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transistor oscillators from A to Z

Here's how transistors fit into many different circuits.

by Forest H. Belt

Many servicemen seem to find the oscillator circuits of transistor radios difficult to understand. One reason for this apparent difficulty is that oscillator-circuit action is self-sustaining; therefore, a fault can be very elusive to the serviceman who hasn't a thorough knowledge of oscillator operation. In this book section, we will explain the fundamental workings of oscillators, and show you a way to analyze and classify any oscillator circuit you may encounter. Once the oscillator is classified, you'll discover its operation is simple to understand.

Oscillator Fundamentals

An oscillator can be considered as an amplifier that has enough regenerative feedback to cause the circuit to generate a signal. Since an ordinary amplifier with a simple feedback arrangement might oscillate at any random frequency, a way is provided to control the frequency of the oscillations; in the RF oscillators we'll be discussing, this control is handled by LC tank circuits.

Take a look at Fig. 1. This block diagram explains the fundamental operation of any oscillator. The factors necessary to sustain and control oscillation are labeled *amplifier, tuned circuit, feedback,* and *power source*. The other block represents the method of connecting the oscillator output to its load, which in the case of transistor radios is the mixer stage; the output of the oscillator is generally called *injection voltage*.

Oscillations in a transistor oscillator are initiated when power is first applied to the amplifier. The initial rise of current shock-excites the tuned circuit, causing an effect known as *flywheel action*. Energy is developed in the tuned circuit, and a portion passes back through the feedback network to the input of the amplifier, where it is amplified and again applied to the tuning circuit. As a result of this continuous amplifying, tuning, and feeding back of the signal, the action becomes constant, and the circuit acts as an oscillator. Any losses that occur in the amplifier, tuned circuit, or feedback network are replaced by the power source, thus sustaining the oscillation while power is applied. The important factors, then, which must be considered in an oscillator are *amplification, frequency control* (tuning), *feedback,* and *power*.

Classification

Since the actions described are fundamental to the operation of all oscillators, it follows that oscillator circuits differ primarily in how these functions are carried out. Because of this, oscillators can be classified according to how they get the job done.

For example, the amplifier portion can utilize either a common-emitter, common-base, or common-collector configuration. In troubleshooting, the configuration that is used will often serve as a clue to what voltage shift you might expect if the oscillator stage became inoperative.

It will also be important to know whether an NPN or a PNP transistor is used, because the structure of the transistor will definitely determine the nature of the power source.

In various oscillator circuits, you will encounter a number of different methods of applying power to sustain oscillation. The source may be in series with a tuning coil in the collector circuit, a method known as *series* feeding; or voltage may be fed through a resistor that parallels the tuning coil, a system known as *parallel* feeding. On the other hand, the collector may be returned to ground via the tuning circuit, and the transistor power applied to the emitter.

Base bias comes from the power source, either in conjunction with the power connection to the collector or emitter circuits, or through its own divider arrangement. The exact arrangement used for base bias depends on the type of transistor used—NPN or PNP—and on whether the main power is applied to the collector or the emitter.

The tuned circuit can be in either the collector, the emitter, or the base circuit. It is important to consider the location of the tuned circuit, because it will deter-

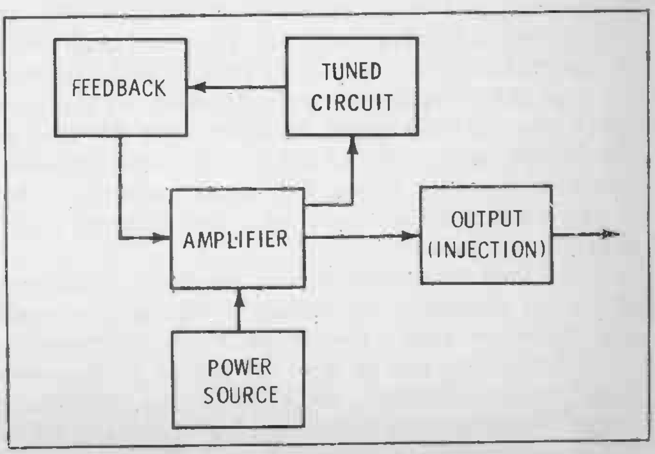
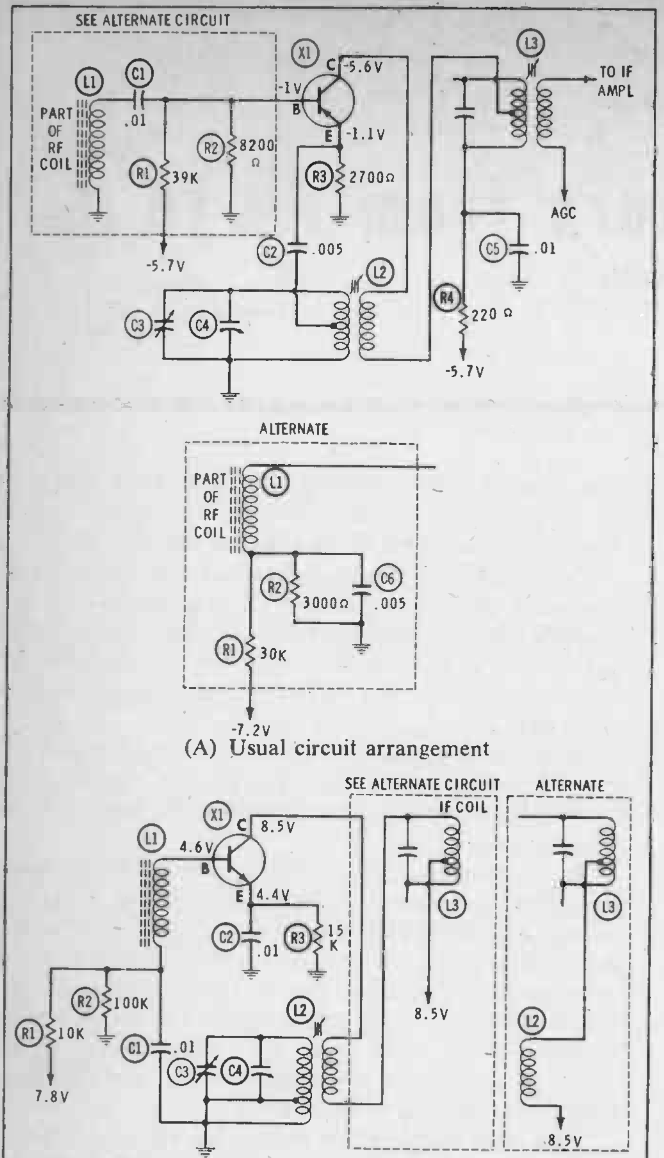


Fig. 1. Addition of tuned circuit and feedback loop makes an oscillator circuit out of an ordinary amplifier stage.



(A) Usual circuit arrangement

(B) Tuned tank in base circuit

Fig. 2. Most common form of converter stage in modern sets.

mine the method of feedback, the element to which the feedback is applied, and the nature of the injection-voltage coupling. The ground return for the tuned circuit—both RF and DC—is also important, because the RF return may be entirely different from that for DC.

Next, you'll want to note how the feedback is accomplished and to which transistor element it is applied. Feedback taken from the collector circuit could be coupled either to the base or emitter; and this could be done either capacitively or inductively. By the same token, the feedback could be taken from the base or the emitter and coupled to either of the other transistor elements, by either means. The important factor is that the feedback must be regenerative, and sufficient to sustain circuit oscillation.

The final consideration in a transistor oscillator is its output circuit, or the means of injecting its signal into the mixer stage. This injection can be capacitive or inductive, and can be from any one of the transistor elements—base, emitter, or collector. In addition, it may also help to note the mixer-stage element to which the injection voltage is applied; it will be either the base or the emitter of the mixer transistor.

With so many possible variations in transistor oscillators, they sound very complicated; but they're not! In fact, the majority of transistor superheterodyne receivers use a very simple and uncomplicated type of circuit called a *converter,* with a single transistor serving as both oscillator and mixer. There are also variations of the common converter—some used in AM receivers, some for shortwave, and some in FM sets.

A number of higher-gain receivers use the more costly oscillator-mixer arrangement to increase selectivity and sensitivity. There are many types of oscillators, but these can be "boiled down" into simple, easy-to-understand circuits. No matter if the transistor radio you are servicing uses a converter or a separate oscillator and mixer, the fundamental rule for oscillators will apply: there must be amplification, frequency control, regenerative feedback, a source of power, and a means of injecting the oscillator signal into the mixer stage. If you keep these basic factors in mind, you'll have no trouble identifying, classifying, and troubleshooting any oscillator you may encounter.

Converters

A combination mixer and oscillator stage is named a "converter" because it converts the RF signal directly to the intermediate frequency, using only one stage. Several circuit arrangements are used, but all of them incorporate the basic requirements of an oscillator.

A Common Variety

Fig. 2A shows the converter circuit used in at least half the transistor radios you'll be called on to service. This circuit is found in the converter section of nearly all inexpensive transistor portables. Before studying the operation of this circuit, let's analyze it according to the six classifications we set forth earlier: (1) The amplifier for this oscillator circuit is essentially a common-base type. (2) The transistor is a PNP type which requires a negative collector voltage. (3) Power is applied to the collector in series with coils L3 and L2, so the circuit is classified as *series-fed.* The base, on the other hand, is parallel-fed, because coil L1 is in parallel with the base-bias source. Note that in the alternate circuit the base bias is applied in series with coil L1, making this portion of the circuit series-fed; divider network R1-R2 is the bias-voltage source. (4) The tuned circuit is part of the emitter load circuit; the primary of L2 forms an RF load in the emitter circuit because it is coupled to the emitter by capacitor C2. R3 serves as the DC load in the emitter, and one end of the tuned circuit is grounded. (5) Positive (regenerative) feedback is brought from the collector circuit to the emitter circuit by inductive coupling in L2. (6) Since the mixer is included in a converter, there is no need for external injection; mixing takes place within the transistor.

Now that you've classified the nature of the various elements of this oscillator, see how easy it is to analyze the operation: The initial surge of collector current, inductively coupled in L2, shock-excites the tuned circuit consisting of the L2 primary, C3, and C4. This short oscillation, or wave train, is coupled by C2 to the emitter of transistor X1.

Amplification takes place in X1, developing a high-amplitude signal across the secondary of L2 and in transformer L3. (Note that C5 keeps the "bottom" end of L3's primary at RF ground.) Inductive coupling in L2 couples a portion of the amplified signal back to the emitter, and the amplifying action is repeated. As long as power is applied to the circuit, oscillations will continue.

Mixing occurs — in this converter — in the base circuit. Ground, L1, and C1 form the path by which the oscillator signal in tuned circuit L2-C3-C4 reaches the base of the transistor. L1 is part of the RF coil (sometimes called the antenna coil), so the station signal is likewise applied to the base of transistor X1; the sum and difference of these two signals appear in the collector circuit. Since signals in the collector circuit are developed in transformer L3 as well as coil L2, L3 can be tuned to the IF (difference) frequency and will couple the signal to the IF amplifiers. Thus, in only one stage—with one transistor—signal conversion takes place.

Fig. 2B shows a variation in the common variety of converter circuit, in which the oscillator coil L2 is wired a bit differently. According to our method of classifying oscillator circuits, this one has a common-emitter configuration, using an NPN transistor. Collector voltage is series-fed through L2 and L3, while base-bias voltage—developed in R1 and R2—is also series-fed through L1. The tuned circuit is grounded via a tap on coil L2, matching the high-impedance tank circuit to the low-impedance base circuit. Feedback from the collector circuit is coupled inductively to the tuned circuit, which is capacitively connected to the base by C1. Capacitor C2 holds the emitter at RF ground, thus completing the RF circuit so X1 can amplify the feedback signal.

The alternate collector circuit in Fig. 2B shows a variation in circuit layout. The difference lies only in the matter of which coil is connected "near" the power source; there is no difference insofar as the RF signals are concerned, since both coils are still in series and form the collector-circuit RF load. The only advantage to this arrangement would arise from simpler physical layout of the printed board on which the components are mounted.

Operation of the converter circuit in Fig. 2B is essentially the same as that in Fig. 2A. The initial collector-current surge shock-excites tuned circuit L2-C3-C4 into oscillation; the signal is coupled by C1 to the base of transistor X1. Since C2 holds the emitter at RF ground potential, X1 amplifies the small oscillatory wave train. Both the oscillator signal and the RF signal,

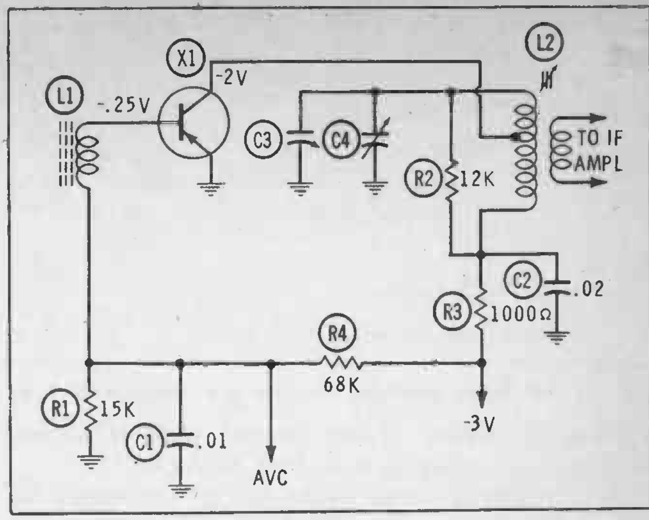


Fig. 3. Less common circuit depends on internal feedback.

plus their sum and difference, are developed in the load circuit—the secondary of L2 and the primary of L3. The secondary of L2 inductively feeds the signal back to the tuned circuit to sustain oscillation, while the primary of L3—since it is tuned to the IF frequency—couples that component of the signal to the first IF stage.

Less Common Forms

The unusual converter circuit in Fig. 3, while not found in a great many units, is most notable for its stark simplicity. This very simplicity could make it—without our "classification" method of analysis—quite difficult to understand. However, let's look more closely.

The common-emitter circuit incorporates a PNP transistor, whose collector is series-fed from decoupling network R3-C2 through a portion of the primary winding of L2. Base bias is derived from the divider consisting of R1 and R4, and is series-fed through the secondary winding of L1. (The AVC connection, which goes to the detector diode, may not appear in some sets.) The tuned circuit consists of the entire primary winding of L2 and capacitors C3 and C4; you'll notice C3 and C4 are grounded directly, whereas the RF ground for L2 is via decoupling capacitor C2. R2 is simply a damping resistor across L2, to lower the Q of the tuned circuit.

But how can feedback take place? It depends on the internal capacitance across the transistor junctions. If a high-gain transistor is operated "wide open," it can

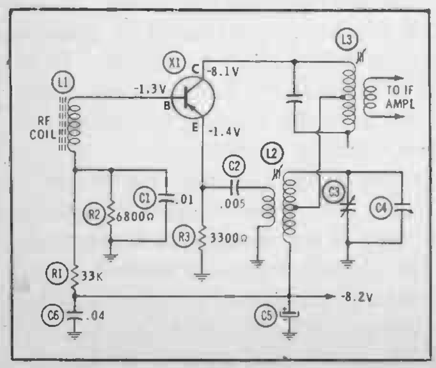


Fig. 4. Tuned tank is part of collector circuit, with emitter feedback.

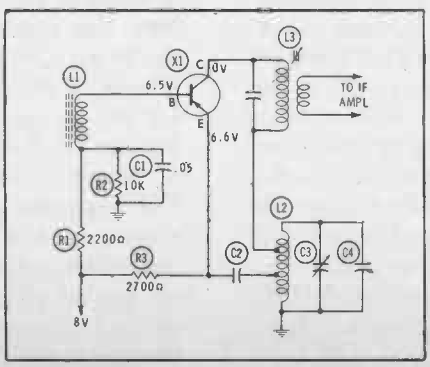


Fig. 5. Tapped coil in collector and emitter distinguishes this converter.

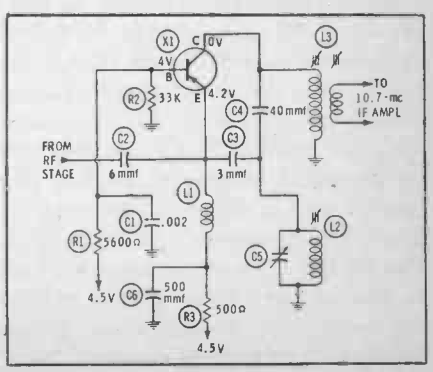


Fig. 6. FM converter uses tuned collector loads and capacitive feedback.

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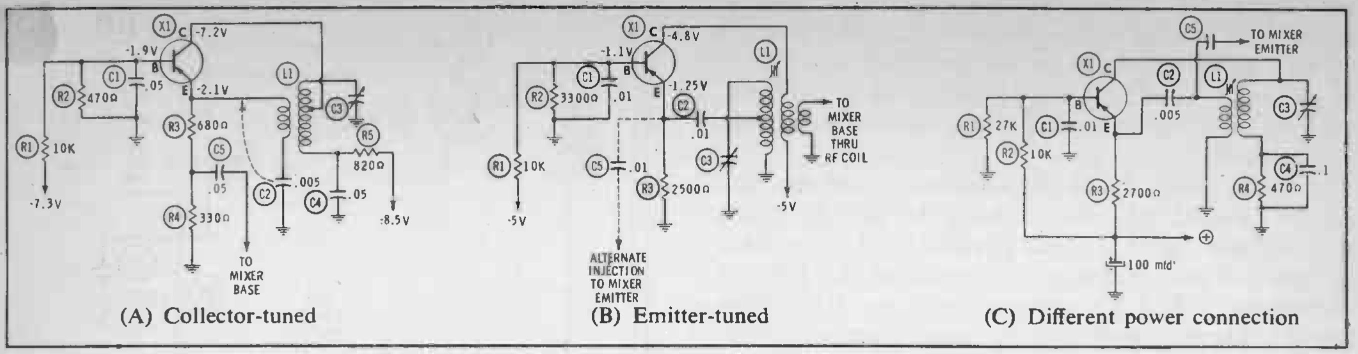


Fig. 7. All these oscillator circuits are characterized by the use of inductive feedback from collector to emitter.

be made to oscillate. It only remains, then, to control the frequency, which is done by L2-C3-C4.

The converter circuit shown in Fig. 4 is similar to that of Fig. 2A; the major difference is the changing of the tuned winding of L2 to the collector circuit. The common-emitter PNP amplifier is series-fed from the main power-supply source through portions of the primary windings of L2 and L3. Base bias develops—from the same source—in divider network R1-R2 and is applied through the secondary of RF coil L1. The tuned circuit in this case is the secondary of L2, whose RF ground is via C5 and C6; C3 and C4 are the tuning capacitors. Feedback is accomplished inductively from the secondary to the primary of L2, from whence the feedback signal is capacitively coupled through C2 to the emitter of transistor X1. The action of the oscillator is as described for that in Fig. 2A, with appropriate allowances for the slight change in component layout.

The converter arrangement shown in Fig. 5 is somewhat more complicated, but still contains the essential ingredients for a combination oscillator-mixer circuit. The PNP transistor is connected in a common-emitter amplifier configuration, but this circuit varies from those shown earlier in that the emitter rather than the collector is connected to the main power source. Accordingly, the base is biased—at a potential close to the value of the emitter voltage—by divider network R1-R2. The collector, meanwhile, operates at DC ground potential, through the coils of L2 and L3. The tuned circuit consists of coil L2 resonating with capacitors C3 and C4. The bottom end of L2 connects directly to ground, furnishing a DC return for the collector circuit and an RF return for the signals developed in L2 and L3. Feedback is via capacitor C2 from a tap on L2 to the emitter of transistor X1.

The operation is similar to that of other converter circuits. The initial surge of collector current shock-excites the tuned circuit of L2 into brief "flywheel" oscillation. The small signal is coupled via C2 to the emitter of X1. Since the base circuit is held at oscillator-RF ground by C1, amplification takes place, and an amplified oscillator signal is developed across that portion of L2 which lies between the collector tap and ground. Tuned-tank action controls the frequency of this signal, a small portion of which is again fed back to the emitter. Thus, all the requirements are fulfilled for oscillation: amplification, frequency control, feedback, and a source of power.

High-Frequency Converters

Multiband AM receivers are becoming increasingly popular in the transistor-radio line. Converters in these units differ from those found in ordinary broadcast receivers only in the use of more than one coil, chosen by a band switch. Therefore, to permit analyzing the oscillator and converter circuits in such receivers, it is necessary only to trace the circuit with the band switch set for the band in question. Slight differences in circuit configuration from band to band might be apparent, because of the use of tapped coils for certain bands, but the operation will remain the same for each band. Therefore, it is easy to classify each portion of the oscillator and analyze its operation on that basis.

FM converters, on the other hand, operate at frequencies so high as to require different techniques, but they still require the basic factors for oscillation.

For example, in Fig. 6, the PNP transistor is operated as a common-base amplifier, since C1 holds the base at RF ground; this configuration improves the frequency characteristics of the transistor, enabling it to operate at the very high frequencies involved. The emitter is connected to the power source via L1 and decoupling network C6-R3. The base is held at a potential near that of the emitter, by divider network R1-R2. The collector operates at zero volts DC, being held at DC ground potential by the primary winding of L3. Tuned circuit L2-C5 is a part of the collector load circuit, effectively in parallel with L3. Capacitor C3 couples feedback energy from the tuned collector circuit to the emitter of transistor X1; the emitter load consists of L1, which is returned to RF ground through C6.

Mixing of the oscillator signal with the RF station signal takes place in the emitter circuit of X1, across load coil L1; capacitor C2 couples the station signal from the RF stage to the emitter. The mixed output develops in the entire load circuit, but transformer L3 is tuned to the 10.7-mc intermediate frequency. Therefore, this component of the output signal is coupled to the first IF amplifier; the oscillator-frequency component of the signal is coupled by C4 to tuned circuit L2 and through C3 back to the emitter, furnishing the positive feedback that sustains oscillations.

Other circuit configurations you may encounter in FM receivers will fulfill the same oscillator requirements, and will vary only in the manner of accomplishing each function. The classification and analysis method you've learned should simplify the understanding of each converter circuit—whether FM or AM—so troubleshooting will be a relatively simple operation.

Just Plain Oscillators

Oscillator circuits have the same basic requirements as the converter circuit, with the exception that mixing does not take place within the oscillator; its sole purpose is to generate an RF signal for mixing with the station signal in a separate stage called the *mixer*. Accordingly, oscillator circuits will be found to differ from converter circuits in two respects: they will not include the RF-coil winding usually found in the base circuit of converter stages, and they must include some form of output coupling device for injecting the oscillator signal into the mixer stage.

In all other respects, the full-fledged oscillator must include all the basic functions described in Fig. 1—amplification, frequency control, feedback, and a source of power. The same classification rules that apply to converter circuits apply to oscillator circuits that are used alone. They, too, can best be analyzed by simply classifying the various portions of the circuit—amplifier configuration, transistor type, power-supply connection, tuned-circuit arrangement, feedback method, and form of injection device used.

Collector-Emitter Feedback Types

The oscillator circuits shown schematically in Fig. 7 are all characterized by the use of inductive feedback from the collector circuit to the emitter circuit; their primary difference lies only in the fact that two have tuned tanks in the collector circuit, while in the other the tuned tank is a part of the emitter load.

By our usual method of classification, we can analyze the circuits rather simply. All three use PNP-type transistors; Fig. 7A and 7B are series-fed through a coil in the collector lead, while Fig. 7C is emitter-fed—in parallel. Base bias is accomplished in each circuit by divider network R1 and R2. The amplifier configuration is common-base, since the base is held at RF ground by capacitor C1, and the load circuits are in the collector and emitter leads. All three tuned circuits are operated at RF ground potential; the tuned tank in Fig. 7A—and in 7C—is grounded for RF through capacitor C4, while the tank in Fig. 7B is grounded directly. Feedback is inductive, with energy being coupled from the collector circuit to the emitter element. Injection voltage for the mixer can be taken capacitively and fed to the mixer base as shown in Fig. 7A, inductively and fed to the mixer base as shown in Fig. 7B, or capacitively and fed to the mixer emitter as shown by the dashed lines in Fig. 7B. We'll discuss Fig. 7C presently, but first let's examine Fig. 7A and 7B.

Operation of these oscillators is very simple and very similar. The initial surge of collector current when the power is applied initiates a small flywheel oscillation, triggered directly in the tank circuit of Fig. 7A and triggered inductively in coil L1 of 7B. In both cases, capacitor C2 couples the slight oscillation action to the emitter of transistor X1 and blocks the DC path through L1, so as not to upset the emitter bias. Since the base is connected directly to RF ground by capacitor C1, the small RF signal at the emitter is amplified and developed across the collector winding of L1. A small portion of the signal is then coupled back to the emitter, causing the stage to oscillate. The frequency is controlled by the resonant characteristics of tank circuit L1-C3.

Another variation of this arrangement is shown in Fig. 7C, with one basic change and one minor difference. The basic change is the manner of applying power to the transistor; the source voltage is parallel-fed to the emitter stage rather than to the collector. The collector, then, is operated at near zero volts DC, although a slight voltage will appear because of collector current through R4. The minor change simply involves the injection capacitor, which connects directly at L1 instead of at the emitter.

This PNP common-base circuit incorporates collector-to-emitter feedback, with the tuned tank in the collector load. C4 holds the "bottom" end of the oscillator-coil secondary at RF ground, while C2 connects the feedback winding to the emitter of X1. Circuit operation is the same as described for the other oscillators in Fig. 7.

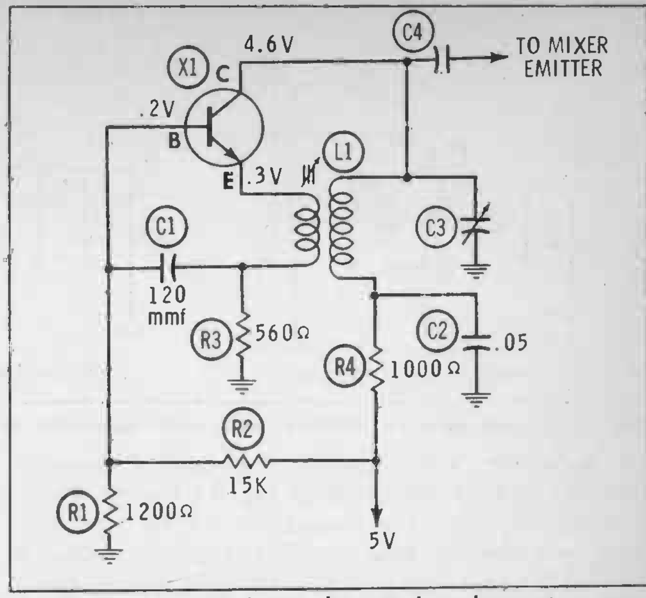
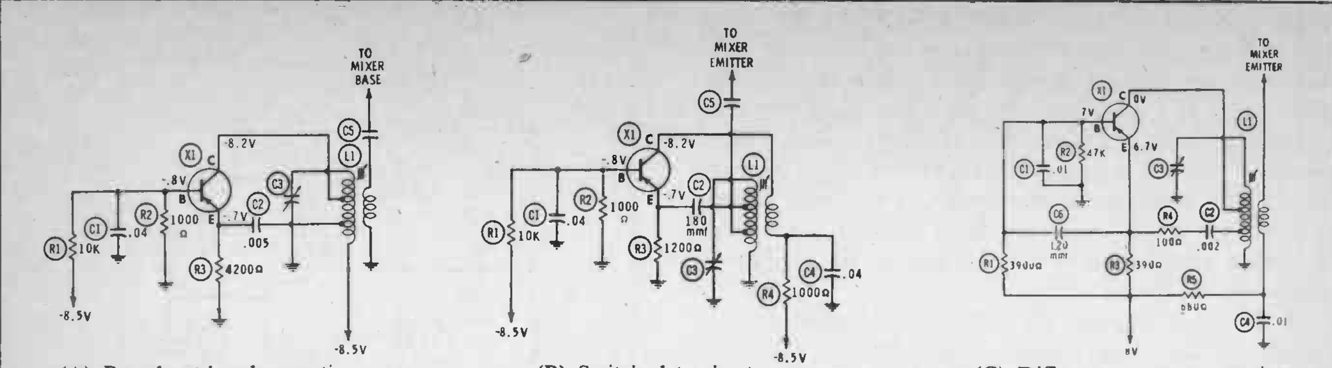


Fig. 8. Capacitor C1 keeps the transistor base at or near the RF potential on the lower side of the emitter RF load.

Fig. 8 shows an oscillator circuit that is a bit uncommon but repeats the basic principles of the usual oscillator. The two major differences involve the way the base is returned (for RF) to the emitter load circuit, and the method of coupling injection voltage directly from decoupling network R4-C2 through the secondary winding of L1; base bias is obtained from the power source via divider network R1-R2. The tuning-circuit, part of the collector load, consists of the secondary of L1 and tuning capacitor C3, with C2 holding the lower end of the coil winding at RF ground. Feedback is inductive, from L1 to the emitter. C1 connects the base to the lower end of the emitter winding, thus applying the feedback signal directly between the base and emitter. The transistor amplifies the signal, developing it again across the tuned collector tank. Mixer injection is via capacitor C4, which takes the oscillator signal directly from the collector of transistor X1 and applies it to the emitter of the mixer transistor.

A different type of oscillator coil is used in the circuits shown in Fig. 10. These circuits still use the isolated-secondary type of oscillator coil, but the primary has two taps. In some of these circuits, the taps are used to provide feedback, while in others the taps are used to provide the injection coupling. In each, however, the feedback arrangement is from the collector circuit to the emitter circuit, with the base operating at RF ground.



(A) Broadcast-band operation (B) Switched to shortwave (C) Different power connection

Fig. 9. Tapped primary oscillator coil, with capacitive feedback, is common characteristic of each of these oscillators.

According to our established method of classification and analysis, the circuit in Fig. 9A has the following characteristics: The transistor is a PNP type, operating as a common-base amplifier. Collector voltage is applied in series with coil L1, while the base is biased from divider network R1-R2. The entire primary of coil L1 operates in conjunction with C3 as the tuned circuit; RF ground for the lower end of L1 is through the bypass capacitors in the power supply. Feedback is obtained at one of the taps on the primary of L1, and is coupled through C2 to the emitter of transistor X1. (The other tap is merely an impedance-matching device to permit a high-Q tuned tank while maintaining the low circuit impedance which characterizes transistor circuits.) Mixer injection voltage is developed across the secondary winding of L1 and is fed by capacitor C5 to the base of the mixer transistor.

Operation of this oscillator in the light of our analysis is entirely the same as for the other oscillators we've described. However, this particular oscillator circuit has an unusual trait: it is used often in multiband broadcast-shortwave receivers. This is not unusual in itself, except that when the receiver is switched to shortwave reception, the entire oscillator circuit is rearranged to the circuit layout and configuration shown in Fig. 9B (Fig. 9A shows the broadcast position).

It is well to analyze and remember this somewhat different way of changing bands, because it is not uncommon in modern multiband receivers. Several of them use this "trick" to obtain more stable operation at the higher frequencies involved in shortwave reception, thus improving—in most cases—the sensitivity and selectivity of the receiver. Now, keeping in mind the classifications established for Fig. 9A, let's examine the circuit in Fig. 9B and see what's been changed.

In the first place, there has been no change in the base-bias arrangement, and the base is still grounded for RF. Collector voltage is still series-fed from the main power source, but in a manner entirely different from that in Fig. 9A; it is now fed through decoupling resistor R4 and the secondary winding of L1 to the collector. Because of this arrangement, C4 is introduced to keep the lower end of the L1 secondary at RF ground, so R4 doesn't form part of the collector-circuit RF load. The entire primary of L1 is still used as the tank circuit, but the bottom end is grounded directly instead of being returned through the power-supply filters. Feedback takes place by inductive action between the two windings, rather than internally as in the tapped winding of Fig. 9A. L1 in Fig. 9B includes a feedback tap that is connected to the emitter through capacitor C2. You'll note at this point that the value of C2 has been changed to a much smaller capacitance, which is entirely sufficient for the high frequencies at which the circuit will now operate. (Actually, a different coil L1 has been substituted, which will resonate with C3 at the new frequency.)

You'll also note that the value of R3 has been reduced to match better the lowered impedance of high-frequency coil L1. Increased activity in the circuit causes the current through R3 and the transistor to be somewhat higher, and the operating voltages remain essentially the same as with the other configuration.

