in CATV-system maintenance was conducted by Heinz Blum, vice-president, engineering. Students from New York, New Jersey, Illinois, Minnesota, Tennessee, Alabama, Mississippi, North Carolina, New Mexico, and Pennsylvania participated in the course, which included instruction in all phases of installation, operation, and maintenance of Entron CATV systems.

The welcoming address to the group was given by Ed Whitney, Entron's vice-president. Irving Kuzminsky, the company's director of advanced engineering, discussed head-end equipment and alignment. Other topics covered included theory; maintenance of various units; and systems layout, extensions, and practices. Each school day consisted of eight hours of instruction and alignment practice. Similar classes are planned for the near future.

New Plant Construction

The contract for construction of a 30,000 square-foot factory building in Sevierville, Tennessee has been awarded by **Electro-Voice, Inc.** Plans for the new building are basically the same as those used in the Newport, Tennessee facility which is presently being used for phonograph-cartridge manufacturing. A training program for employees will be inaugurated in March to facilitate efficient production take-over. Located on 15 acres of land, the plant will be air-conditioned and sprinklered. Complete die casting, plastic molding, and production facilities are included. The Sevierville plant is being designed for complete self-contained production.

New Name

AKG microphones, manufactured by AKG, Akustische U. Kino-Gerate Gesellschaft M.B.H., Vienna, Austria, will henceforth be labelled Norelco Microphones by **North American Philips Company, Inc.,** sole importers of these microphones into the United States. Mr. John H. McConnell, audio-video sales manager for North American Philips, in making the disclosure stated that "the decision to brand these microphones with a Norelco trademark stems from the need to merchandise amplifiers and other sound system components under one strongly identifiable mark." He added that the microphones are the identical microphones previously sold under the AKG name. All Norelco Sound System products, including these microphones, are warehoused and will continue to be serviced at the new North American Philips warehousing and service facility in Long Island City. ▲

Source Guide to Imported Sets

Several "Guides to Importers" listing importers of various brands of electronic products have appeared in electronics publications. However, servicemen have found that many of the companies named were out of business, had moved and left no forwarding address, or simply didn't reply to inquiries.

In compiling the guide shown here, we asked all manufacturers and importers whose addresses were available if they would supply us, or our readers, with information on their sets. Only those who answered are included in this chart. We have indicated whether or not schematics, parts, or repair services are available. If you encounter a brand name not included in this listing, refer to the June 1964 list for the importer's name.

The numbers in the chart refer to the list of manufacturers and importers. The letters "ARS" mean that factory service is taken care of by authorized repair stations; information concerning your nearest one may be obtained by writing the company. "NA" means not available. The final column in the chart tells whether the trade name is covered in the Howard W. Sams specialized series on transistor radios, auto radios, and tape recorders (TSM, AR, and TR series).

Brand Name	Schematics	Parts Available	Repair Service	Sams Coverage
Admiral	1	1	ARS	Yes
Airline	43	43	ARS	Yes
Air Chief	46	46	46	Yes
Akkord	NA	57	ARS	Yes
Alaron	8	8	8	Yes
Arvin	4	4	ARS	Yes
AMD	3	3	3-ARS	No
Autovox	5	5	5A	Yes
AV 250	6	6	6	No
Becker	9	9	9 ARS	Yes
Blaupunkt	10	10	10	Yes
Bradford	30	30	ARS	Yes
Bulova	11	11	11	Yes
Butoba	19	19	19 ARS	No
Califco	ARS	27	27 ARS	No
Califone	12	12	12	No
Capri	45	45	45	No
Channel Master	13	13	13 ARS	Yes
Claricon	3	3	3-ARS	Yes
Concertone	15	15	15	Yes
Conferette	40	40	53	No
Continental	16	16	16	Yes
Coronado	28, 41	28, 41	28, 41 ARS	Yes
Craig	17	17	17	No
Delmonico	18	18	18	Yes
Dorset	66	66	66A	No
Du Mont	20	20	20 ARS	Yes
Duo Sonic	21	21	21	No
Ehrcorder	66	66	66A	No
Electro-Brand	22	22	22	No
Elgin	23	23	23 ARS	Yes
Emerson	ARS	ARS	24 ARS	Yes
Four Star	25	25	25	No
Freeman	26	26	26 ARS	No
Fujiya	ARS	27	27 ARS	No
General Electric	29	29	29 ARS	Yes
Goodyear	41	41	41	No
Grundig	31	31	31 ARS	Yes
Hemisphere	NA	57	ARS	Yes
Hitachi	32	32	32 ARS	Yes
Invicta	NA	68	68	No
ITT	33	33	33	Yes
Kensington	66	66	66A	No
Korting	40	40	53	Yes
Koyo	35	35	35	Yes
Kroy	46	46	46	No
Lafayette	36, 46	36, 46	36, 46	Yes
Lucor	63	63	63	No
Magnavox	37	37	37 ARS	Yes
Masterwork	14	14	NA	Yes
Matsushita	39	39	39 ARS	Yes
Metravox	5	5	5A	Yes
Metz	38	38	38	No

Brand Name	Schematics	Parts Available	Repair Service	Sams Coverage
Midland	41	41	41	Yes
Mitsubishi	42	42	42A	No
Motorola	44	44	ARS	Yes
National Panasonic	39	39	39 ARS	No
Nordmende	63	63	63	Yes
NEC	34	34	34 ARS	Yes
Olson	47	47	ARS	Yes
Olympic	48	48	48 ARS	Yes
Packard Bell	49	49	ARS	Yes
Panasonic	39	39	39 ARS	Yes
Peerless	NA	51	51 ARS	Yes
Penncrest	50	50	ARS	Yes
Philco	52	52	ARS	Yes
Phono-Trix	40	40	53	No
RCA Victor	54	54	ARS	Yes
Realistic	46	46	46	Yes
Realtone	55	55	55A	Yes
Rhapsody	8	8	8	Yes
Roberts	12	12	12	Yes
Ross	56	56	56	Yes
Royal	46	46	46	No
Sampson	NA	57	ARS	Yes
Sears	59	59	ARS	Yes
Seminole	NA	58	58	Yes
Sharp	60	60	60 ARS	Yes
Silvertone	59	59	ARS	Yes
Sony	NA	61	61	Yes
Soundesign	55	55	55A	No
Spectra	6	6	6	No
Standard	ARS	ARS	34 ARS	Yes
Star-Lite	62	62	62	Yes
Star-O-Matic	62	62	62	No
Sterling	63	63	63	No
Sylvania	64	64	64A	Yes
Tandberg	65	65	65 ARS	Yes
Telefunken	2	2	2	Yes
Tempest	7	7	7	No
Three Diamond	42	42	42A	No
Three Star	45	45	45	No
Tokai	67	67	67	Yes
Toshiba	69	69	69 ARS	Yes
Transette	41	41	41	Yes
Truetone	41, 46	41, 46	41, 46	Yes
Uher	38	38	38	No
Unimet	70	70	70	No
Unitone	70	70	70	No
Valiant	71	71	71	No
Vista	17	17	17	Yes
Waltham	NA	57	ARS	Yes
Westinghouse	72	72	ARS	Yes
York	46	46	46	Yes
Zenith	73	73	ARS	Yes

1. Admiral Corporation
P.O. Box 845
Bloomington, Ill.

2. American Elite, Inc.
48-50 34th Street
Long Island City, N.Y.

3. AMD Electronics, Inc.
5648 Friendship Avenue
Pittsburgh, Pa.

4. Arvin Industries, Inc.
Columbus, Ind.

5. Autovox Corp. of America
250 West 57th Street
New York 19, N.Y.

5A. Metravox Corporation
660 McDonald Avenue
Brooklyn, N.Y.

6. A-V Electronics, Inc.
240 South Teilman Avenue
Fresno Calif.

7. Azad International
1133 Broadway
New York, N.Y.

8. B & B Import-Export Co.
15755 Wyoming Avenue
Detroit 38, Mich.

9. Becker Auto Radio U.S.A., Inc.
613-19 South 24th Street
Philadelphia, Pa.

10. Robert Bosch Corporation
40-25 Cresent Street
Long Island City, N.Y.

11. Bulova Watch Co.
Sunrise Highway
Valley Stream, N.Y.

12. Califone-Roberts Electronics
5922 Bowcroft Street
Los Angeles, Calif.

13. Channel Master Corporation
Ellenville, N.Y.

14. Columbia Records Sales Corp.
1080 Goffle Road
Hawthorne, N.J.

15. Concertone, Div. of Astro-Science Corp.
9731 Factorial Way
South El Monte, Calif.

16. Continental Merchandise Co., Inc.
236 5th Avenue
New York, N.Y.

17. Craig Panorama
3412 South La Cienega
Los Angeles, Calif.

18. Delmonico International
50-35 56 Road
Maspeth, N.Y.

19. Dobbs, Stanford
569 Laurel Street
San Carlos, Calif.

20. DuMont, Div. of Emerson Radio, Inc.
524 West 23rd Street
New York, N.Y.

21. Duosonic Corp. of America
251 Park Avenue South
New York, N.Y.

22. Electro-Brand
325 West Huron Street
Chicago, Ill.

23. Elgin Radio Div. of Elgin Watch Co.
847 Jackson Boulevard
Chicago, Ill.

24. Emerson Radio Inc.
524 West 23rd Street
New York, N.Y.

25. Fortune Star Product Co.
1207 Broadway
New York, N.Y.

26. Freeman Electronics
733 North Highland Avenue
Los Angeles, Calif.

27. Fujiya Corporation, Ltd.
45 West 21st Street
New York, N.Y.

28. Gamble-Skogmo
15 North 8th Street
Minneapolis, Minn.

29. General Electric Co.
1101 Broad Street
Utica, N.Y.

30. W. T. Grant Company
1441 Broadway
New York, N.Y.

31. Grundig Triumph Adler Sales Corp.
845 3rd Avenue
New York, N.Y.

32. Hitachi Sales Corp.
666 Fifth Avenue
New York N.Y.

33. ITT Distributor Products Div.
250 Broadway
New York, N.Y.

34. Kanematsu New York, Inc.
606 South Hill Street
Los Angeles, Calif.

35. Koyo Electronics
330 Madison Avenue
New York, N.Y.

36. Lafayette Electronics Intl., Inc.
111 Jericho Turnpike
Syosset, N.Y.

37. Magnavox Company
2131 Bueter Road
Fort Wayne, Ind.

38. Martel Electronics
2356 South Cotner
Los Angeles, Calif.

39. Matsushita Elec. Corp. of America
200 Park Avenue
New York, N.Y.

40. Matthew Stuart & Co., Inc.
156 Fifth Avenue
New York, N.Y.

41. Midland International Corp.
1519-21 Atlantic Street
North Kansas City, Mo.

42. Mitsubishi Electric Corp.
119 Lake Street
Chicago, Ill.

42A. Valley Television Service
5932 West Chicago Avenue
Chicago, Ill.

43. Montgomery Ward & Co.
619 Chicago Avenue
Chicago, Ill.

44. Motorola Inc.
9401 West Grand Avenue
Franklin Park, Ill.

45. Nason Trading Co., Inc.
230 Fifth Avenue
New York, N.Y.

46. New York Transistor Corp.
150 Fifth Avenue
New York, N.Y.

47. Olson Electronics Inc.
260 South Forge Street
Akron, Ohio

48. Olympic Radio & TV Sales Corp.
34-01 38 Avenue
Long Island City, N.Y.

49. Packard Bell
12333 West Olympic Boulevard
Los Angeles, Calif.

50. J. C. Penney Co., Inc.
1301 Avenue of the Americas
New York, N.Y.

51. Peerless Telerad
22 West 27th Street
New York, N.Y.

52. Philco Corporation
Tioga & C Streets
Philadelphia, Pa.

53. Phono Trix Service, Inc.
3650 Dyre Avenue
Bronx, N.Y.

54. RCA Sales Corporation
600 North Sherman Drive
Indianapolis, Ind.

55. Realtone Electronics Corp.
34 Exchange Place
Jersey City, N.J.

55A. Realwest Service Corporation
10823 East Rush Street
El Monte Calif.

56. Ross Electronics
589 East Illinois Street
Chicago, Ill.

57. Sampson Electronic Products Div.
2244 South Western Avenue
Chicago 8, Ill.

58. Sons & Streiffe, Inc.
8400 Brookfield Avenue
Brookfield, Ill.

59. Sears Roebuck & Co.
925 South Homan Avenue
Chicago, Ill.

60. Sharp Electronics
178 Commerce Road
Carlstadt, N.J.

61. Sony Corporation of America
514 Broadway
New York N.Y.

62. Star-Lite Electronics Corp.
37 West 23rd Street
New York, N.Y.

63. Sterling Hi-Fidelity Inc.
22-20 40th Street
Long Island City, N.Y.

64. Sylvania
700 Ellicott Street
Batavia, N.Y.

64A. Sylvania Service & Parts Depot
2001 North Cornell Avenue
Chicago, Ill.

65. Tandberg of America
8 Third Avenue
Pelham, N.Y.

66. Terra International Co., Ltd.
3 East 28th Street
New York, N.Y.

66A. Terra International Co., Ltd.
5 East 28th Street
New York, N.Y.

67. Tokai Corporation of America
500 Fifth Avenue
New York, N.Y.

68. Toyomenka Inc.
73 Pearl Street
New York, N.Y.

69. Transistor World Corp.
52 Broadway
New York, N.Y.

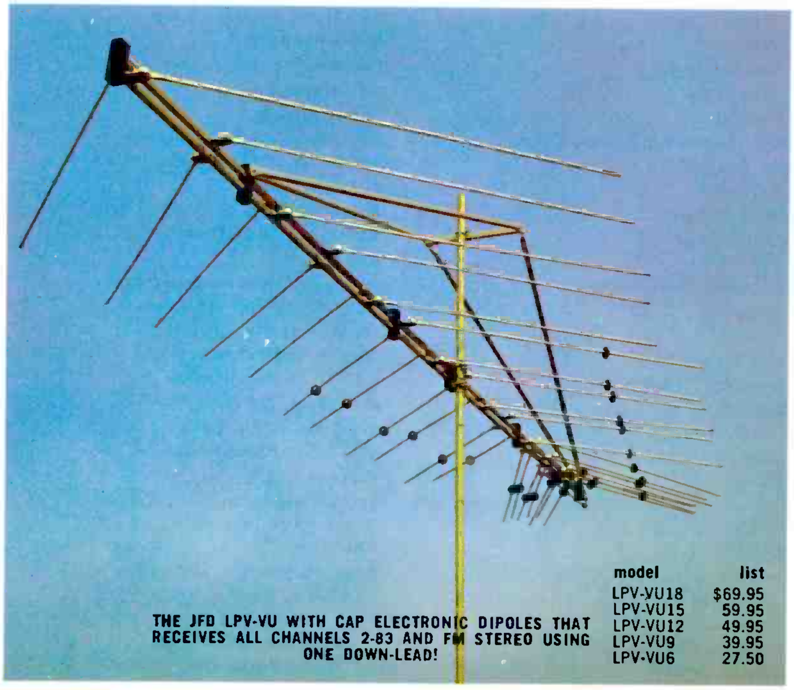
70. Union Metal Works Ltd.
Rooms 1933-36 Union House
Chater Road, Hong Kong

71. Valiant Radio Corporation
156 Fifth Avenue
New York, N.Y.

72. Westinghouse Electric Corp.
Metuchen, N.J.

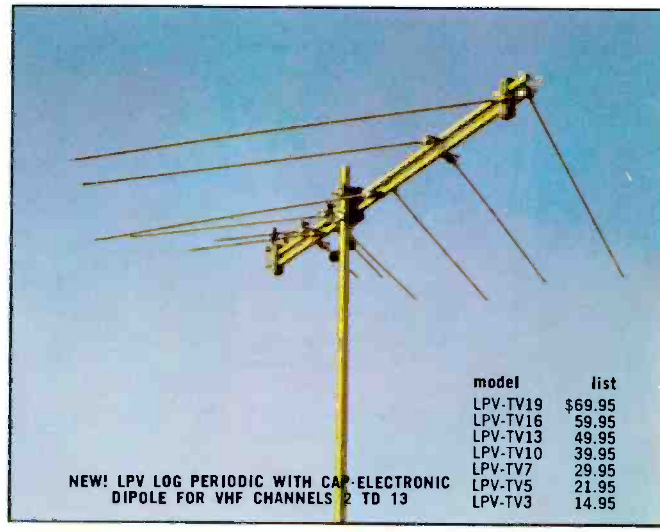
73. Zenith Sales Corporation
1900 North Austin Avenue
Chicago, Ill.

Don't Be 1/2 Set... With JFD LPV Log



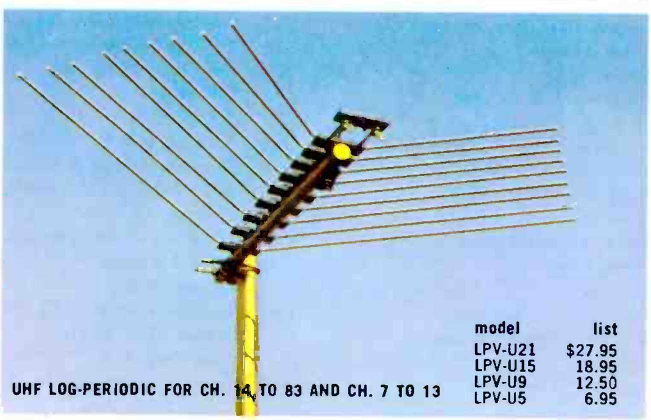
THE JFD LPV-VU WITH CAP ELECTRONIC DIPOLES THAT RECEIVES ALL CHANNELS 2-83 AND FM STEREO USING ONE DOWN-LEAD!

model	list
LPV-VU18	$69.95
LPV-VU15	59.95
LPV-VU12	49.95
LPV-VU9	39.95
LPV-VU6	27.50



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

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



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

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

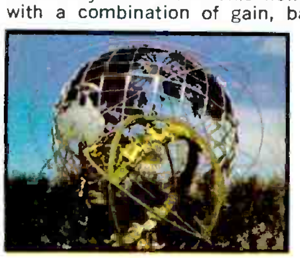
UHF ZIG-A-LOG ANTENNA FOR CHANNELS 14 TO 83

model	list
LPV-ZU20	$34.95
LPV-ZU10	15.95

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

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

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



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

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

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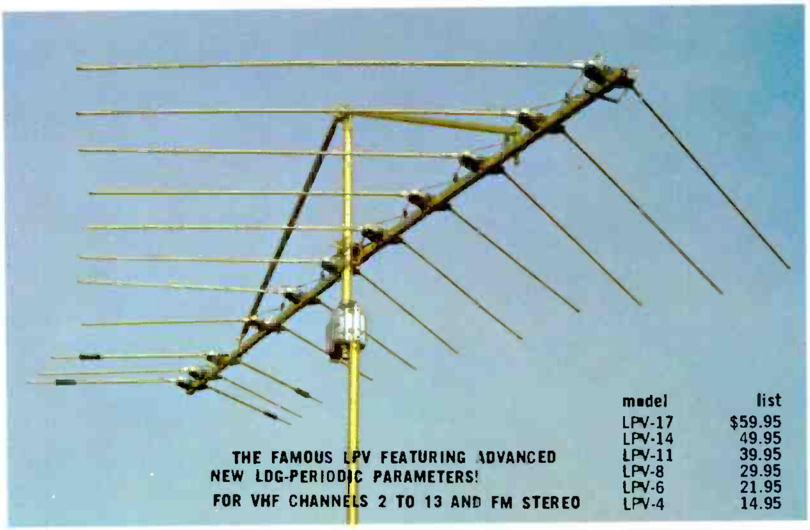

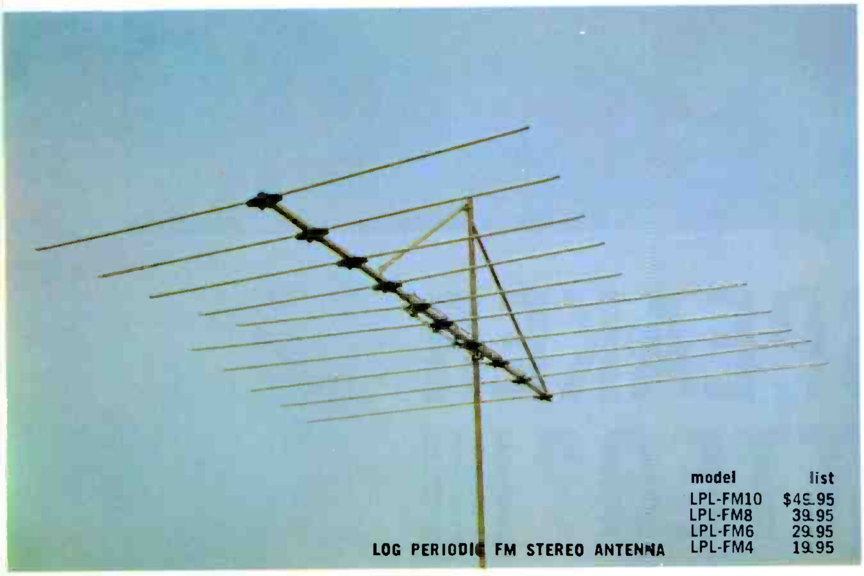

(Ch. 14-83)...FM/Stereo...VHF/UHF/FM–COLOR & Black/White

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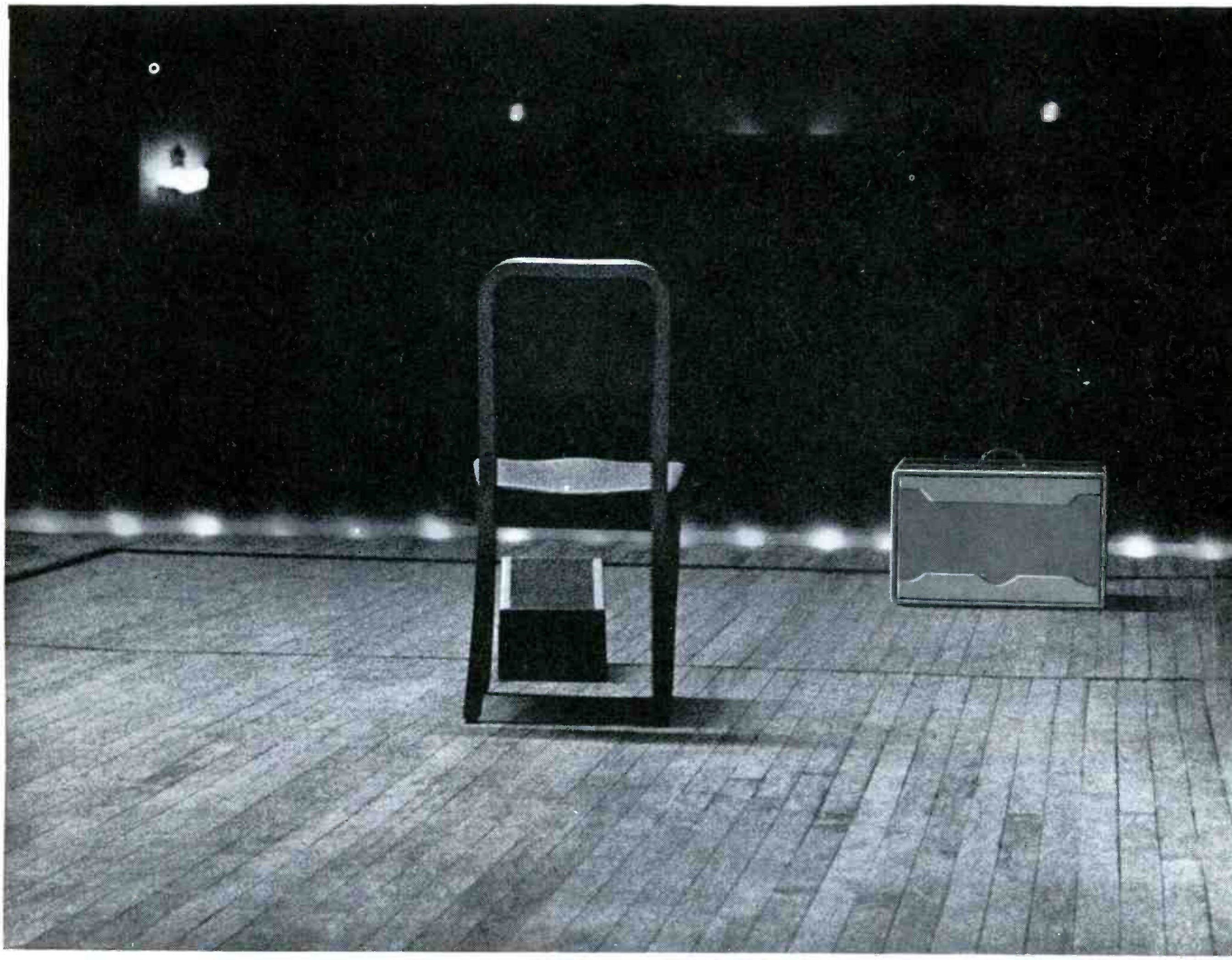

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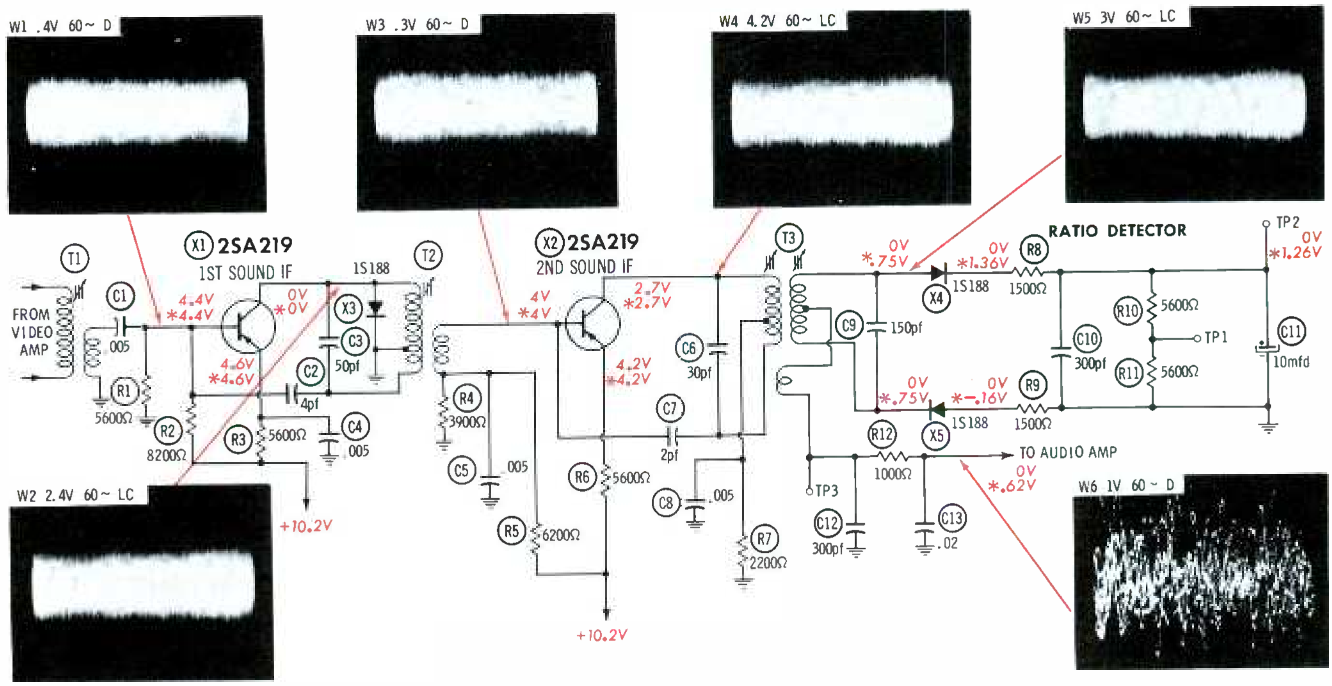
Circle 13 on literature card

Transistor Sound IF

With Ratio Detector



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

WAVEFORMS taken with wideband scope; TV controls set to produce normal picture and sound. Direct (D) and low-cap (LC) probes used where indicated.

Normal Operation

Sound IF signal is coupled from collector of video amplifier to base of X1 by T1. Signal is amplified by X1 and partially limited by diode X3. Limiting action of X3 affects positive alternations low signal, but tank circuit (C3 and T2) provides some smoothing action for both positive and negative half-cycles. T2 applies signal with proper matching to X2. Further amplification and limiting of signal is provided by X2. Limiting action of X2 is caused by more positive collector potential which lowers difference of potential between emitter and collector. This allows saturation to occur with low levels of signal input. Two ratio-detector diodes are X4 and X5. Unbalanced ratio detector is used—ground is at one side of C11 instead of between R10 and R11, location of TP1. C11 provides stabilization necessary to eliminate response to amplitude variations in IF signal. This accomplished by C11 charging to average voltage level of IF signal. Quick amplitude changes in IF signal do not cause increase in output because of time constant of C11-R10-R11. Voltage variations corresponding to frequency variations in IF signal (which represents audio) are developed across C12. C12, R12, and C13 make up deemphasis network. Two types of bias are used by X1 and X2: safety bias, provided by R3 for X1 and R6 for X2, and fixed bias, provided by R1 and R2 for X1 and R4 and R5 for X2. Positive potential is developed at collector of X2 by dropping resistor R7.

Operating Variations

DETECTOR OUTPUT DC voltage at output of detector varies according to modulation content of signal. No audio voltage is present without signal and modulation. Waveform amplitude shown is average, since audio strength is constantly varying.

ANODE X4 DC voltage at top of T3 secondary is zero without signal and .75 volt with signal, although voltage will vary according to signal strength. Same voltage will be measured on cathode of diode X5.

TP2 DC voltage at TP2 is zero without signal and 1.26 volt with signal, again varying according to signal strength. Remember that voltage readings at high-impedance points must be made with VTVM.

WAVE-FORMS Significant stage-to-stage changes are evident from photos of waveform amplitudes. This does not mean that signal strength is changing; signal voltages are simply being transferred from high-impedance to low-impedance circuits. This is because of difference between base and collector impedances of common-emitter configuration. Notice that waveforms at low-impedance points were taken with direct probe, high-impedance points with low-capacitance probe.

Symptom 1

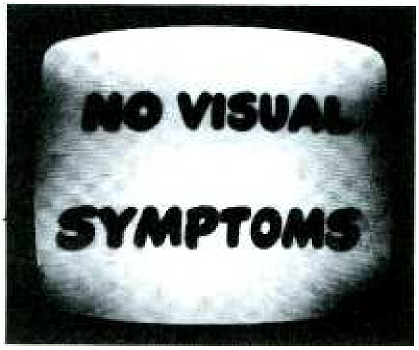
No Audio

Faint Buzz

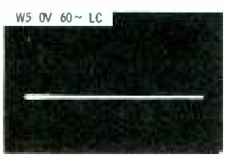
X1 Shorted

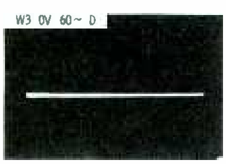
(1st Sound IF Transistor—2SA219)

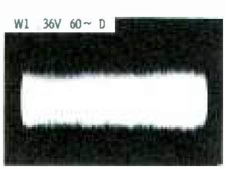
Symptom Analysis



No audio at all. With volume control at maximum, low-level buzz is heard. Output stage is okay since rotating volume-control changes buzz level. Fine-tuning control can be rotated to show sound bars in picture; presence of audio at input to sound IF is indicated.



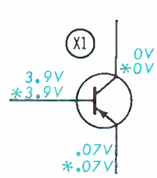




Waveform Analysis

Waveform checks at W5 and W3 show complete loss of RF at these points. RF signal is finally found at W1, but amplitude is slightly below normal. Scope check at W2 shows no signal. Lack of signal at emitter of X1 is normal, but signal should appear with C4 disconnected (by cutting fine line through printed-circuit foil). Absence of waveform at emitter of X1 indicates either emitter is open or X1 is shorted.

Voltage and Component Analysis



Voltage at X1 base is slightly reduced, while that at emitter is reduced almost to zero. Voltages present at emitter and base would cut off good transistor. However, if transistor were biased beyond cutoff, emitter voltage could not be that low. Shorted C4 could be cause of reduced voltage, but test shows C4 to be good. This indicates high conduction from emitter to collector is occurring, which could only be due to shorted X1. Slightly reduced base voltage is due to loading caused by shorted transistor.

Best Bet: Scope, then voltage checks.

Symptom 2

Background Noise

Slight Buzz

T3 Secondary Open

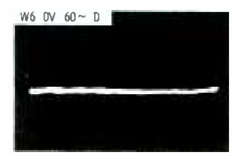
(Ratio-Detector Transformer)

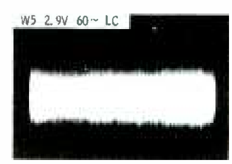
Symptom Analysis

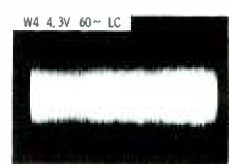
With volume control at maximum, slight buzz and background noise are heard; no audio signal is present. Since noise and buzz are heard from speaker, audio stages must be good. Noise is low in volume, so suspected stage is near end rather than near beginning of sound IF strip.

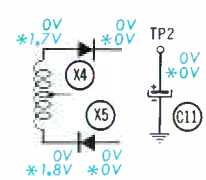
Waveform Analysis

Indication of fault prior to audio stages is given by W6 check—shows zero voltage delivered by ratio detector. Waveform at W5 is slightly weaker than normal, and W4 is slightly higher. Other waveform checks through IF strip are normal. Only apparent clue is small amplitude change of W5 and W4. Even though W4 is slightly high, trouble in circuit of X2 is not likely cause of symptom. This leaves as suspect ratio-detector circuit.









Voltage and Component Analysis

Voltages at X4 anode, X5 cathode are over twice normal. No voltage is measured at X4 cathode, X5 anode, nor at top of C11 (best clue). For voltage to be applied to C11, current must flow through X4. Path for RF current is from ground, up through R11 and R10, left through R8 and X4, down through secondary of T3, and right through X5 and R9 to ground. (Additional path is through tertiary winding of T3 and down through C12.) X4 tests good. Continuity checks show T3 secondary open.

Best Bet: Voltage and resistance checks.

SYMPTOM 3

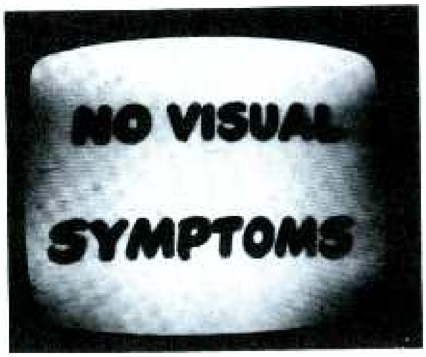
Volume Insufficient

High-Frequency Audio Reduced

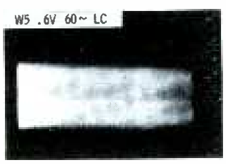
X2 Leaky

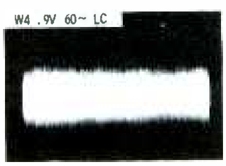
(2nd Sound IF Transistor—2SA219)

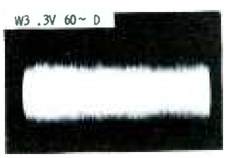
Symptom Analysis



Normal volume is developed, but with volume control near maximum. High-frequency audio is slightly reduced. Symptom might suggest audio-circuit trouble, but any trouble there would generally cause more pronounced change.



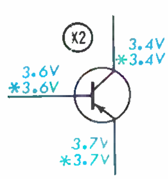




Waveform Analysis

Low amplitude of RF waveform W5 indicates either low drive from X2 stage or trouble in ratio-detector circuit. Check of W4 also reveals weak signal. This eliminates trouble in ratio detector. Normal amplitude of W3 indicates trouble in X2 and/or biasing components. Scope check at C8 would give normal no-signal indication, proving that signal amplitude is not reduced by R7 (which is bypassed by C8). All these clues point to bad X2.

Voltage and Component Analysis



Base voltage is reduced by .4 volt, and emitter voltage is reduced by .5 volt. Forward bias voltage is therefore .1 volt. Reduced emitter voltage indicates increased voltage drop across R6, or increased emitter current. Collector voltage is .7 volt too high, indicating collector current has increased. However, collector current has increased in greater proportion than has emitter current. Extra current must be flowing from base; increased voltage drop across R5 (lower base voltage) further confirms this condition. Culprit is X2.

Best Bet: Scope, then voltage measurements.

SYMPTOM 4

Volume Severely Reduced

Slight Buzz

R7 Increased In Value

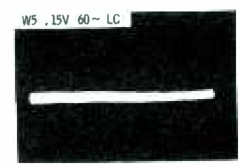
(Collector Dropping Resistor—2200 ohms)

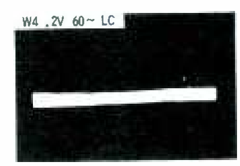
Symptom Analysis

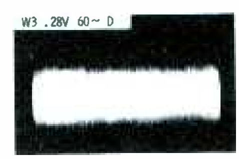
Normal volume can only be obtained by setting volume control almost to maximum. Since audio is so low at normal setting, noise and vertical buzz are heard with higher setting. Such noise is most likely to be picked up in stages where audio is weak.

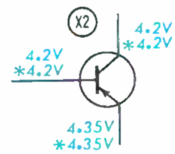
Waveform Analysis

RF at ratio detector is low in amplitude, as shown by W5. Scope check of W4 also shows greatly reduced RF signal. Examination of W3 shows almost normal amplitude RF; signal is reduced by .02 volt. Checks of W2 and W1 show normal signal strengths in first stage. Signal strength at X2 emitter is reduced; indicates X2 is not conducting at normal strength. Absence of signal at top of C5 and C8 indicates these capacitors are good.









Voltage and Component Analysis

Base voltage is up .2 volt; collector voltage is 1.5 volt high; emitter voltage has increased .15 volt. Potential difference between emitter and collector is down 1.35 volt, reduces conduction of X2. Base-emitter potential difference is down .05 volt; reduced forward bias also decreases conduction. Remember X2 conduction has decreased; voltage at collector has increased, pointing to R7. Resistance check shows R7 to have increased in value. Good idea would be to replace X2 and R6 as well as R7.

Best Bet: Scope, then voltage checks.

Symptom 5

Volume Reduced

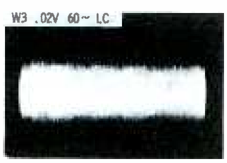
Slight Background Noise

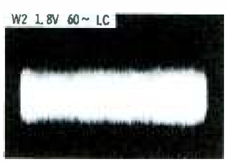
T2 Primary Open

(Coupling Transformer)

Symptom Analysis

Volume control must be set close to maximum for normal listening level. Along with audio, slight background noise and distortion are heard. Trouble doesn't seem to be in ratio detector circuit, since fault there would probably cause more distortion.

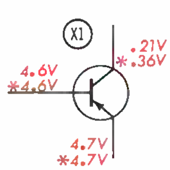




Waveform Analysis

Inadequate signal at W3 narrows search to stages ahead of this testing point. W2 amplitude is down by .6 volt; trouble is either at this point or around X1. W1 shows normal-amplitude signal being applied to X1. Lack of signal at X1 emitter shows C4 is good. Scope test at junction of C2 and C3 shows small signal present; this indicates C2 and C3 are good. Scope clues are not conclusive but do at least point to stage where trouble is located.

Voltage and Component Analysis



Voltage on base is up by .2 volt. Emitter voltage is up by .1 volt. Collector voltage should be zero; is .21 volt without signal, .36 volt with signal. Resistance checks clear emitter and base-bias resistors. High emitter voltage indicates increased resistance (and decreased current) in collector circuit. Ohmmeter check shows X3 is good. Voltage checks at center tap and bottom of T2 primary show zero voltage at those points. T2 primary must be open; otherwise collector (connected to top of T2) would read zero.

Best Bet: Voltage checks are adequate.

Symptom 6

Loud Buzz

Audio Reduced

X4 Shorted

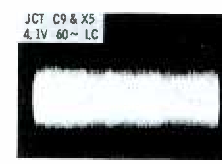
(Ratio Detector Diode—1S188)

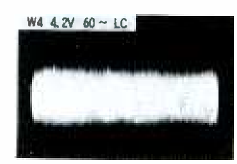
Symptom Analysis

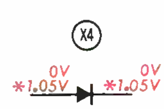
Normal volume can be obtained only by setting volume control almost to maximum. When this is done, buzz becomes quite loud. Slight distortion of audio also is evident. Most likely location of trouble is in stages prior to audio, so tests can be limited to IF and detector.

Waveform Analysis

Examination of W5 shows reduced amplitude of signal at anode of X4. Scope check at junction of C9 and X5 shows larger signal than normal W5; difference in amplitudes of waveforms seems to indicate unbalance. Correct-amplitude signal is being applied to ratio detector as shown by W4. Normal no-signal indication is revealed by scope check at C10. Source of trouble is not pointed out directly, but is localized to ratio detector.







Voltage and Component Analysis

Voltage measurements around ratio-detector circuit are altered but are not completely out of reason except for voltage on X4. Voltage is same on both sides of diode, indicating greater conductivity than normal and therefore less resistance to current flow. Ohmmeter check shows X4 to be shorted. Since ratio detector is normally low-voltage circuit, check further for voltage leakage from T3 and any other trouble that may cause abnormally high voltage to appear in circuit and cause diode to break down.

Best Bet: Scope and voltage checks.

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Picture Tube A	6.9	9.8	8.9	7.4
Picture Tube B	9.5	13.7	13.4	7.1
Picture Tube C	7.5	9.9	9.7	7.8

Test made under supervision of John J. Henderson and Associates, N. Y. Note: Not all people answered all questions—votes tabulated for 100% of answers to each.

In six major cities from coast to coast, 9,789 consumers compared the new *color bright 85*™ picture tube to ordinary non-rare-earth color tubes in three leading brands of TV sets. Sylvania's new tube, the first with rare-earth phosphors, was the overwhelming choice.

Here's why.

The vivid colors, derived from europium rare-earth compounds, are unexcelled for true color fidelity. In monochrome, the picture is noticeably brighter; there's better contrast too. And today this extraordinary tube is still the performance leader. Sylvania's new air-spun screening process gives *color bright 85* picture tubes the competitive difference in the sharpest images ever displayed.

The *color bright 85* tube is available to you now for today's growing color TV market. It is a product of Sylvania Electronic Tube Division, Electronic Components Group, Seneca Falls, N. Y.

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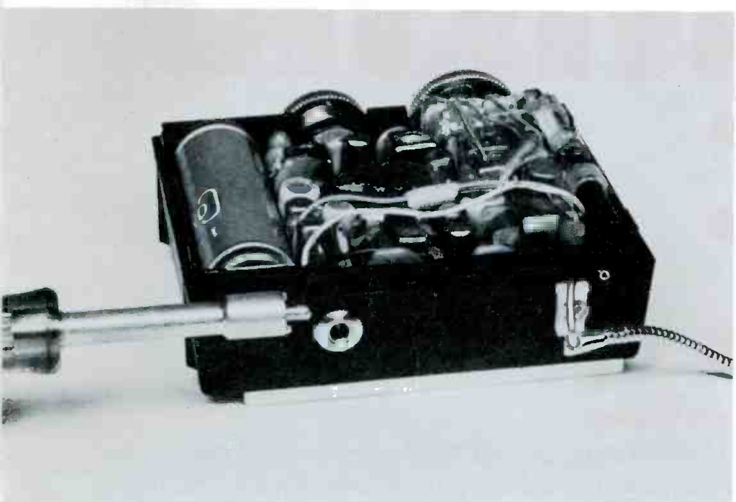
Circle 15 on literature card

Microservicing in Pocket Portables

Transistor radios have taken on a new shape in the past few months; some of the latest ones are only about half the size of a pack of cigarettes. To service these tiny critters, special tools, instruments, and techniques are required together with delicate care. The series of photos here shows most of the instruments that are required and illustrates some procedures for saving time and labor.

To disassemble these radios, a collection of miniature tools is needed. The set shown here requires a small Phillips screwdriver; however, for other makes and models you will need a set of jeweler's screwdrivers and a multitude of small-size spindrivers. Magnetized tools make the job considerably easier, especially during reassembly.

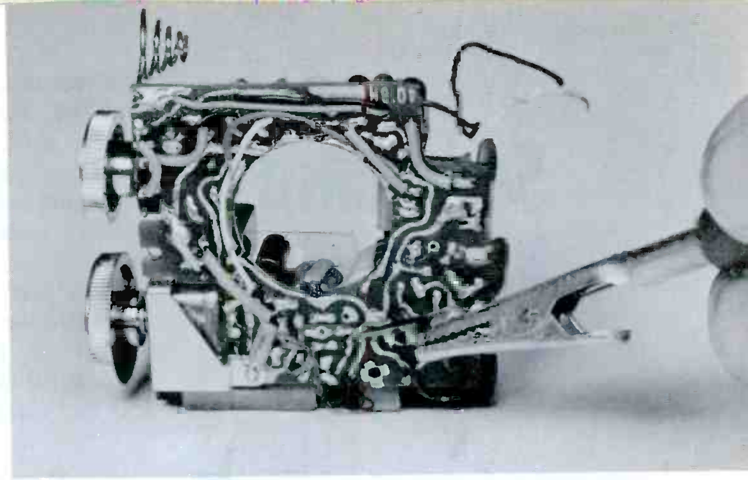


The terminal wrench (sometimes referred to as spanner wrench) is invaluable for removing the nut from tiny earphone jacks. This tool is available in two sizes — ½" and 5/16". Once the screws and earphone jacks are removed, the only thing left is to disconnect the speaker wires. These wires will break quite easily—be careful.