Instead of the secondary-winding coupling for mixer-injection signal voltage, a tap on the L1 primary is utilized for this purpose. The tapped-off signal is coupled via C5 to the emitter of the mixer stage rather than to the base (as it was in Fig. 9A). The effect of this change is to reduce the noise level in the mixer at higher frequencies by causing the mixer to operate in a grounded-base configuration for the shortwave bands.

Fig. 9C shows a third oscillator that uses a tapped coil similar to L1 in Figs. 9A and 9B. Applying the classifications you've learned for oscillator circuits, you'll see the amplifier is the same—common-base. You'll notice the power source is applied at the emitter instead of the collector, leaving the collector at DC ground through the primary winding of L1. Base bias is developed the same as in the other circuits. The tuned circuit is as before, including the impedance-matching tap for the collector and the tap for coupling feedback through C2 and R4 to the emitter. Injection is accomplished by a winding on the secondary of L1; the bottom end is held at RF ground by C4, and connected to the DC power source through R5—an unusual arrangement.

Summarizing the differences, then, between this oscillator and those pictured in Figs. 9A and 9B, they are: the DC-return arrangement for the injection winding; the collector running at DC ground, with the emitter receiving voltage from the power source directly; and—an item we've not mentioned yet—the small-value capacitor C6 connected between base and emitter. Let's consider these three differences one at a time, and determine what effect they may have on operation of the circuit.

The power connection through R5 and the secondary of L1 is simply a way to connect the power-supply voltage to the emitter of the mixer transistor, undoubtedly so this unit can operate with its collector at

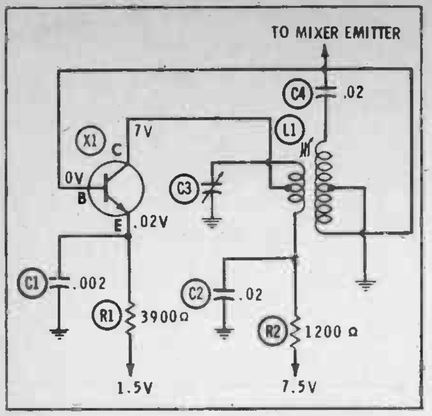
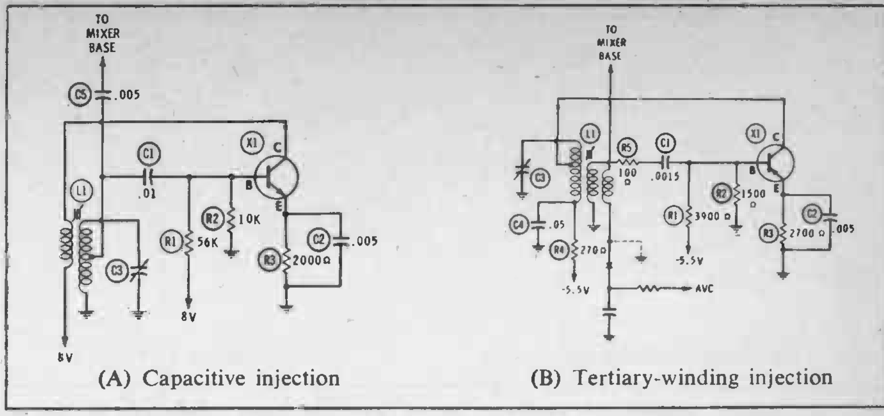


Fig. 10. Using collector-base feedback.



(A) Capacitive injection

(B) Tertiary-winding injection

Fig. 11. Tapped-coil versions of oscillators with collector-to-base feedback.

DC ground. The power connection to the emitter of X1 needs little explanation, since we've already discussed this means of supplying power to the transistor.

The small capacitor C6 connected between the base and emitter of X1 provides a slight amount of degeneration in the stage, to counteract the regenerative feedback being coupled to the emitter by C2. It is a reasonably well-known fact that too much feedback can be just as troublesome in an oscillator circuit as too little; since the oscillator circuit in Fig. 9C is designed for use at higher as well as lower frequencies, C6 helps combat the tendency of the circuit to provide too much regenerative feedback at some points in the bands covered.

How, you ask? The higher the frequency, the less the reactance of C2, and the greater the value of RF signal that reaches the emitter from the tap on the primary of L1—notwithstanding the slight "leveling" effect of resistor R4. However, the reactance of capacitor C6 also lessens as the frequency increases; therefore, more degeneration is introduced to help counterbalance the increased regenerative feedback. The net result is a reasonably constant feedback in the oscillator circuit, to maintain a normal level of injection voltage going to the mixer—regardless of frequency.

Thus, another form of oscillator circuit yields itself to easy understanding by the "classify-analyze" method of explanation.

Collector-Base Feedback Systems

A lesser-used feedback system for transistor RF oscillators is the arrangement of coupling the feedback to the base circuit rather than to the emitter. However, a number of transistor-radio manufacturers use this arrangement because of its stability. Fig. 10 shows an oscillator circuit that uses this collector-to-base feedback system.

This circuit uses an NPN transistor, connected as a common-emitter amplifier, and series-fed through the primary of L1 from decoupling network R2-C2. The tuned circuit consists of the primary of L1 and capacitor C3; capacitor C2 holds the "cold" end of L1 at RF ground. Feedback is inductive, being coupled from the collector circuit into the base circuit via part of the L1 secondary. The feedback signal is amplified in X1 and developed in tuned tank L1-C3. A portion of the secondary windings of L1 also develops the injection voltage, which is coupled to the mixer emitter by injection capacitor C4.

Fig. 11 shows three similar types, with the variations you're likely to encounter. Analyzing Fig. 11A by the classification method, you'll note the transistor is an NPN type, connected as a common-emitter amplifier. The collector voltage is series-fed through the primary winding of L1, and base-bias voltage is derived from the main power source through divider network R1-R2. The emitter is connected to DC ground through temperature-stabilizing resistor R3, which helps prevent thermal runaway in this sensitive transistor circuit.

Tuned circuit L1-C3 is connected via C1 to the base of the transistor; the tapped winding allows an improved impedance match to the low-impedance base circuit. Feedback is accomplished inductively by the untuned collector winding of L1; it couples energy to the tuned tank, and through C1 to the base. Since the emitter is at RF ground, the transistor amplifies the RF signal, and causes oscillation. The injection voltage is "picked off" at the same tap as the feedback voltage —on the secondary of L1—and coupled by C5 to the mixer base.

The circuit in Fig. 11B is essentially the same as that in Fig. 11A. The common-emitter amplifier uses — in this case — a PNP transistor that is series-fed through the primary of coil L1 and resistor R4. The base circuit, as before, is parallel-fed by divider network R1-R2. The tuned tank, while it appears similar to that in Fig. 11A, is located in the collector circuit; it is part of the series-fed collector-voltage arrangement, so the lower end is bypassed by C4 to provide an RF ground.

Feedback is via the secondary winding, which is untuned and couples energy through R5 and C1 back to the base of the transistor. A third (tertiary) winding feeds the injection voltage to the mixer. In one receiver that uses this form of oscillator injection, the mixer stage is AVC-controlled by simply series-feeding the AVC through tertiary winding of L1 and to the mixer base; in other sets where the mixer gain is not controlled, the lower end of the extra winding is simply grounded.

Autoformer-Coil Oscillator

A circuit that is being used in certain of the more elaborate transistor receivers is the oscillator shown in Fig. 12; its chief identifying characteristic is the tapped autoformer coil L1. Even in this circuit, the method of analyzing by classification will simplify our understanding. Accordingly, let's analyze the circuit in Fig. 12A and classify the various functions within the circuit.

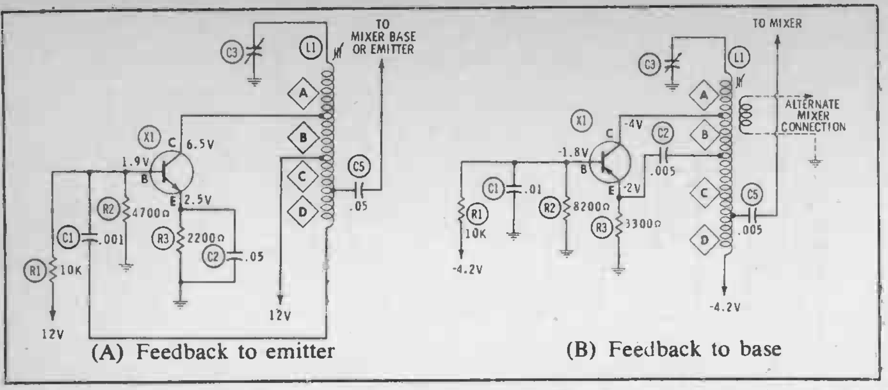


Fig. 12. Special tapped-coil oscillator being used in many elaborate receivers.

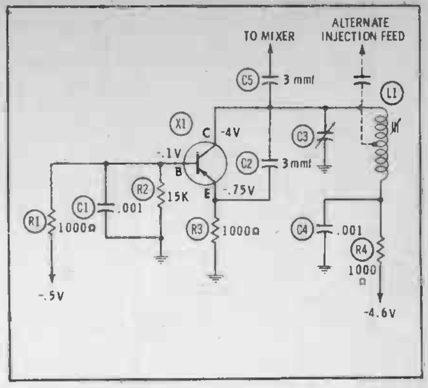


Fig. 13. Common FM-receiver oscillator.

The PNP transistor is connected as a common-base amplifier, with collector voltage being series-fed through the B portion of L1; the base bias is developed in divider network R1-R2; emitter bias is developed by collector current through temperature-stabilizing resistor R3 in the emitter circuit, in conjunction with capacitor C2.

The A and B portions of L1 form the coil for the tuned tank circuit, with tuning capacitor C3; the tap between B and C is returned to RF ground through the power-supply capacitors. With this center tap at RF ground, the phase reversal necessary for regenerative feedback automatically takes place in L1. The feedback voltage, developed in the C and D sections of the winding, is fed by C1 to the base of transistor X1 for amplification.

The emitter is held at RF ground by C2. Injection voltage is developed in the C portion of L1 and is fed via C5 to the mixer.

Having duly noted in the schematic of Fig. 12A that the feedback arrangement is inductive and goes from collector to base, it will be easy for you to recognize the configuration changes in the oscillator of Fig. 12B. It utilizes collector-to-emitter feedback with the same type of coil. A PNP transistor is used in a common-base amplifier circuit. Collector power is fed from the main power-supply source through winding portions D, C, and B to the collector of transistor X1. Base bias is developed in divider network R1-R2, with C1 holding the base at RF ground.

The tuned circuit in this oscillator consists of the entire coil winding of L1, since the RF ground is furnished by the decoupling capacitors in the power supply; therefore, L1-C3 is the tuned tank. Feedback—in the same phase as the collector signal— is applied to the emitter by coupling and blocking capacitor C2, having been developed in the C and D windings of L1.

Fig. 12B also includes two popular injection connections for use with this type of circuit; either one can also be used with the circuit shown in Fig. 12A. Injection voltage may be taken off at a low-impedance point by capacitor C5 and fed directly to the mixer base or emitter. Or, if set design prevents that, a low-impedance secondary winding may have been added to coil L1 to furnish injection voltage for the mixer. Both arrangements have been used quite extensively, so you're as likely to encounter one as the other.

From the many circuit explanations we've covered, you can readily see that oscillator circuits—no matter how complicated they appear—can be quickly analyzed and classified as we've outlined. Whether for use with high frequencies or shortwave signals, for standard broadcast signals, or for low-frequency longwave signals such as used in beacon receivers, the oscillator still must perform the four basic functions we outlined at the beginning of this section. The same thing is true of FM oscillators which operate in the VHF region, although more care must be taken in design and physical layout because of the "touchy" characteristics of the frequencies involved.

FM Oscillators

The circuit shown in Fig. 13 is by far the most common FM oscillator used in modern receivers. It uses a PNP transistor, although an NPN transistor is often substituted merely by reversing the polarity of the voltages from the power source. The configuration of the amplifier circuit is common-base, and the collector voltage is series-fed from power-supply decoupling network R4-C4, through coil L1. Emitter bias is allowed to develop across stabilizing resistor R3; base bias is developed in divider network R1-R2, which is connected to a low-voltage tap in the power supply. The tuned circuit—at the collector—consists of coil L1 and capacitor C3; capacitor C4 holds the lower end of L1 at RF ground.

The feedback arrangement used in this circuit is rather different from any we have looked at so far; it consists of a direct capacitor connection from the collector to the emitter, feeding back in-phase signal voltages that are developed in the collector circuit to sustain oscillations in the circuit. The injection voltage is ordinarily taken from the collector circuit and fed to the mixer stage via capacitor C5. In a few receivers, the alternate injection connection shown taps off a portion of the voltage developed across coil L1 and feeds that signal voltage to the mixer. The values of the feedback capacitor C2 and injection capacitor C5 are very small, but are entirely sufficient for passing the VHF frequencies involved in the FM band.

Conclusion

We have covered the basic oscillator configurations you are likely to encounter in practically any modern transistorized receiver, whether it is a simple AM radio, a shortwave multiband receiver, or a combination FM-AM set. By recognizing the operating characteristics of these various circuits, and by classifying each portion of circuit operation, you can understand the functioning of any oscillator circuit in any transistor radio. Armed with this knowledge, you will find this usually troublesome circuit submitting itself rapidly and easily to ordinary servicing techniques. ▲

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VOLUME 13, No. 6 — JUNE, 1963

CONTENTS

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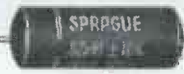

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CHARLES H. MILLS
Detroit, Mich.

We hate to lose such a faithful subscriber. The best of luck to you.—Ed.

Dear Editor:

The *Symfact* section in the April issue was placed more conveniently than in previous issues. Many thanks, as this is one of the important sections of PF REPORTER. An added improvement would be to place it following the eight-page section in front, still backed by an ad, to facilitate removal and filing.

PAUL E. TAYLOR
Columbus, Ohio

Thanks, Paul, for the excellent suggestion. However, we're one step ahead of you. Watch the July issue for a much larger, more informative Symfact*—laid out for easier use and simpler filing.—Ed.*

Dear Editor:

I enjoy the magazine very much, especially *Symfact*. I missed a few issues when *Symfact* first started, and wonder if there is a way of collecting only these charts.

ROY FORTNER
Long Island, New York

Dear Editor:

Is it possible to obtain the back issues from the beginning of *Symfact* last September? I just subscribed, and would like to have all the copies that contain *Symfact*.

RENE RACINE
So. Burlington, Vt.

Back issues are available in limited quantities. The price is only 50¢ per copy; requests should be addressed to our Circulation Dept.—Ed.

Dear Editor:

I was reading an old issue of PF REPORTER (February, 1958) and saw a "Homeowner's TV Antenna Handbook." Are these still available in quantities?

JACK TURNBULL
Cedar Rapids, Iowa

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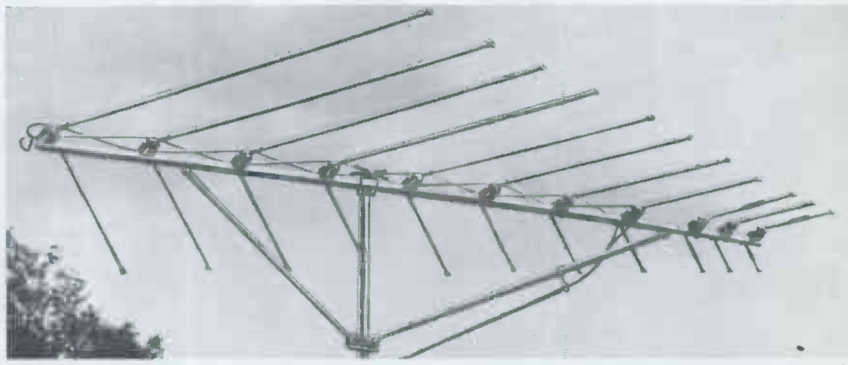

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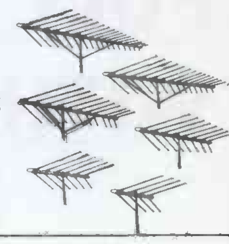

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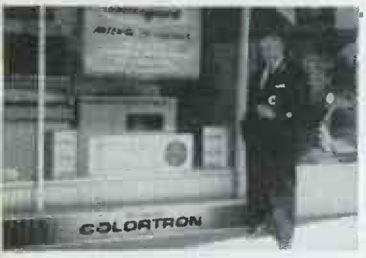

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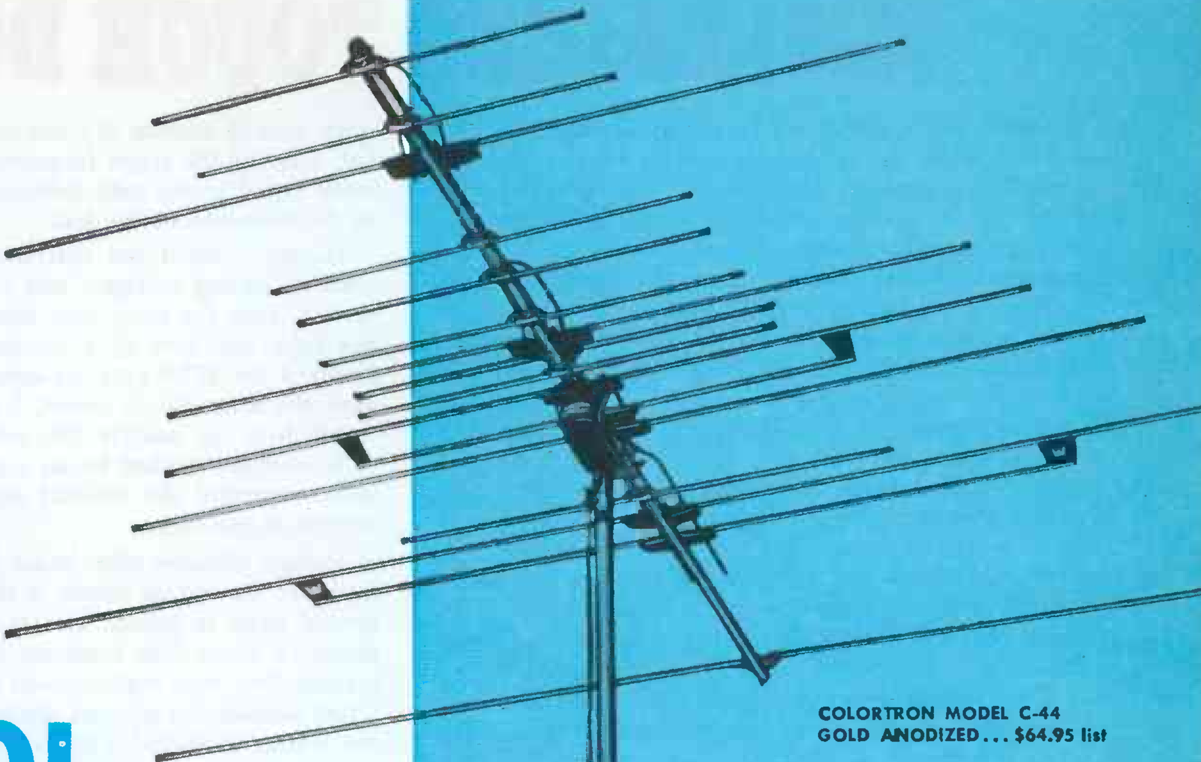

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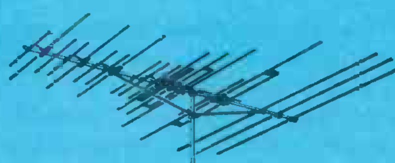
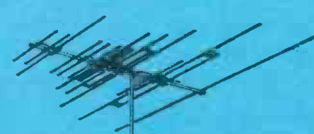


MODEL C-43 $51.90 list



MODEL C-42 $34.95 list

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MISLEADING TOUGH DOG

Only a small bunch of wavy lines appeared on the CRT, forming the design depicted in Fig. 1. My first analysis was somewhat as follows: The vertical sweep is obviously missing, and since width is shrunken—and accompanied by the curious foldover in the center—the horizontal circuits must be in trouble, too.

Digging out the circuit diagram, I did a bit of analysis. The vertical circuit in this set consists of a Hartley oscillator (one half of a 6CS7) driving the second half of the 6CS7; the output is connected to the yoke via an autoformer.

Noting that the boost B+ feeds both the horizontal and vertical circuits, I proceeded down another avenue of thought: Suppose the boost was low enough to cause vertical collapse, but still sufficient to keep the horizontal sweep and high voltage working (the horizontal oscillator was connected to regular B+). This could also account for the narrow width of the raster lines.

Checking the boost B+ proved it to be rather low—only 330 volts instead of the normal 510 volts. Pursuing this theory, I substituted tubes in the horizontal section—including the HV rectifier—but this caused no improvement in either the boost voltage or the picture symptom. To check the possibility of an overload reducing the boost voltage, I disconnected the vertical output stage, but the boost voltage remained low.

Now I brought the scope into play. A quick check of the horizontal output waveform (by placing the probe near the plate-cap lead) revealed a very irregular trace, accounting for the foldover in the center of the lines on the picture tube, but not revealing the cause. The horizontal drive waveform seemed normal. A thorough check of the yoke and flyback proved these components to be okay.

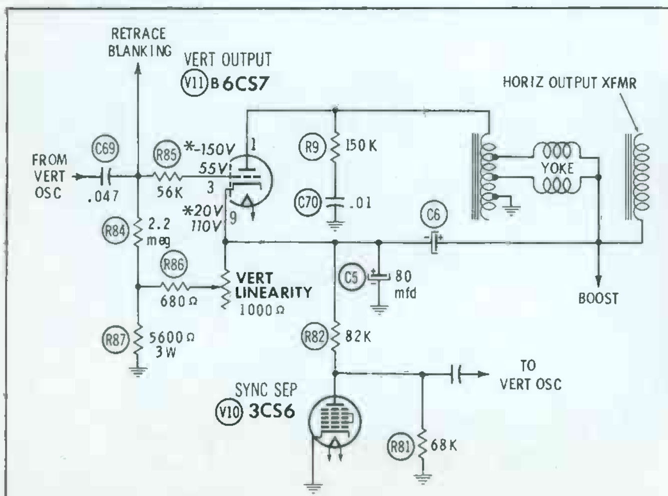
Failing to locate any serious trouble in the horizontal stages, I turned my attention to the vertical circuit. Waveform analysis showed a weak signal at the plate of the vertical oscillator; it was about the same on both sides of the coupling capacitor, proving that component to be okay. A waveform check at the plate of the output tube showed no vertical energy; but, since a small amount of some sort of energy was present, I varied the scope frequency until I identified the small signal as the odd horizontal waveform I'd seen on the horizontal output lead.

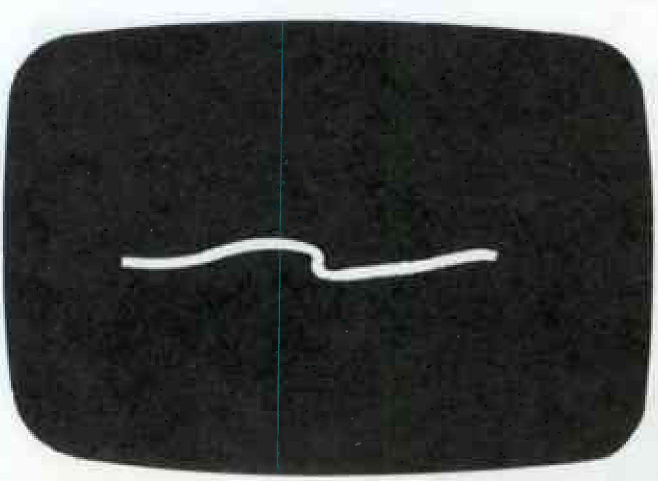
Having isolated the defective section positively, I tried measuring voltages, and got some very puzzling results. Time for more hard thought. The vertical output tube was part of a divider network which also involved the 3CS6 sync separator; so I decided to redraw the schematic as shown, hoping the simplification would help me analyze this odd voltage distribution. (The voltages marked by an asterisk (*) on the schematic represent the unusual voltages I found on the vertical output tube.)

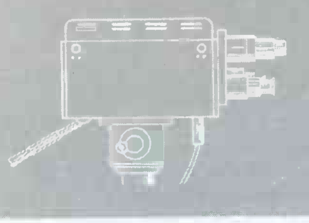
Voltage division takes place in several legs of this network; the voltage source is the boost B+ line, and several paths to ground can be found through various networks. Since both tubes are involved in this divider system, they were replaced—to no avail. By this time, I had decided the greatest mystery was the high negative voltage measured at the grid of V11B.

Since no fault in this circuit could plausibly connect the grid to a source of negative DC voltage, I began to wonder if some stray signal waveform of high amplitude was somehow being impressed on the grid of V11B, and was causing this reading. Checking with the scope, I found that the only signal visible at this point was the same small, odd horizontal waveform I'd seen before at the plate.

Ah—but then a glimmer of realization began to dawn, and the scope was moved to the cathode of V11B. There—in great, sweeping magnitude—stood nearly 300 volts of horizontal waveform energy. A glance at the diagram and some quick deduction indicated that bypass capacitor C5 was open. C6, which normally bypassed horizontal energy to C5 for subsequent bypassing to ground, was acting as a good coupling capacitor from the boost line to the cathode circuit of V11B. Replacing C5 cured the problem, proving that a step-by-step analysis is very effective in laying these tough dogs to rest, even though the symptoms may tend to be sidetracking. ▲





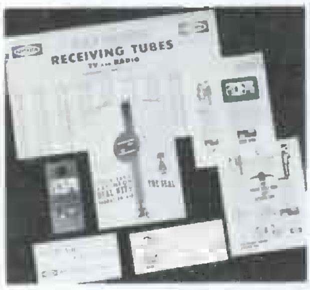


The Electronic Scanner

Join the Contest

A finish-the-jingle contest for service technicians, being offered by **General Electric,** is easy to enter. Merely obtain one of the official entry blanks from your authorized G-E dealer, complete the last line of the jingle, and submit with two orange squares from any G-E "five-pack" tube container. A total of $4,800 in prizes will be awarded.

Technician's Promotional Kit



A "Deal With the Seal" promotion program is still underway at **Raytheon,** as a business aid to independent service technicians who use the firm's replacement tubes. Newspaper ad mats, direct mail pieces, scripts for aired commercials, and enlarged ad reprints are among the many items offered in the kit. The materials are being offered through Glenn M. Foster, advertising and sales-promotion manager of the Dealer Products Div.

Color TV Training Program

Motorola has initiated a color-television training and indoctrination program for service technicians. The format of the program consists of three different sessions totalling more than eight hours of training. Sessions include four hours of theory lecture, and four hours of practical training, working with Motorola's own color chassis. Additional time is used, as needed, for color troubleshooting and testing procedures. At the completion of the seminars, each technician is presented with a Motorola Color-Training Diploma and a pocket identification card. The program is being handled by the company's regional service and parts managers.

Springboard Phono Needle

The phonograph needle shown in this photo, designed by **Sonotone,** can be flexed, flipped, or bent, and—when released—will immediately spring back into playing position, without damage to either needle or cartridge. A high-quality rubber expansion link between the stylus and lever arm of the needle assembly permits it to withstand all sorts of rough treatment. By the way, the needle can be installed in present Sonotone stereo cartridges without modification.

Tube Division Formed

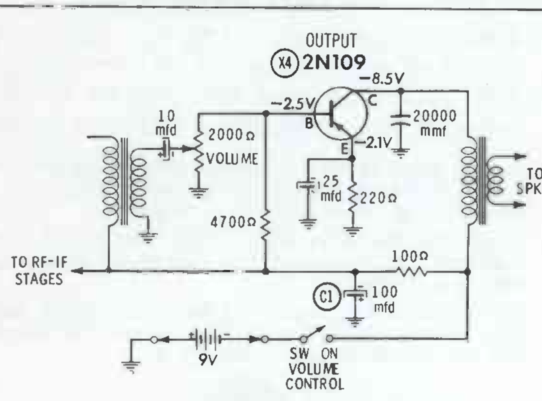
International Telephone and Telegraph Corp. recently announced the formation of a special Electron Tube Division. The activity will be located in the new plant that will open this spring in Palmer Township, near Easton, Pa. Estimated employment figures indicate 500 to 550 employees will be required for the division within the next few years. In addition to manufacturing special-purpose electron tubes, the division will contribute to ITT's research activities.

February Was Good

Kenneth R. Johnson, Home Products Division vice president of **Packard Bell Electronics,** recently announced a significant increase in sales of TV, radio, and audio equipment. New designs in the firm's color-TV and stereo lines were named as the largest single factor in the higher sales volume. Next in importance were the new phono combinations, portables, and 23" TV receivers introduced in January.

THE TROUBLESHOOTER

answers your service problems



Doubled Drain

I've just replaced a shorted filter capacitor C1 in an RCA Model 8-BT-7J transistor radio (PHOTOFACT Folder 364-10). The radio now seems to operate normally, except that the current drain from the battery measures 17-18 ma instead of the rated 8.5 ma. All transistors have been substituted without making any noticeable difference in the current. The only way I can make a substantial change in the current reading is to disconnect output transistor X4 from the circuit; however, voltage measurements on X4 all seem to be okay.

WALTER W. ELLETT

Slim's Radio & TV Repair
Cupertino, Calif.

The condition under which you measured the current may be the key to your problem. The 8.5-ma reading given in the PHOTOFACT *Folder was taken with no signal applied to the radio, and with the volume turned all the way down. Since X4 operates class B, it will draw more current from the battery when it receives an input signal, or when the volume control is advanced to a higher setting. A current of 17 or 18 ma under such conditions does not sound at all unreasonable. It's likely you cured your problem with this radio when you replaced C1.*

By the Numbers

I have several questions related to servicing transistor circuits:

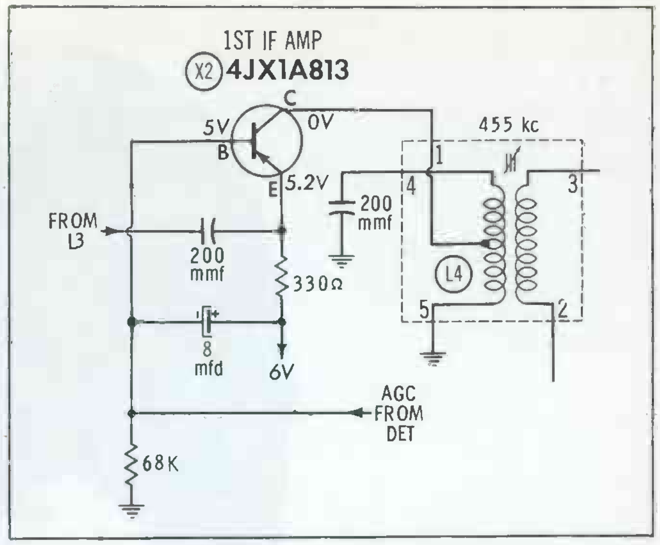
1. Can an audio-type signal tracer be used to trace through a transistor radio, stage by stage?
2. Will a signal tracer inject a signal at any of the three elements of a transistor—collector, base, or emitter—the same as it will do at the plate, grid, and cathode of a tube?
3. Do you hear a click in the speaker each time you touch any lead of a transistor with a test prod?
4. What defects are most apt to cause a fuse to blow in a transistorized auto radio?

EDWIN MORIO

East Patchogue, L.I., N.Y.

I'll answer your questions in the same order you asked them:

1. *A signal tracer that develops a sine-wave audio output signal can be used to troubleshoot any stage of a transistor radio following the detector. However, if the signal tracer is designed for use with tube circuits, be very careful to keep the output at a low level, to avoid overdriving the transistors. If you wish to troubleshoot the RF and IF stages, you*



be able to obtain acceptably good results by using any PNP transistor specifically recommended by the supplier for replacement use in IF stages.

Needs a Nudge

The converter stage of a Marconi Model 888 transistor radio doesn't work, and the trouble seems to be a failure to oscillate. When I apply an unmodulated RF signal to the base of the converter transistor to substitute for the local oscillator, I can tune in five or six stations; but when I disconnect the signal generator, there is nothing but silence. I've replaced the converter transistor, and all parts in the circuit except the tuning capacitor and antenna coil, but still can't

• *Please turn to page 84*

must use a demodulator probe to convert high-frequency signals to audio. If you use a harmonic-generator type of signal tracer (a description that fits most pocket-sized units), the output contains RF as well as audio signal energy; therefore, it can be used to trace through all stages of an AM radio without using any accessory probes.