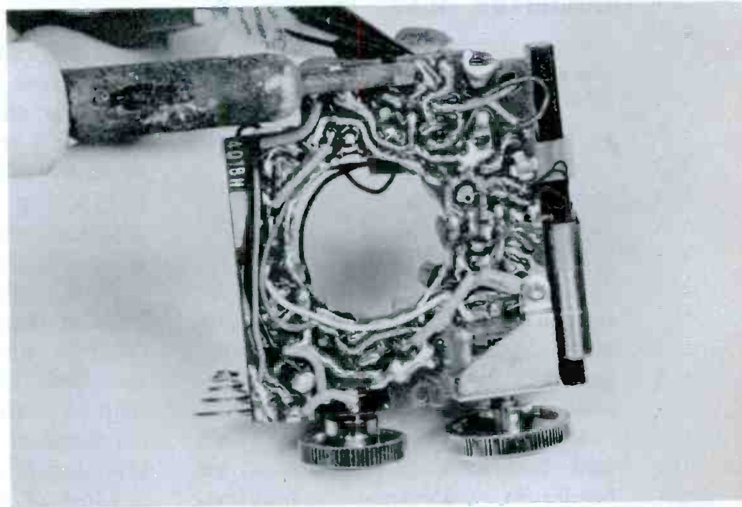
Many small radios operate on a single 1.5-volt battery. A DC power supply capable of supplying from 1.5 to 12 volts is suitable for practically any transistor radio. Before connecting the external power source, check to see if the radio requires a positive or negative voltage. Improper supply connection can damage the transistors.

At the right, a lamp is positioned near the wiring side of the printed board. This allows you to locate a specific connection on the rear of the board while viewing the radio from the component side of the board. The components are mounted extremely close together, and the light is almost a must for printed-circuit tracing jobs.

This home-made probe is certainly an advantage when making voltage or resistance measurements on any small portable receiver. The probe is quite inexpensive and simple to construct. Simply take an alligator clip and solder a steel phono needle to the end of the clip. Such a probe is handy to use on any printed circuit board.

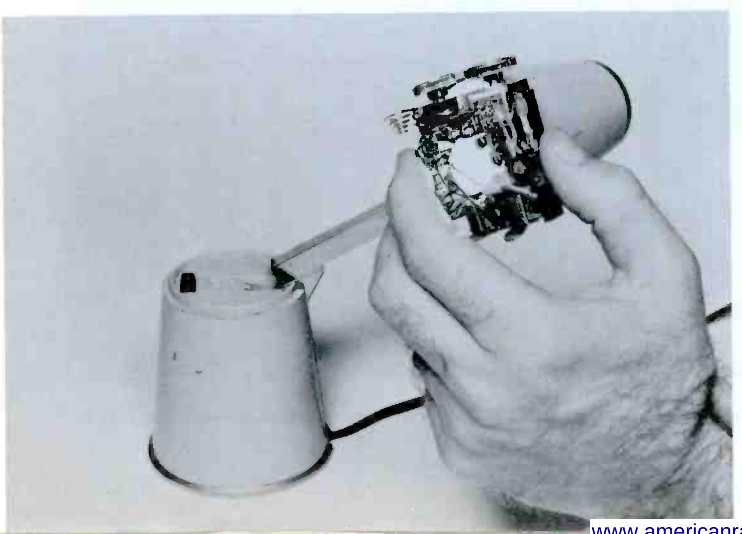


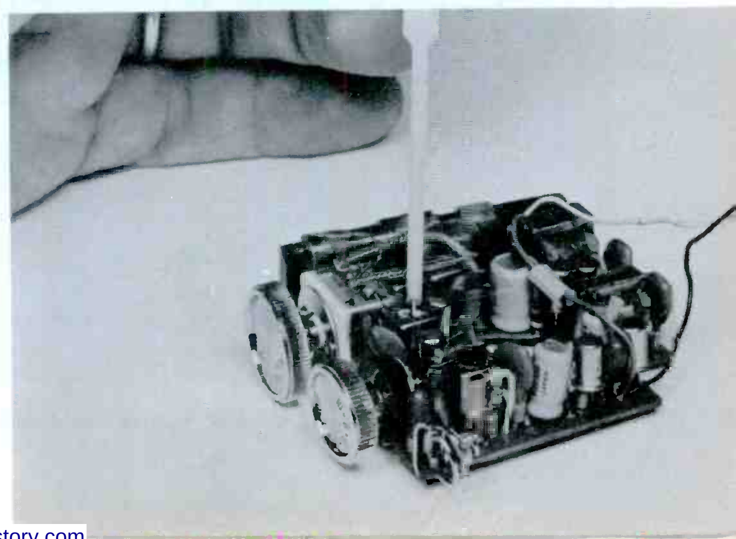
When replacing resistors or capacitors, use a pair of miniature long-nose pliers or small tweezers and a low wattage soldering iron—producing not more than 50 watts. When replacing components or making any repair to the printed board, use rosin-core solder; under no circumstances should an acid-core solder be used for repair.



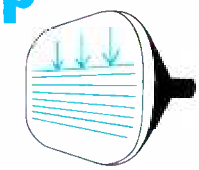
When replacing coils or transformers with multiple connection lugs, a desoldering iron makes the job much easier, quicker, and neater. This type of iron removes all the solder from around the connection point and leaves the hole open so that the defective component can be removed and the new one reinserted without trouble.

Below, right, is an example of the type of alignment tool required for aligning IF transformers in these miniature sets. Some slugs have screwdriver slots; others have square or hexagonal openings. The specific tool for any particular adjustment is listed, along with the alignment instructions, in all Sams transistor radio manuals.





Servicing Vertical Sweep in TRANSISTOR SETS



Not a whole lot different from tubes stages.

by George F. Corne, Jr.

The procedure for servicing vertical-deflection stages in transistorized television receivers is the same generally as it is for tube-type receivers—from the standpoint of symptom analysis. However, you'll find transistorized circuits a bit harder to troubleshoot, mainly because servicing is compounded by mechanical designs and more caution is needed in testing procedures—transistors can be damaged more easily than their tube counterparts. There are several do's and don'ts for transistor servicing, and you've probably heard most of them for transistorized radios. For this reason, we won't relist them here; rather, we'll mention them as the occasions arises through this article, and emphasize the ones especially important for vertical circuits.

Let's start by recapping a vertical-deflection system, one that is typical of those presently being used. We'll look at both the mechanical and electrical designs.

Three-Stage System

Although there are slight variations in component values, number of controls used, and various RC networks, the schematic in Fig. 1 is similar to vertical stages you'll find in many transistorized TV's. Here, a blocking oscillator, driver, and output stage combine to provide vertical deflection.

First, let's take a brief overall look at these stages and see what controls and special components are used. The photo in Fig. 2 will help us learn to recognize the physical shape of main components—for servicing reference.

Most of the major components, except the output choke and yoke, are located on printed circuit boards. In this receiver, notice the vertical-deflection stages are mostly located on a small board that is mounted in piggyback fashion to a larger board. This design presents quite a servicing problem, for the underside of the small board is concealed; access to the bottom can't be obtained without unsoldering the small board at seven or eight places. The transistors for the oscillator and driver stages are low-power types, also located on the small board. The output transistor, however, handles a large amount of current, so a high-power type must be used; it's located on a heat sink close to the board, with other power transistors used in this set.

Unlike tubes, transistors have more parameters, and more controls are necessary to obtain good linearity. Notice in Figs. 1 and 2 that a total of five controls (four mounted on the board) is used throughout the circuits. In addition to hold, linearity, and height controls, this receiver has an auxiliary linearity control that adjusts the amount of feedback from the output to the driver stage. This control is necessary to obtain best linearity for the reason mentioned above. In the base circuit of the output transistor is a bias control to set the bias and thus the current through X3 (similar in application to the bias control used in the output circuits of transistorized auto radios). A thermistor is used in the output stage to maintain vertical sweep and protect X3 from thermal runaway. Two other protective devices are used in these circuits: A diode (X6) shunting the base winding of the oscillator transformer suppresses the reverse volt-

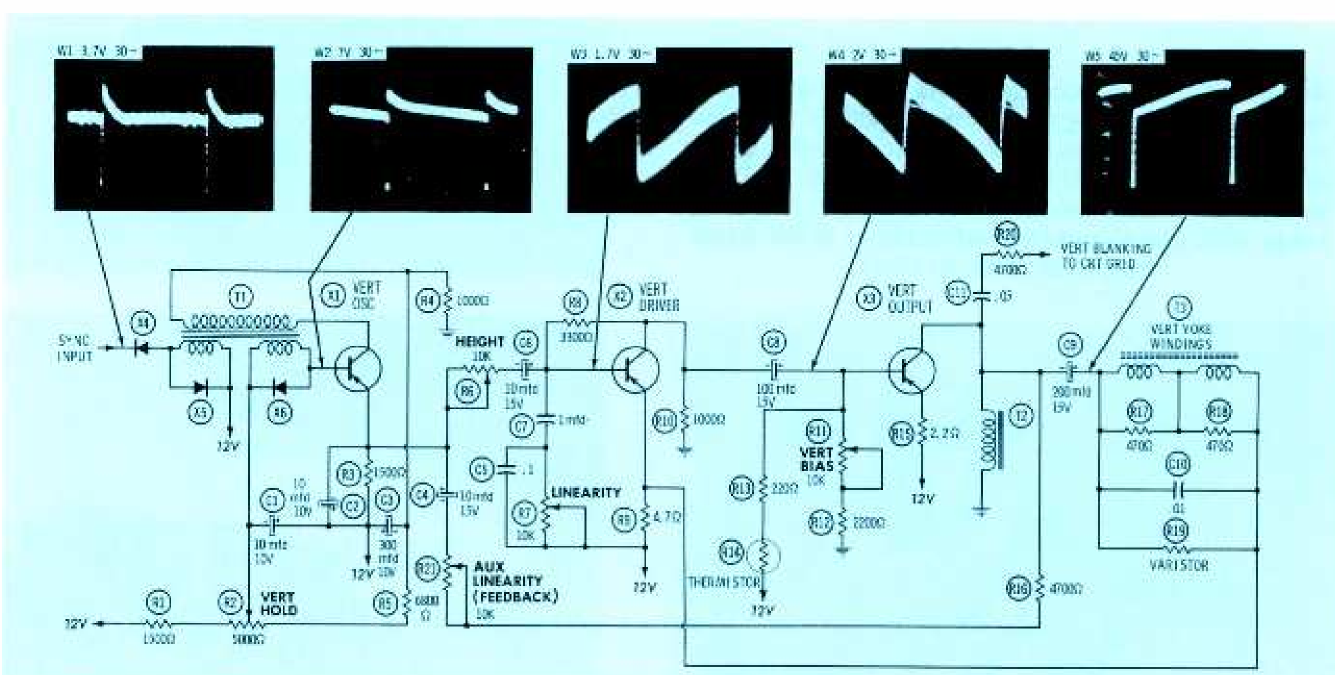


Fig. 1. Schematic diagram of common transistorized vertical deflection system shows basic blocking oscillator-driver-output.

age spike (from collapsing magnetic field) during the flyback time—when X1 is suddenly cut off. A varistor shunting the yoke windings limits the sweep amplitude across the deflection coils and prevents breakdown of the output transistor due to the flyback pulse. This component is located on the bottom of the large printed circuit board; its location is pointed out in Fig. 3.

Troubleshooting

Before discussing specific troubleshooting procedures, let's establish a few ground rules for servicing transistor vertical-deflection circuits.

1. Regardless of the symptom present in the receiver, obtain the proper service literature *before* trying to pinpoint the specific area of trouble. It's best to know exactly what is in a particular circuit. Unlike in tube circuits, transistors in TV's are normally soldered in; they can't be unplugged and substituted for—easily.

2. Use your oscilloscope at every opportunity to help isolate a loss of signal or a distorted signal. If the signal is of sufficient amplitude to permit using a low-capacitance probe, use it. Sometimes, the signal amplitude will be too small, and a direct probe will be necessary.

3. A high-quality VOM or VTVM (having small voltage ranges) can be used for checking voltages and resistances in transistor circuits. With few exceptions, an emitter resistor is used in vertical amplifiers. Make every use of analysis of voltages on the emitter, base, and collector to help zero in on the defective stage before unsoldering and checking individual components.

4. It may be necessary to adapt special (or gimmick) probes to permit quicker servicing in miniature-size TV's. Shown in Fig. 4 is a handy device for easy attachment to any type of probe—scope, VTVM, etc. Here, we've taken an ordinary clip lead, to which we've soldered the straight section of a safety pin (a needle is good, too). The point is rigid, and the clip lead can be slipped onto the end of the test probe you select. Notice in the photo the value this simple gimmick has. Here, the needle point has two main advantages for servicing in small spaces: (1) Testing must be done from the top side of this board, and even then, access to some particular point in the circuit couldn't be reached with a large probe—the needle probe reaches all points easily; (2) Circuit contact with a blunt point is hard to make in many instances (normal probe for example), but the sharp point of this probe makes good contact, even to the transistor lead, as here. The point fits snugly into the lead holes on the board, too.

As in tube circuits, troubles in vertical circuits can be classified into three main faults—(1) poor or missing vertical sync, (2) insufficient height, and (3) distorted sweep (poor linearity), or no sweep.

Sync Troubles

When uncontrollable or intermittent rolling is the symptom, chances are you'll find the trouble in the input-sync path (separator or some previous stage) or directly in the vertical-oscillator stage. In the circuit of Fig. 1, negative-going sync proper to key PNP transistors is inductively coupled to the oscillator by a tertiary winding of T1. W1 is a mixture of the oscillator pulses and the incoming sync pulses. As in tube receivers, a check on the sync pulses can be made by disabling the oscillator. In this circuit, a 1-mfd capacitor connected from collector to emitter of X1 will do the job. If the incoming sync is good, then proceed to check out the oscillator circuit.

The free running frequency of X1 is determined by the time constant of the RC network (C1-R2) in the base circuit of X1; the vertical-hold control varies this time constant to set this free running frequency. Symptoms of off-frequency operation usually indicate trouble in the base circuit. Prime components here are C1, R2, and R1. Of course, X1 could be defective; if it is, make sure you check and/or replace suppressor diode M3 before pronouncing the trouble cured.

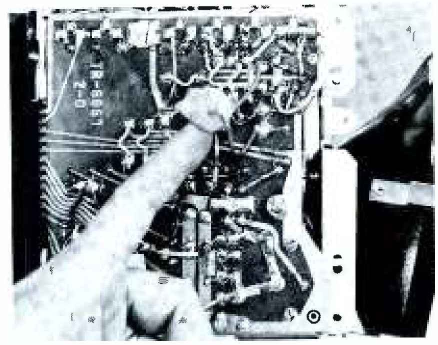


Fig. 3. A varistor protects transistor.

In addition to causing sync troubles, a defect in the oscillator can cause a complete loss of vertical sweep. If this is the case, W2 at the base of X1 is a good starting point to see if the oscillator is functioning. If W2 is missing, proceed to use normal voltage and resistance measurements for locating the cause of oscillator failure.

Height Troubles

Insufficient sweep can result from low gain in X2 or X3, or a defect in the deflection yoke circuit. Your scope, in conjunction with the shape and amplitude of waveforms shown

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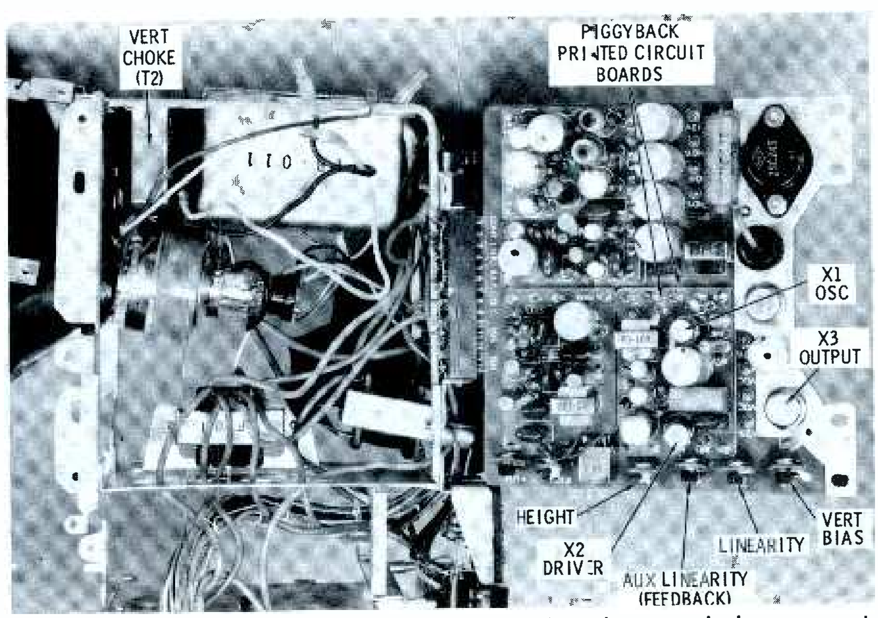

Fig. 2. View of transistorized vertical-sweep section shows typical components.

Introducing...

ZENITH 25" COLOR

In the new 25MC36 color chassis, technicians will find perhaps the most significant change in Zenith's color line since this company actively entered the color field in 1961. In addition to several new electronic circuits, a new chassis shape (Fig. 1) can be noted—especially in the area of the high-voltage cage. (Compare the chassis in Fig. 1 with Zenith's latest 21" chassis shown in Fig. 2.)

The biggest change, of course, is the use of a 90°, 25" rectangular picture tube, the 25GP22; and most of the new circuitry in the chassis was necessary to produce the wider deflection required by this CRT. Let's take a closer look at the new chassis, concentrating on the particular features and adjustments you'll need to know about in servicing it.

Color Circuits

Most of the circuits used in the color stages should be familiar to you. Zenith is continuing to use two chroma bandpass stages—both using pentode sections of 6KT8's. The triode sections of these tubes function as the cathode follower (in the luminance channel) and as the color killer. Two high-level demodulators with 6JH8's complete the chroma-signal path to the CRT grids—in circuits very similar to those used previously in 21" chassis. Operation of the screen and drive controls and the service switch associated with the CRT are unchanged.

You'll find the tube complement and wiring in the color-sync sections also follow closely those in Zenith's latest 21-inchers: a 6EW6 burst amplifier, 6JU8 (quadruple diode) ACC/killer phase detector/color sync phase detector, and 6KT8 chroma oscillator control/chroma oscillator. Circuits having similar operation were described in the September and November 1963 issues of PF REPORTER.

Sweep Circuits

The vertical and horizontal deflection stages contain the greatest number of new circuits due to the wider deflection angle required by the 90° picture tube.

Controls

Since Zenith's first color chassis (the 29JC20) was introduced, vertical and horizontal centering has been mechanically adjusted by means of movable magnets located in a special sleeve inside the cavity of the deflection yoke. The 25GP22, being a small-neck tube, has prompted a change to electrical centering. The horizontal-centering control is located in the flyback/yoke circuit. The vertical-centering circuit will be seen presently when the pincushion-corrector stage is discussed.

Width in the 25MC36 chassis is altered by moving a jumper in the yoke circuit—either connecting or removing a 75-pf capacitor from the circuit. The jumper (and the minimum and maximum positions) is marked in Fig. 1.

Fig. 3 shows a closeup of the neck of the new 25" tube; deflection and convergence components are identified. The cloverleaf convergence yoke and blue lateral magnet are familiar and occupy their normal positions on the tube. However, notice the location of the purity rings. On this new tube, the purity rings are placed in *front* of the deflection yoke. Adjustment is made in the normal way, but you must first loosen a metal screw before the rings can be moved.

The action of these static convergence controls and of the 12 dynamic convergence controls found in this chassis is similar to the action of controls in other Zenith sets.

High Voltage

Comparison of Zenith's 21" chassis (Fig. 2) and with the 25" version reveals a change in physical design of the high-voltage cage; in the latter receiver, the cage rises higher

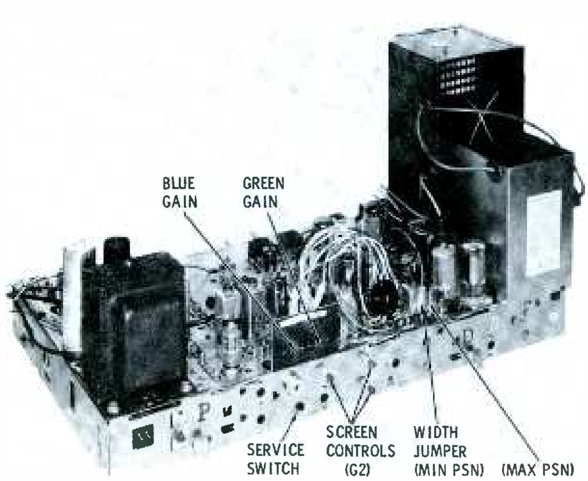

Fig. 1. Zenith's 25" color chassis contains a width jumper.

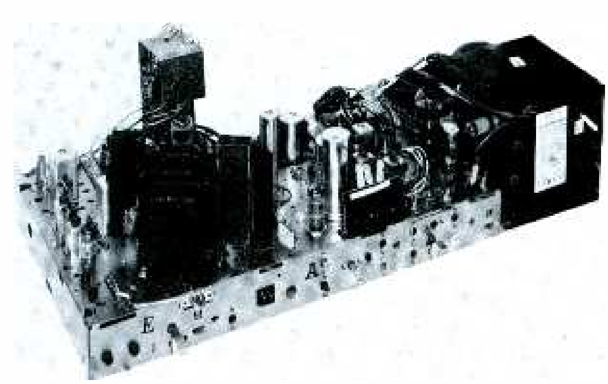

Fig. 2. High voltage cage on late-model 21" set is smaller.

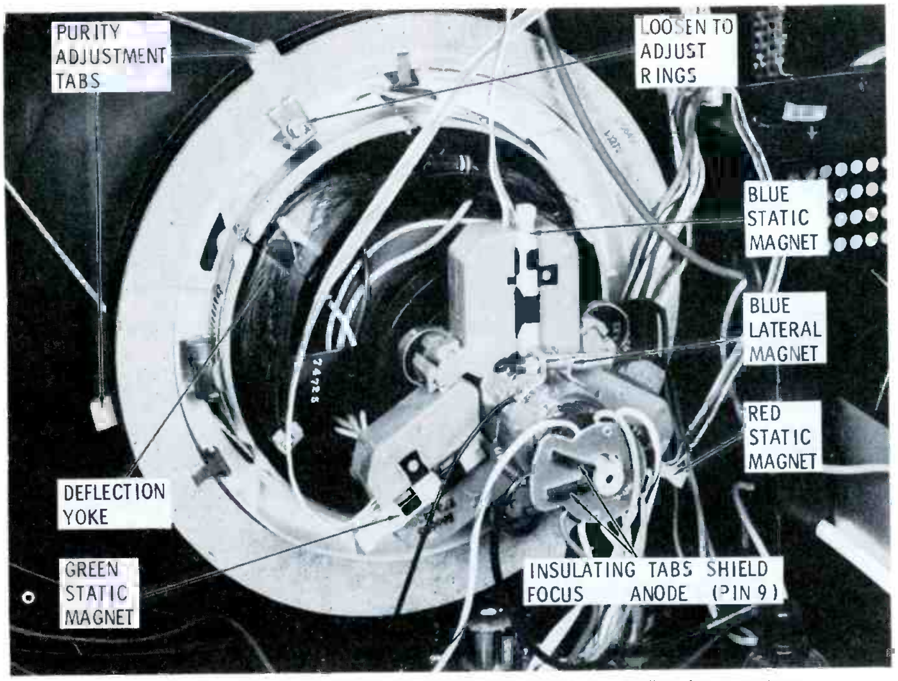

Fig. 3. Purity ring is in front of deflection yoke on 25" color receivers.

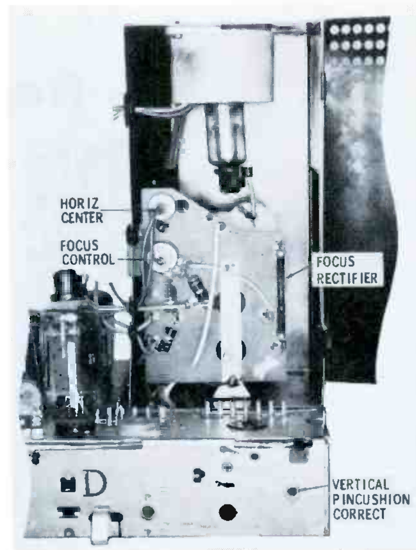

Fig. 4. Diode functions as focus rect.

above the chassis. Inside the cage, numerous other changes are apparent, as shown in Fig. 4.

The flyback and the diode (Fig. 5) in the focus circuit are completely new. In previous chassis, a 1V2 functioned as the focus rectifier. (The inset in Fig. 5 shows this circuit—still being used in 21" models.) Although a special diode has replaced the 1V2 tube, circuit operation remains basically unchanged. Horizontal pulses derived from a winding on the flyback transformer, are rectified and filtered. The resulting DC is reduced to approximately 4.3 kv) by a voltage divider and is then fed to the common focus anode (pin 9) of the picture tube.

Referring again to Fig. 3, notice pin 9 is shielded by insulating tabs. The smaller neck diameter of this tube reduces the distance between the base pins. Therefore, the insulating tabs are used to guard against arc-over of the high potential from the focus anode to another pin.

Horizontal

Adjustments in the horizontal-sweep section are also quite similar to those used previously. One significant change is the removal of the horizontal efficiency coil; consequently, the damper current is not adjustable. The high-voltage-adjust control should be set for a specified anode voltage corresponding to the line voltage. (Table 1 shows the correct high-voltage reading for various line voltages.) Regulator current is monitored in the normal manner and should remain within the specified rating (.85 ma to 1.4 ma).

Otherwise the horizontal-sweep circuit is much the same as in other Zenith color receivers, and the same troubleshooting procedures apply.

Table 1

Line Voltage	High Voltage
100 VAC	20.9 KV
105 VAC	22.2 KV
110 VAC	23.2 KV
115 VAC	24.4 KV
120 VAC	25 KV
125 VAC	25.6 KV
130 VAC	26.5 KV
135 VAC	27.1 KV

Vertical

The most unfamiliar circuit you'll find in this chassis is probably the pincushion corrector shown in Fig. 6. A closer examination of this circuit will show why it is necessary, how it functions, and where it fits into the overall receiver operations.

As the deflection angle increases,

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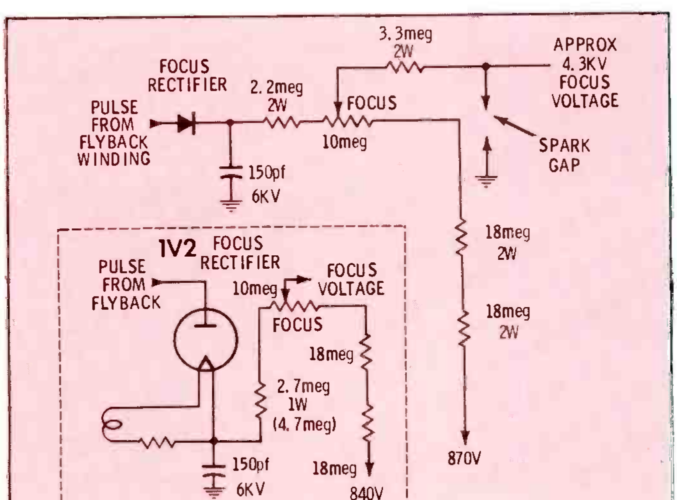


Fig. 5. Focus circuit for the 21" and 25" color receivers.

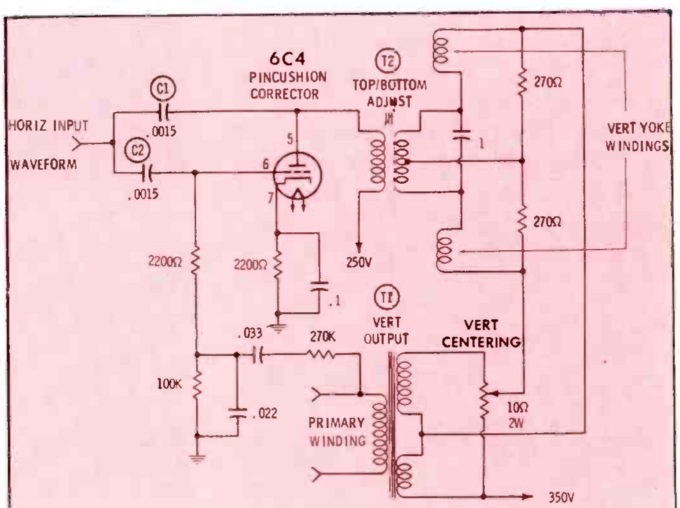


Fig. 6. Circuit compensates for vertical pincushioning.

Repairing

ETCHED CIRCUIT BOARDS

A few handy hints to speed the process.

by Homer L. Davidson

Practically all radios, and many TV sets, made today use etched circuit boards. You may not like to work on etched boards or wouldn't be caught dead selling a TV set with one in it, but a quick look at the service business as it exists today may change your mind.

When Henry Ford switched from the Model T to the Model A, that was a great change. Today's cars have made an even bigger change from the Model A, and are much more complicated. Modern tools and techniques are needed to do the service job. This premise also applies to the electronic industry. The TV receiver of 1950 surely doesn't look at all like the 1965 sets that are just rolling off the assembly line. How about the TV set of 1975? Are you going to refuse to service them?

You old timers recall the time when you were called to repair your first TV set. Difficulty—definitely! But you did it, and now it's old hat. There is nothing mysterious about repairing an etched-circuit receiver, either, if you find out how and then *do* it. Some manufacturers have held service clinics on their transistor radios and included information on servicing their etched boards. In this article we are going to try to pass along a few hints and ideas on how you can repair etched circuit boards.

Take a look at the etched board in Fig. 1. This board is lettered on one side with the placement marking of components. From the same (top) side, you can also see where the wiring goes to each component. Practically all parts are close to the tube or transistor they work with. This means the numbered parts are located close to the stage, and a suspected defective part is easier to find for testing.

The first circuit boards manufactured did give some trouble. But, what doesn't have some bugs in it, at first? We will agree that today the boards are constructed well and give far less trouble. Nevertheless, many servicemen still use the board as an excuse for many of their own mistakes.

The layout—top and bottom—of a typical etched-board assembly is shown in Fig. 2. Fig. 2A shows the mounted parts, part numbers, and white-dotted areas indicating the etched wiring underneath. Turn the board over (Fig. 2B) and you see the etched wiring itself. On some boards, the wiring is covered completely with solder; on this one, only the parts leads are soldered to the etched copper wiring.

TV Boards

In the TV receiver, there may be one large board or several smaller ones with different circuit sections on each board. Today's manufacturers are placing more components on one large board. You will sometimes find the sound, IF, video, sync, horizontal-sweep, and vertical-sweep stages all laid out in rows.

The etched board doesn't really cause too much trouble in TV receivers. In some AC-DC chassis, where tubes with high heater voltages are used, heater terminals become quite warm and open up. One serviceman I know solders heavy copper wire to these connections, thus bypassing the soldered joints. The heavy, solid wire also acts as a heat sink.

Fig. 3. "Looping" new part to board.

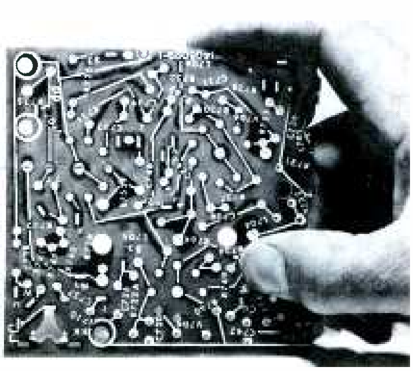
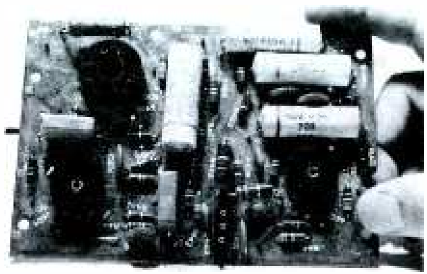
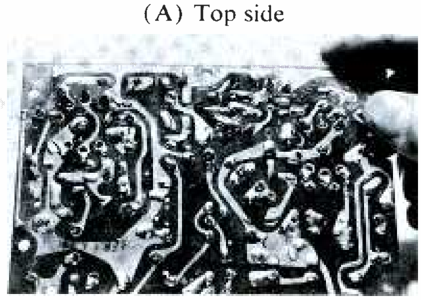


Fig. 1. Backlighting reveals wiring.



(A) Top side



(B) Bottom side

Fig. 2. Both sides of a single board.

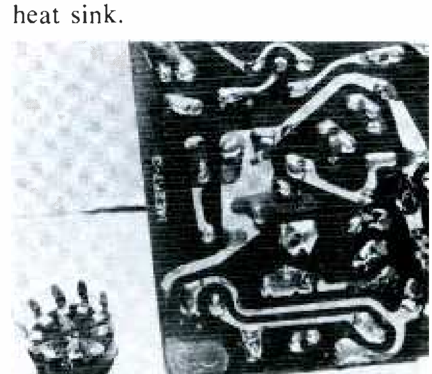


Fig. 4. Molded socket after removal.

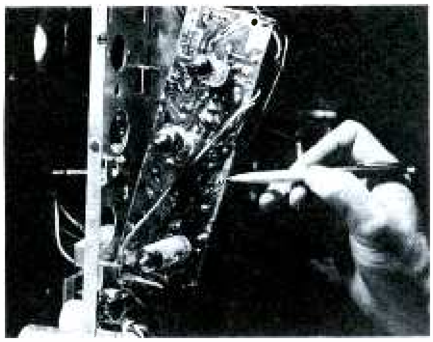


Fig. 5. Notice loose grounding eyelet.

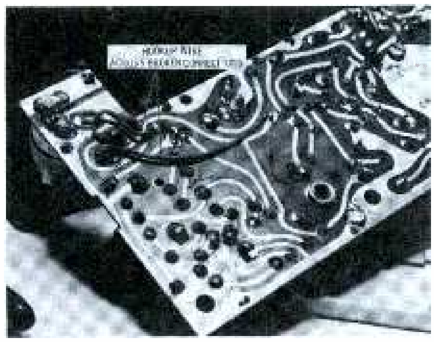


Fig. 7. Easy repair for break in foil.

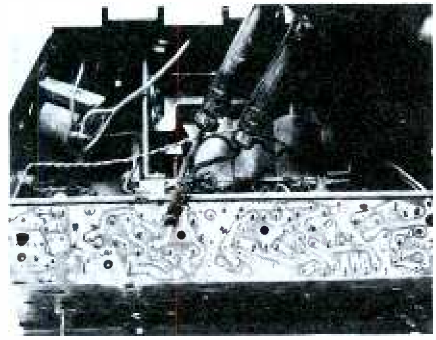


Fig. 8. With foil on both top and bottom of etched board, extra heat is required.

Although rosin joints are not common with an etched board, a defective joint may show up sometimes when a tube is pulled excessively hard from its socket. The excessive heat needed to "boil out" a rosin joint can damage the etched board, so care must be exercised. Most boards in a TV receiver won't crack or break as easily as those of a transistor or car radio.

Parts can usually be replaced on an etched board without a great deal of difficulty, if you know how. When replacing a burned resistor or leaky capacitor, simply cut the old one in two with your diags. Crush the component thoroughly until it falls away from its lead. Form a loop at the ends of the wires that are left. Then cut the leads on the new resistor or capacitor, and slip the ends through the loops you've made on the board—see Fig. 3. Don't hold the iron too long on this joint, or the old loops may melt away from the etched board.

If you can get at the board from below, melt the solder out of the hole and solder the part directly into the etched wiring. If you don't have any way of drawing the solder out of the holes, stick a wood toothpick down into the melted solder to form a mounting hole. There are soldering irons on the market with hand-operated suction devices that do a good job of removing old solder. A medicine dropper can also be used.

(A) Before

(B) After

Fig. 6. Repair of broken PC board.

A defective wafer-type tube socket can be removed by first cutting the center support off and snipping away the wafer material, then unsoldering each pin connection from the etched board. The molded socket is a little harder to remove (Fig. 4). Place the tip of your iron under each pin and pry upward, then draw the solder away from each pin connection. Unsolder the center ground terminal. Use a screwdriver to pry upward around the socket, being very careful not to damage the board. Apply the hot iron to any connection that may still have a little solder holding it to the board. The old socket will drop out, and a new one can be soldered in its place.

Fig. 5 shows a sound-section board removed from an RCA TV receiver. The ground eyelet was not securely soldered to the etched board, and the TV sound was intermittent.

Etched Radio Boards

Components can be replaced in transistor radios by the same methods used in TV receivers. The transistor radio board is usually damaged by the owner who has accidentally dropped the set. Fig. 6A shows a portable with the board broken in two. Fig. 6B shows how the board was repaired, using #14 solid copper wire with two solid twisted loops that hold the board together. The other broken connections are made with hookup wire run directly to a solder joint. Some etched boards are covered with green enamel that must be scraped away for a good connection.

In Fig. 7 is shown the etched board of a transistor radio that had been dropped, landing on the volume-control knob. This pushed the board backward and broke the etched connections. The two broken connections were remade with lengths of hookup wire as shown in the photo.

You will find that when a transistor set is dropped or otherwise treated roughly, the heavy components will be the first to break loose. Sometimes their looseness will cause intermittent reception when the board is touched.

Components in car radios are replaced much the same as with TV or radio receiver boards. In some, the board is etched on both top and bottom. When replacing IF transformers in these, be sure to apply enough heat to unsolder the etched wiring on top as well as on the bottom. If some of the foil pulls up or off, replace it with bare hookup wire, pushed down through the board to the corresponding IF coil terminals. Fig. 8 shows the unsoldering of lugs on the second IF transformer in a car radio.

Vibration and twisting of the board cause frequent trouble in in car-radio etched boards. Transformers, filter capacitors, and other large components easily develop broken connections. When the board is mounted vertically, large components soldered directly to the board

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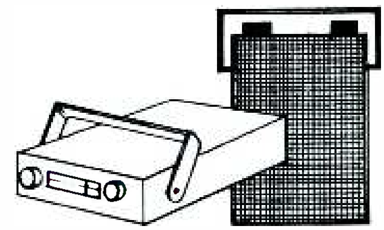
Fig. 9. Small brace supports a filter.

Shortcuts
through Transportable Car Radios



Peculiarities of these multipurpose receivers.

by Philip R. Powell

Transportable radios started appearing in automobiles in 1958. In some cases, these radios were the first all-transistor receivers to be used in automobiles. For about three years, manufacturers offered transportables as optional radios, and today there are a number of independent retail stores still selling portable receivers for cars.

Many servicemen think of these radios as monsters compared to conventional auto radios, and are very reluctant to service them. They needn't be; failures in these receivers run in typical patterns, and knowing what to look for can simplify and speed service work on these sets.

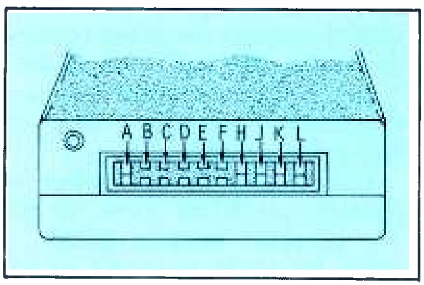


Fig. 1. Note some contacts should touch.

1958 Pontiac and Oldsmobile

Transportables appeared in considerable volume in 1958 Pontiacs and Oldsmobiles. The following is a rundown on what to look for when servicing these units.

Weak Batteries

Transportables, when out of the dash, operate with four 1.5-volt mercury cells. The voltage from these cells drops very soon from 6 volts to approximately 5.2 volts and stays at that level for most of their useful life. A good rule is to replace all four cells when their voltage drops to 5 volts or less. Always use mercury cells in transportables, since regular batteries will corrode if the radio is left in the car during the winter months. In the automobile, the radio operates from the car battery, so defective portable batteries may go undetected until too late. Always start troubleshooting transportables by checking the battery voltage—there should be at least 5 volts with the radio turned on.

Intermittent Connector

A common failure is in the connector at the rear of the portable—see Fig. 1. The upper and lower contacts at A, H, J, K, and L are supposed to touch when the unit is out of the car. The terminals at A connect the internal antenna to the portable in place of the car antenna. Terminals at H apply internal battery power, J and K terminals actuate the internal speaker, and the terminals at L boost the volume.

Radios produced early in the 1958 model year had considerable connector trouble. The old-style connector has a flat contact surface which is not reliable, even if you clean the contacts. The improved connector has two teeth that, with their small contact surface, have greater contact pressure (see Fig. 2). If you encounter one of these portables with the old-style connector, replace it with the improved type.

Leaky AGC Transistor

Fig. 3 shows the AGC circuit used in the 1958 transportables. Leaky AGC transistors are common in these radios, and the symptoms could prove very confusing to a repairman unfamiliar with the receiver. This particular failure has probably accounted for more wasted repair time than all other defects combined.

With no signal, the AGC transistor's emitter voltage should be under 1 volt. If the AGC transistor is leaky, the no-signal emitter voltage will be above 1 volt. Leakage current in the transistor reduces the gain of the RF and first IF stages, which has led many repairmen to think the trouble lies in either of these two stages.

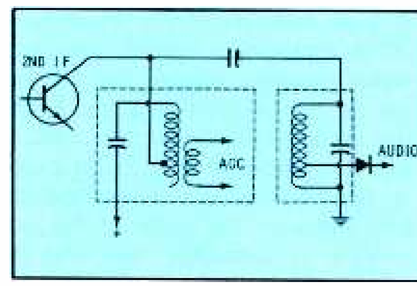


Fig. 4. Cascade IF's, separate purposes.

The simple voltage reading described can quickly verify this condition. When you make this test and find the no-signal voltage to be normal (under 1 volt), also try tuning to a strong local station to see if the voltage rises as it should with proper AGC action.

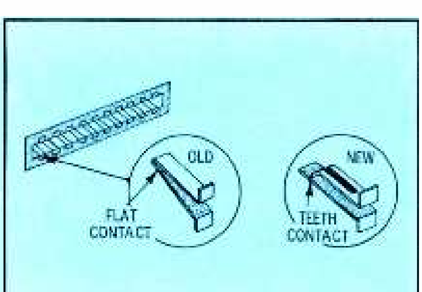


Fig. 2. New contact type solves fault.

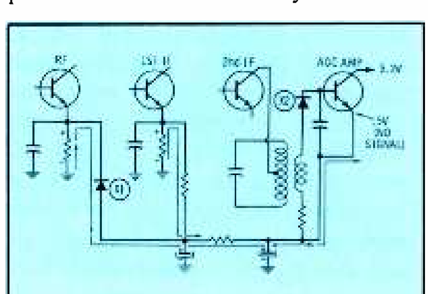


Fig. 3. Emitter volts clue to leakage.

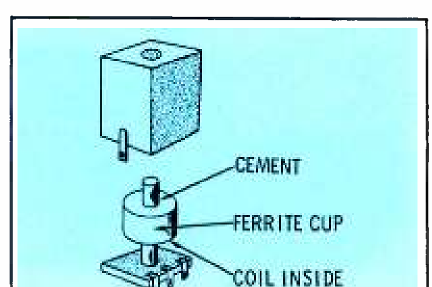


Fig. 5. Loose collar shifts frequency.

Fig. 6. Tapping case aggravates fault.

Third IF Coil

An unusual circuit is used in the third IF stage—see Fig. 4—and requires special consideration. Two tuned circuits are located in separate cans, connected capacitively. Isolating trouble to this stage is easy enough, but determining which can is defective can be puzzling. The trick is to use the AGC circuit to select the defective can. If normal AGC action can be obtained, then

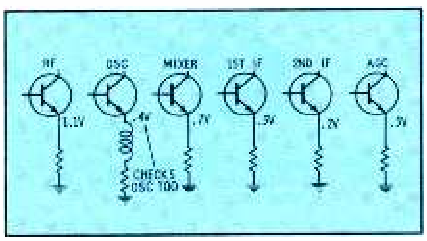


Fig. 7. Emitter test for open transistor.

the first can is good and the second is defective. In many cases, a defective second can "unloads" the first one and causes an abnormally strong AGC action.

Loose Ferrite Cup in IF

Each IF coil is surrounded by a ferrite cup (see Fig. 5) that has a nasty habit of working loose from the paper coil form. As the portable is hand-carried, it can change from a hot set to a weak set with only a slight jar. Needless to say, this type of failure could be hard to locate without any prior knowledge of the problem.

Check for this condition by turning the portable over and tapping the case lightly, as in Fig. 6. If the

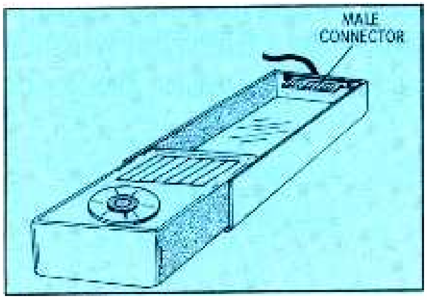


Fig. 8. Don't insert radio upside down.

trouble recurs each time the set is turned over, remove the case and tap each coil individually to determine which is defective. Keep turning the portable so that gravity will cause the cup to slide when the coil is tapped.

Open NPN Leads

Open transistors can be located quickly by measuring the emitter voltage—see Fig. 7. The emitter current (and thus voltage) will drop very low when a transistor is defective due to an open internal lead wire. Due to their design, the NPN transistors used in these portables are susceptible to internal opens. As a double check of your diagnosis, bridge a new transistor across the suspected one, and see if the set will respond. Leaky transistors can be detected by a higher-than-normal emitter voltage.

Oscillator Check

The oscillator can also be checked by the open-lead test shown in Fig. 7. The voltage read on the emitter of the oscillator transistor should change slightly as the tuning dial is moved up and down the band. This is because every transistor oscillates slightly better at one frequency than at another. The three most common problems that result in no oscillation are an open or leaky transistor or open coil.

'59 and '60 Buick, Olds, Pontiac

These later-model portables came in for their share of repetitious troubles. Ordinary repair procedures will solve most problems, but these hints will help with a large percentage of common faults:

Broken Connector

The Buick portable, when placed in its car rack upside down, can break the male connector—see Fig. 8. The diagnosis is simple—the portable plays out of the car but not in the car. A good visual check will disclose the cracked connector.

Crackling Sound When Jarred

This complaint occurs only with the portable out of the automobile. The crackling sound can be eliminated by taping each pair of batteries with one turn of electrical tape (Fig. 9).