2. *Yes, the signal tracer can be connected to any of the three transistor elements, and will satisfactorily inject a signal if the element is not bypassed or grounded.*
3. *You can use the "click test" in transistor radios, but it should be used sparingly, since sudden surges might possibly "blow" a junction in certain delicate types of small-signal transistors.*
4. *The troubles most likely to cause a blown fuse are a shorted bypass capacitor on the DC input line, or a shorted output transistor. In the latter case, an incorrect bias adjustment or some component defect in the output stage may be responsible for transistor failure.*

Whispers

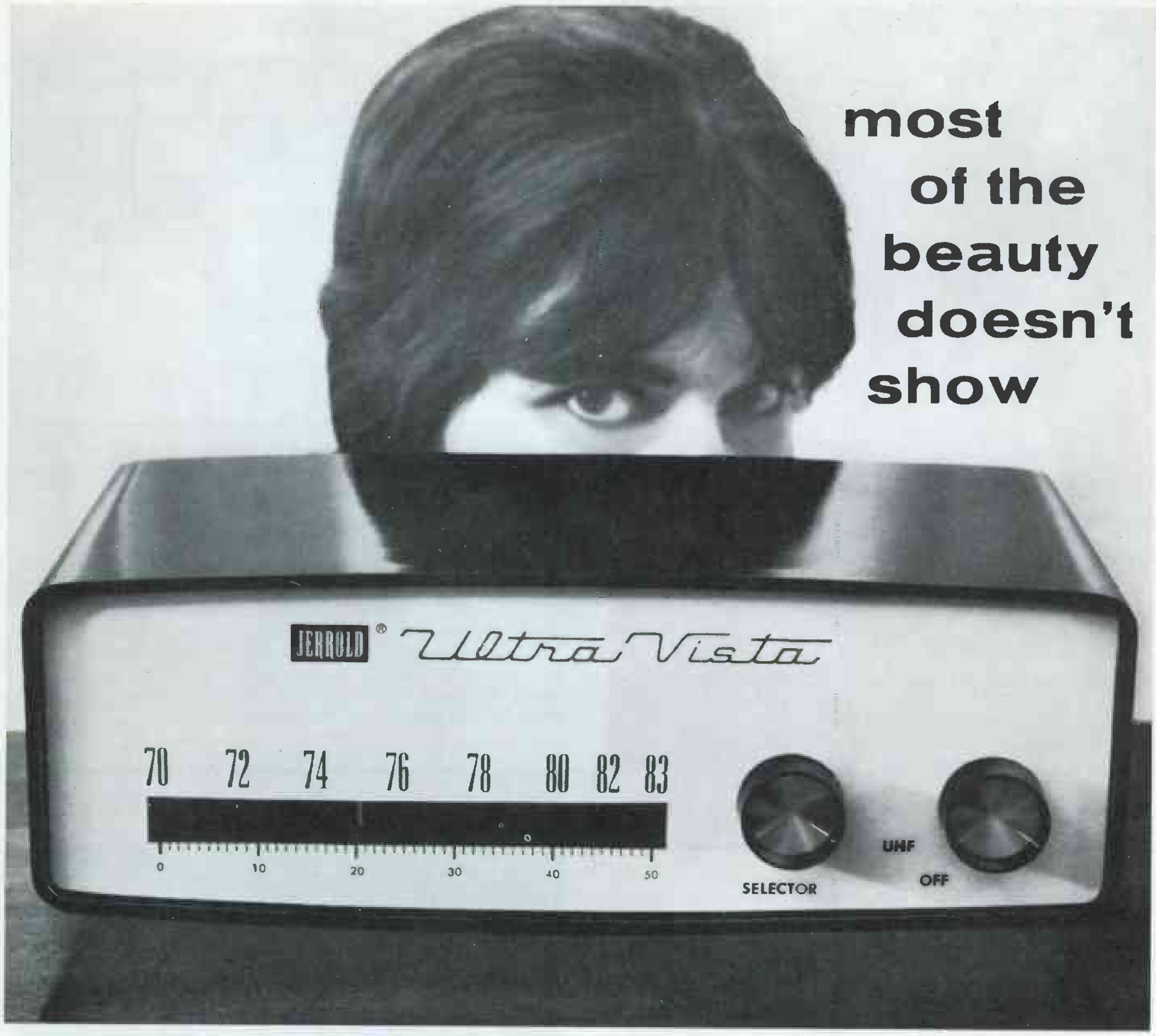
I have a General Electric Model P800A transistor radio (PHOTOFACT Folder 482-10) with very weak output, especially on the high end of the broadcast band. Voltage readings indicate nothing wrong, except possibly a defective X2, but I cannot locate a replacement for this unusual transistor. I have replaced L4 with no success.

CHESTER RICKARD

Girard, Ohio

It was a good idea to try replacing L4, since an open winding is a common occurrence in IF coils of this type. (The usual symptoms are very broad tuning and weak volume.) Also check the tuning of the other two IF coils, L3 and L5; if either of these coils does not peak in normal fashion, replace it.

If replacement of X2 should appear necessary, you should



Beneath the attractive surface of the new JERROLD Ultra-Vista you find the only UHF converter with its own rf preamplification. For translator areas and other communities using the Channel 70-to-83 band, this means superior low-noise reception, thanks to the amplifying of antenna signals before they reach the mixer stage.

Look at the sleek bandspread tuning. When you twirl the selector knob, you experience a fineness of tuning offered nowhere else in UHF. A long-life nuvistor oscillator, a radar-type mixer diode, and a transistor post-amplifier operating at Channel 7 or 8 are additional features that set Ultra-Vista several cuts above the second-best converter. Minimum gain of 10db throughout the entire band.

Ultra-Vista is obviously destined for great popularity in difficult translator reception areas, for it removes snow from television screens as no other converter can do. Speak with your Jerrold distributor, or write for complete information. *List price $49.95*

NEW ULTRA-VISTA . . . the only UHF converter with its own rf preamplification

JERROLD ELECTRONICS

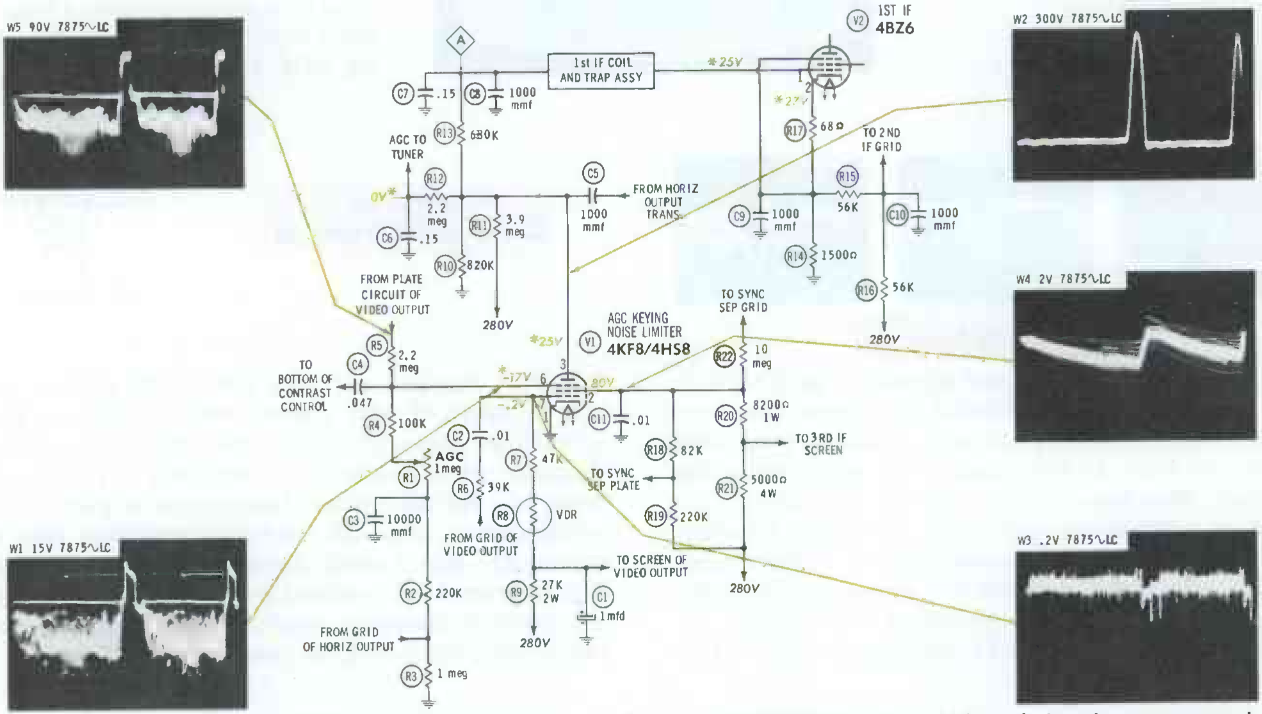
A subsidiary of THE JERROLD CORPORATION

Distributor Sales Division, Philadelphia 32, Pa.

PF REPORTER Symfact™

Keyed AGC

Cathode Grounded; IF Grid Positive



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

WAVEFORMS taken with wide-band scope; controls set for 2-volt p-p output from video detector. Low-cap probe (LC) used to obtain all waveforms.

Normal Operation

This circuit is generally similar to the 6BU8 type in October, 1962 *Symfact*, except DC voltages are considerably different. To permit grounding cathode of V1, negative voltage must be supplied to pin 6. Grid-leak bias cannot be used, because DC coupling from video output tube is necessary; thus, negative bias is "borrowed" from horizontal output. Unusual IF-AGC setup shown here has recently been popular among largest TV manufacturers. Set uses "stacked" IF system, requiring AGC bias only on first stage. Grid operates 25 volts above ground, and voltage divider across B+ holds cathode slightly more positive. When a signal is applied, negative charge on AGC filters causes grid voltage to drop sharply (to value slightly more negative than ground, on strong stations). Reduction in cathode current through R14 lowers cathode voltage, too; difference between grid and cathode voltages is proportional to signal strength. This circuit has no FRINGE LOCK control in noise-limiter circuit at pin 7; instead, voltage-dependent resistor R8 provides automatic bias control.

Operating Variations

PIN 6 AGC control R1 varies DC voltage from 0 to –25 volts, except when signal is present; then, useful range is –13 to –5 volts. Control varies W1 from 4 to 25 volts peak to peak. Past these limits, IF is overloaded or blocked.

PIN 3 Station signals drive V1 into conduction, charging AGC filters and lowering DC voltage. Typical readings are from +10 volts on very weak channels to –3 volts on strongest channels.

B Usually is clamped at zero volts by grid current in RF amplifier, providing AGC delay. If station signal is strong, C6 charges sufficiently to apply small negative bias to tuner.

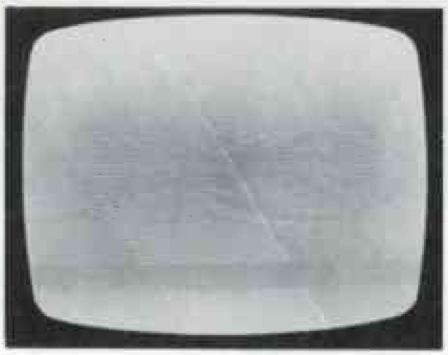
V2 Three examples show how grid-cathode bias increases with more signal: With +9, +4, and –1 volts at grid, cathode reads +10, +6.6, and +5.6. Bias: 1, 2.6, and 6.6 volts, respectively.

SYMPTOM 1

Video Overloading

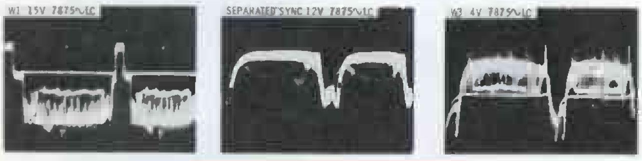
No Picture on Strongest Stations

R8 Open



Symptom Analysis

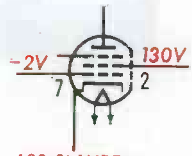
Even weak stations have poor sync. Stronger channels show excessive contrast or even complete "whiteout"; AGC control is ineffective. Grounding point A (useful "quick check" in strong-signal areas) improves picture. Clamping pin 3 with fixed bias permits servicing AGC system.



Waveform Analysis

With pin 3 clamped at some negative or positive voltage (whatever value is normal for signal being received), W1 amplitude is normal. However, sync-pulse tips do not slant, as they would if V1 were conducting normally. Waveform at sync-separator plate of V1 (pin 8) shows notched sync-pulse tips, a common symptom of trouble in noise-limiter circuit at pin 7. Further proof of fault here is distorted W3, far above normal amplitude. Negative pulses in this signal are reducing V1 conduction during sync peaks, affecting sync and AGC.

Voltage and Component Analysis



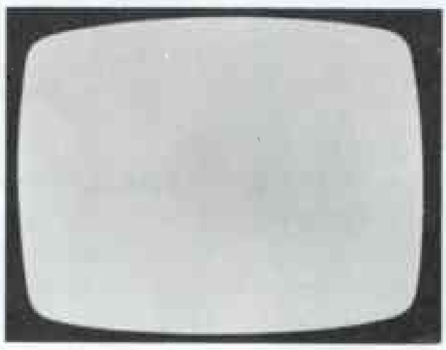
If AGC is clamped, pin 6 has correct DC voltage, variable by means of AGC control. Screen voltage at pin 2 is much too high (130 volts), indicating screen current definitely below normal. Pin 7 measures −2 volts—too much bias for this circuit. Interruption in path to B+ would explain this fault. In-circuit resistance tests are meaningful only if made directly across resistors; readings to ground are confused by charging of B+ filters. R8 normally measures approximately 5 meg in ohmmeter tests, depending on exact voltage applied.

SYMPTOM 2

Blank Raster on All Channels

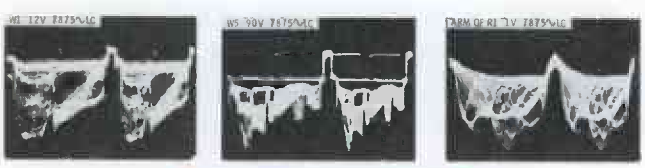
Faint Buzz From Speaker

R1 Open



Symptom Analysis

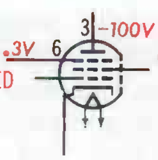
Picture may appear briefly when set is first turned on. No snow is seen on vacant channels; AGC control has no effect. Ground lead temporarily touched to point A does not restore picture, but draws spark. Clamping pin 3 of V1 at correct level restores normal operation of video stages.



Waveform Analysis

Even at optimum value of clamping bias, sync pulses in W1 are somewhat compressed, and best obtainable amplitude is still below normal; but W5 has proper shape and amplitude. This test isolates trouble to AGC circuit. Further checking in pin-6 circuit reveals only weak video trace at arm of R1, with amplitude unaffected by rotating control. Normally, this waveform (the portion of W5 developed across R1, R2, and R3) should have about ⅔ as much amplitude as W1, and vary as control turns. W2, W3, and W4 give no clues.

Voltage and Component Analysis



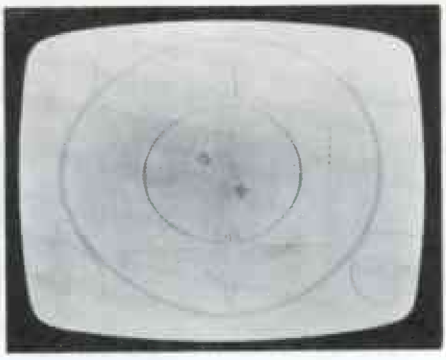
Until AGC line is clamped, all points on it measure approximately 100 volts negative with respect to ground. Clamping directly at pin 3 overrides this bias, since bias box kills keying pulse and stops conduction of V1. Voltage error at pin 6 is then obvious: +0.3 volt on vacant channel, and −2 volts with signal applied. Ohmmeter reading from pin 6 to ground should be 1.5 to 3 megohms, varying with setting of R1; in this case, meter reads in reverse direction. Shorted C3 causes similar trouble symptoms.

SYMPTOM 3

Washed-Out Picture on Weak Stations

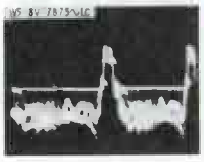
Local Reception Nearly Normal

R11 Increased in Value

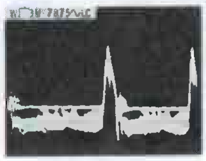


Symptom Analysis

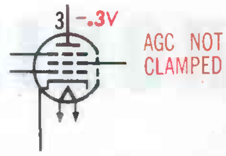
No snow is seen on vacant channels—just blank raster. Contrast on all active channels can be improved by advancing AGC control toward minimum resistance; but even at extreme setting, expected overloading does not occur, and pictures from fringe stations are still too weak to watch.



Waveform Analysis



Voltage and Component Analysis



Good contrast can be restored by clamping AGC line with positive or negative DC voltage that simulates normal bias. All pertinent waveforms then assume correct shape and amplitude; therefore, no scope clues can be obtained unless clamp bias is removed. When this is done, amplitude of W5 on weak stations falls to less than 10 volts, and strong RF signals produce only 40 to 50 volts of video. Amplitude of W1 is also much lower than normal (only 3 volts on typical weak channel); but this doesn't explain apparent excess of AGC bias.

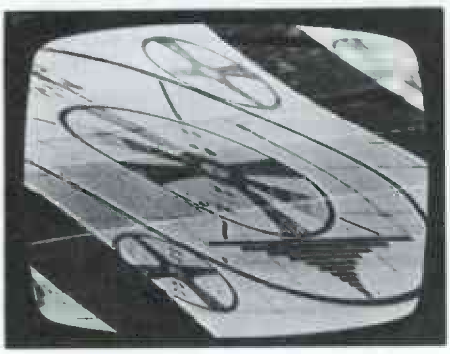
Here's one case where simple DC voltage checks, made with no signal or clamping bias applied, can lead straight to solution. Pin 3 is near zero, instead of normal +25 volts. When active channels are checked, strong signals develop few volts of negative AGC bias, but plate never goes positive. Resulting voltage to IF's is near normal except on fringe reception, which requires fairly high positive voltage on grid of V2. Finding exact fault could be tricky; resistance from pin 3 to ground checks normal, and in-circuit check of R11 is misleading.

SYMPTOM 4

Video Overloading on Strong Stations

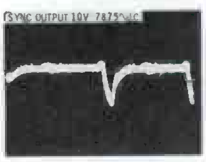
Poor Horizontal Sync

R20 Increased in Value



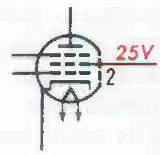
Symptom Analysis

Horizontal pulling affects even weak-signal reception; other symptoms (excessive contrast, buzz in sound) are confined to local channels. There could be two separate troubles, or only one that affects both AGC and sync. AGC control works fairly well, but does not clear up symptoms.



Waveform Analysis

Voltage and Component Analysis

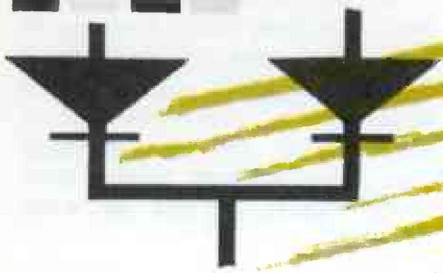


Overloading is eliminated by clamping AGC line as described for previous symptoms; if this is not done, distorted video-signal input to AGC and sync circuits gives confusing results. Horizontal sync remains jittery even after normal video is restored; this trouble is traced to sync-separator section of V1, where horizontal pulses at plate are weak (only half normal amplitude). Input to separator is normal; so is W3. W1 has same shape as in Symptom 1. Sawtooth ripple in W4 has subnormal amplitude—a clue that could be easily overlooked.

"Old standby" method of DC voltage and resistance checking proves its worth here. Pin 2 measures only 25 volts on vacant channels, or 20 volts with strong signal fed to receiver—whether or not AGC is clamped. Resistance measurements can locate faulty R20 or R21 without need for unsoldering connections, since their normal values are much lower than shunt resistance. In this particular case, R20 had risen to 250K. If it opened, some DC voltage would still reach screen via R18-R19; symptoms wouldn't be much worse.

Shop Talk

by Allan F. Kinckiner



UNSCRAMBLING HORIZONTAL-AFC PROBLEMS

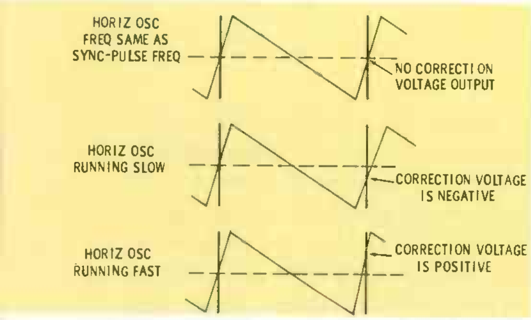


Fig. 1. AFC output voltage depends on relative timing of sync and sawtooth.

The name "automatic frequency control" does not fully describe the function of the circuit that controls the horizontal oscillator of a TV receiver. An action even more important than the AFC's frequency-correcting characteristic is its ability to lock the phase of the oscillator exactly in step with the sync pulses transmitted by stations. Furthermore, the system can maintain stable horizontal sweep even when sync is interrupted for short periods, or in the presence of noise bursts. (This latter capability is the result of charges on capacitors in the AFC circuit.)

Such sensitive control of the oscillator demands rather complex operating conditions in the AFC stage, despite its deceptively simple appearance. Therefore, a reasonably good understanding of circuit theory is the most solid foundation for an AFC-troubleshooting technique you can depend upon. It makes symptom and waveform analysis easier—as we shall see.

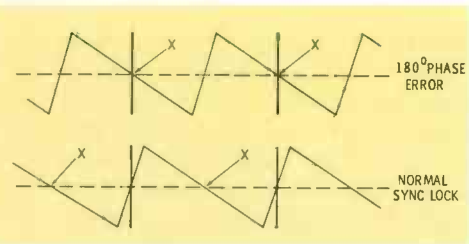


Fig. 2. AFC system automatically rejects null point X, 180° out of phase.

Sync Plus Sawtooth

The development of frequency-correcting voltage is usually explained with the aid of drawings similar to Fig. 1, showing how a sync-pulse signal and a sample of the horizontal sawtooth sweep signal are added in a balanced dual-diode circuit to develop a net output voltage. The accompanying text generally summarizes the circuit operation as follows: "When the oscillator is running slow, the sync pulse arrives at the AFC stage during the negative portion of the sawtooth signal; the result is a negative output voltage. When the oscillator is running fast, the sync pulses occupy a position toward the positive peak of the sawtooth, developing a positive output. These resultant voltages have the correct magnitude and polarity to bring the oscillator frequency back to normal. When the oscillator is running at the sync-pulse frequency, the pulses coincide with the zero axis of the sawtooth slope, and no correction voltage is developed." Thus sum-up is fine, as far as it goes. However, it doesn't explain how the AFC circuit can consistently overcome considerable phasing errors without accidentally locking the oscillator 180° out of phase with the sync signal.

Take another look at the sample sawtooth signal in Fig. 1, and you'll note it has not just one zero-axis point, but two, in each cycle. It is the AFC circuit's ability to latch on to the *correct* zero-axis or crossover point that makes the AFC system an automatic phasing control, as well as a frequency-correcting device. Even when the oscillator and sync signals are as far out of phase as they can possibly get (Fig. 2A), this condition will rapidly be corrected to the in-phase condition shown in Fig. 2B. Here's how it works:

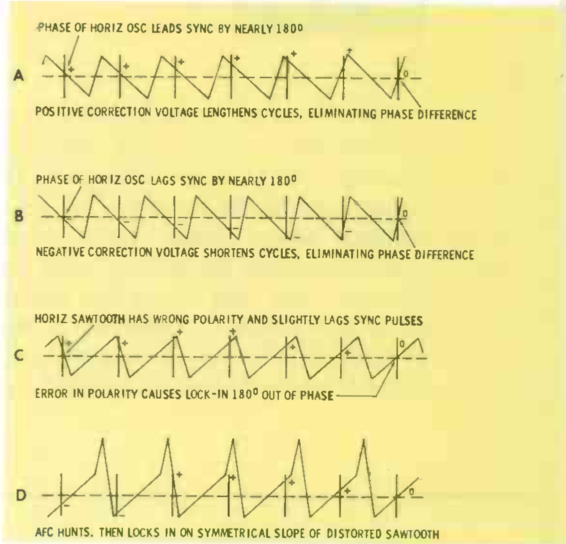
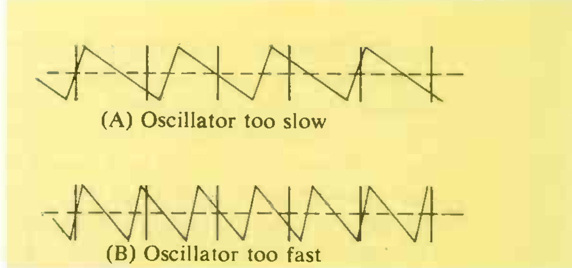


Fig. 3. In-phase operation is quickly reached unless sawtooth is abnormal.

If it were possible for the oscillator to start or run at exactly 15,750 cps *by itself*, it would also be possible for the sync pulses to lock in at the incorrect crossover point (X in Fig. 2), since the zero axis of the sawtooth would coincide with the pulses, and no correction voltage would be developed. In such a case, the oscillator would be op-



(A) Oscillator too slow

(B) Oscillator too fast

Fig. 4. Beyond control range of AFC.

erating at the right frequency, but 180° out of phase.

The frequency of the oscillator when *free-running* is never exactly 15,750 cps except for extremely short periods of time. While the frequency drift is minute, it occurs nonetheless. Therefore, the sawtooth signal fed back to the AFC stage will often appear to be far out of phase with sync, but practically never will be exactly 180° out. Consequently, a correction voltage will be generated. But if the sync pulse arrives during the *longer* slope of the sawtooth, near point X, the corrective action of the AFC system will tend to pull the pulse *away* from the 180° zero-axis point, and seek the in-phase condition.

Figs. 3A and 3B demonstrate how this action can correct leading and lagging phase angles, respectively. With the signals not quite 180° out of phase, a small correction voltage is generated. In Fig. 3A, this voltage is positive; it tends to slow down the oscillator, reducing the phase difference between the signals on the next cycle. Since this places the sync pulse higher on the sawtooth slope, an increased positive correction voltage is generated, and this speeds up the corrective action. Past the positive peak of the sawtooth, the phase-retarding action continues until the correction voltage reaches zero. The system quickly comes to equilibrium at this point. A similar control sequence involving negative correction voltages is presented in Fig. 3B.

A far-out-of-phase condition is usually corrected too fast for the eye to see, but in some receivers the action is slow enough to be noticed. A Sylvania receiver I recently had in my shop worked like this; when the set was turned on, the horizontal blanking bar appeared in dead center, and remained this way for a few seconds before the picture snapped into normal sync.

Inverting the polarity of the sawtooth (Fig. 3C) results in an oscillator signal locked 180° out of phase with sync. This error, sometimes introduced when a flyback is replaced, shifts the picture so a horizontal blanking bar runs down the center of the screen. Some service technicians and writers seem to think a flyback-wiring error is the only possible reason for this symptom, but 'tain't necessarily so. Defective components in the sample-signal feedback network can also cause the same condition—although, in close to 20 years of servicing, I have seen such faults only about three times. Fig. 3D illustrates how out-of-phase operation can be caused by distortion of the sawtooth.

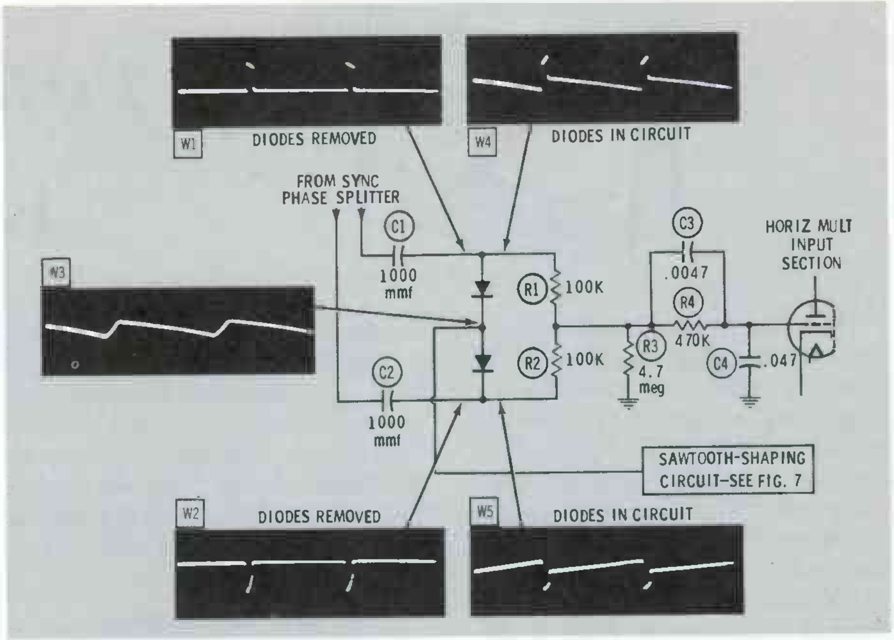


Fig. 5. This portion of unbalanced dual-diode AFC stage is highly standardized.

The frequency-correcting capability of the widest-range AFC system in use (Fig. 5) is less than ±400 cps. Thus, if the oscillator runs fast or slow by about 2½% of its normal 15,750 cps, even the best AFC system is unable to maintain sync. This limitation is partly due to the fact that sync-pulse and sample-signal amplitudes are not sufficient to develop more than a few volts of correction voltage. Also, the reasons for restricted locking range should be obvious from studying the wave trains shown in Fig. 4, where the oscillator signal is considerably off frequency. The range of AFC systems is more than adequate, however, considering the good frequency stability of most horizontal oscillators.

Fig. 6. Out-of-phase horizontal sync caused by faulty selenium dual diodes.

Balanced Diode AFC

The dual-diode system shown in Fig. 5, which requires two sync pulses of opposing polarities, is probably found in more different receiver models than any other type of AFC. It has been used by practically every manufacturer at some time, although it is more prevalent in older models than in recent sets.

In troubleshooting this circuit, an important preliminary step is to determine whether the horizonal multivibrator is able to run by itself—with reasonable stability—at the correct frequency of 15,750 cps. The AFC correction voltage is easily removed by pulling out the dual diode (if a plug-in type is used), or by grounding either point A or the input grid of the multivibrator. If the picture can be brought almost into synchronization by operating the horizontal hold and frequency adjustments, but sync is below par when AFC action is restored, troubleshooting of the AFC circuit is obviously necessary.

The best way to begin is to replace the dual diodes. Semiconductor types (especially selenium) lose efficiency after a few years, and while diode tubes seem to have almost unlimited life spans, their good condition shouldn't be taken for

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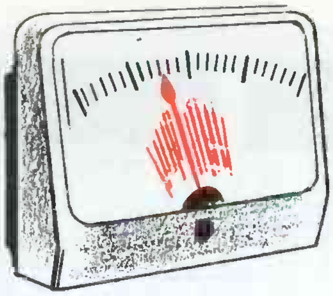

Troubleshoot by Current

There are a number of systems for troubleshooting transistor radios, from the "cut and try" method practiced by the inexperienced student to the logical step-by-step procedures used by transistor specialists. Between these two extremes lie a number of ways of going at this problem, and each different method has its staunch proponents. The troubleshooting system we're going to describe here has advantages incorporated in the step-by-step method, plus certain advantages of simplicity offered by less highly organized procedures.

One of the primary advantages of this method of troubleshooting is the simplicity of the test equipment or "tools" needed. Most of the tests outlined can be accomplished with the following testing devices: a pair of 24″ jumpers with needle-point test prods at each end, a 100K potentiometer equipped the same (see page 36 of the February, 1963 article "Boosting Sensitivity in Transistor Portables"), and a VOM (a 100-ma current meter will do, but the VOM offers the advantages of several current ranges).

Another advantage of this troubleshooting method lies in the fact that few test-equipment connections are necessary; most of the troubleshooting can be done with one simple VOM connection. The VOM or current meter should be connected in series with the power-supply leads, thus checking the input current to the entire set. Once you understand the principles of this way of troubleshooting, you will find it very easy to apply. You'll probably want to add it to your own servicing procedures.

Test Connections

The first step in any methodical troubleshooting procedure should determine which general section of the receiver contains the trouble. No matter what the actual complaint in the set—whether it be dead, distorted, or oscillating—it is almost invariably caused by a single faulty component (or connection) in one particular stage. Once the faulty stage has been located, the transistor can be tested and the faulty component or connection pinpointed—by checking the current drain.

The transistor-radio troubleshooting procedure begins by connecting a current meter in series with one of the battery leads (as in Fig. 1A) to monitor the input current to the receiver. The easiest way may be to connect the meter across the switch; one disadvantage to this method, however, is that the set can't be shut off without disconnecting the meter. Some transistor technicians alleviate this problem by the alternate connection shown.

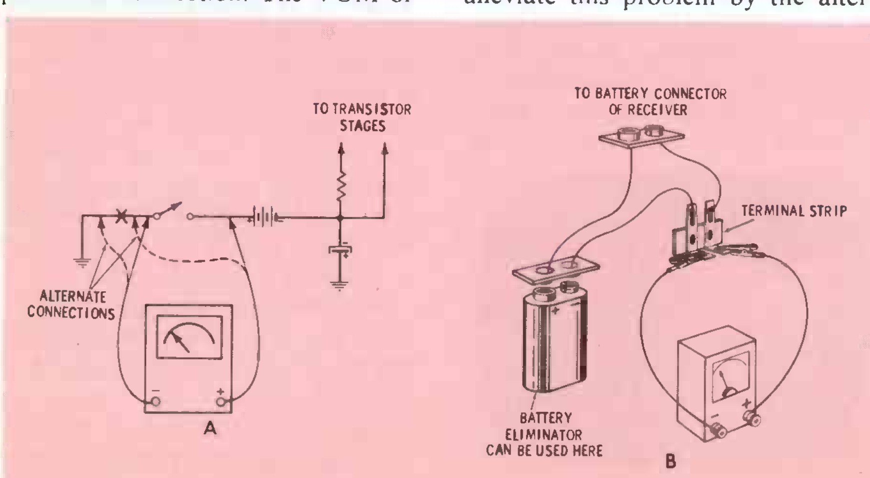

Fig. 1. Methods of connecting milliammeter into the power-supply circuit.

The device shown in Fig. 1B can be made up and used if you do quite a bit of transistor servicing. It will simplify making connections by allowing you to connect the battery (or battery eliminator) outside the set and insert the current meter at a convenient terminal strip. Similar devices can be made for other types of transistor batteries.

Localizing a Fault

Locating the faulty stage in a dead transistor receiver is by far the most simple of all the troubleshooting procedures we'll discuss. Each stage in a transistor receiver draws a certain amount of current—in most cases, just a few milliamps. If the stage is completely dead, the fault that is causing the trouble will almost invariably upset the DC current and voltages. Thus, by interpreting any incorrect reaction to DC-current tests, it is relatively easy to pinpoint the stage that isn't acting normally.

It isn't practical to draw a conclusion from measuring the *exact* current of each stage, because this quantity can vary considerably. The RF and IF stages may draw anywhere from .5 to 1.5 ma; audio amplifier and driver stages can draw as much as 3.5 ma (seldom less than 1.5 ma); and, depending on the station signal and the setting of the volume control, the output stages can draw 5, 10, 20, or even 60 to 70 ma. There's a better way to check operation.

Dead Stages

Almost any component defect will affect the DC currents in its associated stage. Therefore, a good check of the operation of a stage is to note if collector current is being drawn. This can be done in either of two ways: by actually measuring current in the stage, or by disabling the stage and noting the change in the total input current. The stage can

Transistors Drain!

Analyze a whole stage with one simple test.

by Forest H. Belt

be disabled by opening either the collector or the emitter lead. (A slash of the foil with a razor blade will do the job.)

As an example, consider a typical transistor receiver. The set is dead, and your job is to find which stage is inoperative. With the set connected and turned on, the milliammeter indicates nearly the full normal no-signal current (given in the service notes). A major portion of the current drain of any transistor receiver, whether operating at full volume or simply idling, is drawn by the output stages. Since the current in this set approaches the 8 ma normally expected, it is safe to assume the driver and output stages are drawing normal current. A quick slice across the emitter foil of the second IF amplifier produces a 1-ma reduction in total input current; so you logically assume the second IF amplifier is operative. Without even stopping to resolder this foil (yet), a quick slice across the first-IF emitter foil causes no change whatsoever in input current; the assumption, then, is that this stage is not functioning.

While it is common for a stage to draw less than normal current when it is inoperative, there are also conditions that will cause the stage to draw too much current. For example, consider the same set again, but assume that the initial no-signal current reading is 20 ma. This seems to indicate some stage is drawing more than the normal amount of current. Your first step is to disable the driver and output stages, but the current reading remains near 10 ma. Considering that the three remaining stages—converter, first IF, and second IF—should draw less than 1.5 ma each, this is too much current.

Three more quick slashes with the razor blade are sufficient to determine which stage is drawing the excessive current; in this case, the first slash at the emitter of the converter circuit drops the idling input current to 2.5 ma, indicating that more than 7 ma was being drawn by the converter stage alone. Having localized the trouble, hurry back to the driver and output stages and remake the slashed foil connections, to be sure you don't forget they've been cut.

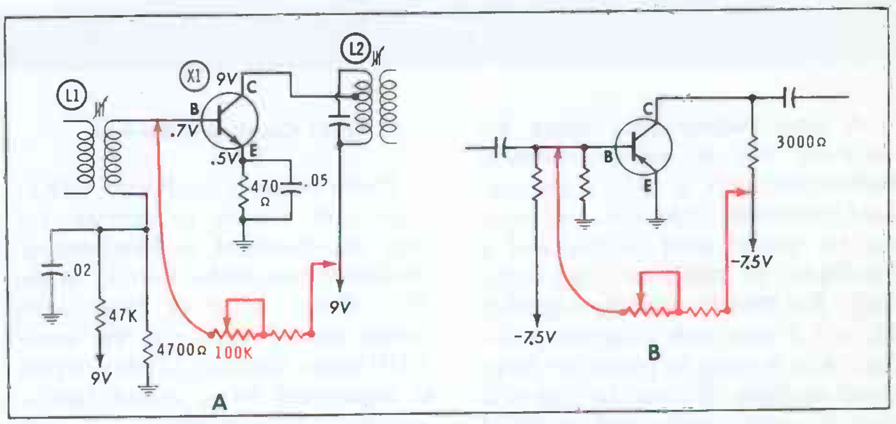

Fig. 2. Simple test device can be used to forward-bias transistor stages.

Unwanted Oscillation

Most cases of oscillation in transistor radios can be blamed on poor decoupling, due to either an ineffective bypass (decoupling) capacitor or high internal resistance in the transistor battery. The most common type of oscillation—motorboating—centers invariably in this area. Other types of oscillation, which can block reception rather effectively, sometimes must be traced to other circuits.

An oscillating stage generally draws considerably more current than a simple amplifier, and this fact can help you localize the offending stage. The already-described method of disabling a stage by opening the emitter lead has two effects that help isolate RF and IF regeneration. If the current drops considerably when such a stage is disabled, that stage is probably causing the oscillation. If the oscillation stops, without the accompanying decrease in input current, it is a sign the oscillatory or regenerative loop has been broken, but the disabled stage may not be the only stage involved.

Testing Transistors

Once the faulty stage is located, another time-saving feature of this troubleshooting method becomes apparent: the relative ease with which a transistor can be tested without disconnecting it from the circuit. As pointed out before, any change in operating current in the collector circuit of a transistor (or in the base for that matter) will be revealed by a change in the total amount of current drain at the receiver input. This fact can be put to use in testing the transistors themselves.

Dead Transistors

We'll assume a dead transistor to be one that is completely inoperative. To discover such a transistor, you can use any one of three meth-

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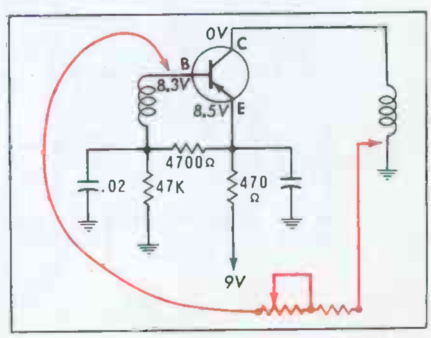


Fig. 3. Grounded-collector connection.

TRANSISTORIZED GARAGE-DOOR OPENERS BUILD PROFITS

A tired businessman enters his driveway late at night, presses a button that keys a small transistorized transmitter in his car, and waits for his garage door to rise and a floodlight to switch on automatically. But tonight, nothing happens! Here is a man with a service problem, who is going to phone for help, come morning. It could be you he'll call, if you're ready and qualified for his business.

Of course, we're talking about radio-controlled garage-door openers (GDO's). If you've been turning down servicing jobs on these units, considering them out of your field, think this over: You can apply the same servicing logic to GDO's as to the remote-control transmitters and receivers used in TV sets.

Just Closing a Switch

Radio controls used with GDO's require no license to operate, for they are classified as restricted-radiation devices under Part 15 of the FCC Rules. Most of these units radiate an RF carrier in the lower VHF range (around 27 mc), which is modulated by a coded tone—usually in the audio-frequency spectrum. These are not the only type, for at least one model transmits and receives a very-low-frequency signal (VLF), in the audio range from 7955 to 9932 cps. This is an electromagnetic signal, radiated from an antenna, and is not to be confused with the transmitted sound waves that are used in many TV remote-control systems. Ten control channels, each on a different frequency, are available with this VLF type of door control.

The ultimate purpose of the transmitter and receiver used with a GDO is to perform one small electrical function—closing a relay-controlling switch. The actual opening and closing of the door is performed by a separate door operator and its control assembly, made up of a motor, a gear train, reversing and limit switches, etc. Most openers also include a manually operated push button that can perform the same function as the relay switch. In troubleshooting, this button comes in handy as a check to determine whether the radio control or the operator assembly is at fault. Because this operator unit is entirely separate from the radio-control equipment, we won't concern ourselves with its circuits except as needed for explanation.

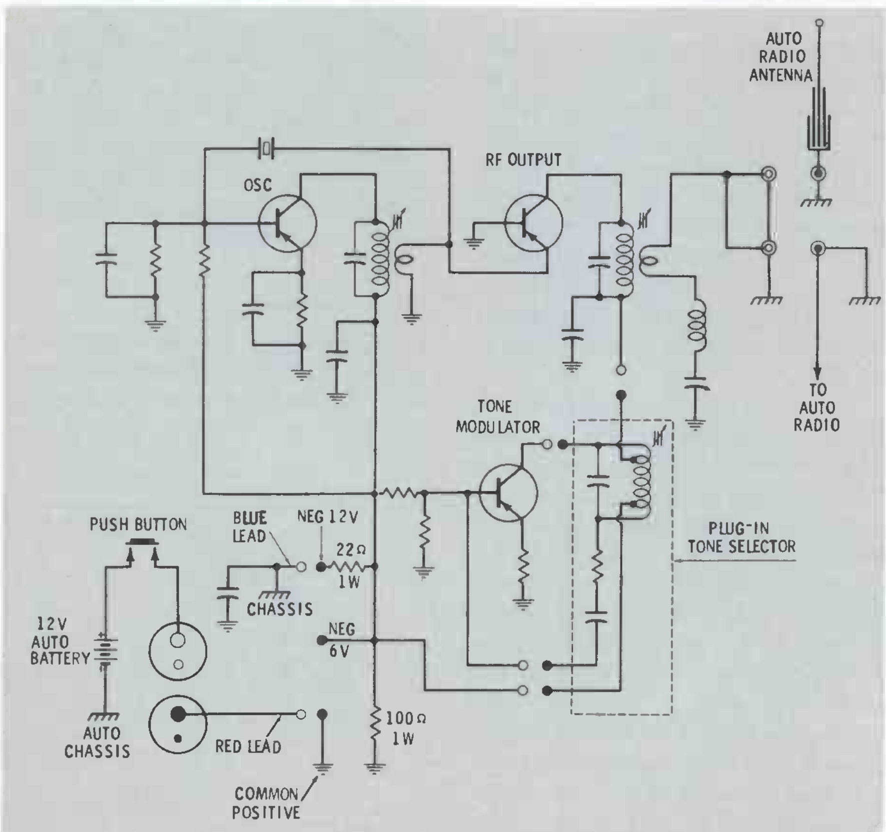


Fig. 1. Schematic of a typical transmitter used with garage-door openers.

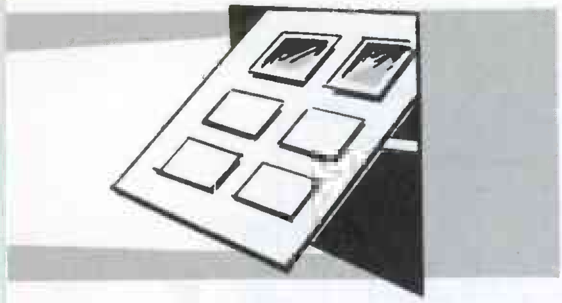
Transmitters

Two types of transmitters are usually available for GDO's: a unit that is mounted someplace in the automobile, and a portable hand unit. Either type will actuate the receiver circuits and initiate the door-lifting operation. Notice the word *initiate:* the door-operator assembly proceeds unaided once it's started, automatically shutting itself off at the end of door travel.

The frequency of the transmitter carrier, and of the modulating tone, is usually marked on both the transmitter and the receiver. The numbering code used to specify the frequencies naturally varies among manufacturers; the frequencies may be encoded in the serial number, or contained in a special letter code.

Permanent Installation

Two or three transistors are normally used in the mounted type of transmitter. Fig. 1 shows the sche-



matic diagram of a typical three-transistor unit, and Fig. 2 explains its physical mounting arrangement.

When the switch button is depressed, power is applied to the transistor circuits, keying the transmitter. An oscillator generates an RF signal whose frequency is determined by a crystal. The RF signal is fed to the emitter of the RF output transistor; an audio tone from the modulator transistor is added in the collector circuit. The tone-modulated carrier is then fed to the automobile antenna, via a dual-purpose antenna socket. This special coupling socket permits the car antenna to serve as the transmitting antenna for the GDO transmitter *and* as the car radio's receiving antenna. Some car-mounted units have a separate antenna that mounts under the hood.

A point to remember when you have occasion to bench-service equipment of this type is: Be sure you know the battery polarity and voltage in the car you removed the transmitter from; write it on the unit, if you have to. The transmitter may be damaged if the power connection is wrong.

In the transmitter of Fig. 1, the frequency of the modulating tone can be changed by removing the plug-in tone-selector circuit and inserting one for a different tone. The photo in Fig. 3 depicts this tone selector, removed from the transmitter.

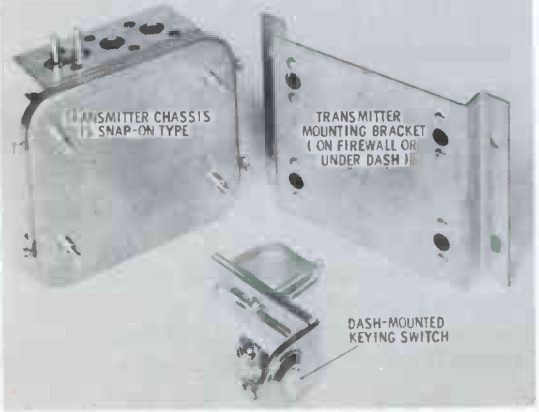


Fig. 2. Depicted here is auto-mount transmitter, switch and accessories.

Portable Transmitter

As mentioned, a portable transmitter can also be used with the radio control system. Sometimes a customer will have both types—one installed in the car and another for his pocket or his wife's purse. If he does have two transmitters, your initial troubleshooting will be somewhat simplified; the trouble can be quickly isolated to one transmitter, or to the receiver.

Fig. 4 shows a portable transmitter removed from its case. In physical design, it resembles a TV remote transmitter. The power supply is a 9-volt battery similar to that used in many transistor radios. Most of the circuits are very much like those in the auto-mounted type; however, there are a few important variations you should be aware of. A ferrite rod is used for the antenna, and the modulating tone frequency is fixed. If one of your customers desires to change the operating frequency of his door opener, and he has a portable transmitter, it will probably be necessary to return the unit to the manufacturer requesting that the frequency be changed.

Receivers

A photo of a typical all-transistor receiver, a companion to the transmitter we have discussed, is shown in Fig. 5. The relay-control stage, the only section that is different from an ordinary radio receiving circuit, is shown in schematic form in Fig. 6; the other stages of the six-transistor receiver are represented here by blocks.

Here's how the relay-control stage works: When present, the audio tone is detected by X4. After being amplified, the tone signal causes the relay transistor to conduct, energizing relay M1. Relay contact set S1 closes, completing the circuit to door-operator power relay M2. Through M2, an electrical path is completed via the sequence switch assembly to the motor circuit, and the door operates. Contact set S1 simply performs the same function as the manual push button—but does it by radio control.

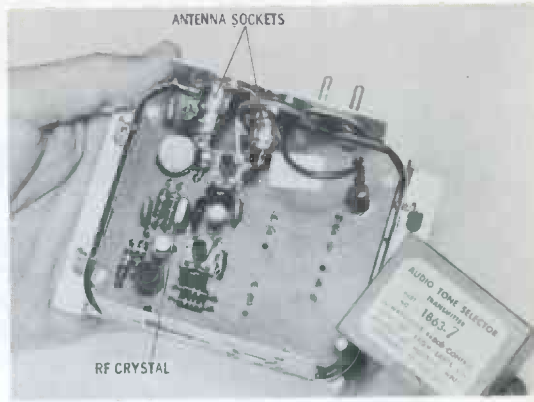


Fig. 3. Audio tone-selector circuit is enclosed plug-in unit in this set.

In case you're wondering, the time delay in the collector circuit prevents keying of the relay transistor by erroneous noise signals. When the transistor starts to conduct, the time delay circuit (usually an RC network) absorbs the initial charge, preventing M1 from energizing for approximately one or two seconds. So, here's a valid point to remember: Because of the time delay circuit, you must hold the transmitter keying button down for a couple of seconds. A momentary transmission, although normal in other remote controls, *will not* key delay-protected relay circuits.

The power supply for the receiver is of the common silicon-rectifier type, complete with filter and dropping resistors. Some receivers obtain their AC voltage directly from the 24-volt supply used for the operator assembly. In sets of this type, the transformer on the receiver is unnecessary, and there would be no line-voltage plug extending from the receiver.

Receivers used with VLF transmitters usually have five transistors, three of which function as VLF amplifiers. The last of these VLF amplifiers feeds a tuned transformer

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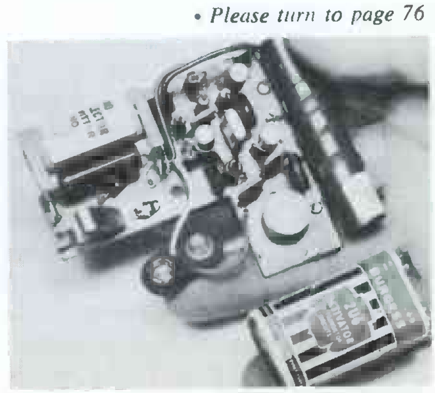


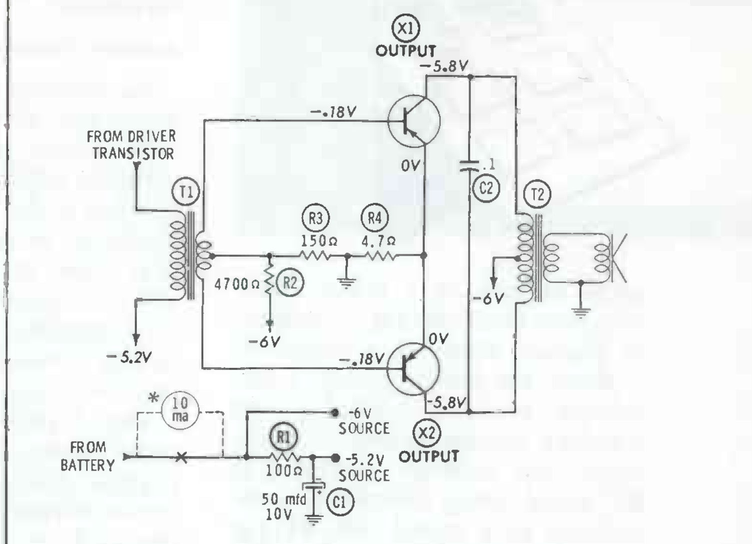
Fig. 4. Portable GDO transmitter is similar to types used in TV remotes.

Transistor Output Stage

Push-Pull

Normal Operation

This push-pull output stage is typical of those used in many modern transistor portables. Transistors X1 and X2, operating class B, are biased near cutoff; incoming signal develops forward bias alternately on each transistor, permitting one to conduct on each half-cycle. When signal excursion at base of X1 is negative, collector current can flow in this transistor. At the same time, positive signal swing at base of X2 drives that transistor deeper into cutoff. When signal polarity is reversed—during next half-cycle—base of X2 receives negative-going voltage swing and conducts, while X1 returns to cutoff. Both signal currents combine in output transformer T2, complementing each other to form complete audio signal in secondary for feeding to speaker. Idling (no-signal) bias for bases of X1 and X2 is set by resistive divider network R2-R3 across main power source. R4 is temperature-compensating resistor, common to both transistors, included to prevent any tendency to thermal runaway. When set is idling—no input signal, and volume control at minimum—total input current drawn by entire receiver is 10 ma, with output stage consuming more than 5 ma of the total current.



Idling current and voltages (VTVM) taken with no signal input; volume control set to minimum.

Variations

With signal applied to set, collector voltage may vary slightly above or below no-signal value of 5.8. Base and emitter voltages also change with signal conditions—to -.12 volt at bases, and to -.06 volt at emitters.

SYMPTOM 1

No Audio Output

Intermittent Popping Noise

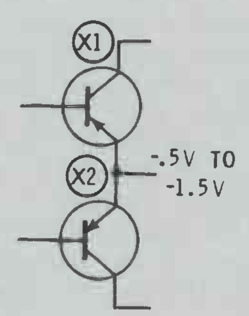
R4 Open

Analysis

Turning volume control to maximum and tuning in strong station may produce very faint audio signal. Ability to receive station signal draws suspicion away from front-end stages. Sound is similar to that from speaker with stuck voice coil—strong indication of severe audio distortion and good clue to output-stage fault. Popping could be intermittent trouble, or characteristic noise of bad resistor.

Troubleshooting Procedures

Substituting for speaker is quickest way to check it for fault. Voltages on base and collector of X1 and X2 offer no clues—they remain near normal. Increased voltage on emitters (-.5 without signal, -1.5 with) might seem to indicate excessive conduction in one of transistors. However, by noting low input current drain of set, and normal collector voltage, you can eliminate this possibility. (This points up importance of input-current reading as troubleshooting aid.) Since idling current drain is 4 ma below normal, output stage is one most likely to be inoperative (it is only circuit normally drawing that much current). By eliminating suspicion of excess conduction, you leave only one alternative — voltage at emitters is result of whatever slight leakage (Iceo) exists in transistors,



SET IDLING CURRENT 6 ma

and emitter resistor R4 is open. R4 wouldn't likely burn open, even if transistor shorted; more likely cause of trouble is poor solder joint. Signal injection could be used to narrow down this fault: Audio signal applied at collector of either transistor produces normal tone in speaker, but signal injected at base of either stage fails to reach speaker, indicating that fault affects both transistors; R2, R3, and R4—common to both stages—are suspects.

SYMPTOM 2

Distortion

Weak and Garbled Audio

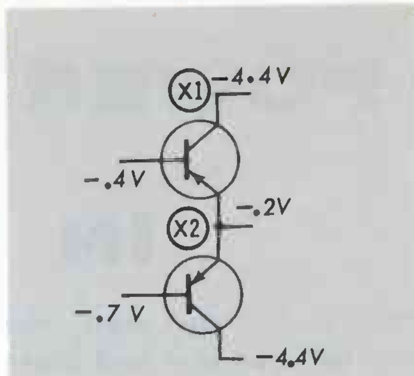
X2 Leaky

Analysis

Station signal can be tuned in normally, proving RF and IF stages are functioning properly. Sound from speaker is very distorted—usually a sure clue to audio-stage problems. Output is also weaker than normal, even with volume control at maximum. Distortion is characteristic of sound produced by a "scratchy" speaker. Fact that audio signal can be heard indicates audio stage is not completely dead.

Troubleshooting Procedures

Most significant clue to this fault is greatly increased idling (no-signal) current—nearly 45 ma. Source voltage drops to 5 volts as result of load on power supply. Possibility of defective filter capacitor C1 is quickly eliminated by disconnecting its ground lead; 45-ma load remains. Focusing attention on shifts in voltage at X1 and X2, note emitter voltage has increased—in spite of reduced collector potential—indicating excessive transistor conduction. Comparatively large change in base voltages points to defective bias divider or leaky transistor. Unequal bias values mean trouble is not common to both transistors; probably one is bad. X2 displays higher base voltage, and is more likely culprit. Opening X2 collector



SET IDLING CURRENT 45 ma

(directly at transistor) reduces excess input current. Defect is excessive base-collector leakage (Icbo): ohmmeter measures 20K instead of normal 400K or more. Excess bias, developed on base of X2 by leakage, is coupled to X1 through T1 winding, causing X1 to overconduct. (Extended operation could damage X1). Thus, disabling X2 by common method of jumpering base and emitter together fails to reveal fault in this case, for X1 continues to overconduct.

SYMPTOM 3

Motorboating

Some Static and Noise

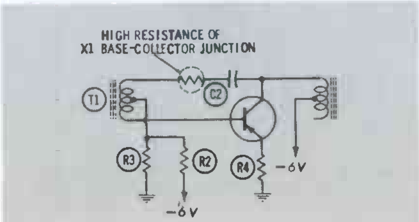
Half T2 Primary Open

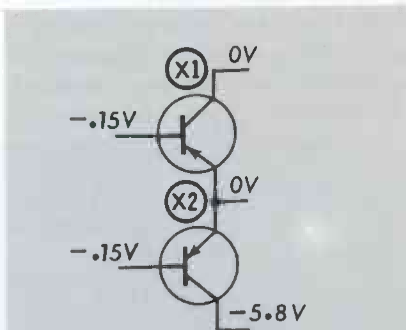
Analysis

Here's an unusual sympton, when compared with ordinary motorboating complaint. In this case, motorboating is rather fast; it almost sounds more like buzz than like "putt-putt" heard when electrolytic filter opens. Tuning in station signal, and increasing volume-control setting, changes frequency of buzzing; station audio shows tendency to override motorboating sound.

Troubleshooting Procedures

Low input current—only 8 ma—eliminates likelihood of short. Motorboating is usually linked with power supply or audio stages, but bridging filters is ineffective here; so attention turns to output stage. Emitter-base jumper applied to either transistor stops motorboating—rather inconclusive test. Base and emitter voltages are normal on both transistors, but zero volts at collector of X1 is tipoff that supply path is open. Tests show one-half of T2 primary open. But—open collector supply should only disable





SET IDLING CURRENT 8 ma

X1; what's causing motorboating? Answer lies in action of capacitor C2 in conjunction with Icbo of X1—see revised schematic at left, which shows circuit as it appears with half of T2 open. C2 couples energy from collector of X2 through leakage resistance of X1 (about 400K in normal unit) to T1. Phase is correct in T1 to cause regeneration, resulting in oscillation in X2 amplifier stage. Disabling X1 with base-emitter jumper kills motorboating by grounding feedback path at base of X1.

POWER vs. SIGNAL IN TRANSISTORS

Where do you draw the line between low- and high-power types?

by Rufus P. Turner

Manufacturers and design engineers have many ways of classifying transistors. Their categories, which numerically put tube groupings to shame, include structure *(NPN, PNP, alloyed, diffused, mesa,* etc.), current gain *(medium-beta, super-alpha,* etc.), collector voltage *(high, low, medium),* frequency response *(audio, IF, RF),* switching time *(fast, slow),* power capability *(high, medium, low),* material used as semiconductor *(germanium, silicon),* and many more.

The picture is a maze to an outsider. But it need not be confusing to the average transistor user, because he usually is more interested in one or two characteristics than in all the many others. The computer man, for example, requires *high-speed* transistors, the communications-receiver designer demands *high-frequency* types, and the audio engineer wants *power* units for output stages. And any one of these men might express a preference for silicon or germanium, low or medium voltage, metal or plastic encapsulation.

The TV-radio service technician's present contact with transistorized circuits is limited mostly to radio receivers and audio amplifiers, but he is already concerned with how to classify and understand the transistors in this equipment. As the number of transistor types continues to grow, he needs all the facts he can obtain to ease the job of replacement and testing.

The simplest classification for practical servicing purposes is into *signal-type* and *power-type* transistors. If the technician will first classify transistors in this way, he then may think specifically and more comfortably about other details and characteristics.

Signal Transistors

The conventional, small - sized transistor is a low-power device having a small direct-current drain and a weak signal output, and it is appropriately called a *small-signal* unit —often shortened to *signal* transistor. Its maximum specified DC input seldom exceeds 30 to 50 ma, and in typical operation the collector current usually is only 0.5 to 10 ma. Like all transistors, it is a power amplifier in the sense that only a small power input is needed to obtain a larger power output. However, its typical output range of 1 to 10 milliwatts hardly fits anyone's conventional concept of a power amplifier. In terms of applications, it is more comparable to a voltage-amplifier tube like the 6C4 triode.

The characteristics and performance of the signal transistor depend upon its type and fabrication. NPN units have a higher upper-frequency limit than equivalent PNP's, silicon units show less temperature drift than germanium, current amplification (beta) ranges from 3.0 in an average 2N122 to 300 in a 2N359, cutoff frequency ranges from 150 kc in the 2N43A to 750 mc in the 2N706A, and typical collector voltage ranges from 1½ to 100 volts. Signal transistors designed for audio applications do not have the special refinements found in those intended for IF and RF use.

The size of these units varies from microminiature (the body consisting of a sphere about 1/32″ in diameter) to the hat-shaped TO-8 package (approximately 0.6″ in diameter and 0.3″ high). Fig. 1 shows actual-size drawings of three representative types.

Signal transistors are used in voltage-amplifying stages of audio amplifiers and in RF-amplifier, IF-amplifier, converter, detector, and oscillator stages of radio receivers. They are also found in the AF output stage of receivers and amplifiers where a great deal of power is not needed. A push-pull pair of inexpensive AF signal transistors, operated class B, will give up to 250 mw of output.

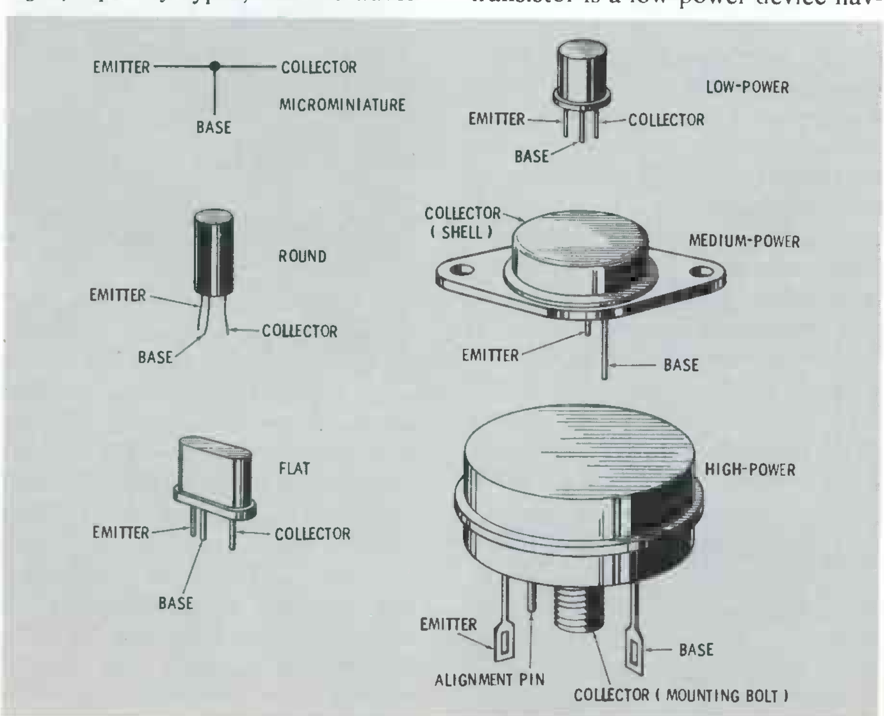


Fig. 1. Actual-size drawings show great variations in sizes of transistors.