Oscillator Can Mistaken for IF

If you inherit a hand-me-down

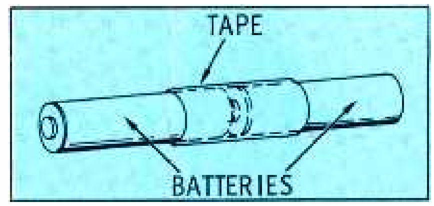


Fig. 9. Tape stops crackling sound.

repair job, alignment may be a problem. The oscillator coil is located in a can that appears identical to the IF cans. Late in production, the label OSC was added to prevent confusion—see Fig. 10. There is a good possibility, if everything else checks, that someone may have confused the oscillator coil for an IF and fouled up the oscillator alignment. Align the portable according to the service instructions.

Won't Work in Car

If the portable works out of the

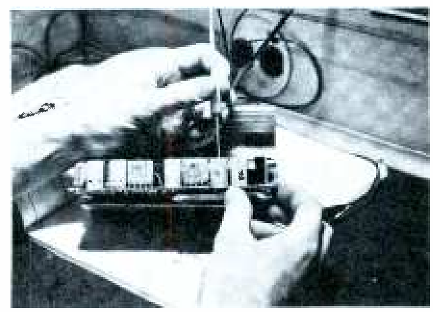


Fig. 10. Don't mistake osc can for IF.

car but only a weak hiss can be heard in the car, the rack unit in the car is probably at fault. The rack unit that stays in the car contains the following: antenna coil, RF coil, oscillator coil, RF transistor, and power-output transistor. These components are switched into the circuit when the portable is plugged into the rack. Since a hiss is present, indicating the output transistor is okay, the three coils and the RF transistor should be checked for opens.

Broken Antenna Wires

The portable radio antenna is located behind a plastic cover (Fig.

Fig. 11. Slipping the antenna cover off.

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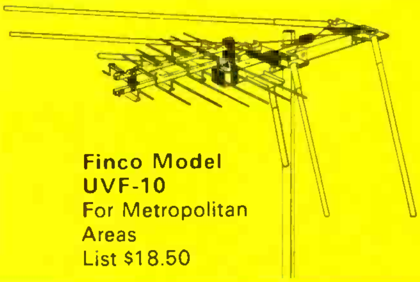

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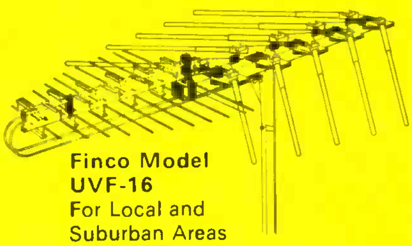

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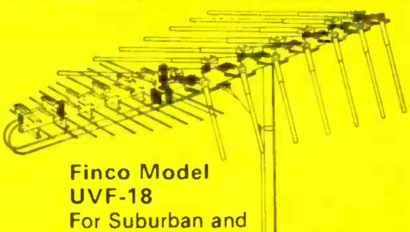

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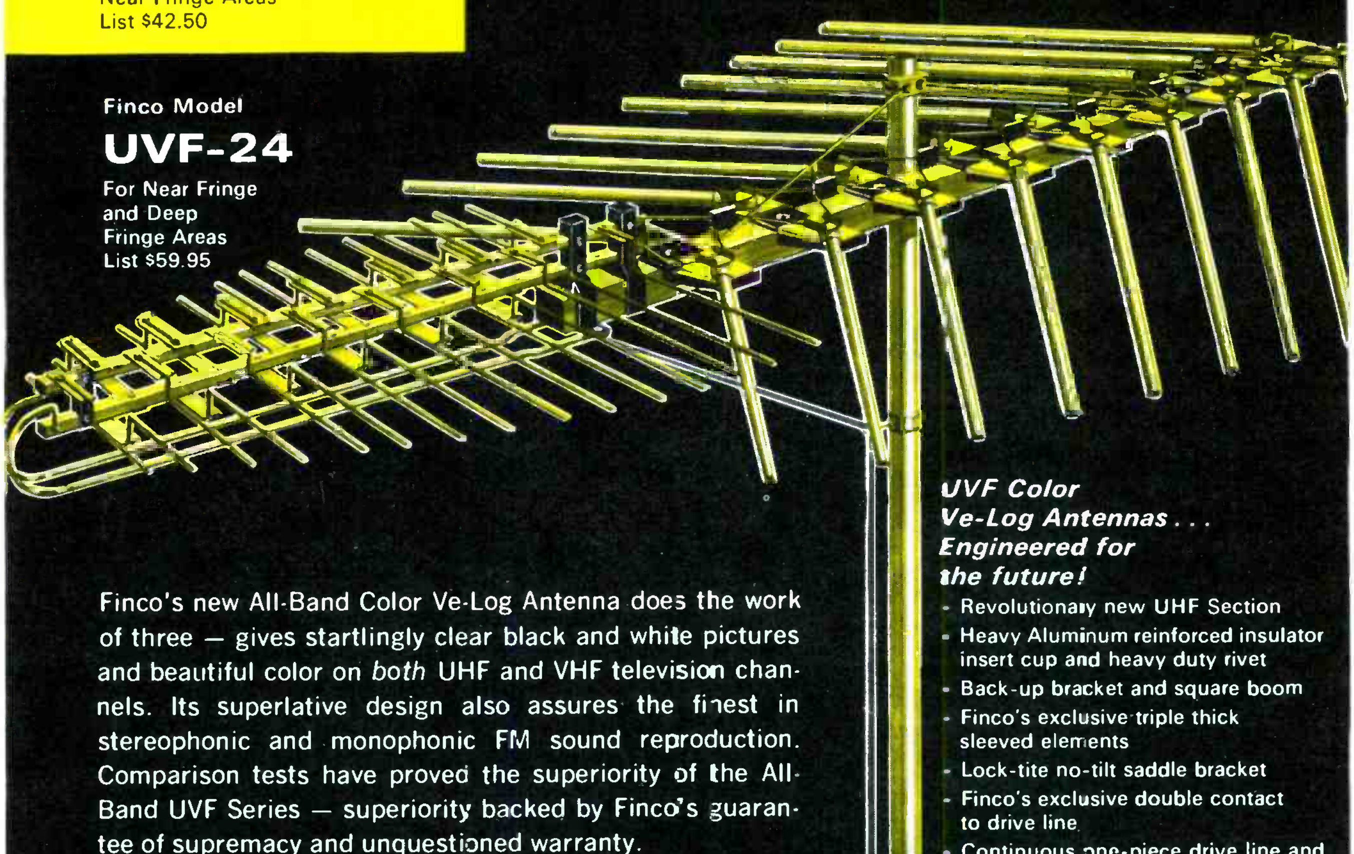

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ZENERS TUNNELS MESAS... so what's new?

They're coming thick and fast.
by Rufus R. Turner

Solid-state technology has expanded rapidly during the past 20 years. In 1945, semiconductor devices consisted of germanium and silicon point-contact diodes, copper-oxide rectifiers, magnesium copper-sulfide rectifiers, selenium rectifiers, selenium photocells, copper-oxide photocells, thermistors, and *Thyrite* varistors. Now, we have dozens of additional devices, each of which is available in a great many types.

A great deal of glamour has attended the growth of the transistor, but the diode has not stood still. Its family now contains many types which perform special functions hardly envisioned 20 years ago.

Zeners

The zener diode is one of the most serviceable of modern special types. This is a silicon junction diode which has the peculiar current-voltage curve shown in Fig. 1. This conduction results from special processing of the silicon and fabrication of the junction. Notice that forward conduction (anode positive, cathode negative) resembles that of a conventional diode; reverse conduction (anode negative, cathode positive), however, resembles that of a conventional diode only up to point Z—a critical value of reverse voltage. At that point, the similarity ceases, because the reverse current increases abruptly and considerably, due to avalanche-type effects within the semiconductor.

This sharp breakdown at a specified reverse voltage has been utilized for several purposes, the chief one being voltage regulation. Fig. 2 shows the basic regulator circuit. Limiting resistance R is chosen, with respect to the diode characteristic, so that the diode conducts zener current—i.e., high reverse current corresponding to the breakdown region of the characteristic. As the unregulated DC input voltage swings widely, the resultant current through R and X varies similarly; but the voltage drop across diode X thus remains almost perfectly constant (see Fig. 1). Stages may be connected in cascade for improved regulation.

Zener diodes may be connected back-to-back in series for AC regulation. These diodes are available in a wide variety of breakdown-voltage ratings (from 2.4 to 200 volts) and power ratings (from 250 mw to 50 watts). Applications are as a voltage standard, voltage regulator, wave squarer, clipper, or limiter.

Tunnel Diodes

The tunnel diode is one of the most exotic members of the semiconductor family. The silicon (usually) or germanium (sometimes) used to make this diode is heavily doped, and the depletion layer (the layer, between the P and N materials at the junction, in which no carriers—holes or electrons—can exist) is made extremely thin. At very low forward voltage, a current — called *tunnel current* — flows across the junction. If the voltage is increased further, the tunnel current decreases to zero, after which normal diode forward current flows.

This action gives rise to the peculiar current-voltage curve shown in Fig. 3. Here, tunnel current varies from zero through A to B, and conventional forward current is represented from B to C. Current is decreasing from A to B, while applied voltage is increasing. This action shows that the tunnel diode is a negative resistance in the A-to-B region.

The negative-resistance characteristic may be used to obtain simple amplification or oscillation. Fig. 4, for example, illustrates a typical tunnel-diode oscillator circuit. In this arrangement, R1 and R2 form a voltage divider to reduce battery voltage to the value (usually about .1 volt) needed to bias the diode midway between A and B in the negative-resistance region of its forward conduction curve (Fig. 3). Capacitor C1 and inductor L1 are chosen to resonate at the desired oscillation frequency.

Other applications of tunnel diodes include frequency converter (in receivers), voltage level sensor, flip-flop, and computer memory cell. The self-resonant frequency of a tunnel diode is in the thousands of megacycles (gigacycles).

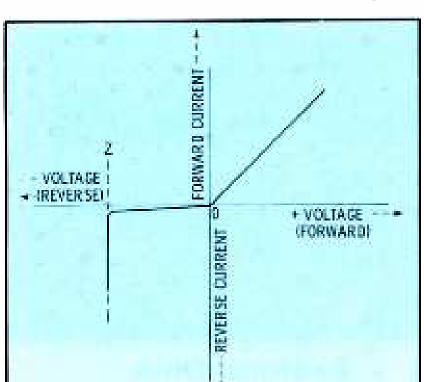


Fig. 1. Voltage-current curve of zener.

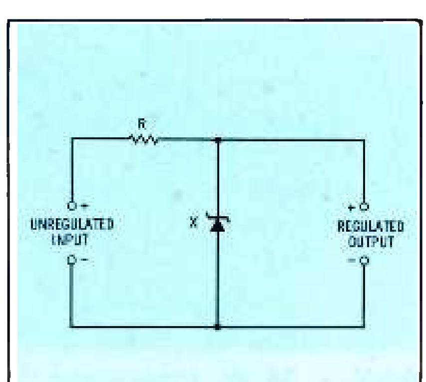


Fig. 2. Zener diode used as regulator.

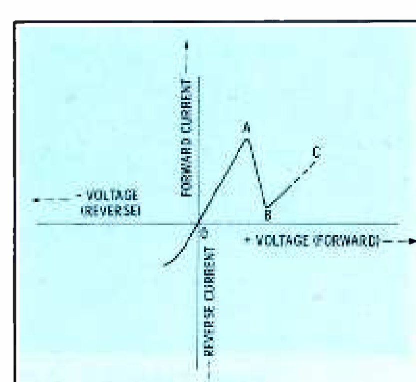
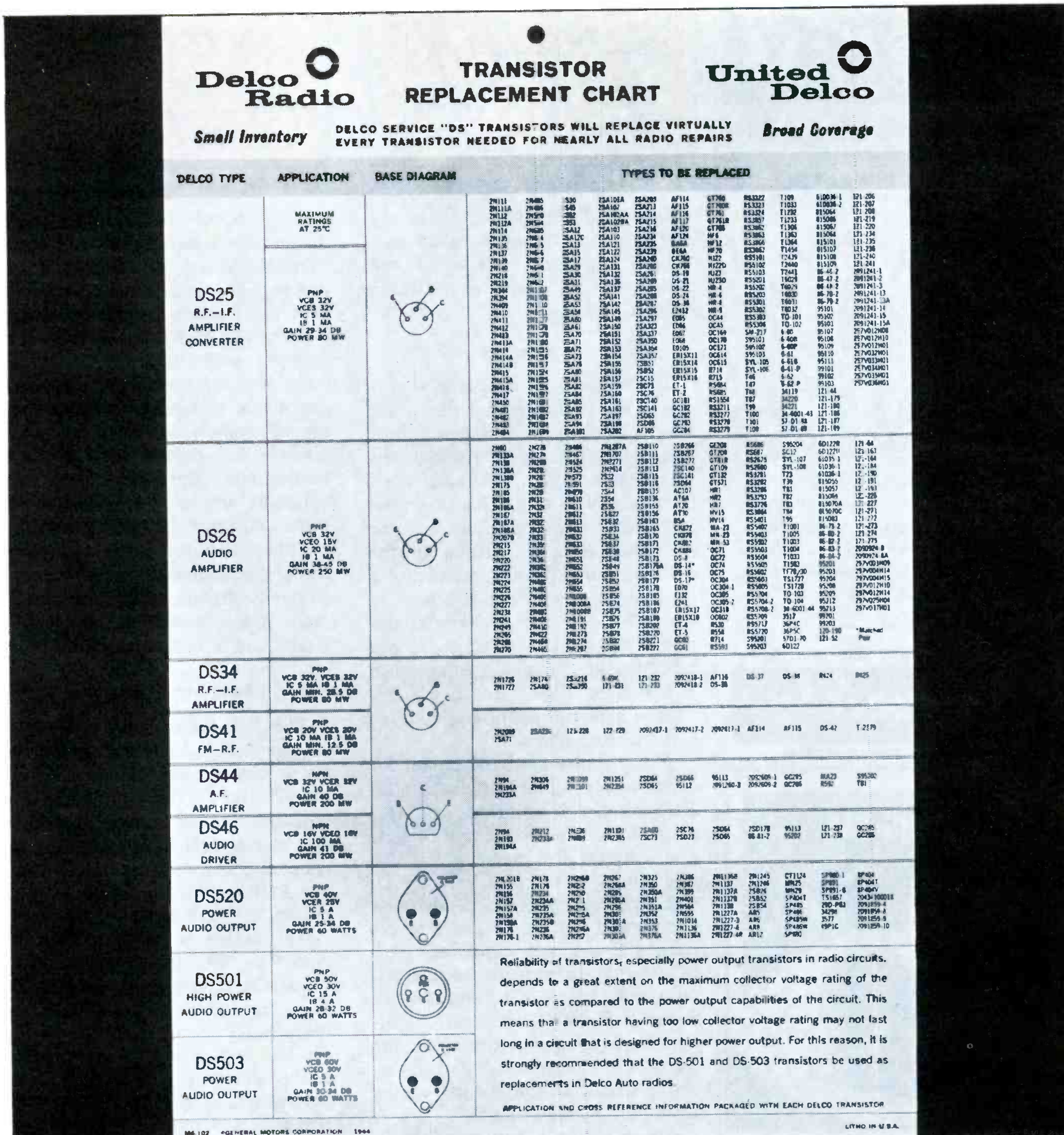


Fig. 3. Characteristic of tunnel diode.



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DS503 POWER AUDIO OUTPUT	PNP VCB 60V VCEO 30V IC 5 A IB 1 A GAIN 30-34 DB POWER 60 WATTS		APPLICATION AND CROSS REFERENCE INFORMATION PACKAGED WITH EACH DELCO TRANSISTOR

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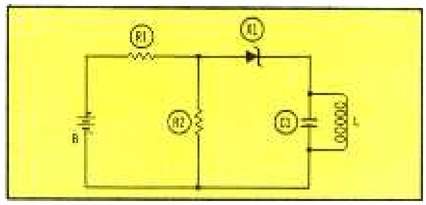

Fig. 4. Tunnel-diode oscillator circuit.

Tunnel diodes are available in current ratings from 1 to 25 ma. Typical forward voltage at the center of the negative-resistance slope is 150 mv.

Varactors

The varactor is a specially processed and fabricated junction diode which exhibits a voltage-sensitive capacitance when a DC reverse voltage (anode negative, cathode positive) is applied to it. This bias voltage widens the depletion layer on the junction in proportion to the voltage value, thereby producing a convenient way to obtain smoothly variable capacitance with one miniature component. Varactors are obtainable in nominal capacitance values from 1 or 2 pf to 500 pf, with maximum operating voltages from 10 to 120 volts.

Fig. 5 shows the basic circuit for continuously variable tuning of an RF tank circuit by means of a varactor. Resonant frequency is determined by the inductance of coil L1 and the capacitance of varactor D. Varactor capacitance depends upon the applied voltage E. Blocking capacitor C has high capacitance (.1 to .5 mfd) to provide low impedance and have no effect on tuning; it serves to block the DC control voltage from the coil—otherwise the coil would DC-short-circuit the varactor. Choke L2 blocks RF energy from the DC bias source.

Fig. 6 shows a varactor used in a frequency-multiplier circuit that delivers some multiple of any input-signal frequency, without needing DC power. In this arrangement, filter L1-C1 is tuned to the input frequency (f), and filter L2-C2 to the desired harmonic output frequency (nf). Frequency multiplication re-

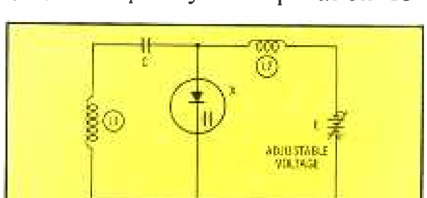

Fig. 5. Varactor diode in tuned circuit.

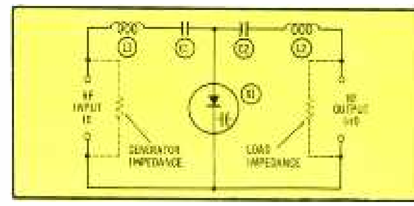

Fig. 6. Varactor used as RF multiplier.

sults from the distorting effect of the nonlinear capacitance-vs-voltage characteristic of the varactor. Since the varactor is a reactive component (its junction reverse resistance is extremely high), it performs this function with efficiency and little loss. Varactor frequency multipliers (harmonic generators) are used—up to microwave frequencies—in instruments, control devices, and transmitters. For transmitter use, varactors are rated from 30 to 50 watts and up to 120 volts.

Other varactor applications include resonant-slope amplification; automatic frequency control; amplitude, phase, and frequency modulation; and flip-flop operation.

Four-Layer Diodes

The four-layer diode (Fig. 7A) contains alternate N and P regions in a single semiconductor chip: NPNP. Hence, there are three PN junctions in this device, and they act electronically as two direct-coupled transistors (one NPN and one PNP), with the output of one fed back to the input ot the other.

The action of this diode takes place in the following manner: When the device is forward-biased (i.e., the end P layer connected to the positive terminal of a low-voltage DC source, and the end N layer to the negative), an extremely small current will flow. If the voltage then is raised momentarily to the critical (firing) value for the particular diode, the current will rise abruptly to a high level and will continue to flow even when the voltage is reduced somewhat. Therefore, the diode can be switched ON by temporarily raising the supply voltage (or applying a momentary pulse in

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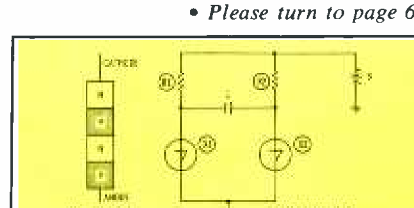

Fig. 7. Circuit using four-layer diode.

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ADVANCED SERVICE TECHNIQUES

SQUARE-WAVE TESTING for Inductors

More on modern component-check techniques. . .

by Robert G. Middleton

Continuing our series of articles on "Advanced Service Techniques," the article on this page deals with the analysis of inductances by square-wave testing procedures. Following an introductory article on the square wave itself (April 1965 PF REPORTER—"Advanced Techniques for Future Servicing"), last month's article on testing resistances introduced you to square-wave testing, and mentioned certain inductive effects that are found in some types of resistors. Next month's article will explain the testing of capacitances. We will then progress into the testing of three-terminal networks that contain combinations of all three—resistance, inductance, and capacitance. When the only visible portion of a component pack is a set of three leads, these special tests are one of the few ways you can identify what's inside or whether a defect lies hidden therein.

The techniques outlined can be carried out properly only with a triggered scope of the variety described in the March 1965 PF REPORTER article "Learning About Triggered-Sweep Scopes." Few service shops have such an instrument available; they are found mostly in television broadcast stations, electronic and research labs, and of course a few truly forward-thinking shops. If you can find any way to gain the use of such a scope, for even a few hours each month, take advantage of the opportunity to familiarize yourself with its operation and to practice the testing techniques we're outlining in this series. The time will come when much of your servicing work will require a scope like this; a lot of your present troubleshooting could be greatly simplified by a high-quality triggered scope on a rollabout cart in your shop.

—The Editor.

Every coil has capacitance and resistance, in addition to its normal inductance. Each turn exhibits capacitance to each adjacent turn; overall, this is called the *distributed capacitance* of the coil. Resistance in a coil is usually minimal, and consists of the resistance of the wire itself. Distributed capacitance combines with the inductance to resonate at a particular frequency.

For example, Fig. 1 illustrates the square-wave test of a 21-mc TV IF coil. The coil has comparatively low resistance, and rings as shown in the photo. If the coil is defective, the ringing waveform damps out much faster, has a different frequency, or doesn't ring at all. If the low-cap probe is omitted, the coil rings at a lower frequency because it is shunted by more of the scope's input capacitance.

Low-Q Coils

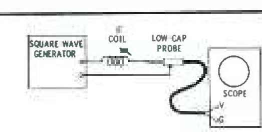
Coils which have substantial resistance will not ring in a square-wave test. The I^2R loss in the resistance causes such rapid damping of the ringing waveform that it decays to zero before the first cycle is completed. The result of a square-wave test on a low-Q coil is seen in Fig. 2. The amount of tilt along the top and bottom of the waveform is related to the impedance of the coil. Observe that the tilt at the top is not the same as that along the bottom. This is because this iron-core inductance is nonlinear—its value varies as the test voltage changes.

When the output from the square-wave generator is low (and scope gain high), there is little tilt of the flat portions of the waveform (Fig. 3). On the other hand, when the generator output is high, there is very noticeable distortion. Of course, if there is a defect in the iron-core coil, distortion may show up even in low-level tests.

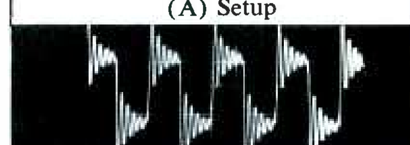
A good square-wave generator will apply up to 100 volts peak-to-peak to an inductor and will supply up to 160 ma of peak-to-peak current. This output is sufficient to test the majority of coils found in TV receivers. Be careful about touching a test circuit operating at square-wave voltages in this range—you can get an unpleasant shock.

Effect of Inductance

The rise of a square wave is slowed down when capacitance is shunted across the output terminals



(A) Setup



(B) Waveform

Fig. 1. Ringing test for air-core coil.