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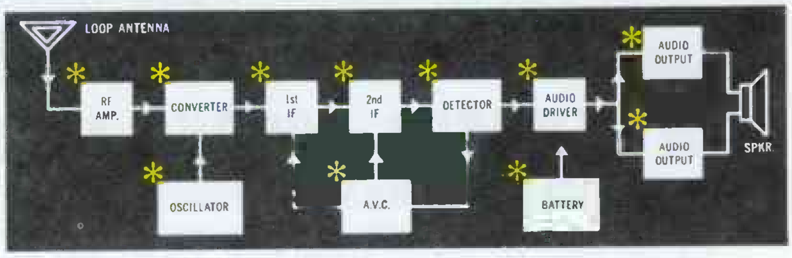

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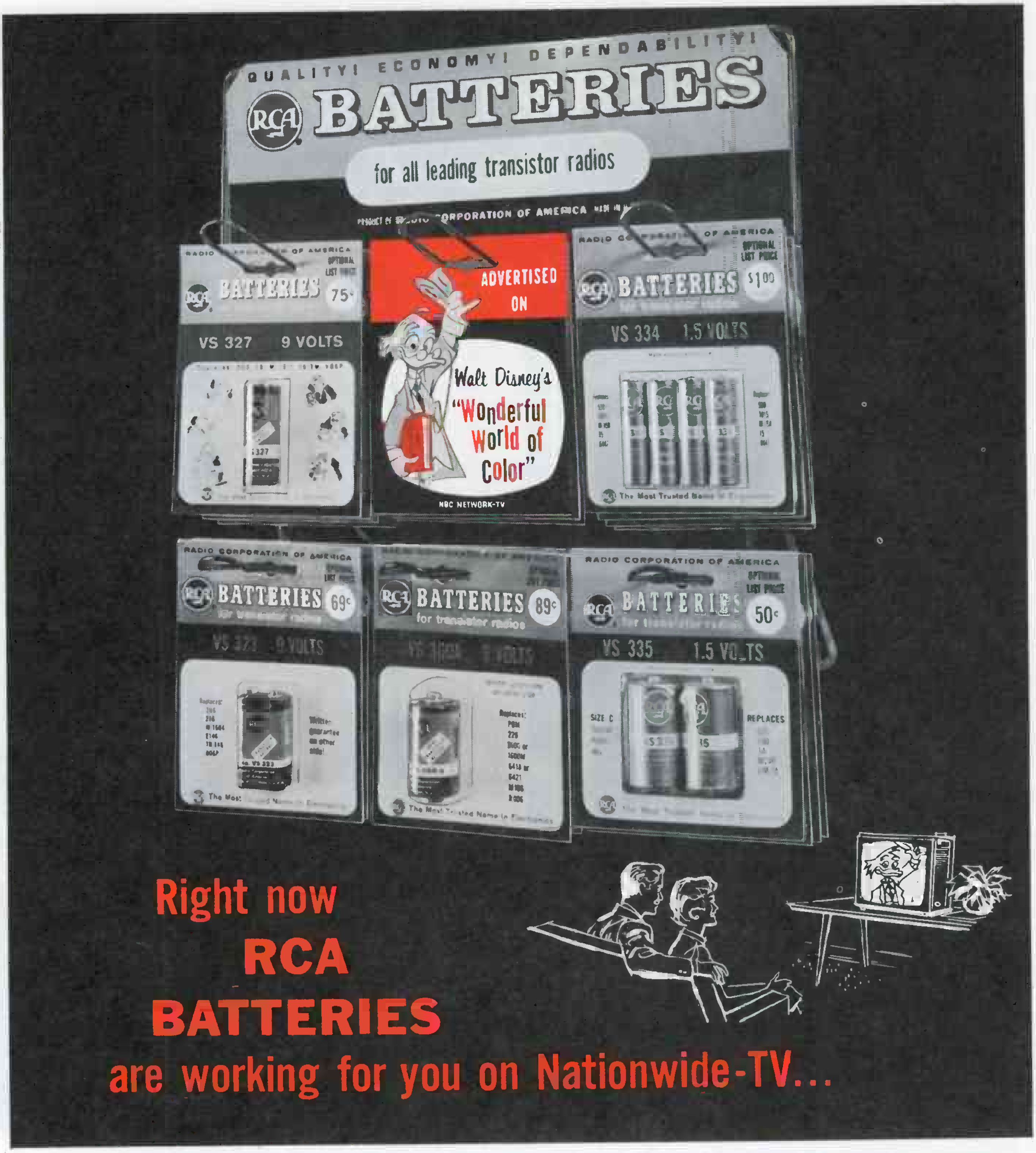
Power Transistors

As its name implies, the *power transistor* is capable of handling significant amounts of both signal power and DC power; otherwise, its operation is basically the same as that of a small-signal transistor. The second group of illustrations in Fig. 1 shows that power transistors are physically bigger than signal types. Both germanium and silicon types are available in packages of various sizes. The units shown are representative of three subgroups into which power transistors are often subdivided: *low-*, *medium-*, and *high-power*. It is difficult to draw lines, but we might say that the low-power category picks up where the signal transistor leaves off (e.g., 2N207's deliver up to 0.5 watt in push-pull class B); medium-power units like the 2N256 deliver up to 10 watts in a similar circuit; and high-power units such as the 2N-1900 provide up to 250 watts in push-pull. These groupings are arbitrary, but nevertheless practical for technicians to use.

Physically, low-power types are simply enlarged versions of signal transistors. For medium - power units, the most common package is the diamond-shaped TO-3 case, now a familiar sight in auto radios. The collector, which is subject to the greatest heat buildup, utilizes the case as a terminal. This, in turn, is bolted to the chassis or mounting bracket. High-power transistors generally use a different type of bolt-down case, the TO-36, which has the mounting bolt connected to the collector.

The surface to which a medium- or high-power transistor is bolted is customarily designed as a *heat sink*, to conduct away and dissipate the considerable heat generated by the high collector current. A finned heat radiator, a heavy metal plate, or the chassis itself may be used. Even low-power transistors are sometimes equipped with small clip-on heat radiators. In certain applications, effective power capabilities of transistors are increased by providing forced-air cooling (fan or blower).

Depending upon type, model, and manufacture, AF power transistors are rated at DC collector voltage from 3 to 150 volts, DC collector current from 20 ma to 10 amps, and maximum power dissipation



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from 10 mw to more than 100 watts. These high power ratings are obtained partly by use of a large-area junction; this means that in the ordinary power transistor the junction capacitance is proportionately increased, and the maximum operating frequency is accordingly decreased. (Special, presently expensive, silicon power transistors are available for 125 watts output at 5 mc.) In ordinary units, cutoff frequency values are 150 kc for the low- and medium-power types, 10 kc for the high-power AF type, and 50 mc for the high-power RF type. While all transistors have low input and output impedances, power transistors have the lowest of all—in some types, only a few ohms.

Transistor Testing

Although the same basic tests are performed in checking both signal and power transistors, the setup requirements for the two groups are different enough that many transistor testers provide special test-switch positions for power types (Fig. 2).

Leakage-test circuits are adjusted to allow for wide variations in normal leakage current. The amount of leakage is generally proportional to the power dissipation of the transis-

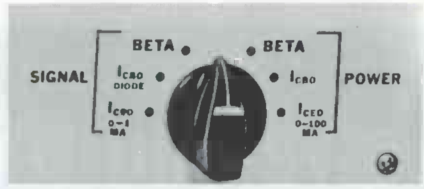

Fig. 2. Testers often have special test-switch positions for power transistors.

tor, and some power types can safely tolerate over 100 times as much leakage as some signal types. The latter should usually be rejected if they give a reading above 1 ma in an I_{CEO} test (emitter-to-collector leakage current with base circuit open); however, power transistors with an I_{CEO} of more than 50 ma are fairly commonplace. Since these values are too different to be accurately read on a single meter scale, two separate scales are often provided—usually by switching a lower-resistance shunt across the meter when power transistors are to be tested (Fig. 3). A typical full-scale reading in the power I_{CEO} position is 100 ma.

Another leakage test provided in some instruments is for I_{CBO}, the leakage current between base and collector when no connection is made to the emitter. Power transistors often give readings as high as 200 to 300 ua, readily measured on a 1-ma meter; but the faint leakage currents in small-signal transistors amount to less than 20 ua, readable only on a sensitive microammeter. Consequently, many inexpensive testers do not provide direct readings of I_{CBO}, but depend on I_{CEO} and gain readings for evaluation of transistors.

It's important to consider the latter two readings in relation to each other. Somewhat low gain is acceptable if the leakage is also low, and high leakage can similarly be offset

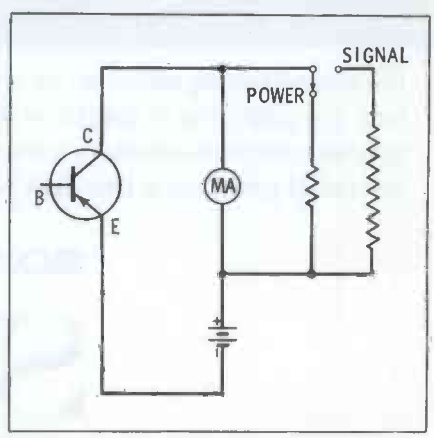

Fig. 3. Higher meter range is used to check power types for Iceo leakage.

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The gain figure most commonly measured is beta—the ratio between a change in output current and the associated change in input current. This characteristic applies to common-collector circuits, which make up the vast majority of transistor stages in actual use. While signal transistors tend to have somewhat higher beta *on the average* than power transistors, there is much overlapping of gain figures between the two classes, and the gain figures in themselves do not dictate different test methods.

Nevertheless, some testers provide different setup arrangements for power transistors, because a more accurate beta test of these units can be secured by increasing the collector current to furnish a closer approximation of actual operating conditions. Both the input to the base and the output from the collector are made larger than for signal transistors, even though the resulting gain figure may be nearly the same.

Replacing Transistors

A defective transistor should be replaced with one of the same type, whenever possible. When an exact replacement is unobtainable, the nearest equivalent type should be selected. Published lists, such as the Howard W. Sams *Transistor Substitution Handbook,* Vol. 4, list suitable replacements based on key specifications such as power dissipation, voltage ratings, gain, and cutoff frequency.

Physical replacement of either signal or power transistors demands reasonable care in protecting the units against heat (a major cause of transistor failures). With signal types, the principal danger occurs during the actual replacement operation. These transistors have very small junctions, poorly equipped to dissipate heat; therefore, *prolonged* heating of the leads with a soldering iron can cause trouble. No special heat-sink provisions are ordinarily needed, as long as soldering and unsoldering are done quickly.

Power transistors require fewer heat precautions than signal types during installation; in fact, most of them have plug-in or bolt-on connections that don't require soldering. But every installation should be made with an eye toward preventing heat problems *later,* as the transistor operates. Considerable heat is continually generated by the high current passing through the emitter-collector circuit, and the transistor is dependent upon an efficient heat sink to conduct the excessive heat away. Air cooling isn't sufficient in itself to do the job. So, to allow a large transistor to operate at full power without thermal problems, be sure it is bolted down securely. A coating of special silicone grease on the transistor case will create a microscopically tight contact to the heat sink when a mica or anodized aluminum washer is used to provide electrical insulation without blocking thermal conduction.

Summary

The only basic difference between signal and power transistors is in their physical size. However, the resulting differences in characteristics are great enough that the two classes of transistors are treated almost like two separate kinds of device for purposes of servicing. ▲

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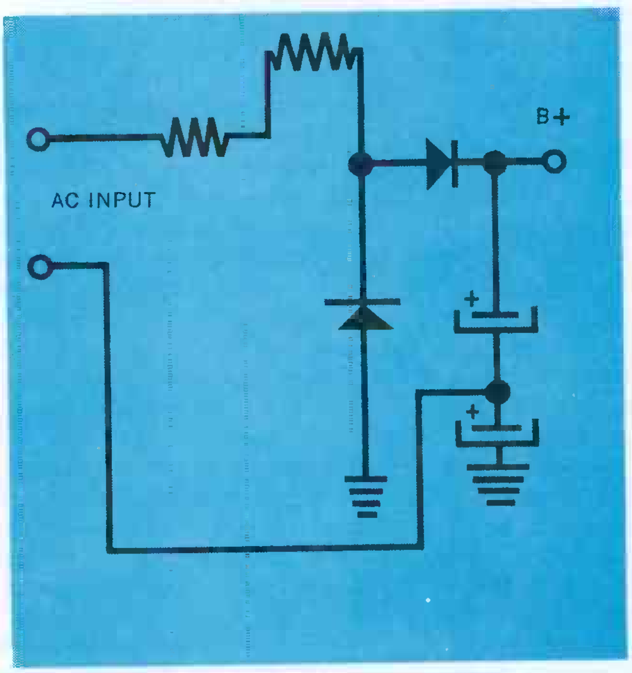
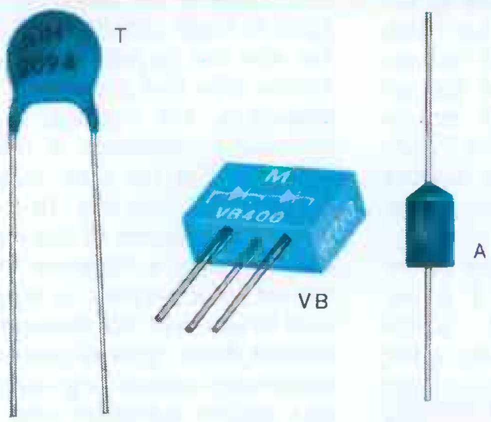
Replacing selenium with silicon rectifiers





Ever wonder about replacing those old selenium rectifiers with modern silicon rectifiers? Stop wondering. It's being done every day and you can do it too! Take a typical TV voltage doubler circuit for example.

1. You know the seleniums are bad or you wouldn't have started . . . right? Right.

2. Forget about the terrific size difference between the new silicons and those old seleniums. Silicons are smaller because they're *much* more efficient.

3. Remove the old seleniums and toss 'em in the trash can. Install the new silicon rectifiers FOLLOWING POLARITY VERY VERY CAREFULLY. The slick way is to use a Mallory VB500 (you'll have one less solder connection to make and the circuit is right on the rectifier). Or you could use a pair of 1N2095's or A500's. Either way those Mallory rectifiers will give you the *best* service you'll ever get.

4. Output voltage (B+) will *usually* be higher because silicon rectifiers are more efficient. So, you'll probably need a dropping resistor in series with the one already there. Turn the set on and check with a voltmeter. Suppose B+ reads 20 volts higher than the schematic calls for. Divide this increase by load current (perhaps 500 ma) to get the value of the resistor you'll need. (40 ohms in this case.) Now multiply the voltage increase by current to get wattage rating (10 watts in this case).

5. But suppose B+ voltage *isn't* higher. This is a clue that something's wrong with the filter capacitors. Check them out with a capacitance bridge or try this very simple deal. Parallel a good TC62 (10 mfd @ 350 WVDC) across each filter in turn. If you get a marked B+ increase you need some replacement electrolytics. We'd suggest a Mallory FP, WP, W, or TC of the proper rating.

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BATTERY ELIMINATORS—INSTANT DC

by Fred G. Biesecker

See how a DC supply makes shop work easier.

In the last few years there has been an accelerated trend toward the use of transistors in portable radios, auto radios, amplifiers, and other types of home entertainment equipment. More than ever, servicemen need to be well prepared for troubleshooting and repairing transistorized units.

One of the primary items needed for this work is a good DC power source that meets the exacting requirements of transistor circuits. It's more practical to use a special DC supply, or battery eliminator, than to maintain a complete stock of batteries for all the different kinds of transistorized equipment likely to come into the shop. A suitable eliminator enables the serviceman to check operation of a set from a known good power supply (in effect, checking the batteries by substitution); it lets him perform long operational checks without running down a battery; and it offers a means of checking receiver sensitivity or working on intermittent troubles by varying the input voltage up and down.

Battery eliminators are available in various shapes and sizes, but nearly all types fall into one or the other of two basic categories. One type is designed for powering only equipment having low current drain, such as portable radios; the other type is capable of handling considerably heavier current loads, like auto radios. The latter type obviously has more than sufficient output to operate a small radio, but may not have a sufficiently low ripple content in its DC output to operate low-power transistor circuits without distortion. An amount of ripple that would not cause a noticeable disturbance in tube circuits can introduce a very troublesome buzz in some transistor circuits.

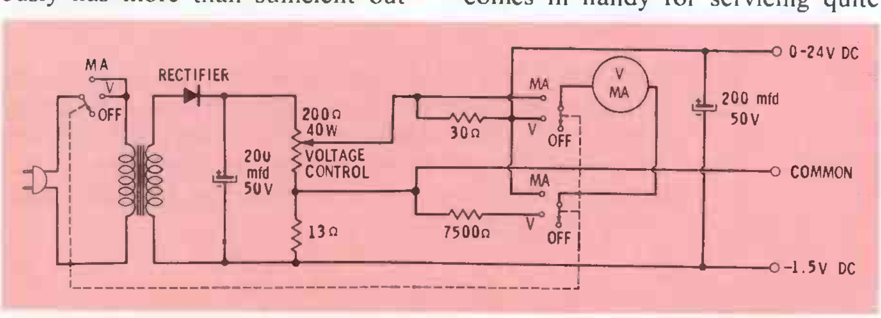

Fig. 1. This eliminator has built-in meter for monitoring voltage and current.

Low-Current Eliminators

The circuit of a typical battery eliminator designed for use with portable transistor radios is shown in Fig. 1. Eliminators of this type are usually designed to supply a variable output voltage from 0 to 24 volts DC, and to deliver a maximum of 200 milliamperes. The particular unit shown in Fig. 1 has a built-in meter with two scales, permitting the operator to monitor either voltage or current output as determined by the setting of the selector switch. This type of arrangement is well adapted to servicing low-power devices containing transistors. For instance, as soon as the correct operating voltage has been set up by reference to the voltage scale, the current drain of the set can then be monitored by merely changing the switch position; there's no need to insert an extra current meter, or to interrupt power to the receiver.

Another interesting feature of the eliminator shown in Fig. 1 is the additional −1.5-volt tap, which comes in handy for servicing quite a few transistor radios that require a tapped power supply for their operation.

Fig. 2 shows the schematic of another type of eliminator for use with transistorized equipment. This unit is similar to the one in Fig. 1, in having a variable output voltage from 0 to 22.5 volts. However, when using this type of eliminator, you'll need separate meters to monitor the output voltage and current being drawn by the unit under test. (You can use your shop VOM for both these requirements, for after initially setting the voltage needed, you can leave the VOM connected to monitor the current; one setting of the voltage control will usually suffice during the repair of one particular unit.)

The second eliminator also omits another convenience feature, the special 1.5-volt tap. Because of its relative simplicity, it is naturally lower in cost than the eliminator in Fig. 1.

Low-current eliminators are not only valuable for powering various types of small transistorized devices, but also can be put to good use for service jobs that don't even involve transistors. For instance, a transistor-battery eliminator is fully capable of doing the same jobs as an ordinary TV bias box. In fact, you can use eliminators of this type anytime you need a moderate DC voltage for some purpose, as long as the load device does not demand a high current. Some types of transistorized equipment contain large-current relays and/or solenoids, and a low-current eliminator might be damaged if it's used to power sets of this type. However, most shops also have an auto-radio battery eliminator that can be used for this purpose.

High Current Eliminators

Most shops presently use large

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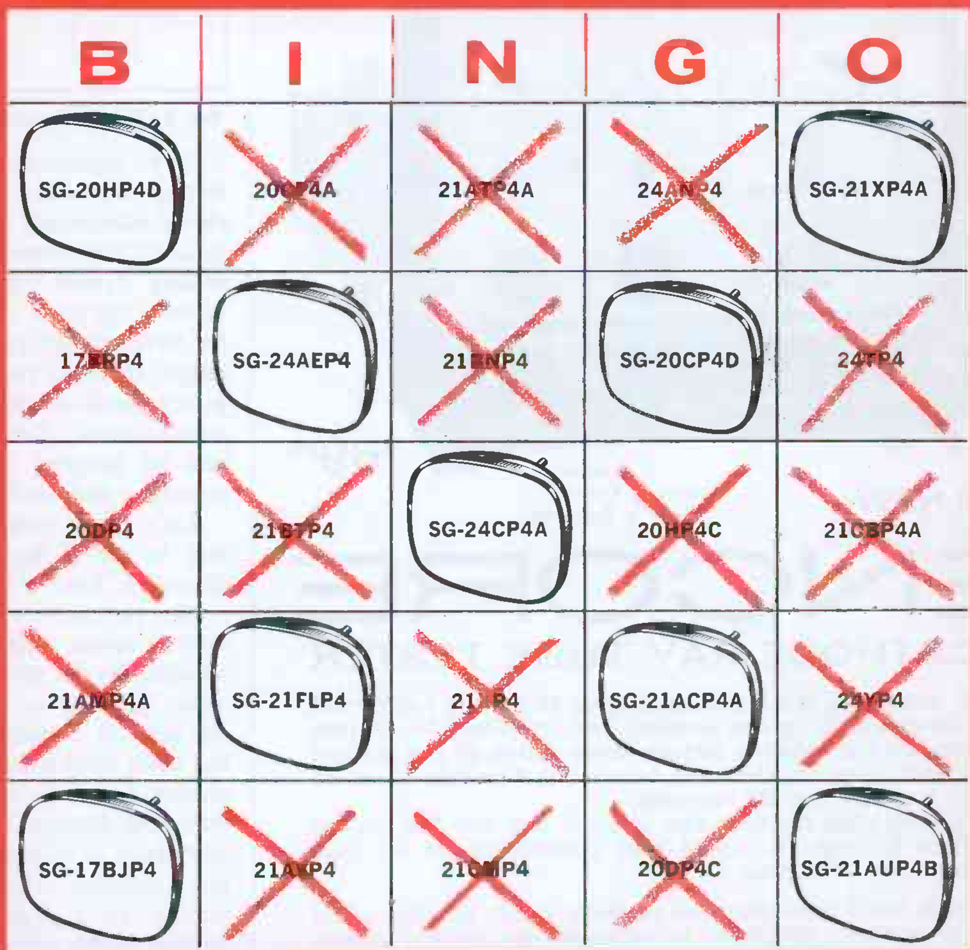

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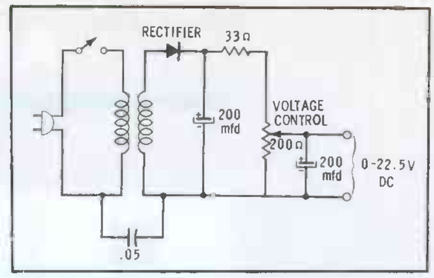


Fig. 2. Simple transistor power supply.

battery eliminators primarily for testing auto radios. The newer models of eliminators generally have a satisfactorily filtered output for operating hybrid transistor auto receivers, but some units now in service have enough ripple in their DC output to cause problems with low-power transistor circuits. With a few modifications, these latter models can be adapted to operate small portables and similar equipment.

Let's check your present eliminator to see if the output ripple is excessive. Take a few normally operating portable transistor radios, requiring source voltages that can be supplied by the eliminator. For each radio, proceed as follows: Turn it on, tune in a station, and listen to the noise level when the radio is operating from its battery. Now, remove the battery and substiute the eliminator in its place. Did the noise level increase? (Listen for a quiet hissing, or a slight buzz.) If the answer to this question is yes, or if in your own judgment the radio just doesn't sound right, the eliminator is probably not the best for powering portables—at least not in its present state.

The solution to this problem is simple: add an elecrolytic filter capacitor—a 1000- to 2000-mfd, 15-volt unit should do the trick—across the output of the eliminator. Now, try the radio again!

We previously mentioned that some portable transistor radios use tapped power supplies—more than one voltage output is taken from the battery pack. Also, various transistorized units require different operating voltages. However, your present eliminator can be adapted to permit easy selection of the different voltages commonly used in low-powered transistor equipment.

The divider network shown in Fig. 3 can be added to your eliminator for just this purpose. You'll need either six 5-ohm, 2-watt resistors or twelve 10-ohm, 1-watt re-

Permohm✓ lead-in wire . . . Better Signals!

in spite of industrial contamination and salt spray

Yes, Slats and Butch are right. Permohm is the finest lead-in cable you can use for color TV . . . and you can really tell the difference in areas where you run into industrial contamination and salt spray. Permohm is easy to install . . . no end sealing necessary. Packaged lengths . . . 50′, 75′, and 100′.

Your Belden jobber carries Permohm and the complete line of Belden Lead-in Cables . . . Weldohm†, Celluline✓, standard 300-ohm line, and the popular ivory colored decorator lead-in.

Be a Cartoon Gag Writer

Win a $25.00 Savings Bond

Send us your gag ideas for future cartoons. For each of your gag ideas used, we'll send you a $25.00 Savings Bond. Write Belden Manufacturing Company, Att: Mrs. Madelsa Allison, 415 S. Kilpatrick Ave., Chicago 80.

**This month's winner! Joseph J. Glannini, Joe's Radio & TV Service, Bronx, N.Y. (see asterisk in cartoon)*

power supply cords • cord sets and portable cordage • electrical household cords • magnet wire • lead wire

Belden
WIREMAKER FOR INDUSTRY
SINCE 1902 — CHICAGO

✓Belden Trademarks and Patents . . U.S. Patent No. 2782251 and 2814666 †Belden Trademark—Reg. U.S. Pat. Off.

8-3-2

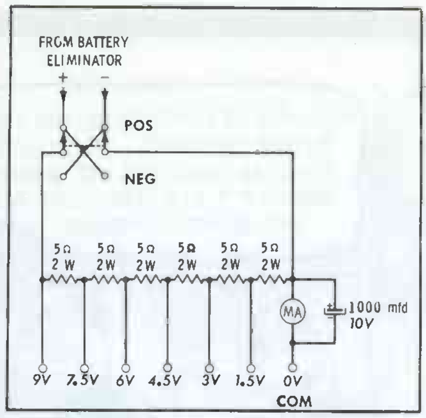


Fig. 3. Voltage-selection network can be added to your present eliminator.

sistors—whichever are more easily procured. Connect the resistors in series, as shown, and connect the network across the negative and positive leads of the eliminator. With the eliminator adjusted to 9 volts, the taps will have the following voltages: 1½, 3, 4½, 6, 7½, and 9. Either positive or negative voltages can be obtained, simply by switching the lead connections to the eliminator. The voltages may not be exact, but for all practical purposes they will be within tolerances. By placing a milliammeter in series with the common-lead tap, you can measure the current drawn by the load. A meter in series with the main line from the battery eliminator would not be as satisfactory, since it would also indicate the bleeder current drawn by the chain of resistors. This current will be close to 300 ma, requiring a relatively high meter scale that would be quite insensitive to small load-current changes produced by connecting transistor radios and similar equipment.

If desired, the resistors and the meter circuit can be mounted on a chassis behind an operating panel similar to that in Fig. 4. Installing banana jacks on the panel will make it very simple to connect equipment to any of the voltage taps provided. A DPDT switch can also be added to facilitate the changeover from positive to negative output.

Summary

A battery eliminator can be a very useful piece of test equipment for servicing transistorized devices. It can be used not only to supply the different operating voltages used in transistorized equipment, but also to obtain any small amount of DC voltage you might have occasion to need for other purposes.

The majority of the eliminators designed to power sets containing transistors are equipped with a combination voltage-current meter. Separate meters are necessary with some types of eliminators, but your VOM will usually serve as the meter for these types.

Monitoring the current drawn by a piece of transistorized equipment can be a valuable troubleshooting aid, both during and after repair. In addition to measuring overall current requirements, you can check individual stages as outlined in the article "Troubleshoot Transistors by Current Drain!" elsewhere in this issue. Checking the total current consumption before returning the set to the customer is your best insurance to prevent a callback. ▲

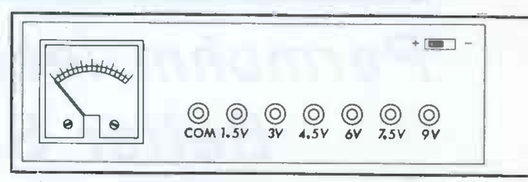


Fig. 4. Proper voltage selection is easy with special panel and chassis.

Latest Jackson Tube Test Data

Model 648

Tube Type	Fil.	D.	E.	Plate Test
6AY11◆	6.3	C6	A58	76XY
		C3	A49	76XY
		C9	7	57X
Nor. -S switch in S position				
		C1	2	57X
6BE3◆	6.3	C5	3	14W
19KG8	19.	A127	AC689	48V
		A123	A45	48V
7984◆	12.6	AC1	257	20W
Latest Chart 648-27				

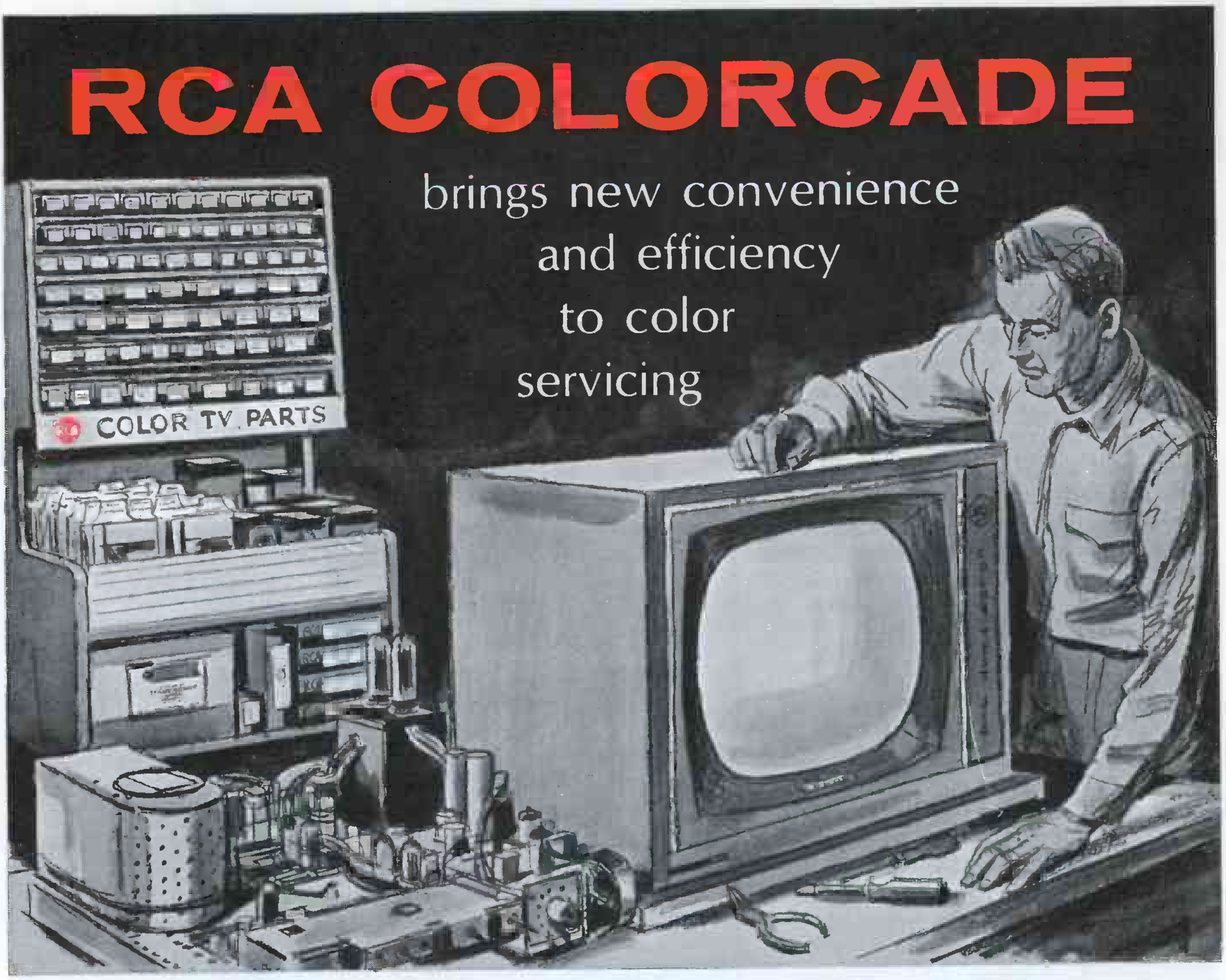
Model 658

Tube Type	Sec.	Heater	Heater H-K	P-G	Plate	Grid Test	Heater Current
6AY11◆	T	6.4K	C6	a50	25Q	5XY•	
	T	"	C3	a49	"	5XY•	
	D	"	C8	7	55U	X	
	D	"	C1	2	"	X	
6BE3◆	D	6.4L	C5	3	18U	V	
19K68	P	22D	127	ac689	40R	15WY•	
	T	"	123	a45	22R	10WY•	
7984◆	P	13.6P	C1	257	11Q	95VY•	
Latest chart 658-6							

Model 598

Tube Type	A.	B.	C.	Fil. Cont.	D.	E.	F.	G.
19K68	19.	4Y	—	5	6	9	7	41
		4	—	—	1	2	—	58
Latest chart 598-4								

SUPPLEMENT TO LATEST ROLL CHART 648-27
658-6



For a limited time only—through June 30—these essential color-TV service aids are available through your participating RCA Parts Distributor *at new prices*, under the RCA "Colorcade" Program. Together they can cut HOURS off color-TV servicing time—add vital profits to your shop operation.

RCA COLOR PARTS, ACCESSORIES AND DISPLAY RACK

A Complete, Self-Contained, Space-Saving Color Service Center

This newly designed rack contains 120 essential parts and accessories for color servicing. Comes with all necessary cables. Organizes color parts into one convenient, efficient color service center. Space-saving design permits mounting on wall or service workbench. Stock No. 11A1014.

POPULAR RCA COLOR TEST JIG

Makes Pulling a Color Set a One-Man Job

With this jig, no longer is pulling in a color set a costly two-man operation. One man alone goes to the customer's home, removes the chassis without the picture tube, and brings it back for testing and alignment in the Color Test Jig. Comes with all necessary components, hardware, and instructions for installation of RCA Color Picture Tube. No need to reconverge customer's set when chassis is returned. Stock No. 11A1015.

For more information, and the name of your nearest participating RCA Parts Distributor, ATTACH COUPON TO A POSTCARD AND MAIL. BUT DO IT NOW. OFFER EXPIRES JUNE 30!

RCA PARTS AND ACCESSORIES, CAMDEN, N.J.

The Most Trusted Name in Electronics

RCA PARTS AND ACCESSORIES
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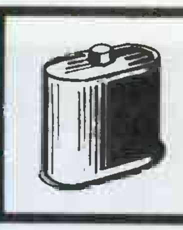
Please send full information on the new RCA "Colorcade" offer, together with the name of my nearest participating distributor.

NAME__________ OCCUPATION__________
COMPANY__________
ADDRESS__________
CITY__________ ZONE____ STATE____

RADIO BATTERY GUIDE



The 23 basic types of transistor-radio batteries listed on this page are a sufficient stock to satisfy most needs of a shop that does a considerable volume of transistor work, or one that sells quite a few batteries to people who come into the shop. Even if you repair transistorized equipment only occasionally, you'll find it helpful to stock several of the most popular types of batteries—marked with asterisks in the chart.

The left-hand column lists the nominal output voltage for each battery. Next come the NEDA numbers, which are general type numbers adopted by the National Electronic Distributors' Association to aid standardization and interchangeability of batteries. Each NEDA number can readily be cross-referenced to the stock numbers used by different manufacturers.

Where multiple listings appear for a given NEDA type and brand of battery, these usually indicate units that have similar size and output, but different chemical makeup. Although the common zinc-carbon "dry cell" is still used most widely, it can be directly replaced with premium-priced types having a longer service and shelf life. Alkaline batteries last several times as long as zinc-carbon types, and mercury batteries last even longer. ▲

Voltage	NEDA	Burgess	Eveready	Mallory	RCA	Ray-O-Vac
1½	* 13	AL2 or 230	A100 or E95	M13R or MN3100	VS336 or VS1336	13
1½	* 14	AL1, 1, or 130	E93 or 635	M14R or MN1400	VS335 or VS1335	14
1½	* 15	AL9, Z, or 930	E9, E91, or 1015	M15R or MN1500	VS334 or VS1334	15
22½	215	U15	412	M215	VS084	215
1½	824	AL7 or 7	912	M24F or MN2400	VS074	400
1½	910	AL-N or N	E90, E401 or 904	M910F or MN9100	VS073 or VS1073	716
1.4	1104	Hg 630	E-630	RM630	VS147	—
1.4	1105	Hg 640	E-640	RM640	VS150	—
4.2	1300	H233	E233	TR233	VS400	—
4.2	*1304	H133 or H133R	E133 or E133N	TR133 or TR133R	VS149	1304M
4.2	1305	H163	E163	TR163	VS163	—
4.5	1306	AL133	E133, 333, or 523	MN1306	VS1149	1304M
5.6	1404	H164	E164	TR164	VS164	—
9	*1600	P6 or PM6	226	M1600 or TR286	VS300A	1600 or 1600M
3, 6, 9	1601	D6PI	2506	—	VS301	1601
9	*1602	2N6	246	M1602	VS305	1602
9	1603	D6	276	M1603	VS306	1603
9	*1604	H146, 2MN6, or 2U6	E146, 216, or 528	M1604, MN1604, or TR146	VS312 or VS323	1604 or 1604M
9	*1605	M6	266	M1605	VS322	1605
9.8	1606	H177 or Y6	E177	TR177	VS309A	1606
9	1608	D6S	2761	M1608	—	1608
9	*1611	H126 or L6	E126 or 206	M1611 or TR126	VS327 or VS328	1611M
9, 13½	1900	XX9	239	—	VS304	1900

*The NEDA numbers having an asterisk are the most often used of the ones listed.

GUIDE TO PROFITS

Quality components are the first, and basic step, in profitable servicing. For resistors, potentiometers and switches always refer to the brand-new 1963 Clarostat Service Components Catalog now available from your Clarostat distributor, or write . . .

CLAROSTAT

MFG. CO. INC., DOVER, NEW HAMPSHIRE

STOP! LOOK! SAVE!

All crystal controlled

A STANDARD COLOR BAR GENERATOR at 1/2 THE COST OF OTHERS

only $99^{50}

the all new SENCORE

CG126 STANDARD COLOR BAR GENERATOR

A standard color bar, white dot, crosshatch generator especially made for field service on color TV . . . and at a great savings to you.

Check these outstanding features and you will see why this generator belongs on the top of your list for color TV servicing.

All patterns crystal controlled offering "rock like" stability. You'll think the patterns are painted on the TV screen.

Simplified operation speeds up every servicing job. Just dial the standard keyed bars, white dots, crosshatch, vertical bars or horizontal bars and watch them "pop" on the screen. That's all there is to it.

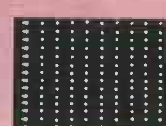
Exclusive adjustable dot size. The white dots can be adjusted to the size that satisfies your needs by a screwdriver adjustment on the rear. No need to argue about dot size anymore. Just select the size that you like to work with best.

Pretuned RF output to Channel 4. Other low channels can be selected if Channel 4 is being used in your area by simple slug adjustment. Patterns are injected directly into antenna terminals, simplifying operation and saving servicing time.

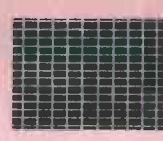
Reserved output on color bars for forcing signal through defective color circuits. The color output control is calibrated at 100 percent at the center of rotation, representing normal output. A reserve up to 200 percent is available on the remainder of rotation.

Smaller and more portable. With color receivers weighing much more than black and white TV, portable equipment becomes essential for home servicing. The CG126 weighs less than 10 pounds and measures only 11" x 8" x 6".

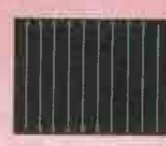
Ten standard keyed color bars (RCA type) that automatically provide all colors at specified NTSC phases . . . but without need of interpretation when servicing.



Stable white dots with new exclusive dot size adjustment in rear.



Stablilized crosshatch pattern for simplifying convergence adjustments.



10 thin white vertical lines for horizontal dynamic convergence adjustments . . . often missing on other generators.

14 thin horizontal lines for vertical dynamic convergence. Also missing on many high priced generators.

March into your local parts distributor and demand the CG126 Sencore color generator that sells at ½ the price of others. Don't let him switch you.

SENCORE

426 SO. WESTGATE DRIVE • ADDISON, ILL.

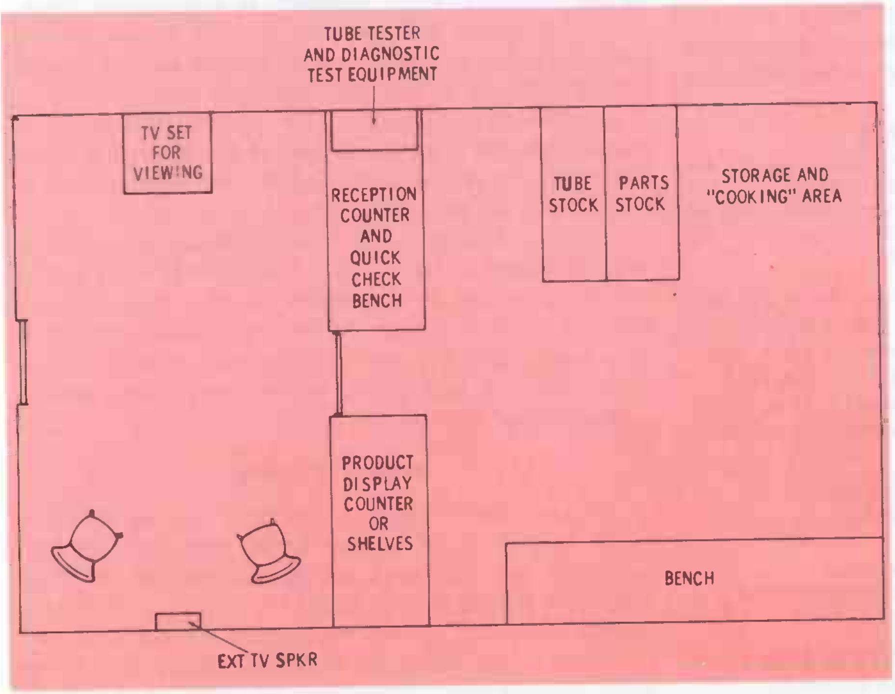
by Thomas A. Lesh

HANDLING *While-You Wait* SERVICE

Is it good business for you to encourage your customers to bring in their own TV sets and other electronic equipment for repairs on a "While-U-Wait" basis? Most servicemen don't seriously consider trying this venture, being daunted (or should we say haunted?) by the image of a customer pacing back and forth across the shop floor. However, the advantages of carry-in service are too great to be passed off lightly, and a "While-U-Wait" approach can help to make carry-in service attractive to customers.

What are the advantages of having equipment brought in to you for repair? Here are a few:

1. Your complete shop facilities are right at hand; you don't have to work within the narrow limitations of the tests you can make in the home. Therefore, you can work more efficiently and spend less total time on each set, passing savings on to the customer.
2. The customer knows your service charge will be materially less than for a home call, and a great deal less than if you had to come out to his home and take the set into the shop. Accordingly, he's more likely to turn his service problems over to you without attempting to find the trouble himself.
3. When carry-in service brings customers to your shop, it exposes them to everything you have on sale. While they are waiting for you to service sets, they will look around, and if they see something they need, they are likely to buy it.



Layout of operational area in one shop offering "while-you-wait" service.

The increasing popularity of portable TV sets is increasing the potential market for carry-in service, and offers an antidote for the injurious idea that professional TV service is pricing itself out of the market. In our present economy, it's reasonable to ask, "Why *would* a consumer call a serviceman to his home, at extra expense, to repair an item that the owner could easily bring to the service shop himself?"

Will They Wait?

Previous experience of shop owners who have tried W-U-W service has shown that 30 minutes is generally the longest period of time a customer should be expected to wait for results. Actually, it should be possible for a competent technician to find a rather high percentage of troubles within that time limit. Remember — carry-in sets, on the whole, will be less difficult to service than conventional "bench-job" sets, because a fair number of those in the carry-in category will contain simple troubles such as bad tubes or broken antenna leads. Even when the trouble is a component failure requiring bench troubleshooting, rapid isolation of the fault is often possible; once this has been accomplished, the customer will be in a better mood to wait awhile longer for actual replacement of the part.

Since even an estimate of the trouble represents some progress, it's best to work toward this goal as speedily as you can. Only those tubes which seem pertinent to the existing trouble should be tested or substituted—at least for the time being—and other routine checking and cleaning operations should be postponed. In many late-model receivers (especially portables), it will be unnecessary to take the chassis out of the cabinet for basic troubleshooting; this in itself can save valuable time at a crucial point in the procedure. Most of the test terminals can be reached with a meter or scope probe as soon as the rear cover has been taken off, even though the actual removal of bad parts may require further disassembly.

Well within the 30-minute period, you should have a pretty clear notion of whether you're going to find the trouble soon. If it looks as if you're in for a fairly long session of troubleshooting, the best policy is to make whatever tests are necessary to get an estimate of the set's condition, and then present the problem frankly to the customer. You can explain that his trouble is somewhat complex, and that you will handle it like a conventional "bench job"; although the only charges will be for bench servicing and parts, these might run somewhat higher than for a simple tube or part replacement. Make a point of saying that you thought you'd better consult with him before proceeding.

A reasonable customer, although he'll be disappointed will probably agree to come back later to pick up the set—he can understand the human limitations on the "While-U-Wait" promise. If a set owner thinks he's being taken, he's welcome to pick up the set and leave; he's out no more money than a modest charge for an estimate, or you may prefer to make no charge at all if that's your policy. The chance of damage to your reputation is no worse than if you'd made a home call at this same character's house, and he'd refused to let you take the set into the shop.

When a customer has brought in an old, decrepit set, and learns he has a fairly serious trouble in it, you can be in an excellent position to offer him a choice between a repair and an on-the-spot trade-in on a new set. Again, the key to handling this situation is to discuss it with him before he has sunk any service-charge money into the old unit.

Proper Pricing

Elimination of delays—nominally the main reason for W-U-W service—is actually less important to most customers than the cash saving they obtain by doing their own pickup and delivery work. The fact is self-evident that the repair work itself would cost just about the same wherever it is performed; and it logically follows that eliminating the serviceman's travel costs must reduce overhead. So, if carry-in service is to

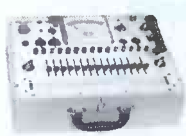
EICO 369 tv-fm sweep & post injection marker generator

With the 369, circuit response is not affected by markers and markers are not affected by circuit response. The 369 feeds only the required sweep signal to the input of the circuit being aligned or tested. At the output end, a demodulator cable picks off the signal and feeds it to a mixer stage inside the generator, where the markers are added. The combined signal is fed to the oscilloscope. This means that circuitry under test or alignment is not affected by the marker signal, and that traps in the circuitry will not reduce or eliminate the marker.

The EICO 369 has a controllable inductor sweep circuit—all electronic, with no mechanical parts to wear and give trouble later. The sweep generator is independent of the marker generator. It has five ranges: 3.5–9 mc; 7.5–19 mc; 16–40 mc; 32–85 mc and 75–216 mc. All five ranges are fundamentals; tuning to the desired center frequency is simplified by a 6:1 vernier dial and a 330° scale. Output impedance is 50 ohms. Retrace blanking is obtained by both direct grid cut-off and indirect B+ cut-off (via the AGC chain) of the oscillator with a blanking tube that conducts during the negative excursion of the 60 cps sine sweep. A three-stage AGC circuit keeps the level of the swept signal constant over its entire frequency range, even when the widest sweep width of 20 mc is being used. A phasing control at the rear of the EICO 369 adjusts permanently the horizontal sweep signal fed to the scope.

The marker generator in the EICO 369 has 4 ranges covering 2–225 mc. The highest range, 60–225 mc, is the third harmonic of the next lower range. All other ranges are fundamentals. Frequency setting is simplified by a 6:1 vernier dial and a 330° scale. As a rapid check of marker generator alignment a 4.5 mc crystal is supplied with each generator. When plugged into a front panel socket it automatically turns on a fixed frequency marker oscillator. The 4.5 mc signal produced by this oscillator is mixed with the variable frequency marker. The 4.5 mc crystal is used also for alignment of sound circuitry in TV Receivers.

The demodulated wave form with the post injected marker is fed to the vertical input of the "scope", and the horizontal sweep to the horizontal input of the "scope" through one shielded two-conductor cable. Separate level controls for trace size and marker size on the front panel can be used independently. Kit $89.95; Wired $139.95



PUT THE BEST ON YOUR BENCH

EICO 667 dynamic conductance tube and transistor tester will earn money for you by catching the bad tubes an emission tester would miss. The EICO 667 combines a mutual conductance test with a peak emission test to give a single reading of tube quality. Bad transistors can be spotted easily. Gain and leakage tests will find the defective ones.

TESTS ALMOST EVERY DOMESTIC OR FOREIGN RECEIVING TUBE MADE. The EICO 667 checks 5 and 7-pin Nuvistors; 9-pin Novars; 12-pin Compactrons; 7, 9 and the new 10-pin miniatures; 5, 6, 7 and 8-pin subminiatures; octals and loctals. It will also check many low-power transmitting and special purpose tubes, voltage regulators, cold-cathode regulators, electron ray indicators, and ballast tubes. And by inserting pilot lamps into the special output in the center of the Novar socket you get an instant good-bad test of these lamps.

TESTS MADE UNDER ACTUAL TUBE OPERATING CONDITIONS. When one section of a multi-purpose tube is being tested, all sections are drawing their full rated current. Pentodes are tested as pentodes rather than combining all the elements for a simple emission check. Leakage between tube elements is read directly on a 4½-inch meter in ohms.

TRANSISTORS CHECKED IN TWO STEPS. First for leakage, then for beta or current amplification factor. Both are read directly off the meter dial and both n-p-n and p-n-p transistors can be checked. Price, $79.95, kit; $129.95, wired.

Tests all Color, B & W CRT's—70, 90 and 110°!

EICO CRU universal crt test adapter—New CRT adapter for models 667 and 628 has 12-pin socket for 70° and early 90° deflection black and white tubes. Three additional back-to-back plug-socket adapters for 7- and 8-pin 90 and 110° and color CRT's. Adaptable to many other tube testers. Wired $9.95

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EICO

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Add 5% in West.

be popular, customers must clearly understand that the basic price for this service is well under that for a service call in the home.

Shops now providing W-U-W service have reported using basic repair charges averaging $3 to $4 for simple jobs that take a half hour or less. Additional work is priced at prevailing bench rates, after the customer has been given an estimate of the probable cost. As in any other phase of service work, it's extremely important to make a realistic estimate, to avoid misunderstandings that grow out of underestimating. Also, if you find you're going over your estimate, consult the customer (by phone, if necessary) before continuing.

As stated above, W-U-W service should be fast, but not so fast the customer might think he isn't getting his money's worth. The public has proved itself quite reluctant to pay a service charge of several dollars when the only "service" is to give the set a quick once over, and change a small plug-in part or tube—taking only ten or fifteen minutes.

It's doubtful if you could overcome this attitude even by cutting your charges to the bone (from *your* point of view). A more successful strategy is to charge a fee that will return a decent profit, and perform enough small extra services to better justify this fee. Just as on home calls, you can clean the safety glass, touch up the service controls, inject fluid into the tuner to clean the contacts, and otherwise put the set in "shipshape" condition.

Since you're in the shop when you're dealing with a W-U-W customer, you're well situated to carry this final touch-up a step further. Your theme in impressing this customer: "While the set's right here in the shop, I'll be able to make some special tests (included in my regular service, of course) that will help guard against further trouble." Your best tube tester is right at hand, so you can accurately check the remainder of the tubes in his set after finding the original trouble. If he can watch, he probably won't even think of the time it takes, and you'll often sell additional tubes as preventive maintenance. You might even land a CRT-replacement job, either by using a tester or by making a demonstration with a check tube. Voltage and waveform checks at certain key points (B+, sync input and output, horizontal drive, etc.) can help you forewarn him of troubles just beginning, so you can let him make the decision of catching them immediately or waiting for further developments.

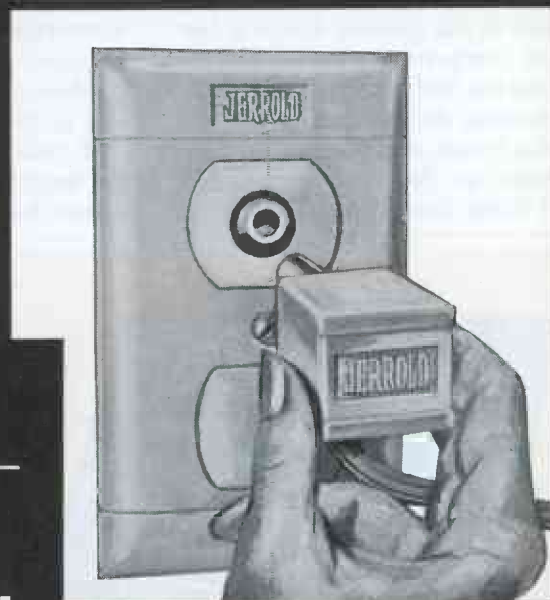
Shop Facilities

Setting up for W-U-W service imposes no great demands for elaborate shop arrangements, but there are a few particular features that will notably improve your handling of this service.

There should be a comfortable waiting area for as many customers as you expect to have in the shop at one time. To keep them occupied during bench work on their sets, it's a good idea to have an operating TV set located where they can watch it. (If you sell sets, this is a good chance to demonstrate what the latest models can do!)

The front counter should have somewhat more elaborate facilities than in the usual shop for "checking in" receivers that are carried in. It should be convenient to disassemble the set at least partially in this spot. (A vacuum cleaner or other

from JERROLD,
the world leader in master-antenna systems



...a revolution in
TV/FM distribution systems—
ALL NEW FROM ANTENNA TO OUTLET!

Always the innovator, always the source of improvements in master-antenna technology, JERROLD now goes another giant step ahead with this radically new signal-distribution system equipment tailored to your motel, hotel, and apartment-house market.

Here, for the first time, is an antenna designed specifically for a master-antenna system—the new "J"-series extra-heavy-duty Jerrold-TACO cut-to-channel yagis. Built to last as long as the system, these new, rugged high-gain antennas feed a selection of four exciting new high-output broadband amplifiers with per-channel outputs (for 7 channels) of 0.2 to 1 volt at 0.5% cross modulation.

We've even given a new look to the individual room outlets, and the result is the beautiful yet durable and versatile Ultra-Tap, which delivers TV and FM signals through Jerrold's new 300-ohm or 75-ohm plug-in connectors.

In short, everything—from antenna to outlet—has been designed *as a system* to help you sell your share of the booming TV and FM market in motels, hotels, hospitals, and multiple dwellings. See your Jerrold distributor for full details.

JERROLD ELECTRONICS
A subsidiary of THE JERROLD CORPORATION

Distributor Sales Division, Philadelphia 32, Pa.

chassis would be extremely useful here.) A tube tester should be within easy reach, as should an extensive stock of tubes and other often-needed replacements. Time can be saved on many jobs by having basic test instruments for diagnosing troubles—VTVM, scope, and DC power supply, in particular—permanently located at the counter. Quite a few simple component troubles can be intercepted and repaired here without hauling the receiver back to the regular bench, thus creating less disturbance to the more complicated work being done there.

Much of the preliminary disassembly and testing work can be done while the technician remains in conversation with the customer, and this period can be used to advantage to learn more about the trouble. The kind of customer who has enough "savvy" to bring the set in for service is likely to have made some worthwhile observations of the set's behavior, and will probably be highly pleased that you give consideration to his judgment.

If routine testing fails to locate the trouble, the set may then be moved back to the regular bench. A type of bench construction using roll-out sections (see "Blueprints for Service Benches" in the June, 1962 issue) can expedite W-U-W service by making it easier to transport partially disassembled sets around the shop.

The main parts stock for a W-U-W shop should be somewhat more extensive than for the usual shop, unless delivery service by the local distributor is exceptionally fast. Precious minutes can be saved, and more customers better pleased, by having a good selection of the rarer tubes and fuses; also, it may pay to keep an assortment of such parts as vertical output transformers and built-in antennas for popular models of portable TV.

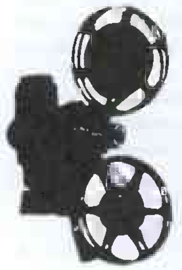
Promoting While-U Wait

When you decide to encourage W-U-W work, promote it by featuring it prominently in all your advertising. Besides the usual ads, why not try an informational leaflet (for direct mail, handbill, or counter-display distribution) giving pointers to customers about bringing in their sets for service?

For example, you could include a list of simple conditions to check before hauling in the set; this could relieve many people of the exasperation of making an unnecessary trip because they failed to notice a blown house fuse, network trouble at the TV station, or other outside causes of trouble. Another helpful hint would be to caution owners of portable sets against resting the CRT safety shield on the seat of the car during the trip to the shop: (Unless a protective cover is provided, some types of plastic or fiber seat covers can badly mar the soft plastic shields used on many portables.) To summarize the contents of the leaflet, it should convey the message, "You can save money by bringing your TV and radio sets to *us* for service; here's how you can bring them safely."

If you've been hunting for ways to strengthen your competitive advantage in the TV service business (and who hasn't?), stop and ask yourself for an honest answer to this question: Do you have what it takes to furnish the attentive, efficient service that qualifies as "While-U-Wait"? If you feel you do, by all means try it—it's unbeatable. ▲

Preview & Review of Mosley's Citizen Band Antennas



SCOTCH-MASTER

UL-27 For Citizen Band operation, the Uni-Linear tops Mosley's New Scotch-Master Line. The UL-27 is an Omni-Directional Vertical Ground Plane Antenna which "overshadows" all other antennas of similar type available today. . . Because of an extreme low angle radiation. A completely revolutionary matching system, featuring Grounded Element for lightning protection and drastic reduction of Rain Static Noise. These superior features combined with the world famous Mosley Construction assures the CB'er of an outstanding antenna for dependable communications

SPECIFICATIONS AND PERFORMANCE DATA: Gain over standard ground plane up to 4Db. VSWR: 1.5-1 over entire band. Feed Point Impedance: 52 ohm coax Unbalanced line. Assembled Weight: 8 pounds. Wind Load (EIA STA): 50 pounds. Antenna Height: Less than 20 ft. Number of Radials: 3. Antenna mounting fits masts up to 1½ inches.

LIST PRICE $45.80

A-311-S Mosley A-311-S, 3 element beam is designed for the economy minded CB'er who wants the utmost in dependable two-way communications. Mosley A-311-S offers excellent front-to-back ratio, maximum gain, yet has unmatched quality found only in a Mosley Beam.

SPECIFICATIONS AND PERFORMANCE DATA: Number of Elements - 3. Antenna Weight - 12.5 lbs. Boom Length - 12 ft. Maximum Element Length - 18' 8¾". Front-to-Back - 20 db. Vertical Wind Load - 65 lbs. Horizontal Wind Load - 35 lbs. Forward Gain - 8 db. Type Matching - Gamma. Impedance Point - 52 ohms. Radiation - Uni-Directional.

LIST PRICE $46.68

A-511-S Mosley A-511-S, the big brother to the A-311-S, has 5 elements wide spaced on a 24 foot boom and offers a perfect Uni-directional pattern with excellent Front-to-Back Ratio and Forward Gain. Here is the ultimate in beams for the economy minded CB'er looking for the best communications.

SPECIFICATIONS AND PERFORMANCE DATA: Number of Elements - 5. Antenna Weight - 16.5 lbs. Boom Length - 24 ft. Maximum Element Length - 18' 8¾". Front-to-Back - 20 db. Vertical Wind Load - 112 lbs. Horizontal Wind Load - 62 lbs. Forward Gain - 9.5 db. Type Matching - Gamma. Impedance Point - 52 ohms. Radiation - Uni-Directional.

LIST PRICE $73.35

DELUXE LINE

A-311 In the Deluxe Line, Mosley offers the A-311, 3 Element Beam for best point-to-point communication. FCC regulations limit actual power input of Citizens Band transmitters to 5 watts. Use a Mosley A-311 Beam Antenna to achieve a legal effective power input of 40 watts!

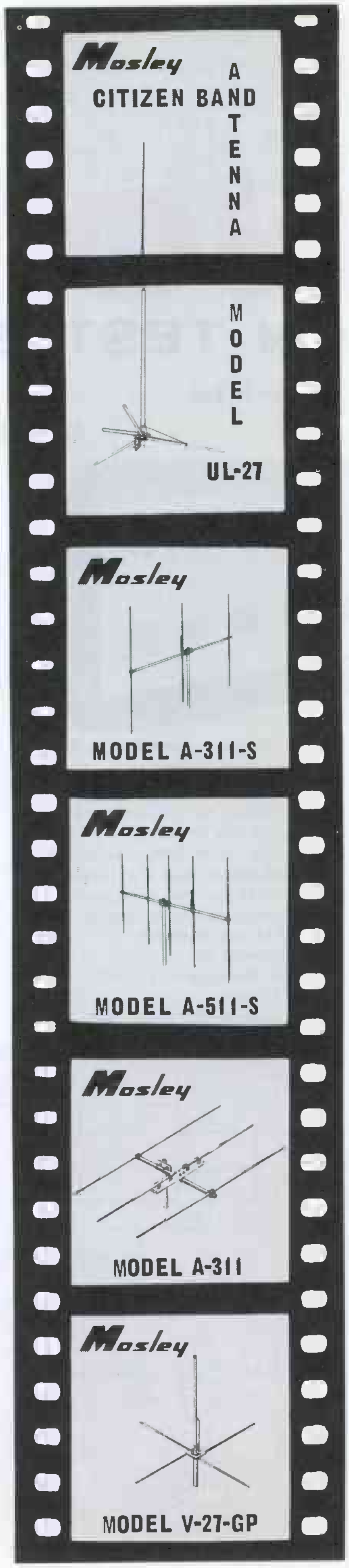
SPECIFICATION AND PERFORMANCE DATA: Boom Length - 12 ft. 1¼ OD X .058" wall. Element Extensions - 5/8" OD X .035" wall. Center Elements - 3/4" OD X .058" wall. High-impact Polystyrene Clamping Blocks. All Aluminum 6061 - T6. Wind Load - 78 lbs. Maximum Turning Radius - 9.5 ft.

Beams can be turned with heavy duty TV rotors in communication circuits comprised of more than two stations. NOTE: 9 db signal gives a power gain of approximately 8.

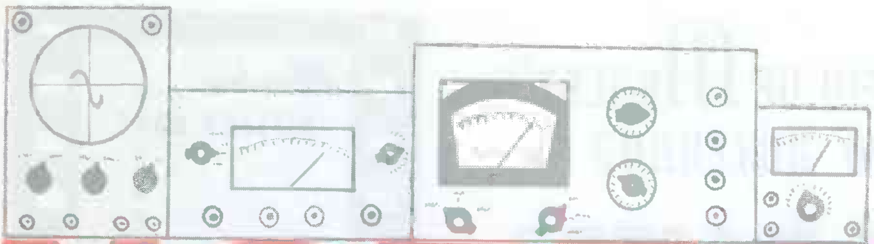
LIST PRICE $53.00

V-27-GP The Mosley Ground Plane Vertical, Model V-27-GP, is ideal as a base station antenna. 360 degree pattern is attained and vertical polorization for effective communication with mobiles. Entire Antenna is grounded for lightning protection and improved signal to noise ratio. "Cycolac" Base with internal coax fitting. Vertical Tube - 7/8" X .058" X 9'. Gamma Connection extends from Base to 2½ ft. above Base. 4 Radials or Ground Plane measure 3/4" X .035" X 9'. SWR - 1.2 (approximately).

LIST PRICE $45.87



Mosley Electronics, Inc. 4610 NORTH LINDBERGH BLVD. BRIDGETON, MISSOURI



NOTES ON TEST EQUIPMENT

by Forest H. Belt

Simplified Color

Fig. 1. Simple operation is keynote of this new color-circuit analyzer.

The trend in modern test equipment is to simplicity of use, and an excellent example of this tendency is pictured in Fig. 1—the SENCORE Model CA122 Color Generator. With a picture-window function indicator and a single-cable RF output connection, this instrument is characterized by easy operation.