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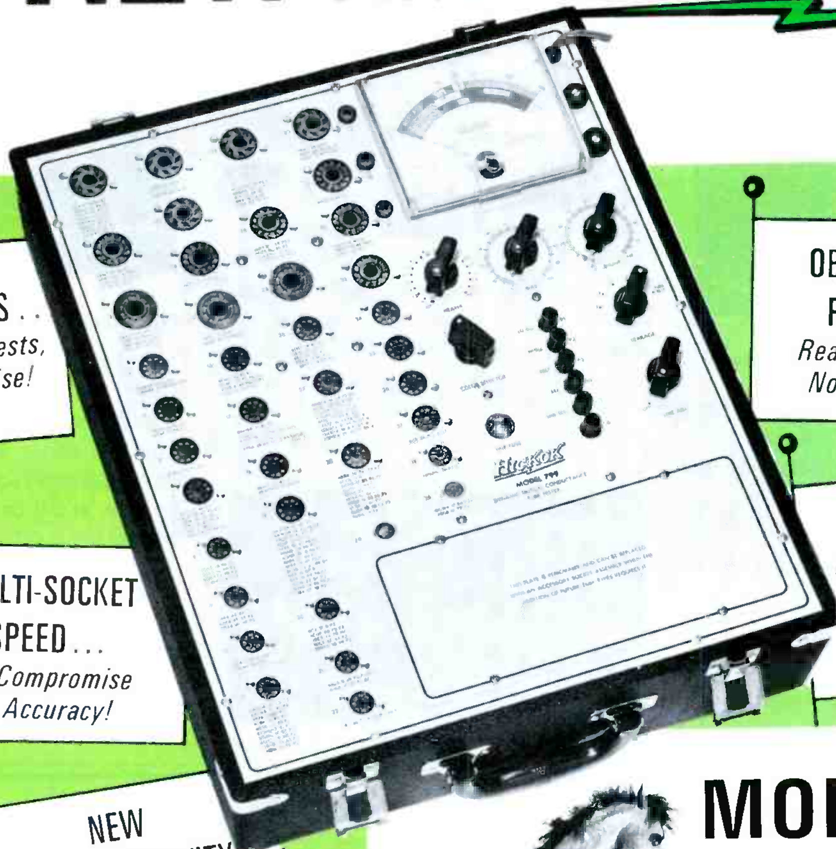

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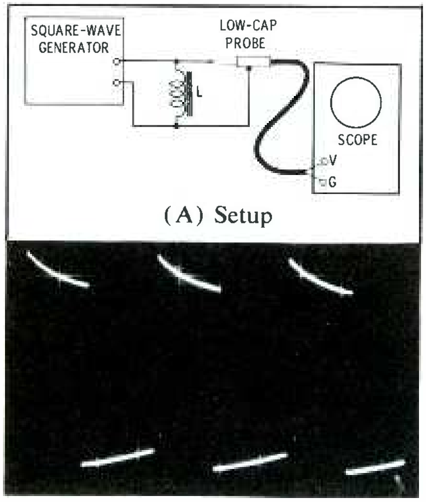


(A) Setup

(B) Waveform

Fig. 2. Iron-core test results differ.

of the generator. Hence, we might expect that the rise would be speeded up when inductance is placed across the generator output, as depicted in Fig. 4A. The wave does actually rise faster (Fig. 4B), accompanied by overshoot and ringing.

Fig. 5 shows how rise time is measured when a square wave rings and overshoots. Zero and 100% are defined by the flat-top portions of the waveform; rise time is measured from the 10% point to the 90% point. The overshoot extends above the 100% level; during the ringing interval, the voltage oscillates above and below the 100% level.

Referring back to Fig. 4B, we see that if inductance is zero, there is no overshoot. An inductance of 5 μh produces substantial overshoot. An inductance of 10 μh produces much more overshoot. Other things being equal, the height of the first overshoot pip is directly proportional to the inductance value. This fact is useful in comparing or measuring small inductance values. It permits streamlined tests of replacement coils at the service bench.

If you make the test depicted in Fig. 1 with an ordinary service-type scope, you will see little or no over-

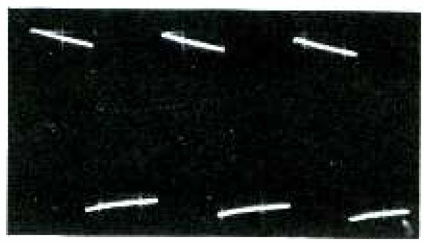
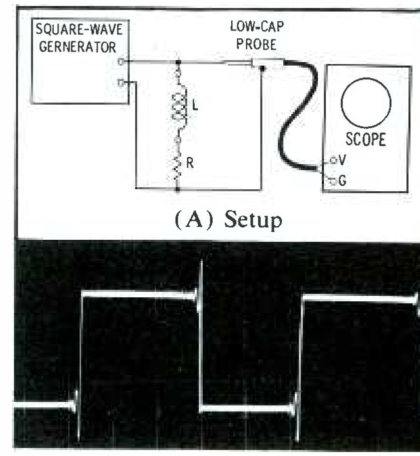


Fig. 3. Waveform with low-level signal.



(A) Setup

(B) Waveform

Fig. 4. Shunted inductance will ring.

shoot or ringing, because the IF coil rings at a frequency which is practically out of the scope's passband. On the other hand, a 15-mc triggered-sweep scope has usable response at 20 or even 25 mc—which permits a useful ringing test.

If you make the test depicted in Fig. 1 with a 40-mc IF coil, you will observe no overshoot or ringing, even on a triggered-sweep scope with responses past 15 mc. The reason is that the ringing frequency is

• *Please turn to page 67*

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SOLID-STATE RELAYS for Industry

take the place of electro-mechanical units.

by S. E. Lipsky

Solid-state relays have made their appearance in many forms in recent years. Perhaps the most familiar application is in the switching circuit of low voltage DC-to-DC converters for mobile-radio power supplies, taking the place of vibrator-type power supplies. Other applications are in telephone and telegraph circuits, as well as in industrial control circuits. In all of these, some unique properties of this device are utilized.

Description

Any relay is a device in which a set of contacts is controlled (made to open or close) by power from a separate, independent circuit. For example, it may be necessary to switch many amperes of current on or off in one circuit, but the controlling energy—from another circuit—is only a few milliamperes. Or, it may be desirable to have one circuit control a multiple array of circuits, perhaps using double-pole double-throw, triple-pole double-throw, or other complex switching arrangements.

If a relay is thought of simply as a "black box," an input signal (or condition), appropriately applied, will result in certain desired output conditions. Although it is not an amplifier, a relay can be thought of as acting as an amplifier in the sense that a small input change (as little as a few milliamperes) can effect a large output change (up to many amperes)

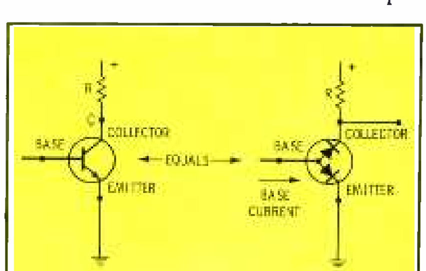


Fig. 1. Switch equivalent of transistor.

The application of semiconductors to form solid-state relays results from certain properties characteristic of solid-state devices. Fig. 1 represents an NPN transistor in its simple two-diode equivalent form. In the usual configuration (common emitter), the transistor is biased so it doesn't conduct. In other words, if base current is zero (base grounded), the diode comprising the base and emitter is not conducting; thus the diode comprising the collector and base is open (doesn't conduct either). Collector-to-ground impedance is the back resistance of the diode. By proper choice of semiconductor properties, the collector-to-ground impedance can be made extremely high in the unbiased condition.

If the base is fed sufficient current (bias), the base-to-collector diode will conduct heavily. This means that the collector will appear to be grounded, or nearly so. The two conduction modes just discussed are the basis for use of the transistor as a relay; one mode is the high-impedance or OFF state, the other is the low-impedance, or ON, state. The operation described is in reality a switching action; but it is a modified one. Semiconductor characteristics are such that, if the amount of current fed to the base is continuously raised, the collector current will increase to some point and then remain fairly constant no matter how much further base current is increased. This condition is called *saturation* and represents the maximum current the transistor can carry in its ON state.

This simple switch is thus the basis for all solid-state switching and control circuits. A circuit connected to the collector will be connected effectively to the emitter whenever base bias is increased enough to cause saturation.

When the base is grounded, the collector connection will be removed from ground. There are two slight limitations to a solid-state relay. The switching action is not perfect, for there is still a small resistance be-

• *Please turn to page 72*

Notes on Test Equipment

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

by Allen B. Smith

Low-Cost Color Generator

During the past few months, several color-bar and convergence-pattern generators have been described in "Notes on Test Equipment." The design and function of these instruments has varied only slightly, with most using a series of multi-vibrator or blocking-oscillator dividers to derive 15,750-cps and 60-cps synchronizing pulses from the 189-kc crystal oscillator. Convergence patterns are formed from these two basic signals. The color signal is generated, using the offset-carrier method, by a second crystal-controlled oscillator operating at 3.563795 mc. The Seco Model 980 Color Signal Generator shown in Fig. 1 follows these same general specifications, providing a full set of color bars and the convergence patterns listed in the *Specifications* box.

Fig. 1. Color-signal generator employs time-proved circuits.

A block diagram of the Model 980 is shown in Fig. 2. From this, the manner of dividing the basic 189-kc signal and of mixing the pulses is shown clearly. All information passes through either the video mixer and the phase inverter or the phase inverter alone prior to being combined with the RF signal in the modulator.

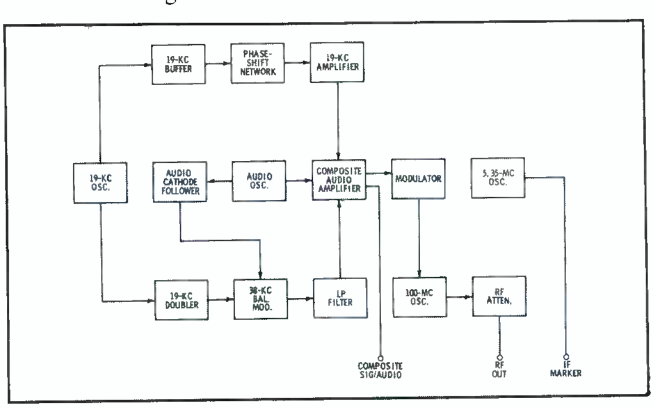


Fig. 2. Monostable multivibrators give frequency division.

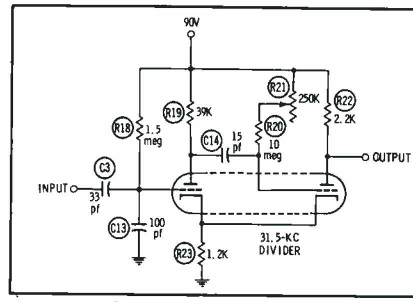


Fig. 3. Schematic is typical of the six multivibrator frequency-divider stages.

The schematic in Fig. 3 shows one of the frequency-dividing multivibrators used in the Model 980. Component values are typical for all six divider circuits (the 15,750-cps divider, however, has no frequency-control potentiometer). In the divider shown —the 31.5-kc multivibrator—every sixth pulse of the 189-kc oscillator signal triggers the multivibrator action.

Operation of the cathode-coupled monostable multivibrators depends upon the fact that the circuit has one phase of its cycle in which it will rest

Seco Model 980 Specifications

RF Output Frequency:
Factory-adjusted to channel 3, but tunable to either channel 2 or channel 4 by tuning the RF oscillator coil.

RF Output Level:
In excess of 1000 μv at output impedance of 300 ohms, balanced.

Method of Bar Generation:
Keyed - offset - carrier principle; generator frequency offset 15,750 cps from color-receiver reference-oscillator frequency of 3.579545 mc. Subcarrier keying provides bars.

Patterns Available:
Keyed rainbow, vertical lines (9), horizontal lines (6), crosshatch, and dot patterns.

Power Requirements:
105-125 volts AC, 60 cps, 40 watts

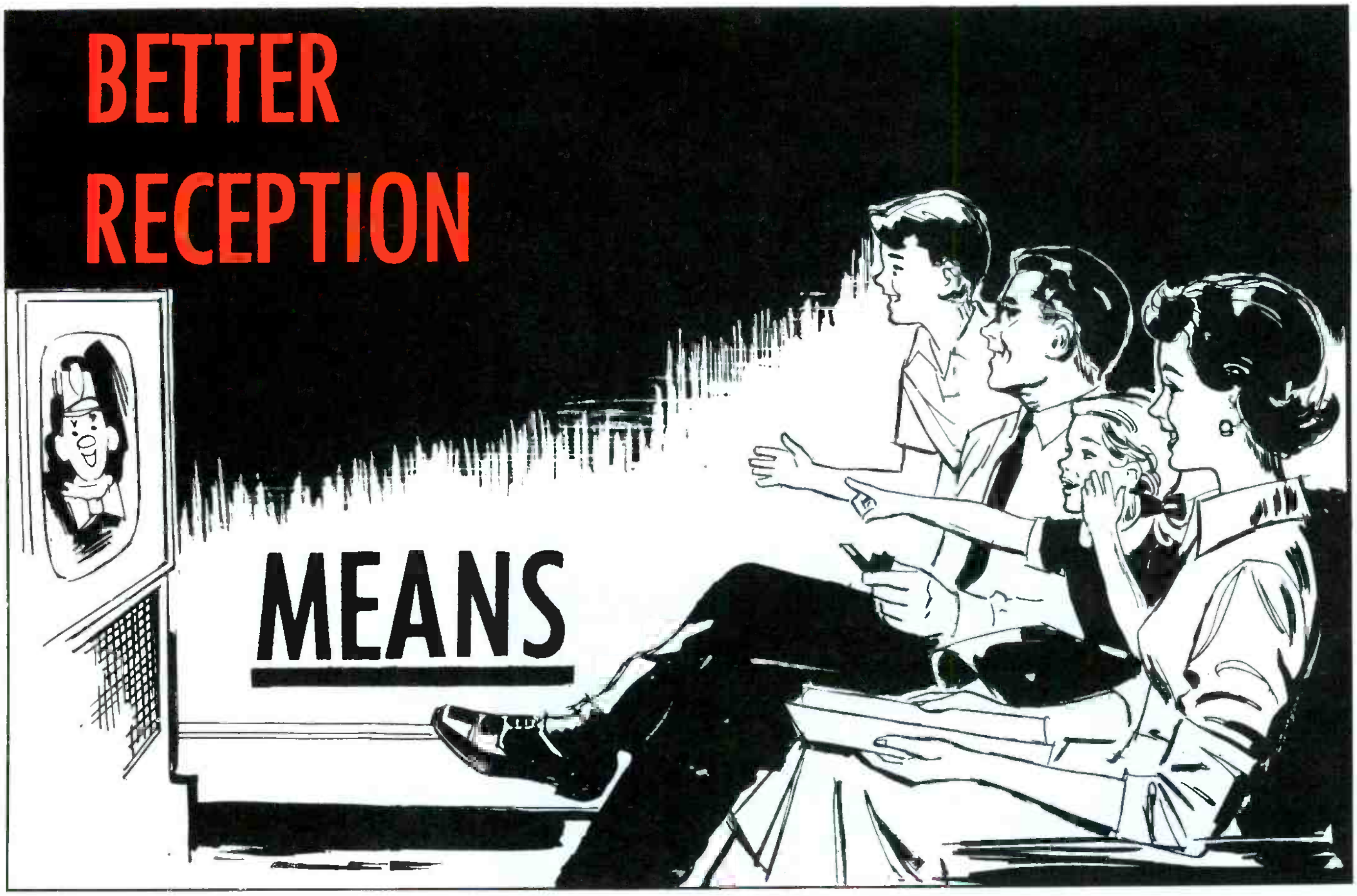
Size (HWD):
6¾" x 11⅛" x 6⅛"

Weight:
10 lbs

Price:
$119.50

until triggered into its unstable phase by an input pulse. During the transition from that unstable state to its preferred stable phase (a time essentially determined by the RC constant of C14 and R21) the circuit is insensitive to successive input pulses. After reaching the stable state once again, however, the next input pulse to arrive will again

• *Please turn to page 69*



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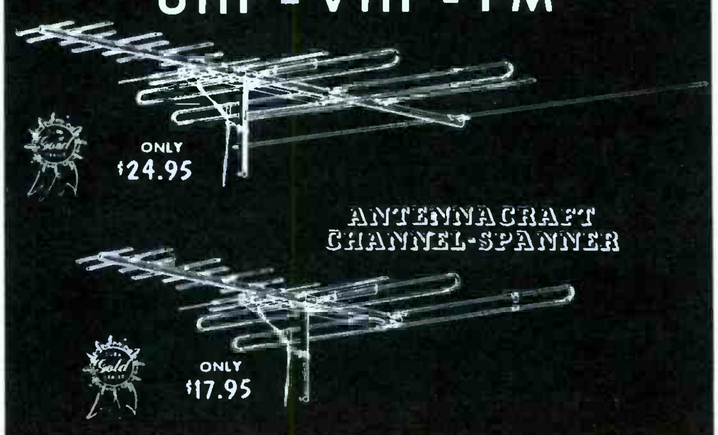

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Servicing Vertical

(Continued from page 35)

on service literature, is your quickest method to locate this type of trouble.

Most transistorized vertical stages use a driver to develop a signal sufficient to drive the output stage. The pulse signal originated by the oscillator is available at the emitter of X1. At this point, the pulses are shaped into a sawtooth by network C2-R3 (see W3). The height control is in series with the signal and controls the amount of signal fed to the base of X2. An easy operational check of the height control is made by scoping W3 and rotating the control—this action should affect the amplitude of W3. R21 is an auxiliary linearity control used to adjust the amount of feedback from the output stage. The *shape* (and to some extent, the amplitude) of W3 should change when this control is adjusted. Although the change will be slight, it can be noticed on the scope. The main linearity control circuit is the RC network located in the base circuit. The setting of R7 doesn't effect the DC operation of the driver; rather, it alters the shape of the signal on the base. Prime components for breakdown in the driver circuit includes both linearity controls, electrolytics C4 and C6, and emitter resistor R9.

Distortion Troubles

Problems that produce non-linear sweep are usually associated with defects in the output stage. Of course, a defect associated with the driver stage could cause distortion, too—but not as often as a defect in the output stage.

Naturally, X3 needs to be a high-power transistor, for it must supply currents to the yoke. Usually the output is mounted on some type of heat sink and is easy to locate. In transistor circuits, no matching transformer is used between the output and the yoke; the low impedance of transistors matches the low-impedance yoke windings, and the transformer isn't needed. Typical is a choke-capacitor arrangement between the output transistor and the yoke; C9 couples drive to the yoke windings and serves as a DC isolating capacitor. The yoke return is to the emitter of X2.

The output drive signal in transistorized vertical circuits seldom exceeds 100 volts—a more typical value in the majority of receivers is 40 to 50 volts—and the oscilloscope can be used to check the signal directly at the high side of the yoke windings. The vertical-blanking arrangement in this receiver is typical of that used in receivers that blank the CRT *grid*; here, a negative pulse from the collector of X3 is coupled via C11 and R20 to the grid.

Bias for X3 is obtained from the resistive network R11, R12, R13, and R14 across the 12-volt supply. Current through the stage is adjustable with the vertical bias control (R11); a thermistor (R14) is used to hold constant bias (and thus constant sweep), and protect X3 from runaway.

Conclusion

Servicing transistorized vertical-deflection circuits isn't basically difficult. The methods are a little different from those used in tube circuits, but, once you master the differences, you should have no trouble. ▲

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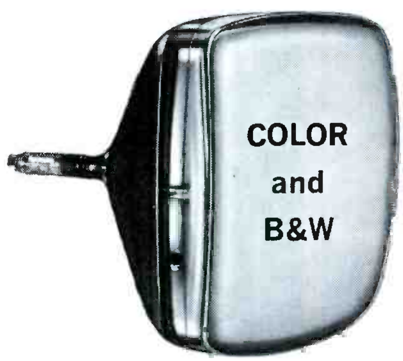

Zenith black-and-white replacement picture tubes are made only from new parts and material except for the envelope which prior to re-use, is inspected to the same standards as a new envelope. In color tubes the screen, aperture mask assembly and envelope are inspected and tested to meet Zenith's high quality standards prior to re-use. *All* electron guns are new.

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Circle 28 on literature card

Circle 29 on literature card

Etched Circuit Boards

(Continued from page 41)

will often vibrate until they break the soldered joints. Fig. 9 shows a metal brace added to hold a filter capacitor in place.

Simple Tools

Intermittent breaks can be found in a board by using a test lead. Solder two insulated test prods to a flexible wire and grind sharp points on their ends. Check between soldered points by pushing the sharp points into the etched wiring. When the broken section is bridged, the radio will play as it should.

Few extra tools are needed to repair etched circuit boards. A bench light behind the etched board will sometimes show up a broken connection and certainly makes it easier to follow the wiring on an earlier, unmarked board. There are magnifying flourescent lamps that light up the etched board and enlarge it at the same time. These are especially helpful for tiny etched circuits found in some pocket portables.

Simple tools, easily learned practices, and a little perseverance make servicing etched circuit boards not difficult at all. ▲

Circle 31 on literature card

Circle 33 on literature card

Circle 34 on literature card

Introducing Zenith

(Continued from page 39)

vertical and horizontal sweep tend to *bow* at the top, bottom, and sides of the screen (a condition commonly known as pincushioning). In black-and-white receivers, correction is accomplished by pincushion magnets located either inside or outside of the deflection yoke. In color receivers, however, this is impractical because each beam (red, blue, and green) would be affected differently and obtaining suitable purity and convergence of the receiver would be nearly impossible.

As shown in the diagram (Fig. 6), a 6C4 is used as the dynamic pincushion corrector. Horizontal pulses (parabolic voltage waveform) are coupled through the two .0015-mfd capacitors to the grid of the tube and to correction transformer T2. The tube bias is such that the pulses passing through the tube are just large enough to cancel the pulses coupled through C1. A 60-cps waveform from the vertical output transformer is also applied to the grid of the 6C4. This vertical sawtooth controls the gain of the tube and thus the amplitude of the plate signal. The amplified signal is maximum at the start of the vertical sweep and is only partially cancelled by the direct signal. Approximately midway through the sweep, both signals are of equal amplitude, and cancellation occurs. At the end of the sweep, the tube approaches cutoff, and only the direct signal is present at T2. Therefore, the maximum correction voltage is applied to the vertical yoke winding through T2 at the two extremes of the sweep —when the beam is near the top and bottom of the screen. T2 is tuned to 15,750 cps to provide maximum correction when the beam is at the top or bottom of the screen.

Correction for pincushioning at the sides of the screen is accomplished by coupling a 60-cps waveform from the screen of the vertical-output tube to the grid of the horizontal-output tube.

Summary

It is impossible to point out in one short article all the changes that are incorporated in this new color receiver. We have mentioned the ones most important to the serviceman from the standpoint of servicing. ▲

Zeners, etc.

(Continued from page 48)

series with the supply voltage), and switched OFF by reducing the voltage momentarily to near zero.

This effect makes possible the design of simple relaxation oscillators, flip-flops, voltage-level sensors, pulse generators, and power inverters. Fig. 7B shows a free-running multivibrator circuit using a pair of four-layer diodes, X1 and X2. The frequency is determined principally by the values of C, R1, and R2.

Four-layer diodes are supplied at various *holding current* ratings from a few milliamps to 10 amps.

PIN Diode

A semiconductor diode which has been conducting forward current (A in Fig. 8) will not switch off instantaneously when a reverse voltage is subsequently applied. Instead, a heavy reverse current flows momentarily (B in Fig. 8) and then decreases to zero (C in Fig. 8). The reason for this action is the presence of carriers (holes or electrons) which are injected into the junction by the forward current and add to the reverse current until they are completely swept away. In fast

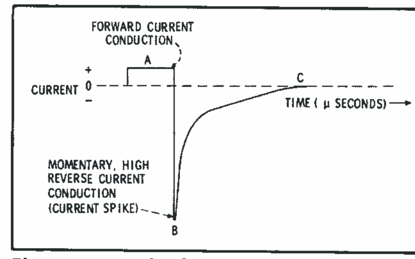


Fig. 8. PIN-diode characteristic curve.

switching, as in digital computers, diode recovery time (the time required for reverse current to settle to zero) must be short; computer diodes consequently are processed to reduce both the amplitude and duration of the initial reverse-current spike.

The reverse-conduction spike has been utilized, however, in pulse generation and harmonic production. Diodes especially suited to these applications are the PIN types (those containing an *intrinsic* (I) layer between the P and N layers of the junction). The step recovery diode may be connected into a frequency multiplier circuit, in place of the varactor shown in Fig. 6. Such circuits have been used to obtain microwave output for a VHF input signal, at an efficiency of 15%.

New Signal Diodes

Germanium and silicon small-signal diodes are now available in a wide variety of types. Aside from conventional diodes in a multitude of current, voltage, power, capacitance, temperature, frequency, and recovery-time ratings, diodes with special frequency and switching-speed characteristics are manufactured by any of the several processes (and in the several corresponding types) common to modern transistor fabrication: mesa, planar, and planar epitaxial passivated (PEP).

Perhaps the most unusual of all the new units are the gallium-arsenide light-generating diodes. These diodes, when DC-biased (often at 1½ volts), generate infrared light output at levels up to 150 mw.

Conclusion

The increased use of semiconductors in home-entertainment equipment means you will be encountering considerably more solid-state equipment that will need repair. The foregoing general information about the various types of semiconductors and how they fit into circuit operation can simplify troubleshooting and repair of this equipment. ▲

Shortcuts

(Continued from page 43)

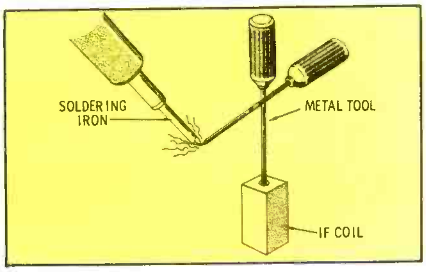


Fig. 12. Melting wax in a sealed IF can.

11) that slides off after either end plate is removed. The lead wires which connect the antenna to the printed circuit board are delicate. If the portable has been serviced previously, the lead wires have been flexed and should be inspected visually for possible breakage.

Common to All

Besides the defects that appear consistently in particular models of these radios, there are some failures common to all models. When you're servicing any transportable receiver, stay alert for these symptoms:

Damaged IF Coils

The IF coils used in the transportable radios were sealed with wax to prevent them from shifting frequency due to car vibrations. Fig. 12 illustrates how a metal tool may be heated with a soldering iron and used to free the IF coil slugs. The slug should be turned back and forth until the tool has cooled off. A plastic alignment tool can then be used to adjust the slug.

An important point to note is that if a radio has been previously repaired, you should be on the lookout for a coil damaged by someone forcing the sealed slug to turn. A coil that has been forced can usually be detected by a visual check or by the way it feels when adjusted.

Output Transformer Distortion

The transformer referred to in this case is the small output transformer used to drive the portable speaker. Shorts, opens, and changes in resistance are frequent failure modes of this unit. The primary windings (30 ohms each) have push-pull audio transistors driving them. A poor or open connection in one winding produces distortion. A normal secondary winding should read between .8 and 1.4 ohms, and it isn't uncommon in a bad unit to find the resistance varying between

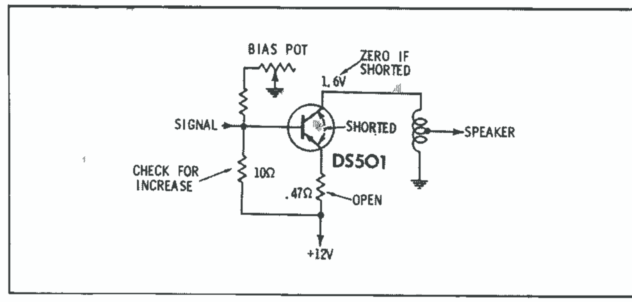


Fig. 13. Watch for these possible faults in power stage.

0 and 70 ohms when the leads are flexed.

Power Transistor Failures

The output stage of a transportable radio is shown in Fig. 13. This stage is located permanently in the car, and a defective stage can be detected by the fact that the portable plays out of the car but not in it. Wih the portable plugged into the car, a "thump" should be heard in the speaker as the radio is turned on. Provided the radio is receiving power and the speaker is good, failure to "thump" usually indicates a shorted power transistor. When this component is shorted, the collector voltage will read zero volts, and the .47-ohm fusible resistor will be open. Out of the circuit, the emitter-to-collector resistance will read less than 50 ohms on the Rx1 scale.

Before replacing the transistor, check the 10-ohm bias resistor—since the 10-ohm resistor is sometimes overheated when the transistor fails. The resistor then swells and its value rises. The bias pot should be used to set the collector voltage at 1.6 volts after the transistor is replaced.

Summary

Many of the failures listed above may seem to be of an unusual nature and might appear to be one-of-a-kind repairs. However, unusual as they appear, they do represent the major failures in these radios. A little advance warning can prevent hours of "dog" work trying to locate a defect. If you keep these hints in mind, servicing these transportables should present few problems. ▲

BOOK REVIEW

Radio and Television Receiver Circuitry and Operation, Revised Edition; Ghirardi and Dines; Holt, Rinehart, and Winston, Inc., New York, New York, 1964; 560 pages, 6" x 9", hard cover; $10.00.

Much of the material appearing in this revised edition is new, since the book was extensively rewritten to bring itup to date. However, in addition to the coverage of recent developments, some old—and still useful and interesting—material is retained. This provides the reader with a knowledge of "what happened before," background information which provides continuity between basic theory and the exotic circuits found in modern receivers.

Tube circuits are treated, according to function, in separate chapters, while transistor operation and application is treated in a single, separate chapter. Each of the 14 chapters is ended with a summary and review questions. Answers to the odd-numbered questions are given at the back of the book. Overall, the text should be of value to the reader for either classroom or home study.

Square Waves

(Continued from page 52)

so high it is practically choked out by the scope's vertical amplifier. You can obtain a display of overshoot and ringing by connecting a small capacitor across the 40-mc coil, because this reduces its ringing frequency to within the passband of the vertical amplifier. This is a useful expedient in a few situations.

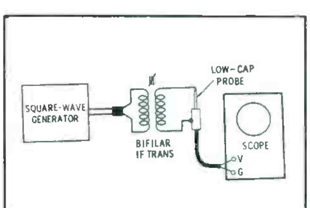
Transformer Tests

Many IF coils are designed as bifilar transformers. When such an IF transformer is tested (Fig. 6), it exhibits *transformer differentiation*. In other words, pulses are displayed at the leading and trailing edges of the square wave,although the square wave itself is not passed. Baseline irregularity following the pulse is also characteristic. With this type of unit, pulse height, pulse width, and baseline shape indicate whether or not the transformer is defective. The waveform in Fig. 6B shows no clearly definable ringing interval because the scope cannot respond to such a high ringing frequency. Nevertheless, ringing is present; a scope with sufficient vertical-amplifier bandwith would display it.

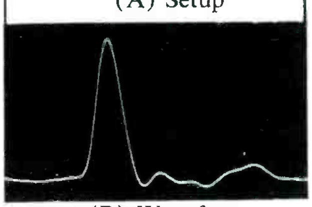
Next, let's examine how a radio IF transformer rings on a square-wave test. The waveform in Fig. 7 is the normal ringing pattern for a 455-kc IF transformer connected as in Fig. 6A.

What is happening here? When the leading edge of the square wave is applied to the transformer, a damped sine wave develops across the primary winding. Meanwhile, 455-kc energy is being coupled into the secondary winding. As the damped sine wave decays in the primary, the ringing voltage in the secondary builds up to a peak. As the next cycle of the ringing waveform builds in the primary, the secondary voltage starts to decay. As the secondary voltage decays, it is coupled back into the primary. When the secondary voltage has decayed to zero, the primary voltage has again built up to a peak. However, because of losses in the winding resistance, the second peak is less than the first. Primary and secondary thus transfer 455-kc energy back and forth until the resistance completely damps it out. When the trailing edge arrives, the back-and-forth pattern is again established, as seen in Fig. 7.

Since this waveform depends upon the Q of both the primary and the secondary, it provides a critical test of an IF transformer. Any defect shows up as a change in



(A) Setup



(B) Waveform

Fig. 6. HF-inductor test.

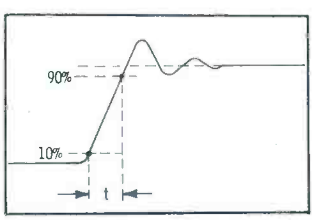


Fig. 5. Rise time vs. ringing.

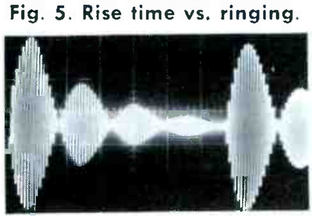


Fig. 7. Ringing IF transformer.

successive peaks, in the ringing frequency, or in both. Serious defects result in no ringing in the pattern.

The transformr depicted in Fig. 6A appears as a four-terminal network. However, if you connect the generator ground lead to the scope ground lead, a three-terminal network results, and the waveform is unchanged. In other words, an IF transformer is arranged as a four-terminal network merely to provide DC isolation. In an AC test, it makes no difference if the ground-reference terminals of primary and secondary are connected.

When you test different types of IF transformers, you will find they have a different number of cycles in each ringing sequence (from zero to peak and back to zero). The number of cycles is determined by the coupling between primary and secondary; tighter coupling produces fewer cycles in each ringing sequence. Hence, the number of cycles is significant when transformers are quick-tested for response or bandwidth.

Conclusion

Keep these facts about inductance testing firmly in mind. In the next article of the series, we'll be showing you the effects of square-wave testing for capacitors. At the end of that article, we'll summarize the fundamentals of square-wave testing as you're learned them for all three types of components—resistors, inductors, and, by then, capacitors. In the articles to follow, you'll learn how to put all this knowledge together and apply it to practical square-wave testing of unknown three-terminal networks. ▲

Notes on Test Equipment

(Continued from page 56)

trigger the circuit to its unstable condition, from which state the cycle is repeated. Varying the value of resistance R21 provides control of the recovery time so that precise pulse counting can be achieved.

The output waveform is a series of squared pulses which is differentiated by the input circuits of succeeding dividers or other stages. Stability of the output-pulse frequency is dependent primarily upon the values of R19 and R23.

Referring once again to the block diagram, the overall circuit functions can be understood easily. The heart of the generator (for sync pulses and convergence patterns) is the 189-kc oscillator, which uses a high-stability temperature-compensated crystal-controlled circuit; the color bars begin with a similar oscillator operating at 3.563795 mc.

The 189-kc signal is fed through a shaper circuit which modifies the sine-wave output of the oscillator into a series of sharp pulses which is fed to the video mixer in the VERTICAL BARS position of PATTERN SELECTOR switch S1. The pulse train, when impressed on the RF carrier and fed to the set, generates a series of vertical bars (12 in all, but because of overscan only 9 appear on the face of a round color CRT, and 10 appear on the rectangular types). Horizontal bars are achieved by dividing the 189-kc signal through a series of four monostable-multivibrator dividers, the operation of which has already been described. This series of dividers (31.5-kc, 6300-cps, 1260-cps, and 420-cps) reduces the frequency of the pulse train applied to the video mixer so that six horizontal lines are generated on the CRT. An additional pair of dividers (15,750 cps and 60 cps) is used to achieve horixontal- and vertical-rate pulses, which are used to synchronize the set being aligned.

The color-bar generator uses a simple keyed-rainbow circuit that begins with the 3.563795-mc oscillator. This frequency is used because it is exactly 15,750 cps lower than the 3.579545-mc color-reference oscillators used in color receivers. When the generator color signal is applied to the set, the relative phase of the two signals (3.563795 and 3.579545) varies from 0° to 360° during the time required to sweep one horizontal line on the face of the CRT. This phase relationship is repeated for each successive horizontal-sweep trace. Since the color set demodulators generate color signals from phase-change information, a continuously variable color rainbow is displayed on the CRT, ranging from yellow, through red and blue, to green. This rainbow pattern is divided into vertical bars by keying the offset carrier at a 189-kc rate. This action generates a series of 12 bars, 10 of which appear on the screen of the color CRT.

The composite color- or convergence-pattern output of the generator is taken from the modulator in which all patterns are impressed upon the RF signal generated at the frequency of channels 2, 3, or 4. The generator is connected to the TV set antenna terminals.

Actual operation of the Model 980 is simply a matter of selecting the desired test pattern and adjusting the COLOR OUTPUT level control for normal saturation in the COLOR BARS position of S1. No provision is made for using the test set to short successive color CRT grids (red, blue, or green) for purity adjustments; a separate device or simple resistor-shorting techniques must be employed.

For the technician who requires a color-bar and convergence-pattern signal source for color servicing, the Model 980 should provide good service. Patterns are stable, and the color-bars provide the standard pattern required for chroma adjustments. The manual provided with the instrument contains information on adjusting the various dividers for correct operation should circuits require servicing or adjustment. ▲

For further information, circle 131 on literature card.

The Troubleshooter

answers your servicing problems

Unsound Bars

I am having considerable trouble correcting horizontal lines, or bands, in the picture of an Emerson Chassis 1282 X. (This receiver is covered in PHOTOFACT Folder 408-2.) The bands appear similar to sound bars; however, they are present at all times, whether sound is being transmitted or not. They do not drift vertically like 60- or 120-cps hum bars, but appear to move up and down approximately ½″ rapidly as a group. They appear similar to streaks caused by open peaking coils, but do not trail from any object; they are uniform across the screen.

When the brightness control is reduced to a darker-than-normal picture, the lines (or bands, disappear. When the brightness control is increased, they become more pronounced. They are present on all active channels, and are also visible on inactive channels to a lesser degree. They are present at the top and diminish to zero at about halfway down the screen.

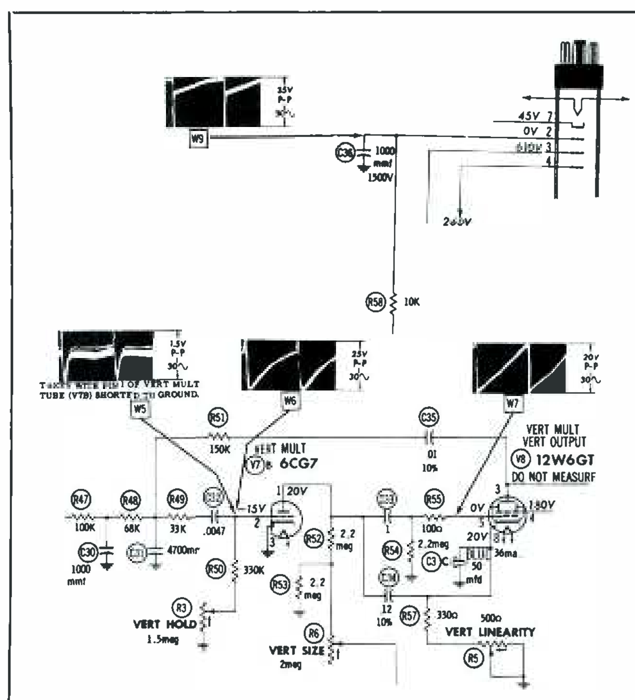
The only abnormal waveforms noted were at the picture tube grid and the plate of the vertical oscillator. The top of the waveform at the grid of the picture tube is contaminated with video.

Is it normal to detect video at the picture-tube grid if the CRT is cathode driven? Is it possible there is interaction between sections of the electrolytic capacitors? Where would you suggest I look next?

HOMER GADOW

Redwood City, Calif.

There should not be video in the vertical-blanking waveform at the grid of the picture tube. There is a possibility of a timing defect in the vertical-multivibrator circuit which could be causing the grassy appearance you see on the top of the waveform. This appearance could also be caused by a small amount of video reaching the vertical-multivibrator grid. I suggest you make a detailed check on all components associated with the vertical-integrator circuit and the feedback network consisting of C35 and R51.



The possibility of leakage between electrolytics, as you mentioned, could be causing the trouble. It may be necessary to disconnect each electrolytic and substitute for it individually. You should also try a substitute picture tube or a test CRT. The original picture tube may have some internal defect that is causing the trouble, although it's only a vague possibility.

Erratic Horizontal Sync

I am having horizontal-sync trouble with a Hoffman TV Model 637. The set has a good picture, but will lose horizontal sync every few minutes. Adjusting the horizontal-hold control will restore a steady picture, but only for a short period or until channels are changed. I think I have tried almost everything, but still no luck. Where am I goofing?

JOSEPH J. BRUCCLEIN

Washington, D. C.

The complaint on this chassis (covered in PHOTOFACT *Folder 141-7) is a common one for receivers that have logged as much service time as it has. The trouble is that a component in the critical waveshaping networks of the horizontal AFC/multivibrator stages has changed or is fluctuating in value. There is no quick and magic service method. A scope must be employed to examine the symmetry and amplitude of the waveforms associated with this circuitry. I suggest you start at the cathode (pin 6) of V19, and trace the horizontal signal through the horizontal AFC, multivibrator, and to the grid of the horizontal output tube (pin 5 of V22). If any waveform is distorted or low in amplitude look for trouble in the associated circuit. You might better isolate the defective component(s) by placing a hot soldering iron close to each one (in turn) while watching the screen. If sync is lost when a particular part is heated—replace it. I suggest you perform this test on all capacitors associated with horizontal sync control; in a receiver this old you'll probably find several sensitive capacitors.*

BOOK REVIEW

Transistor AF and RF Circuits (TAL-1); Allan Lytel; Howard W. Sams & Co., Inc., Indianapolis, Indiana, 1965; 128 pages, 5½" x 8½", paperback; $2.95.

A sampling of the contents reveals transistor circuits for use in AM, FM, and single-sideband transmitters; superheterodyne and superrengerative receivers; oscillators and code-practice oscillators; converters, RF amplifiers, and IF amplifiers; video amplifiers; stereo amplifiers; audio amplifiers, preamplifiers, and power amplifiers; modulators and speech clippers; and varactor multipliers. Along with the schematic diagram of each circuit is included an explanation of the circuit and a parts list containing instructions for winding coils not commercially available.

Besides circuits for the widely used PNP and NPN transistors, applications for special types of semiconductors, such as dual and unijunction transistors, tunnel diodes, and varactors are illustrated.

Power supplies for the various circuits are not included, but the power-supply requirements are. No mechanical layout details are given except in special cases, such as high-temperature or high-frequency operation.

While this book will appeal mainly to the electronics experimenter, others will find it a handy reference text.

Solid-State Relays

(Continued from page 54)

tween collector and ground, even when the transistor is saturated. Also, there is some leakage from collector-to-ground when the switch is open. Compare these deficiencies to the action of a mechanical relay, whose contacts are almost a perfect short when closed and which exhibits an almost infinite resistance when open, and the limitations of the solid-state switch become evident. For many practical purposes, however, these limitations are negligible. Furthermore, the semiconductor transistor switch has the advantage of high-speed operation, with no moving parts; transistor switching action can be made to take place in nanoseconds.

This leads us to a basic, practical definition of the solid-state relay: a device capable of performing electronic circuit-control functions in the manner of a conventional relay, without the use of moving parts.

One other consideration when using solid-state relays is the requirement for isolation between the controlling circuit and controlled circuits. Because of leakage, however slight, isolation just can't be as complete as with electromechanical units.

It is also desirable that the relay have only an ON and OFF state—or, in effect, a "snap" action. For this reason, most applications of the simple transistor relay are of a regenerative or positive nature. Regeneration can be provided by the solid-state device itself, as in the case of a silicon controlled rectifier, a tunnel diode, or a unijunction transistor: or, it may be provided by interconnecting several components, as in a blocking oscillator or bistable multivibrator.

Simple Transistor Relay

One way of obtaining isolation along with positive switching action is shown in the circuit of Fig. 2. The controlling voltage at the input is increased to a point that slightly exceeds the Zener (regulator) diode breakdown voltage. This increases the gain of X1, which then oscillates. The output of X1 is rectified by diode D2, filtered by C1 and R1, and fed as drive current to the base of X2 to turn it on. The circuit to be switched is connected in series with the collector and a battery to ground; battery current flows through the load when the input signal (or current) initiates the action described.

Fig. 3 is the circuit of a transistorized vibrator, one of the units now being sold to replace conventional vibrators in communications and CB sets; it illustrates

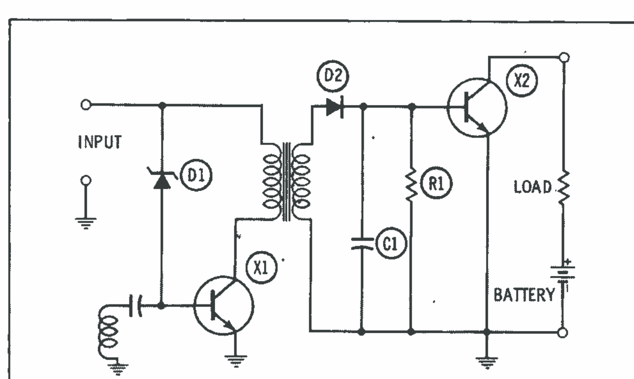


Fig. 2. Transistor oscillator keys switch in this circuit.

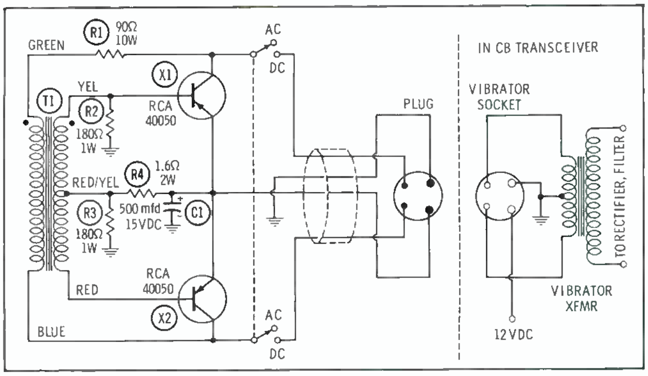


Fig. 3. Transistorized circuit replaces conventional vibrator.

another application of the transistor as a solid-state relay or fast-switching device. Transistors X1 and X2 alternately are turned on and off by push-pull feedback action in transformer T1.