Specifications are:

1. *Power Required—117 volts AC; 60 cps; 55 watts.*
2. *RF Output—50 to 90 mc, continuously variable, covering channels 2 through 6; 20 to 50 mc, continuously variable, for injection into IF stages; four output levels: 1, 2, 10, and 100 mv rms; output cable impedance 93 ohms, with 300-ohm termination; unmodulated sound carrier displaced 4.5 mc from video carrier.*
3. *Video Patterns—Convergence signals consisting of 140 white dots, 10 vertical or 14 horizontal lines, or crosshatch of 10 vertical and 14 horizontal lines; shading-bar pattern with three shades of brightness; output level variable from 0 to 30 volts peak to peak, positive or negative; output impedance 5000 ohms; all video patterns also modulated on RF carrier.*
4. *Color Signals — Keyed-rainbow pattern, generated by offset-carrier method, consisting of 10 color bars.*
5. *Other Signals—Combined horizontal and vertical sync, variable from 0 to 30 volts peak to peak, positive or negative; 900-cps audio signal, 3 volts peak to peak.*
6. *Controls and Terminals—*PATTERN ADJUST *rotary switch and indicator; three* COLOR GUN INTERRUPTOR *slide switches; variable* TUNING *control, with concentric RF-IF switch; switch-type* OUTPUT *level control;* CHROMA, VIDEO, *and* SYNC *level potentiometers;* OFF-STANDBY-ON *slide switch; 4.5-*MC *slide switch;* GND, AUDIO, VIDEO, SYNC, *and 4.5-*MC *pin jacks; service adjustments on rear apron.*
7. *Other Features — Separate color-gun killer cable; rear compartment for cable storage; picture-window indicator on front panel shows pattern being generated; carrying handle for portability.*
8. *Size, Weight, Price — 9½" x 14" x 7⅜"; 15 lbs; $187.50.*

The Model CA122 provides, in addition to the patterns usually furnished by color-bar generators, signals for injection into any section of a television receiver, including the sound, sync, and IF stages. By furnishing signals at these various frequencies and output levels, the instrument serves as more than a mere color-bar generator; it is a television pattern generator that can be used for troubleshooting any section of a color or monochrome receiver.

Fig. 2 shows how the patterns are developed in various stages of the instrument. Instead of the usual blocking-oscillator frequency dividers, multivibrators are used in the "countdown" circuits that develop the several pulse signals from the 189-kc crystal-controlled master oscillator. The simplicity of the CA-122 is characterized by the use of only four countdown stages, considerably fewer than in most other dot-bar generators presently available.

By tracing the operational signal paths, you can easily observe the method of producing each output signal. For example, the audio output signal is taken from a 900-cps multivibrator—a 15-to-1 countdown circuit fed from a 13.5-kc multivibrator; the latter stage is controlled by the 189-kc master oscillator.

The horizontal and vertical sync signals are taken from similar divider multivibrators. The 60-cps sync signal is divided from the 900-cps stage, and the 15,750-cps (15.75-kc) pulses are taken from the 189-kc master oscillator through a 14-to-1 countdown stage. Both signals are fed to a sync amplifier-mixer stage, whose output is fed to the video amplifier-mixer. The combined sync signals are also coupled through the SYNC control to a pin jack for external use (to control a scope, or for some similar purpose).

The line and crosshatch patterns are developed in the pattern switch by selecting the 189-kc pulses for vertical lines, the 900-cps signal for horizontal lines, and combining both for the crosshatch pattern. Dots are formed by producing a crosshatch pattern and clipping the lines wih a diode, leaving only the dots at the intersections.

A color-bar pattern is produced by coupling a 3.56-mc signal into the pattern-signal mixer through the pattern switch. This crystal-controlled signal is offset exactly 15,750 cps from the 3.58-mc reference oscillator used in color TV

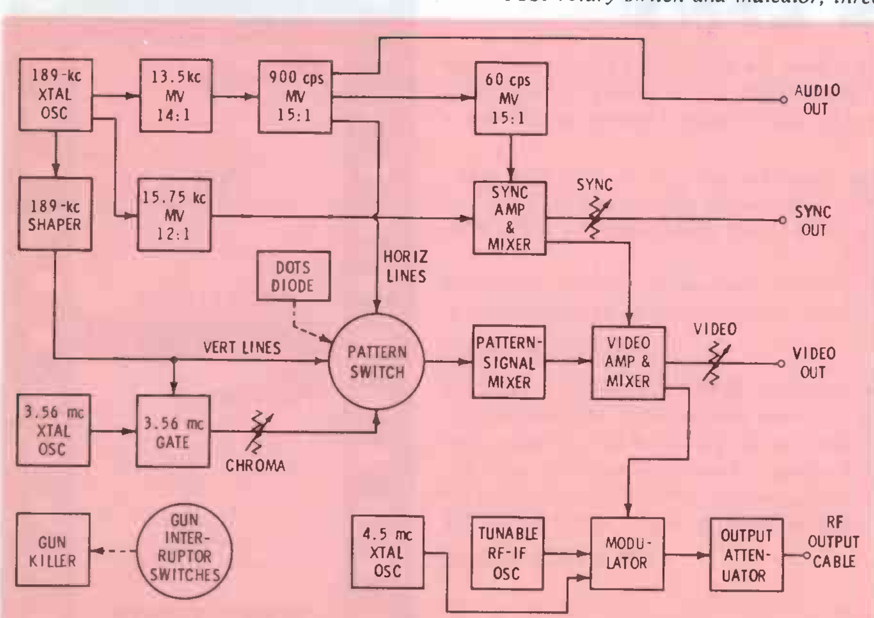
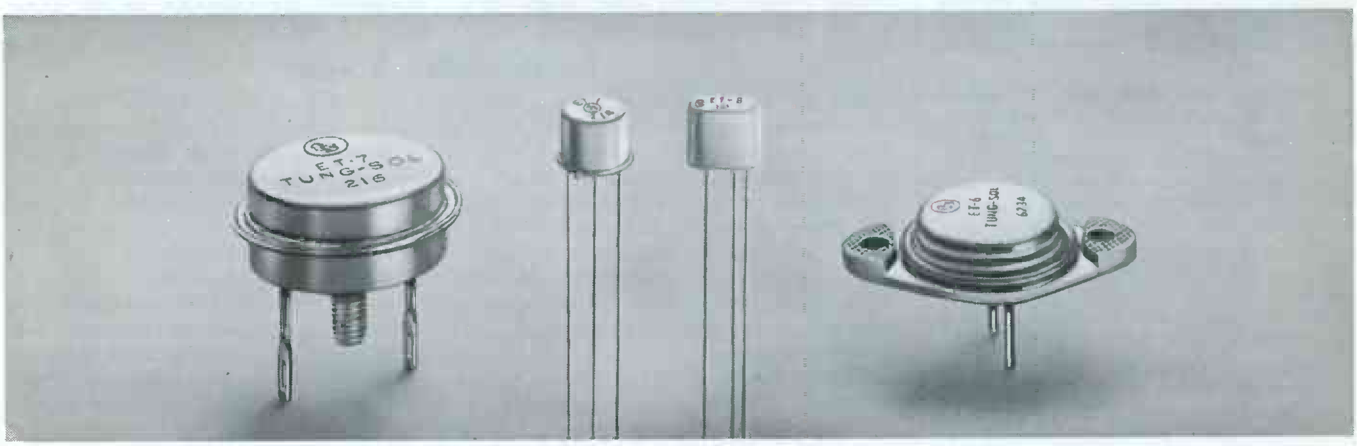


Fig. 2. Unusual design makes use of multivibrators for dividing frequencies.

THREE REASONS WHY TUNG-SOL ET TRANSISTORS ARE YOUR BEST REPLACEMENT LINE

1. COMPLETE SERVICE NEEDS

2. EASY PRODUCT SELECTION



3. TUNG-SOL RELIABILITY

You can make almost all radio transistor replacements from these twelve Tung-Sol types. In addition to part number, packages are marked with type of service. All units are the equivalent of the original part and are products of American plants. The ET transistor line reflects the same quality standards that have made Tung-Sol the leading independent tube manufacturer. Tung-Sol Electric Inc., Newark 4, N. J.

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receivers; when these two signals mix in the receiver, a rainbow CRT display is produced. The gate stage used in the Model CA122 "keys" the 3.56-mc color signal into segments equivalent to 1/12 of each horizontal scanning line, forming color bars at exact 30° intervals. Thus, the name "keyed rainbow" is applied to this type of color presentation.

All patterns formed by the pattern switch, and combined in the pattern-signal mixer, are fed to the video stage where the deflection sync is added. The composite video signal is coupled through an attenuator control to the VIDEO pin jack, for direct injection into video stages of a TV receiver whenever troubleshooting calls for such a connection.

The video signal is also fed to the modulator stage for mixing with the RF (or IF) carrier that is generated by the tunable oscillator. An unmodulated sound carrier is produced by mixing the signal from a 4.5-mc crystal oscillator with the tunable carrier, thus adding a sound carrier just 4.5 mc away from the video carrier.

The modulated RF signal is coupled into a step-type attenuator stage; thus the output level can be adjusted so as not to overload the receiver being tested. In fact, the OUTPUT switch on the front panel of the instrument is labeled with the point of signal injection, rather than in millivolts of signal. Accordingly, if troubleshooting procedure indicates signal injection at the last IF stage of a receiver, the OUTPUT switch would be set at "3rd IF Grid." For feeding a signal into the tuner of a receiver, the switch would be set for "RF."

We found the CA122 useful for troubleshooting monochrome receivers as well as for its primary purpose of testing color sets. The video patterns made tracing trouble in the video stages—or at the CRT—possible, while the sync

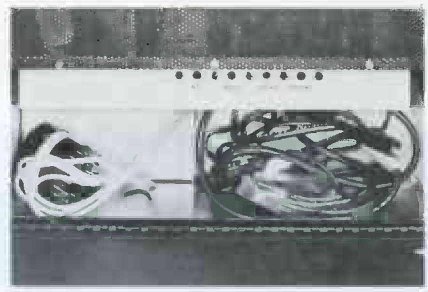

Fig. 3. Storage compartment at rear.

and audio outputs were equally suitable as injection signals in both color and monochrome sets. Although the sound carrier isn't modulated, it can be used for adjusting sound traps in video and chroma circuits, as well as to check the sound IF adjustments in any receiver.

Servicing adjustments are easily accessible at the rear of the instrument with the storage-compartment door open, as shown in Fig. 3. The only adjustment that is likely to need touching up is the 15.75-kc potentiometer, which controls the horizontal sync of the instrument. The best method of adjusting this stage is to tune in a station signal on a TV receiver, feed in a signal from the CA122, and adjust the potentiometer until the CA122 pattern locks in horizontally with the station signal. The stability of the unit is such that other adjustments will seldom be necessary.

The instruction manual for the Model CA122 is in two sections. The first is shipped with the unit, and contains general information on how to operate the unit; the second part is sent on request, and consists of circuit and maintenance data along with detailed troubleshooting procedures for both major color TV chassis. Explanations are also included to help the instrument user understand more completely the operation of the latest color TV circuits.

Combination Scope

For the technician who needs a general-purpose scope that combines minimum phase distortion with maximum linearity, the EICO Model 427 DC-AC Oscilloscope (shown in Fig. 4) fills the bill. Phase distortion is reduced by the use of DC coupling throughout the vertical amplifier, and linearity is assured by push-pull operation all the way from the input to the deflection plates.

Specifications are:

1. *Power Required—105-125 volts AC; 60 cps; 55 watts.*
2. *Vertical Amplifier — Frequency response, flat from DC to 500 kc, down 6 db at 1 mc; sensitivity 3.5 mv rms (10 mv peak-to-peak) per centimeter of deflection; input loading, 1 megohm shunted by 30 mmf.*
3. *Horizontal Amplifier—Frequency response, flat from 2 cps to 450 kc; sensitivity 180 mv rms (500 mv peak-to-peak) per centimeter of deflection; input loading, 10 megohms shunted by 40 mmf; positioning permits centering any portion of trace expanded to twice the CRT diameter.*
4. *Sweep Ranges—10 cps to 100 kc in four ranges; preset TV vertical and horizontal positions; internal or external sync; retrace blanking.*
5. *Cathode-Ray Tube—5DEP1, 5" face, green trace; covered by green graticule marked in centimeters.*
6. *Controls and Terminals —* INTENS, FOCUS, ASTIG, *and* PHASE *(with power switch) potentiometers;* VERTICAL *and* HORIZONTAL *concentric dual potentiometers for* GAIN *and* POSITION; SWEEP VERNIER *potentiometer;* SWEEP SELECTOR, VERT ATTEN, *and* SYNC SELECTOR *rotary switches;* DC-AC *(input) slide switch;* VERT INPUT, SYNC/HORIZ INPUT, *and* SAWTOOTH *binding-post terminals; neon pilot lamp;* DC BAL *screwdriver adjustment; on rear apron:* INT MOD *and* DIR *pin jacks,* DIR-AMP *slide switch, and fuse holder.*
7. *Size, Weight, Price—12½" x 8½" x 16½"; 26 lbs; $109.95 wired, $69.95 in kit form.*

The Model 427 is different from many service scopes in its use of push-pull, DC-coupled vertical amplifiers; most


RAY-TEL 3

Fig. 4. This scope can be used for either AC or DC circuit measurement.

scopes use the push-pull arrangement only for the output stage. The design of this instrument permits the functional advantages of a DC scope to be combined with the operational advantages of an AC scope by providing direct input coupling as well as coupling through a DC-blocking capacitor—hence the term "DC-AC" scope.

Fig. 5 shows, in greatly simplified form, the operating schematic of the instrument. The vertical input signal—from the equipment being tested—is fed into the input attenuator, which is set for the maximum signal that will be applied to the scope; the attenuator reduces the signal voltage to an amount that won't overload the amplifier.

The input connections to vertical amplifiers A and B are such that the signal is developed in push-pull between the two grids; the vertical gain depends on how much of the signal is applied to input amplifier B. The push-pull signal is amplified and fed—across the DC BAL and VERT POS controls—to push-pull cathode followers. These, in turn, feed the output stages, which drive the deflection plates of the CRT. The capacitors shown between the output stages are for neutralization; one is connected from the plate of A to the grid of B, and the other from the plate of B to the grid of A.

The horizontal amplifier consists simply of a cathode follower and a push-pull output stage. Neutralization is used in this stage, just as in the vertical amplifier, to improve linearity and prevent parasitic oscillation. The horizontal amplifier receives its signal via the horizontal selector switch from either the horizontal input jack or the sweep generator.

Synchronization signals are chosen by the sync selector switch from any of several sources: from vertical output stage A or B (a sample of the input signal); from the external SYNC IN jack; or from the 60-cps filament source (not shown). All sync signals are fed to a sync amplifier and limiter; the amplifier builds up weak sync voltages sufficiently to control the sweep generator, while the limiter prevents large sync signals from "swamping" the generator stage.

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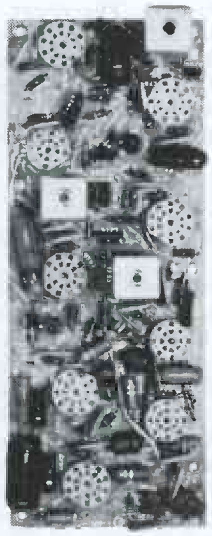

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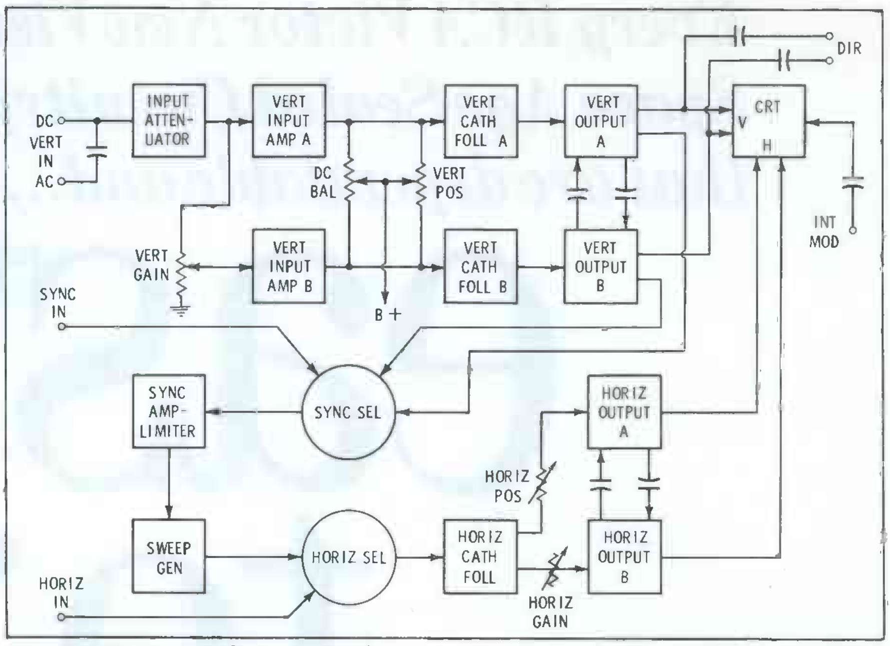


Fig. 5. Direct coupling is used in every stage of the vertical amplifiers.

A pin jack at the rear of the scope permits applying a signal to intensity-modulate the CRT (Z-axis modulation), while a pair of pin jacks and a slide switch provide for connecting a signal directly to the vertical deflection plates (such as for monitoring transmitter modulation).

Putting the Model 427 to work in our lab, we soon discovered the operating controls to be convenient and precise. Having the astigmatism control on the front panel made adjustment easy, although it rarely needs readjusting, once it is set. The vertical centering control is very fast-acting, requiring that care be used during positioning adjustments to prevent the trace from moving completely off-screen. The preset horizontal and vertical TV sweep settings in the unit we tested were very close to optimum, eliminating the troublesome need for resetting the vernier each time we switched from one to the other.

The vertical attenuator is marked in volts per centimeter, and is meant to be used with the centimeter markings on the graticule included with the instrument.

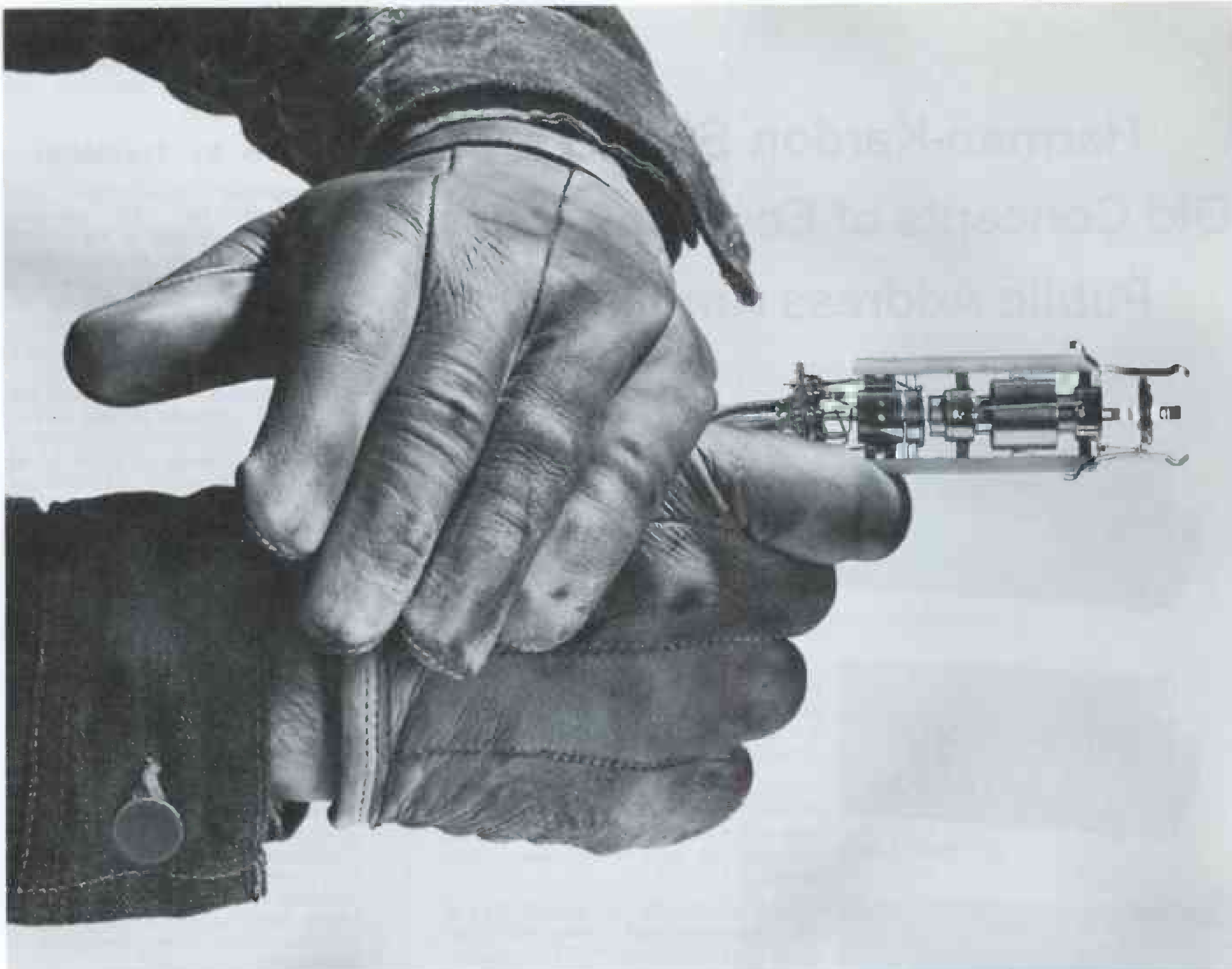
The instruction manual recommends setting the 40-mv internal calibration standard to fill four divisions, which results in a full-screen (10 centimeters) reading of 100 volts at the highest attenuator setting. This is okay when you're using the scope for AC-only measurements; but it could cause some inconvenience with DC measurements, since many TV test points present DC voltages well in excess of 100 volts. We obtained better results by calibrating the scope to two divisions instead of four; by so doing, we increased the full-scale reading to 200 volts (each centimeter equaling 20 volts on the highest attenuator setting). For DC levels above 200 volts, we still had to decenter the sweep a certain amount, but we found it wasn't absolutely necessary to recalibrate for these higher voltage ranges since they weren't quite so common.

In using a DC scope such as the Model 427, you will sometimes find the signal voltage very small in comparison with the DC level; an attenuator setting that keeps the DC reading on screen makes the signal waveform too small for convenient analysis. The Model 427 has the answer to this problem built right in: the DC-AC switch. Once the DC voltage level has been checked, you can flip the switch to AC, and change the attenuator setting to inspect the signal waveform in greater detail.

Another useful feature of the 427 is the sawtooth output on the front panel. Many technicians use the "ringing" technique of checking and testing flyback components; if a 100-mmf capacitor is connected at the SAWTOOTH jack on the Model 427, the unit makes an excellent source of ringing voltage—see Fig. 6.

Although the fast rolloff in frequency response above 500 kc makes the Model 427 unsuitable for work in chroma circuits of color receivers, the bandwidth is plenty wide for audio, ultrasonic, and monochrome-TV servicing. The instru-

Fig. 6. Special hookup for ringing.



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G-E "SG" straight gun picture tubes* do away with ion traps. No fuss, no call-backs. A G-E "SG's" rugged gun fires electrons with uncanny precision straight at the aluminized phosphor screen — assuring sharply resolved pictures up to 80% brighter. How's that for *"Accent on Value"?* These features save your time and give your customers thousands of hours of viewing pleasure.

And that's not all the value accents you get with these "straight shooters." A single G-E "SG" picture tube replaces as many as twenty other types, bent gun or straight gun — the types that get "trapped." In fact, with only 25 G-E "SG's", you're ready to replace *250* other picture tube types. You'll serve customers faster—and say *good-bye* to emergency pick-ups and the ion trap nuisance.

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ment makes an excellent second scope for the larger shop that keeps a wide-band scope for color servicing, and a fine first scope for the shop that isn't doing color work yet.

Microvolts by Transistor

A completely transistorized field-strength meter for VHF television measurements is pictured in Fig. 7—the *Benco* Model FSP-3 by Blonder-Tongue. The unit makes possible readings in actual microvolts, rather than in the relative terms normally offered by field-strength meters used for television work.

Specifications are:

1. *Power Required — Self-contained battery supply consisting of eight mercury cells; current consumption, 17 ma.*
2. *Frequency Coverage — From 52 mc to 200 mc; TV picture and sound carrier frequencies marked on dial; selectivity, all spurious responses down 80 db beyond 4.5 mc from chosen frequency.*
3. *Field-Strength Microvoltmeter—From 5 uv (minimum readable) to 3000 mv of RF signal in 10 ranges; voltage ranges chosen by switching attenuators into signal circuit; VSWR, better than 1.2; input impedance 75 ohms (300 ohms with special connector); accuracy within ± 2 db.*
4. *RF Wattmeter — Requires special power-measuring adapter; from .25 micromicrowatts (minimum readable) to 10 watts, in 10 ranges.*
5. *Modulation Meter — From 0 to 5% and from 0 to 50%; reads AM or sideband modulation only.*
6. *Panel Meter — face size 4½"; scales for microvolts, watts, dbmv, and % modulation.*
7. *Controls and Terminals — On front panel: five latching-type attenuator push buttons; BNC-type* INPUT *connector,* PHONES *jack; 4½" semicircular frequency dial; on end panel:* TUNING *knob; function switch;* SENSITIVITY *control;* BAT SET *control;* % MOD SET *control.*
8. *Size, Weight, Price — 7¾" x 11¼" x 5¼"; 10 lbs; $405.00.*

The Model FSP-3 is an accurate signal-measuring device that combines the low power drain of transistor circuitry with the portability of a self-contained power supply. The unit can be used with any transmitted signal that falls within its frequency range—television, FM, or commercial two-way. The several volt, millivolt, and microvolt ranges make it possible to use the FSP-3 in almost any type of signal area, from within a few feet of a two-way

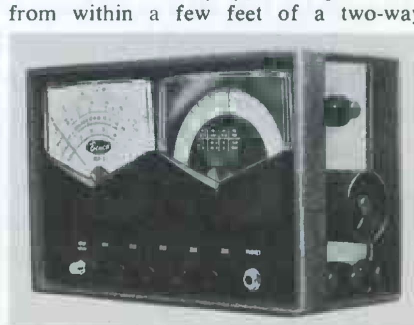


Fig. 7. Accurate field-strength meter.

The Electro-Voice Model 642 Cardiline Microphone Earns

THE FIRST ACADEMY AWARD FOR MICROPHONE DESIGN IN 22 YEARS!

Model 642
$390.00 list

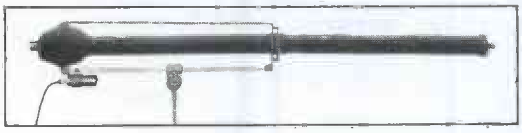
Today's movies, radio, TV and recordings sound better, thanks to a microphone design that has revolutionized sound pickup techniques. It is the Electro-Voice Model 642 Cardiline® ultra-directional microphone.

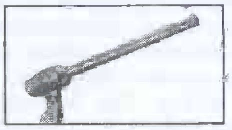
The E-V 642 has contributed so much to motion picture sound that on April 8, 1963 it was presented the coveted Academy Award certificate by the Academy of Motion Picture Arts and Sciences—the first such award to a microphone in 22 years!

Film sound engineers found the unique 642 Cardiline design sharply reduced effects of noise and distance. They obtained clear, crisp sound under circumstances previously thought impossible.

The 642 is another major achievement by Electro-Voice in the art and science of electro-acoustics. This engineering leadership extends equally to professional and commercial sound, home high-fidelity recording and reproduction—even to phonograph needles and cartridges.

No matter what your interest in sound, look to Electro-Voice for the consistently superior engineering that means award-winning performance for you.





The E-V Cardiline* principle is also found in the famed 7-foot long E-V Model 643 ($1,560.00) and the popular Model 644 for critical commercial sound installations ($110.00.) All prices list, less normal trade discounts.

*T.M. Reg., Patents Applied For

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transmitter to many miles from a high-powered television station.

Uses for the field-strength readings of the Model FSP-3 are numerous. Just a sampling of these are: making antenna radiation-pattern measurements; checking the effectiveness of transmitter or antenna tuning adjustments; taking field measurements for the "contours" of a transmitter's service area; using relative readings to locate the best spot for, or to orient, a receiving antenna; or to determine the most effective receiving antenna for a given location. Many other uses will suggest themselves to the imaginative service technician.

The unit consists essentially of a tunable VHF receiver, shown in block form in Fig. 8. The signal is applied to an attenuator which, by controlling the amount of signal voltage applied to the receiver stages, determines the voltage ranges that will be indicated on the panel meter. Past the attenuator section, the instrument resembles a small, transistorized superheterodyne receiver, except for a special feedback-stabilized IF strip. This controlled-gain IF strip assures the accuracy of measurements by equalizing the overall sensitivity of the unit for almost all operating conditions.

The detector is an ordinary diode. The direct accuracy of the instrument is attained only with CW signals, since the detector is a quasi-peak type that clips peaks from the signal; for television signals, the meter readings are about 3 db lower than the true effective signal strength. The demodulated signal is fed to a metering circuit either directly, or via an amplifier, depending on the setting of the function switch. The amplifier system is used in the modulation-measuring function of the instrument, enabling the metering circuit to indicate the modulation percentages of the incoming signal.

The attenuators, singly or in groups, insert fixed amounts of attenuation between the RF input jack and the tuning circuits. Any multiple of 10 db of attenuation can be inserted at will by depressing the proper combination of push buttons. A small chart, printed on the plastic cover of the tuning dial, shows which microvolt scale of the meter corresponds with each attenuator setting; thus, the full-scale meter reading for each degree of attenuation can be easily determined.

The FSP-3 can be used for field-strength surveys with any type of transmitter within its frequency range. Most commonly, surveys of this nature are necessary for FM and television broadcast stations, although communications technicians frequently have occasions when such a survey might help solve a service problem (such as determining if a receiver is being desensitized by RF noise). For field-strength measurements, best results are obtained if a dipole, resonant at the transmitter frequency, is used for signal pickup. The instruction manual gives directions, with dimensions for various frequencies, for constructing a dipole (see Fig. 9) that will serve the purpose well.

Technicians who install and maintain

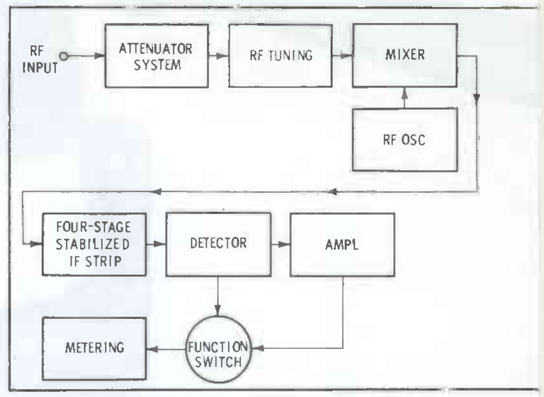

Fig. 8. Instrument is special receiver.

master- or community-antenna television systems will find the FSP-3 very useful to adjust and balance the master amplifiers for consistent signal strengths throughout the system. For example, a certain level of signal voltage should be found at each outlet; the FSP-3 will indicate whether the signal is sufficient (or too great). The master amplifier must be adjusted to compensate for loss differences (between high and low channels) in transmission lines; for this purpose, the FSP-3 can be used to set the "Tilt" control of a broadband amplifier with ease. Even finding the most effective location for the antenna or antennas can be the result of careful surveying with the field-strength meter. Sometimes the level of signal found will dictate the choice of antenna types.

We used the FSP-3 to test the distribution system that serves our lab. This system is fed from an outside antenna, and from a closed-circuit color-television transmitter. Having been troubled with RF interference on one channel, we made use of the FSP-3 to help identify the source. By using a set of headphones, we were able to identify the interference as crosstalk from a nearby television station. A trap filter blocked the unwanted signals from the troubled channel and solved the problem. The same technique can be used to locate, identify, and eliminate interference from other RF sources—such as ham operators, CB transmitters, or commercial two-way stations. ▲

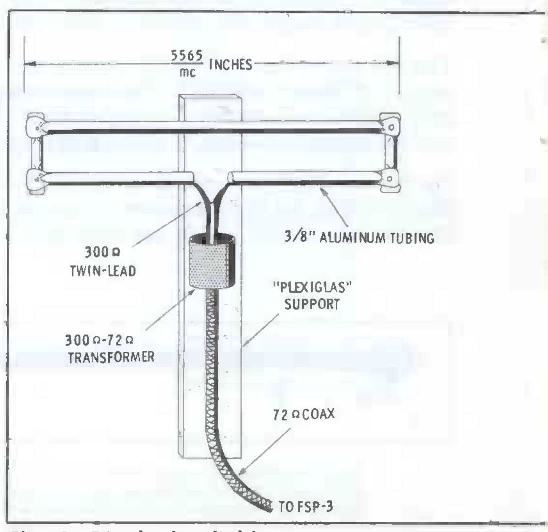

Fig. 9. Dipole for field measurements.