The 12 volts fed through pin 1 of the socket when power is applied causes both emitters to conduct. The slight difference between any two transistors causes one to conduct more than the other. Rising current in the first transistor causes the base current of the other to fall. The current change in the primary of T1 is transferred to the secondary, which is center-tapped. Current builds up until T1 saturates. When no further current change occurs, the direction of the field reverses, due to feedback in T1. This switches the base drive polarities causing the transistors to switch their modes of operation—the one that conducted first cuts off while the other conducts.

The back-and-forth switching of X1 and X2 connects the battery alternately across each half of the vibrator-transformer primary, and circuit behavior is analogous to that with a mechanical vibrator. The advantage of this solid-state circuit is greater reliability, quiet operation, and longer life—all accomplished with no moving parts.

Silicon Controlled Types

Many other semiconductor-type switches are available, one of the most useful of which is the silicon controlled rectifier. To understand how a solid-state relay using this device operates, consider first the SCR device itself. The SCR can be thought of as a pair of internally connected transistors (Fig. 4).

Amplifications in both X1 and X2 is low initially, and the anode-to-ground impedance is high. Under these conditions the SCR is blocked, or OFF. If a forward (slightly positive-going) current is applied to the gate, the gain of the transistors increases. NPN transistor X1 turns on, driving PNP unit X2 on by starting emitter-to-base current in X2. With X2 on the SCR locks in the ON state. Even removal of the external gate signal does not turn off the SCR; the device will latch or stay on until all voltages are removed. We therefore

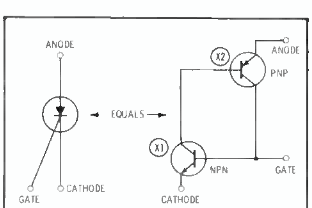


Fig. 4. Equivalent circuit.

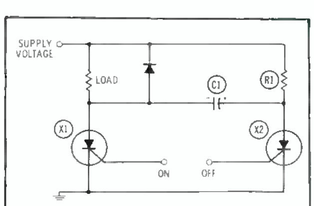


Fig. 5. Two-SCR gate stage.

have a latching relay requiring only a single pulse to turn it on.

Fig. 5 is a diagram of an SCR-ON-OFF switch. A signal applied to the gate X1 triggers it, causing the load to be connected effectively between ground and the supply voltage. Capacitor C1 charges through R1 to the polarity shown when X1 is on. An input trigger to the gate of X2 effectively places this charged capacitor across X1, reverse biasing it and thus cutting it off. The circuit shown here is often used in push-pull applications for multithrow relays.

The SCR has found wide use in AC switching circuits because turn-off can be accomplished so easily by controlling the phase of the gate voltage. The low cost and excellent power-handling capabilities of the SCR have made it a most popular solid-state switching element.

Photocell Type

A mechanical relay has certain characteristics that limit its usefulness in small-signal circuits. The film that often forms on relay contacts causes a signal drop that establishes a minimum on the amount of signal that can be handled properly. A great deal of work has been done to utilize solid-state relays in small-signal applications, and several novel circuits have been developed. In one such special circuit, a photoconductor, exhibiting many megohms of resistance when dark, is connected between the power source and load, blocking the passage of current through the load. When action is wanted, an AC control voltage lights a lamp which is visually coupled to the photoconductor. When illuminated, the photoconductor has a resistance of only about 100 ohms and the source-to-load path is effectively closed, or turned on. This circuit is quite simple and provides excellent isolation between control and signal circuits.

Others

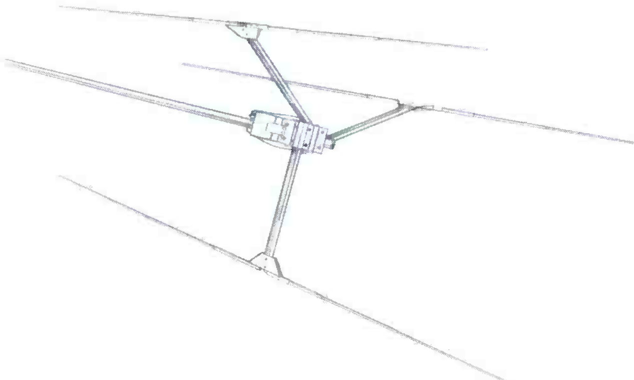
The unijunction transistor, the tunnel diode, and the transwitch are typical of other types of switching circuits that have been developed around semiconductor devices. Most of these relay circuits are used for small-signal applications. The gate-controlled switch or gate-turn-off switch (GTO) has recently appeared as an outgrowth of the basic SCR. This device overcomes the turn-off problem of the SCR by permitting a reversed polarity gate signal to turn it off, without resort to the special two-SCR circuit already shown. A positive pulse applied to the gate terminal will latch the GTO into conduction; a negative pulse will turn it off again. This GTO switch has been made to work at operational speeds up to 100 kc—one-hundred-thousand on-off actions every second!

Conclusion

The wide variety of solid-state relays that have recently been developed all utilize the principles described here. It is certain that applications of these devices will increase as the cost of the components continues to decrease, and home, auto, industrial, and other consumer uses will become very common. ▲

Product Report

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



Rotorless Beam Antenna (126)

This new Citizens band beam antenna uses no mechanical rotator. Built by **Antenna Specialists Co.**, the Model M-119 "Scanner" is technically designated a "sector phased omnibeam CB base antenna," and employs all-electronic techniques to focus and rotate the beam. The Scanner is actually three antennas in one. One of the three is used to radiate power, while the remaining two form a screen to reflect and focus the beam. Beam rotation is accomplished instantly by switching the radiating job from one element to another. The beam patterns provide directional gain of 7.75 db—roughly equivalent to 30 watts effective radiated power from a 5-watt source.

Close-Tolerance Calibrator

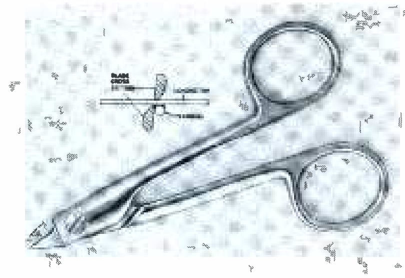
(127)

An ohmmeter calibrator, suitable for bench use and for electronic, medical, and chemical research laboratories in industry and schools is now being manufactured by **Panco Electronics.** The calibrators are available in several models of varying degrees of accuracy to match the requirements of the user, with tolerances ranging from 1% to .05% and with resistances ranging from 1 ohm to 100 megohms. An ohmmeter can be zeroed at both ends of each range without disconnecting or shorting the leads, by using the SHORT and OPEN switch positions. Prices range from $29.88 for a calibrator with 1% tolerance to $79.88 for one with .05% tolerance.

Low-Cost Multimeters

(128)

A line of eight multimeters, ranging in sensitivity from 50,000 ohms/volt to 1000 ohms/volt DC, is offered by **Inter-Tech Instruments Corp.** All models incorporate 2% industrial-quality jeweled movements and 1% wirewound and deposited-film resistors. A mirrored scale-plate eliminates viewing parallax when taking readings. This new line of VOM's is said to be the first in a broad line of imported electronic test equipment designed for economy-minded technicians and hobbyists.



Circuit-Repair Aid
(129)

Flush cutoff of wire or ribbon conductors adjacent to weld or solder connections is now possible with this new hot-hammer-forged wire cutter by **Clauss Cutlery Co.** The tool is made of nickel-plated high-carbon cutlery steel and was designed for use in the manufacture or repair of all types of electronic circuits. It is available in 3½", 4½", and 5½" lengths.

FM-MPX Signal Generator
(130)

The new **EICO** 342 FM Multiplex Signal Generator provides a controlled-amplitude composite audio signal for direct injection beyond the detector into the multiplex section of a tuner or receiver. In addition, it generates a 100% modulated (±75 kc) FM radio carrier, modulated by the same composite audio signal, which can be fed to the antenna terminals of the tuner or receiver. The frequency of the RF carrier is adjustable and is ordinarily set at about 100 mc.

Left-only, right-only, sum, or difference signals may be provided by the built-in 1-kc oscillator or an external audio signal generator connected to a panel jack. The crystal-controlled 19-kc pilot signal may be switched on or off independently and utilized without the audio information.

A cathode-follower oscilloscope-sync output delivers either the 19-kc pilot signal or the 1-kc internal oscillator signal. An input is provided for connecting an external audio signal generator to provide an SCA signal.

The unit measures 8½" x 5¾" x 12½" and weighs 10 lbs. The Model 342 is priced at $149.95, in wired form only. ▲

INDEX TO ADVERTISERS

JUNE, 1965

FREE Catalog and Literature Service

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

Please allow 60 to 90 days for delivery.

ANTENNAS & ACCESSORIES

61. *ALLIANCE*—Two-color catalog sheet describing the new Model T-45 *Tenna-Rotor*.
62. *ANTENNACRAFT*—Latest literature on *Channel-Spanner*, a new broad-band high-gain VHF-UHF TV antenna.*
63. *CORNELL-DUBILIER*—TV-FM reception booklet, 4-page rotor brochure, vibrator replacement guide, and capacitor kit assortments.
64. *FINNEY*—Catalog 20-322 showing newest addition to the All-Band Color-Ve-Log series of UHF-VHF-FM antennas.*
65. *JFD*—Literature on complete line of log-periodic antennas for VHF, UHF, FM, and FM stereo. Brochure showing converters, amplifiers, and accessories; also complete '64-65 dealer catalog plus dealer wall chart of antenna selection by area.*
66. *MOSLEY ELECTRONICS* — Illustrated catalog giving specifications and features on large line of antennas for Citizens band, amateur, and TV applications.
67. *MULTITRON* — Illustrated literature on FM-stereo antenna No. MA-44, Multituner Model M-11, and Minitenna No. MINI-4T.
68. *STANDARD KOLLSMAN* — Catalog sheet on UTC-051 transistor UHF converter kit with IF amplifier.
69. *TRIO*—Brochure on installation and materials for improving UHF translator reception.
70. *ZENITH* — Informative bulletins on antennas, rotors, batteries, tubes, loudspeakers, record changers, and wire and cable.*

AUDIO & HI-FI

71. *ADMIRAL* — Folders describing line of '65 equipment; includes black-and-white TV, color TV, radio, and stereo hi-fi.
72. *ELECTRO-VOICE* — Complete catalog listing and describing microphones and public-address equipment; also folder illustrating microphones with choice of finishes.
73. *EUPHONICS* — New 8-page, 4-color brochure, *The Story of Euphonics Miniconic*, a complete analysis of the role of phono cartridge and tone arm with emphasis on the new line of *Miniconic* semiconductor cartridges and low-mass arm.
74. *GIBBS SPECIAL PRODUCTS*—Folders describing principles of sound reverberation and *Stereo-Verb* reverberation units for automobiles.
75. *GC ELECTRONICS* — New up-to-date phono wall chart, No. FR-250-W, including new drives and hundreds of newly cross-referenced models.
76. *JENSEN* — 24-page catalog, No. 165-K, illustrates and describes speakers and speaker system kits.*
77. *NUTONE*—Two full-color booklets illustrating built-in stereo music systems and intercom-radio systems. Includes specifications, installation ideas, and prizes.
78. *OAKTRON* — "The Blueprint to Better Sound," an 8-page catalog of loudspeakers and baffles giving detailed specifications and list prices.
79. *OXFORD TRANSDUCER*—Product information bulletin describing complete line of loudspeakers for all types of sound applications including replacements for public address and intercom systems.*
80. *QUAM-NICHOLS*—General catalog listing replacement speakers for public address, hi-fi, and radio-TV applications.
81. *SAMPSON*—Full-line four-color catalog page showing transistor radios and tape recorders.
82. *SONOTONE*—Specification sheet on new *Sonomaster* speaker system, Model RM-2.*
83. *TURNER*—New four-page full-color catalog No. 1040 describing microphones designed for church applications.

COMMUNICATIONS

84. *EICO*—1965 full-line catalog featuring the Sentinel 23 frequency synthesizer CB transceiver, and Model 753 SSB-AM-CW triband transceiver in kit form.
85. *NEW-TRONICS* — Four-page illustrated booklet listing line of new base-station and mobile antennas and accessories. Bulletin NT-106 includes antennas for both amateur and Citizens band use.
86. *PEARCE-SIMPSON* — Specification brochure on IBC 301 business-band two-way radio, *Companion 11*, *Escort*, and *Guardian 23* Citizens-band transceivers.
87. *SONAR RADIO* — Specification sheet on Model FM-40 business radio.

COMPONENTS

88. *BUSSMAN*—Bulletin SFH-9 on fuse and holder combination designed for use where identification of open circuit must be positive. GBA fuse has a red-tipped indicating pin that extends from end of fuse when fuse opens. HLD holder has transparent knob to permit indicating pin on open fuse to be seen clearly.*
89. *COMPONENT SPECIALTIES* — Brochure on intercoms, speakers, earphones, and other *Speco* products.
90. *J-B-T-INSTRUMENTS*—General catalog 565; bulletins on reed relays, oscillator controls, toggle switches, and subminiature rotary-lever switches.
91. *OHMITE*—Bulletin 806 describing "*Metersaver*" meter protector; an easy-to-connect semiconductor device capable of converting overloads of 200 times to 3 times.*
92. *RAWN*—Detailed instruction sheets on TV knob and plastic repairs with *Plas-T-Pair*.
93. *SPRAGUE* — Latest catalog C-616 with complete listing of all stock parts for TV and radio replacement use, as well as *Transfarad* and *Tel-Ohmike* capacitor analyzers.*
94. *SWITCHCRAFT*—New product bulletin No. 150 describes locking and nonlocking types of low-capacity lever-actuated switches.*
95. *TRIAD*—1965 replacement catalog and television guide on transformers for television, hi-fi, home and auto radios.
96. *WORKMAN*—Coil catalog No. 109 and cross reference for replacement of antenna coils, IF transformers, RF chokes, linearity coils, and others for FM radios, tape recorders, and color TV receivers.*

SERVICE AIDS

97. *CASTLE*—How to get fast overhaul service on all makes and models of television tuners is described in leaflets. Shipping instructions, labels, and tags are also included.*
98. *CHEMICAL ELECTRONICS*—Literature on contact cleaners engineered for today's requirements.
99. *PRECISION TUNER*—Literature supplying information on complete, low-cost repair and alignment services for any TV tuner.*
100. *YEATS* — The new "back-saving" appliance dolly Model 7 is featured in a four-page booklet describing feather-weight aluminum construction.

SPECIAL EQUIPMENT

101. *DUNWELL*—Catalog sheet LS100 describing smartly styled, low-cost, five-year rechargeable flashlight.
102. *GREYHOUND* — The complete story of the speed, convenience, and special service provided by the Greyhound Package Express method of shipping with rates and routes.
103. *PERMA-POWER*—New Catalog on all-transistor garage-door operator with pulse-tone modulation.
104. *VOLKSWAGEN* — Large, 60-page illustrated booklet, "The Owner's Viewpoint," describes how various VW trucks can be used to save time and money in business enterprises, including complete specifications on line of trucks.
105. *WALLIN-KNIGHT*—Folder on Reflect-O-Scope, an effective tool for static convergence of color TV receivers.

TECHNICAL PUBLICATIONS

106. *CLEVELAND INSTITUTE OF ELECTRONICS*—Free illustrated brochure describes electronic slide rule with four lesson Instruction Course and grading service.*
107. *HAYDEN BOOK CO.*—1965 catalog with complete listing of all books in electricity, electronics, engineering, servicing, radio operation, audio and high fidelity, and computer technology.
108. *RCA INSTITUTES* — 64-page book, "Your Career in Electronics" detailing home study courses in telecommunications, industrial electronics, TV servicing, solid-state electronics, and drafting. Preparation for FCC license, and courses in mobile communications and computer programming also available.*
109. *HOWARD W. SAMS* — Literature describing popular and informative publications on radio and TV servicing, communications, audio, hi-fi, and industrial electronics, including special new 1965 catalog of technical books on every phase of electronics.*

TEST EQUIPMENT

110. *B & K*—Bulletin 108-R on Model 801 Capacitor Analyst. Bulletin No. 124-R on Model 1240 color generator. Catalog AP-21R describing uses for and specifications of Model 1076 Television Analyst, Model 1074 TV Analyst and Color Generator, Model 700 and 600 *Dyna-Quik* Tube testers. Model 445 CRT Tester-Rejuvenator, Model 960 Transistor Radio Analyst, Model 360 *V-O-Matic* VOM, Model 375 *Dynamic* VTVM and other test instruments.
111. *HICKOK*—Specification sheets on Model 662 installer's color generator, Model 677 wideband scope, Model 470A uni-scale VTVM, and Model 799 *Mustang* tube tester.*
112. *I.E.H.*—Information on heavy-duty solid-state vibrator eliminator, *Vi-Tran II*.
113. *JACKSON*—Complete catalog describing all types of electronic test equipment for servicing and other applications.
114. *LECTROTECH*—Bulletins on new color TV test instruments, horizontal deflection circuit meter, meter protective devices, and substitute for VTVM battery.*
115. *MERCURY*—Complete new catalog on line of test equipment to help the serviceman.*
116. *PRECISE*—New 1965 catalog on complete line of test equipment in kit or wired form.
117. *RCA COMPONENTS* — Form 1Q1124 showing Model WR-64B color-bar generator and form 1Q1125 on Model WO-91B 5" oscilloscope.*
118. *SECO* — Complete-line folder describes tube testers, color-bar generators, and other equipment; includes prices.*
119. *SENCORE*—New 8-page catalog No. 257 on complete line of company products: oscilloscopes, generators, testers, and many others.*
120. *SIMPSON*—Complete 16-page brochure on entire line of electronic test equipment; also, catalog on line of panel meters.
121. *TRIPLETT*—Specification sheet on new portable instruments for lab and shop, including full information on ranges and prices.

TOOLS

122. *BERNS*—Data on unique 3-in-1 picture-tube repair tools, on *Audio Pin-Plug Crimper* that enables technician to make solderless plug and ground connections, also for color and other picture tubes. Model AV-2 for RCA type phono plugs, along with C rings for shielded braided wire ground connections and LC-3 for 5/32" pin diameter.*
123. *ENTERPRISE DEVELOPMENT*—Time-saving techniques in brochure from Endeco demonstrate improved desoldering and resoldering techniques for speeding up and simplifying operations on PC boards.*
124. *UNGAR*—Catalog No. 763 giving information on series of soldering irons and accessories.
125. *VACO*—Latest literature on *Guild/Mark* and *Iron Man* screwdrivers.*

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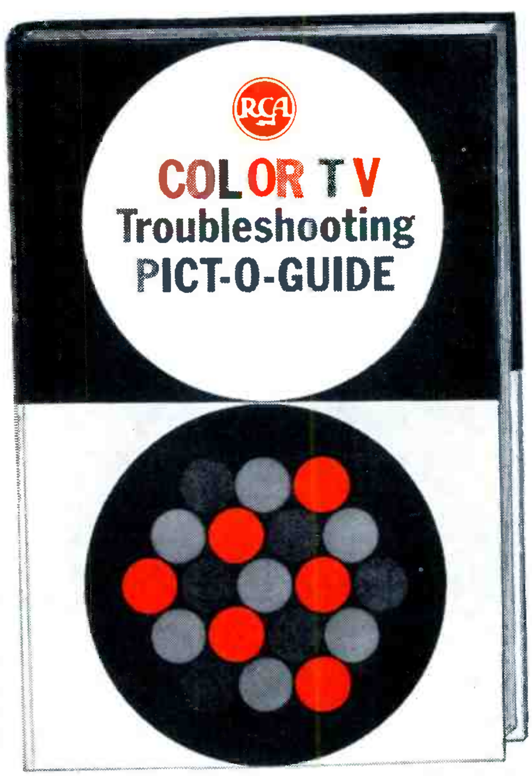

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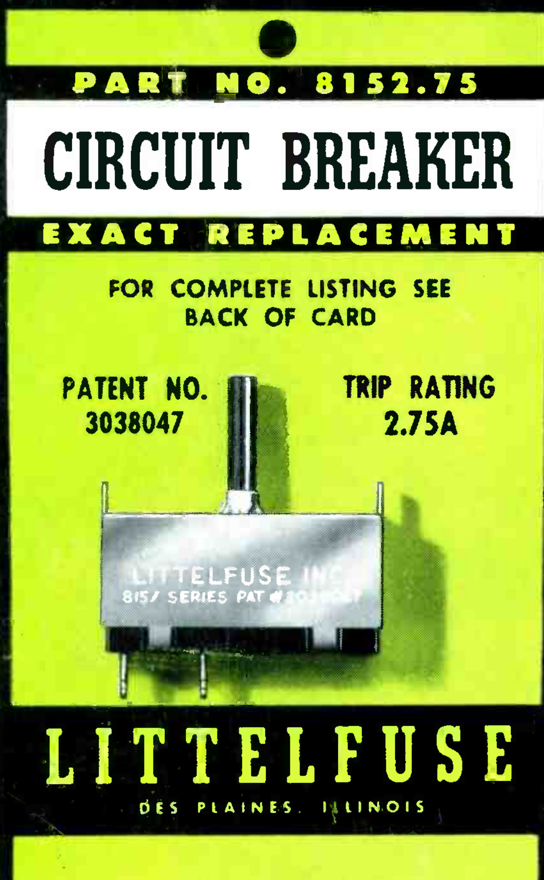

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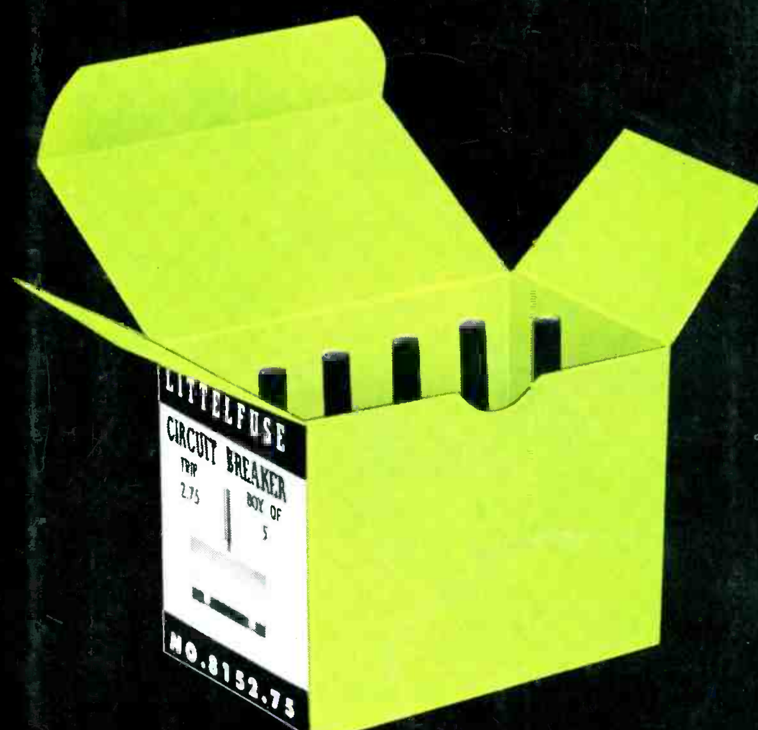

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