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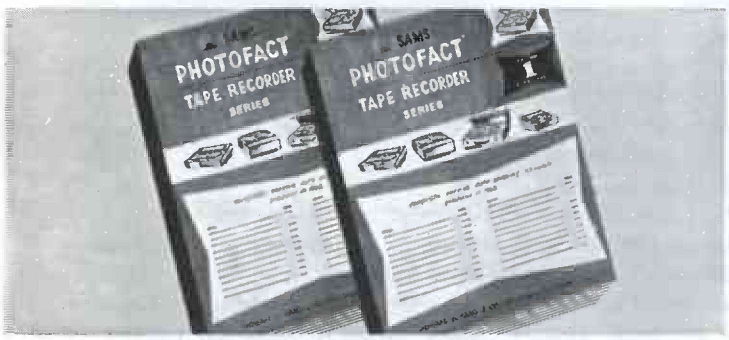

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Troubleshoot Transistors

(Continued from page 31)

ods. The first is that of opening the emitter lead and noting any change —or lack of it—in the input current. If no shift appears, the disabled transistor is probably inoperative, since it draws no noticeable current.

The second method takes advantage of the fact that when the base bias is removed from a transistor it normally ceases to conduct. Carefully locate the emitter and base connections, and, using one of the 24" jumper leads, touch one prod to each. This short will remove the base-emitter bias; as a result, the input current to the receiver will be reduced by the amount of that transistor's collector current. CAUTION: Be very careful not to short the base and collector terminals together, because application of the high collector bias to the base will cause excessive current across the base-emitter junction with resultant overheating and perhaps permanent damage. In signal-type units, this can happen so quickly the transistor can be ruined before you realize what has happened.

The third method of checking a transistor is by applying a certain amount of forward bias to the base junction. Fig. 2 shows how this can be done by using a potentiometer-and-test-lead device. For the NPN transistor shown, the collector voltage must be positive, so the power-supply source is positive. To apply forward bias to the transistor, the base junction must be made more positive than the emitter; therefore, the power source is an excellent place from which to take the test voltage.

Start with the potentiometer at maximum resistance; too much voltage could damage or ruin the transistor. In sensitive signal transistors, the slight forward bias introduced by the test device—even at maximum resistance—may cause a significant increase in collector current. If it does, this increase will appear as a rise in the input current. With some transistors, the rise will be slight but usually noticeable.

In power transistors, such as those used in audio driver and output stages, the shift may be negligible—simply because it requires more forward bias to create a noticeable change in the collector current. This increase can be brought about by advancing the potentiometer control slowly, noting the rise in receiver input current. Be careful not to apply too much forward bias, because the resulting junction current could be damaging to the transistor. The mere fact that increasing the bias increases the collector current is a good indication the transistor is operative and can be considered normal.

The PNP transistor shown in Fig. 2B requires negative bias for the collector, and negative forward bias for the base. As a result, the same power connection that was shown in Fig. 2A would be used to forward-bias this transistor. Once again, the forward bias is kept at a minimum by setting the test potentiometer for maximum resistance, until after the connection is made and the result noted.

The circuit shown in Fig. 3 is common in transistor receivers, but creates a different problem when you're testing a transistor by the forward-bias means we've been discussing. You'll note the power supply is positive, and is applied to the emitter; the collector, which must be more negative than the emitter in a PNP transistor, is connected to DC ground. Forward bias for this transistor requires that the base be made more negative than the emitter, but this voltage cannot be obtained from the power-supply connection. However, the connection shown in Fig. 3 can be used to connect the base to ground, which *is* more negative than the emitter or the existing base potential.

From this last example, it is easy to outline a firm rule that you can apply when forward-bias testing any type of transistor: *To forward-bias any transistor, simply use the test potentiometer—set at maximum resistance—to connect the base terminal to the collector-load termination, whether this point is at the power supply, at ground, or at some other location in the receiver.*

As you gain experience in troubleshooting transistor circuits by current drain, you'll find many other operations can also be pinned down to simple rules like this one. By simplifying and generalizing the various tests as much as possible, you'll be able to work out a rapid, efficient troubleshooting method. ▲

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Garage-Door Openers

(Continued from page 33)

(often a plug-in type) tuned to the operating frequency of the receiver. The fourth transistor is the modulation detector and develops AGC for the VLF amplifiers; the fifth functions as the relay control.

The antenna used with a GDO receiver may be a simple piece of straight wire, like the one shown in Fig. 5. Some models have a special rod antenna for the receiver; sometimes these are adjustable to exactly match the operating frequency. The receiver antenna isn't likely to cause trouble; once installed it is seldom moved or bothered. Any antenna problems likely to develop are in the portable transmitter. The customer may drop the unit, or it could be damaged in other ways.

Troubleshooting

Often, the quickest method of obtaining service literature for a particular radio-control system is to check with your customer; he may have the service information that came with his system. If not, you can contact the manufacturer, requesting the information for the model you're servicing. The names and addresses of several manufacturers of GDO's are included in Table I.

Locating a defect in a radio-controlled GDO system involves first determining which portion is at fault—operator assembly, transmitter, or receiver. Most times, your customer will have already checked the operator assembly by trying to actuate it manually. If not, check it yourself as a first step.

Determining whether the trouble is in the transmitter or the receiver involves a bit more work, unless the system has two transmitters that can be checked against each other. If you have an RF indicator like those used to check Citizen-band transmitters, you can determine quickly if a VHF transmitter is radiating. The RF output of the transmitters used with GDO's is usually not more than 40 or 50 milliwatts, so you won't get a high reading on the meter, but there will be enough of an indication to show if the unit is working.

The procedure for checking the receiver will depend on the type and frequency of operation, and on the circuit design of the particular receiver. The first check you should make is to see if the relay is energizing; with power applied to the receiver, key the transmitter while watching and listening to see if the relay clicks. If it does, check the contacts of the relay; it's possible they are not closing completely. In the receiver shown in Fig. 6, you can close the relay with your finger and see if the door operates.

Shop Service

In the shop, a quick and simple check of the relay-transistor circuit can be made by using a bias box. Under nonoperating conditions, the relay transistor is cut off; when a signal is received, the base voltage (normally zero) shifts to a negative 1.5 volts and the transistor starts to conduct. If you preset the bias box to approximately 2 volts, and connect the negative lead to the base of the transistor, you will have duplicated the effect of a received signal, and the transistor will conduct—if it's okay. However, don't forget the time delay circuit must be given time to charge before the relay will energize—a second or two is sufficient. Nevertheless don't leave the negative voltage connected to the base for any length of time; operation for an extended period might damage the relay transistor. If these checks operate the relay, the stages preceding the control circuit deserve further checking.

Signal Injection

The use of a signal generator to provide an operating signal for the

Table I

Manufacturer	Transmitter	Receiver
Alliance Manufacturing Co., Alliance, Ohio	Transistor	Tube
Delco Radio Division, GM, Kokomo, Indiana	Transistor	Transistor
Multi-Products Co., 21470 Coolidge Highway, Oak Park 37, Michigan	Tube	Tube
Perma-Power Co., 3102 North Elston Ave., Chicago 18, Illinois	Transistor	Transistor

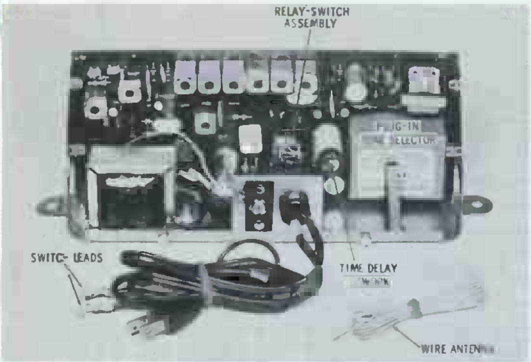


Fig. 5. Internal view of transistorized receiver shows major components.

receiver is often limited in GDO receivers—depending on the design of the receiver. If the frequency of operation is in the audio (VLF) range (we mentioned one that is) you can substitute the output of an audio generator for the transmitter signal.

Using a .1-mfd capacitor in series with the generator lead, inject a signal at the base element of the relay transistor. This transistor is located *after* the tuned circuits; therefore, it's not frequency-selective, and you can set the generator in the audio range. If this stage is okay, the relay will energize when the signal is connected.

To inject signals into stages preceding the tone selector when you don't know what tone frequency the receiver is equipped for, slowly tune the generator through its range, and see if the relay energizes. This tuning must be done very slowly, to allow time to charge the delay circuit. Working backward toward the input, if you find any stage that fails to energize the relay, further testing is in order.

This same technique can be used for checking a receiver that operates from a tone-modulated RF carrier, such as the unit in Fig. 6. You can check the stages following the tone-detector circuit, using the audio generator in the same manner as above. Most signal generators make provision for modulating the RF carrier with an audio signal from an external source; thus, the tone that will actuate the relay when applied to the latter stages can be applied to the RF carrier and used in testing the front-end circuits. The service instructions that accompany the receiver should identify the tuned-circuit adjustments in these stages.

Occasionally, it may be necessary

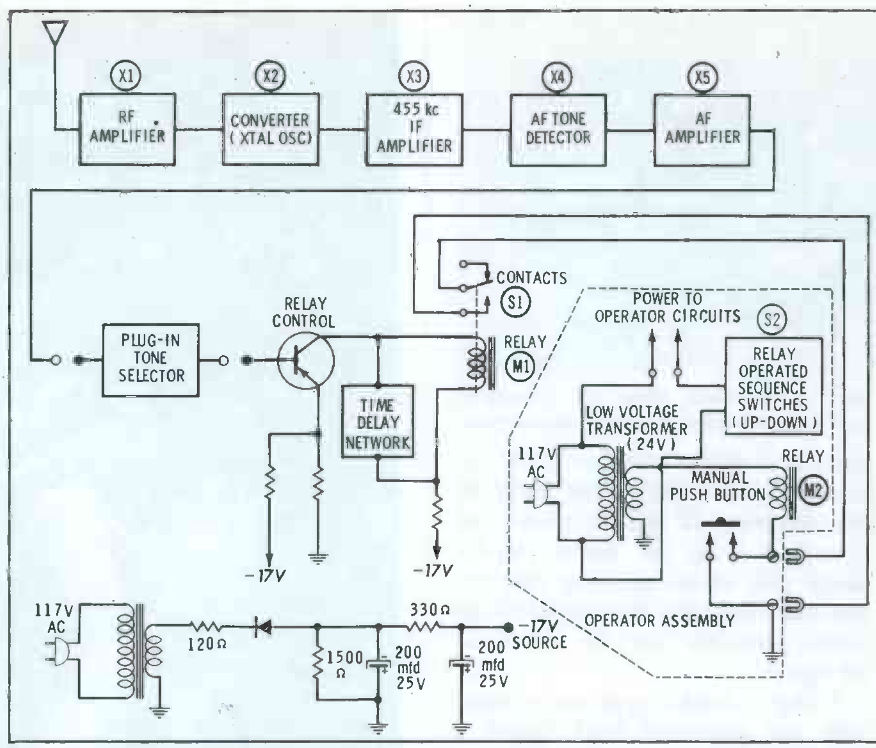


Fig. 6. Relay-control circuit energizes relay M1 to start door action.

to field-align a receiver for maximum operating distance. First, check the distance at which the transmitter will key the receiver circuits—50 to 70 feet is normal for the auto-mounted type. (The distance is reduced when a portable transmitter is used.) If the operating distance isn't sufficient, try touching up the RF and IF tuning slugs—not the tone circuits—in the receiver, using the transmitter as a signal source.

Have someone move the transmitter to a distance where the door just fails to operate. (Remove power from the door operator, to prevent continuous door travel; merely listen for the click of the relay to indicate receiver keying during these tests.) Then, have your helper key the transmitter while you adjust the tuning slugs in the receiver. Repeat this procedure—moving the transmitter farther away and peaking the slugs—until normal range is obtained.

Summary

Servicing radio-control systems—such as the transmitters and receivers used with GDO's—can add extra profit to your repair income. Many people are using radio controls, not only to open garage doors, but also to control external lighting, entrance gates, and other devices.

If you've been servicing TV remote-control systems, you've already laid the groundwork to enter the GDO field. So, if one of your TV customers asks you to repair his GDO system, don't refuse, or say that you can't. Chances are—you can! ▲

Testing Device

The Perma-Power Model 1A89 Transmitter Tester is designed especially for checking and adjusting transmitters used in garage-door opener systems — or other small RF-radiating units. A 1-ma meter on the front panel is used as the indicating device for battery tests and RF output tests that are performed by the unit. A single slide switch, also on the front panel, is used to select either the RF or BAT mode of operation.

You can check the condition of the batteries used in portable transmitter units (usually 9-volt or 22-volt types) by simply connecting them across the terminals marked on the tester. When the slide switch is placed in the RF position, you can test the RF output of a portable-type transmitter by placing it in close proximity to the 1A89 and keying the transmitter. If the unit is radiating properly, the meter will indicate approximately .6 ma—indicating normal operation. This same procedure can also be used to perform tuning adjustments to the transmitter, striving for maximum output.

For testing permanent installations (auto-mounted transmitters, for instance), a wire-hank pickup (included with the tester) can be clipped to the auto whip. On some, the auto antenna is situated so you must wrap the wire around it a few times. You can also check the audio-tone output of the transmitter, using the earphone included with the tester.

The operating manual supplied with the Model 1A89 clearly defines the different tests the instrument will perform, and states explicit instructions for each operation; a schematic diagram of the units is included. ▲

Horizontal-AFC Problems

(Continued from page 29)

granted. Defective diodes can cause any number of symptoms; one of the weirder ones is shown in Fig. 6. In a few cases, the circuit unbalance caused by faulty diodes is great enough to kill the raster whenever a station is tuned in.

If the set uses soldered-in semiconductor diodes, some time may be saved by not removing them for substitution until after the next step in troubleshooting: examination of the waveforms at all diode terminals. The scope might reveal a signal discrepancy for which the diodes obviously couldn't be blamed. But if there is any doubt about the waveform interpretations, the wisest course is to go ahead and remove the diodes so the pure input waveforms (W1, W2, and W3 in Fig. 5) can be seen. Leaving the diodes in the circuit causes some interaction between the signals, changing W1 to W4 and W2 to W5; this may mask distortion in one component of the combined waveform. The obscuring effect is likely to be more serious when defects are present than the normal waveforms in Fig. 5 would indicate.

These waveforms, like most of the component values in balanced dual-diode circuits, are fairly well standardized—at least with respect to shapes and polarities. Amplitudes of W1 and W2 are always equal and range from 12 to 30 volts peak to peak. W3 will usually range from 10 to 30 volts; ordinarily, it has slightly less amplitude than the sync pulses, but sometimes it will have the same value. In rare cases, it may be not much more than half as strong as W1 and W2.

The waveforms in Fig. 5 were taken with the scope sweep set at one-half the horizontal frequency, to show the waveshape of the signals. Sometimes you'll be more concerned with finding out if these signals contain 60-cps hum or if the sync pulses have video contamination; in such cases, better results are obtained if the scope sweep is set at one third or one half of the vertical frequency (20 or 30 cps). Hum will then show up plainly as curva-

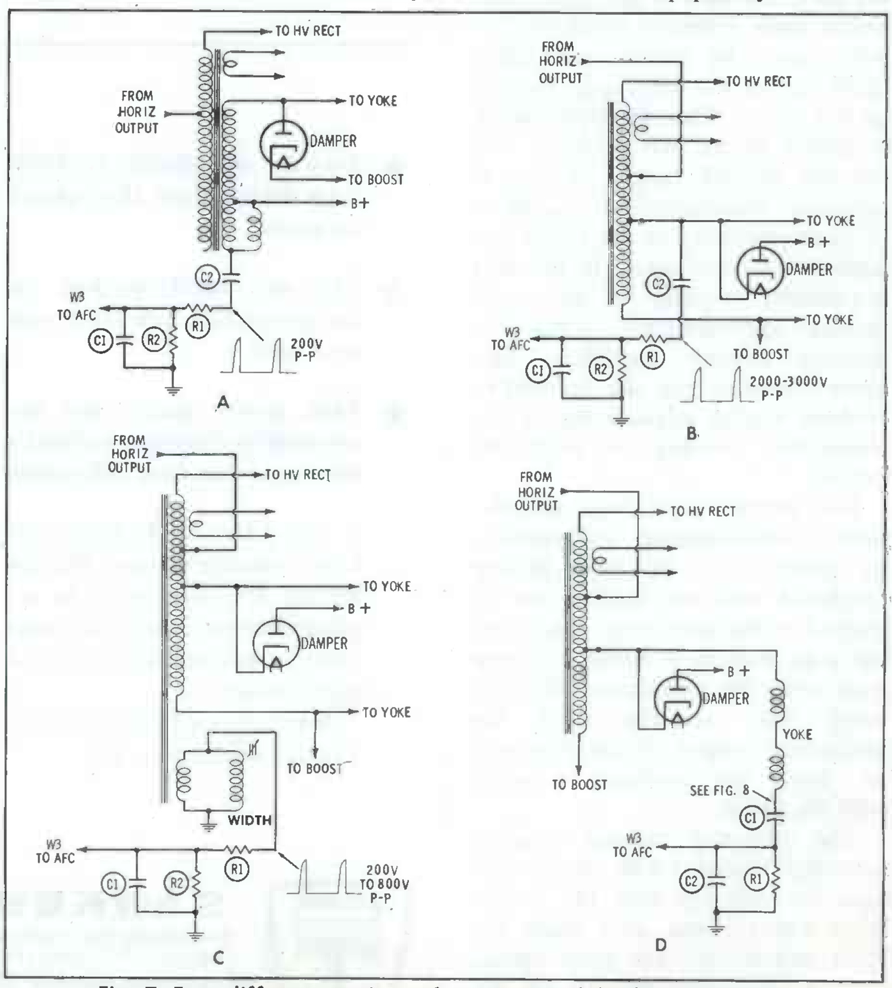


Fig. 7. Four different versions of sweep-signal feedback network.

Fig. 8. Waveshape of signal obtained at low end of yoke—circuit of Fig. 7D.

ture of the trace, and the effects of video in the sync signals will be more obvious.

If distortion in W1 or W2 leads you to suspect component failure in the circuit area shown in Fig. 5, the following tips will help you pinpoint the defective part: If C1 or C2 becomes leaky, poor sync or a complete loss of raster can result; the raster will reappear when the diodes are removed. If C1 or C2 loses capacitance, sync will be critical, and in rare cases this fault can also cause loss of raster. Opening of R1 or R2 has effects similar to a loss of capacitance in C1 or C2. Loss of filtering on the B+ line feeding the sync phase-splitter stage is another defect that can kill the raster. Defects in the correction-voltage filter network (C3, C4, R3, and R4) can cause "piecrust" ripple or reduce the noise immunity of the system. If the defect is such that the correction voltage is prevented from reaching the controlled grid (for instance, a shorted C4 or open R4), the result would be no horizontal sync.

Feedback Circuits

Because the network that feeds the sample sweep signal (W3) to the balanced dual-diode circuit is subject to many variations, such networks were not included in Fig. 5. Four of the most common designs are shown in Fig. 7. The basic component functions in the first three circuits can be analyzed as follows: R1 in conjunction with C1 forms an integrating network that converts a large, sharp positive pulse into a sawtooth of much lower amplitude. R2 is used basically for signal attenuation, although it also serves as a load resistor. C2, used only in circuits A and B, is a DC-blocking capacitor, made necessary by the high DC voltage present at

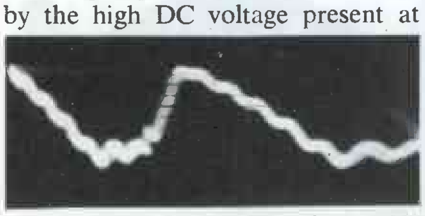


Fig. 9. Fault in the preceding stage distorted W1 into this ragged shape.

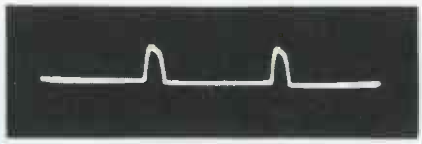


Fig. 10. With feedback network open, W3 contained only a spurious pulse.

the sample-signal source. Values of these components vary too much to permit suggesting standardized values. The desired amplitude of W3 determines the values found in any given circuit. The sample signals at their source generally have amplitudes fairly close to those shown in Fig. 7.

Circuit D in Fig. 7 is different enough to merit a separate discussion. While the sample signals in circuits A, B, and C are sharp pulses at their source, this fourth circuit uses an inverted parabolic signal (Fig. 8) obtained at the low end of the yoke. The amplitude of this signal, on the occasions when I have scoped it, has been found to range from 70 to 100 volts. This parabolic signal is shaped into a sawtooth by C1 and R1. C2 is often omitted; if used, however, it results in a cleaner waveform with more linear slopes. C1 ranges from .047 to .1 mfd, C2 (when used) is .047 mfd, and R1 ranges from 12 to 25 ohms.

Typical Waveform Clues

To illustrate the value of scoping signals in AFC troubleshooting, here are some accounts of actual cases I have run across:

An old Motorola set using the balanced dual-diode circuit had fair horizontal stability, but AFC action seemed abnormal enough to warn me of trouble developing. Removing the diodes and checking with the scope, I noted that W1 had changed to the odd shape shown in Fig. 9. The cause: a noisy resistor in the plate circuit of the sync phase-split-

Fig. 11. Severe distortion of W3 was a result of damaged feedback resistor.

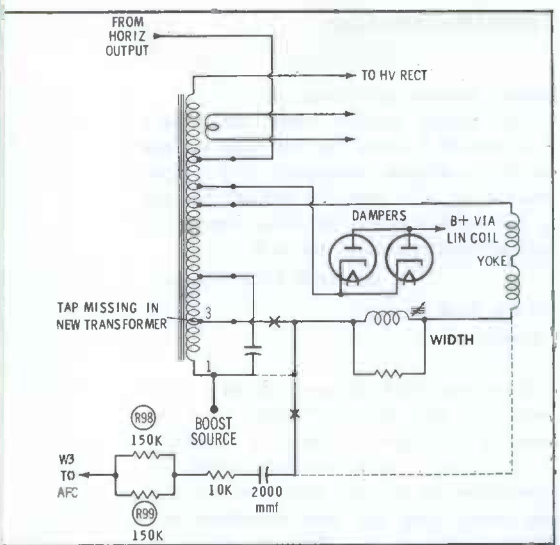


Fig. 12. Good horizontal sync was restored, even with incorrect flyback.

ter stage.

Defects in the sample-sawtooth network, which I find responsible for the majority of AFC troubles, are equally susceptible to quick detection with scope tracing. For example, in a Crosley using the same circuit as Fig. 7B, W3 looked like Fig. 10. The cause was an open resistor equivalent to R1. It might be wondered why any signal appeared at all, but the trace in Fig. 10 can be attributed to pickup of radiated pulses on circuit wiring in the high-voltage cage.

In an Admiral 17L1, the picture locked in with the blanking bar near the center of the screen; removing the plug-in diode unit eliminated this phasing error. When I scoped W3, I noticed sharp spikes in the trace (Fig. 11). A check of the sample-signal circuit (the same as Fig. 7C) revealed a badly overheated R1 which had decreased in value from its normal 22K ohms to not much over 300 ohms.

A tougher trouble was encountered in a CBS-Columbia 1027-1 that was just barely capable of staying in horizontal sync. A quick examination of the set showed that someone had recently replaced the horizontal output transformer; furthermore, the replacement did not have all the taps the circuit called for. The width-coil and AFC leads had simply been connected to the boost terminal instead of the missing terminal 3 (Fig. 12). I could have ripped out the replacement flyback and installed the correct one, but since the raster had good width, linearity and brightness, I wondered if I could find some way to make the replacement unit work. First I transferred the 2000-mmf AFC-coupling capacitor to the yoke-return end of the width coil. Then, with the scope at the W3 end of the network, I juggled the values of R98 and R99 so the amplitude of W3 agreed with that given in the schematic. Result: very stable horizontal sync.

So much for balanced dual-diode AFC. To summarize, here are a few pointers to remember when you're working on one of these circuits: While the components in Fig. 5 are capable of causing problems, the majority of troubles stem from defective components in the networks shown in Fig. 7 (which are under much greater electrical stress). When one of these sample-signal components goes bad, don't skimp on quality or power-handling ability. If the set maker used a 1-watt resistor for R1, replace with a 2-watter. If an original C2 is a 600-volt unit and it needs replacing, use a 1000-volt unit if possible. But the best advice for troubleshooting the AFC is: *Resort early to scope tracing.* ▲

Troubleshooter

(Continued from page 23)

restore normal operation.

The supply voltage from the battery is a normal 6 volts, but the base voltage on the converter transistor is 5.4 volts (should be 4.7) and the emitter voltage is 5.5 volts (should be 4.0). Could the replacement transistor be bad?

BERNIE'S TELE RADIO

Elfros, Sask.
Canada

Have you tried adjusting the new oscillator coil you installed? Give it a few turns in an effort to start the oscillator. If this doesn't work, carefully check the connections of the new parts you installed, and make sure the new transistor is a correct replacement. Although it's a remote possibility, the transistor could be defective, and it might be worth your trouble to try another new one.

UHF Lost

A Motorola Model Y17P5-2 (PHOTOFACT Folder 445-1) has no picture or sound on UHF. However, by using an external converter connected to the VHF tuner of the set, we can tune in all our local channels—70, 72, 76, and 79. Several 2AF4 tubes have been tried, and the UHF-VHF tuner combination was sent into a tuner-repair company for overhaul, but the set still has the same trouble. Voltages on the 2AF4 are normal. I still feel the UHF tuner is to blame.

ALBERT E. ROSSI

(address unknown)

I'd have been glad to send you a personal reply, if you had included your address on the letter with your question.

You're undoubtedly correct in suspecting trouble in or around the UHF tuner. It's possible the repair company could have missed the fault, even in a careful check for defects in this unit and the accompanying VHF tuner. They may have used a moderately strong output from their UHF signal generator to test the tuners, and found them operating normally; yet the sensitivity of the UHF tuner may have become so poor that it can't pick up the weak signals available from the low-powered translator stations that serve your area.

There's also a chance the UHF tuner is misaligned. All your stations are crowded into the upper extreme of the UHF band, and will be missed if the 2AF4 oscillator can't be tuned high enough.

The trouble might be extremely simple —something like an open lead between the UHF antenna terminals and the tuner proper. I'd suggest checking for obvious faults such as this, and then—if necessary—writing back to the tuner service to explain your problem. They'd surely appreciate another chance to help you.

PRODUCT report

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

Assorted Tools (50A)

This pegboard display of "Channellock" tools from **Champion-DeArment Tool Co.** contains a complete line of screwdrivers (both round- and square-shank types), Phillips-head drivers, and nut drivers. The opaque blue plastic handles used on all of these tools are shockproof, breakproof, and shaped for a non-slip grip.

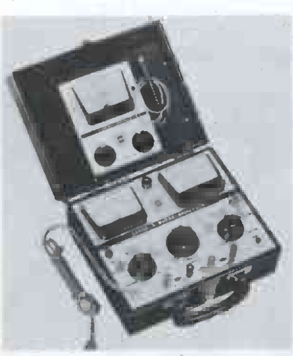
Speaker Wire (51A)

A complete line of "mini-zip" speaker wire for home entertainment equipment and public-address systems was recently introduced by **Jersey Specialty Co.** Each lead contains seven strands of copper wire, and one lead is tinned for identification purposes. The vinyl-insulated wire is available in crystal clear, gray, brown, and ivory colors, and can be purchased in 50′, 100′, 250′, 500′, and 1000′ spools.

UHF Converters (52A)

With the introduction of Models A and B, **Standard Kollsman** has entered the UHF-converter market. These converters will allow present VHF sets to receive channels 14 through 83 without internal modifications. Circuitry of the deluxe Model A includes a three-gang tuning element, a 6DZ4 oscillator, a 6DS4 IF amplifier, and a 1N87A mixer diode. List price of this unit is $39.95. Model B, which excludes the 6DS4 IF amplifier stage, is priced at $29.95. Each unit has a shipping weight of 6 lbs.

Diode Analyzer (53A)

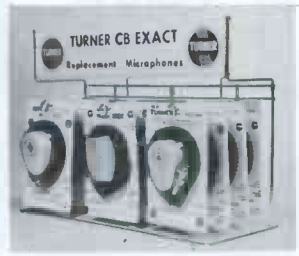


Zener diodes, silicon and germanium signal or power diodes, and selenium rectifiers can be tested with the **Seco** Model 210T "Zener & Diode Analyzer." Tests provided, and ranges covered, are as follows: Forward voltage drop, from 0 to 1, 10, and 30 amps; reverse leakage, from 0 to 150 and 1500 volts; zener saturation knee, from 0 to 30 and 300 volts; temperature, from –20° to 160° C. A battery-operated thermometer, in the cover, checks the operating temperature of diodes and other components. The set has a net price of $274.95.

Coiled Splicers for Leads (54A)

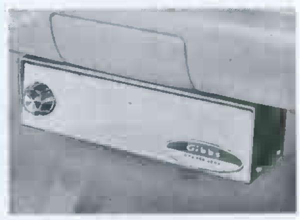
For replacing or checking components on printed-circuit boards, **Adler TV Specialties** coiled splicers are a useful service aid. Here's how to use them: simply clip the component from the printed board, leaving the lead stub sticking up; place one of the small coiled wires over the stub; insert the lead of the new component in the other end of the coil; then solder. The splicers are available for $1.00 per gross.

CB Microphone (55A)



The various models in the **Turner** display of "exact replacement" Citizens-band microphones are designed specifically for nine popular brands of transceivers, so they can be easily installed without soldering or rewiring. Each microphone is individually "bubble-packaged" on a card marked with basic specifications and the list price.

"Reverb" on Wheels (56A)



Auto-radio sound acquires a "live," 3-D effect from the "Stereo-Verb" by **Gibbs Special Products Corp.,** a subsidiary of the Hammond Organ Co. Designed to be used with any 12-volt auto radio, the unit consists of a speaker, amplifier, volume control, rear-seat-speaker switch, and special delay line. The compact size of the enclosure, 5″ x 2⅝″ x 9″, makes it easy to mount under the dash of the vehicle. The fully transistorized set carries a list price of $29.95.

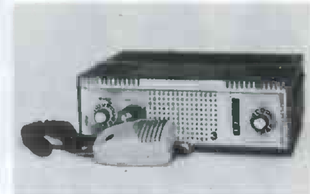
CB Transceiver (57A)

Equipped with a dual AC-DC power supply, the **Regency** "Range Gain" CB transceiver can be used for either mobile or base-station operation. The unit features crystal control on both transmit and receive for all 23 Citizens-band channels, a built-in S-meter, double-sideband reduced carrier circuitry, and an adjustable squelch control. The set carries a 12-month warranty that includes all crystals in its coverage. List price is $269.95; a special bracket for vehicle mounting is available at extra cost.

Aerosol Spray (58A)

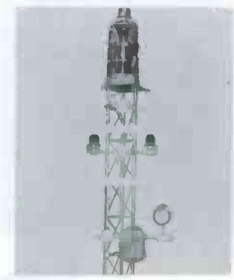
Supplied in a 16-ounce aerosol can, "HumiSeal" Type 1B15 **from Columbia Technical Corp.** is a water- and fungus- proof plastic spray used to insulate printed circuit boards and components while protecting them from the effects of heat and vibration. Because the spray is transparent, components or markings are easily recognized. Also, it is possible to solder or unsolder parts without destroying the sprayed-on coating.

CB Transceiver (59A)



This Citizens-band transceiver, the **RCA** Mark VIII, is suitable for either base or mobile operation. The unit features: 9 crystal-controlled transmit and receive channels, a continuously variable tuner for receiving all 23 CB channels, and TVI traps for eliminating interference to nearby TV receivers. The Mark VIII operates on 115 volts AC; however, 6- or 12-volt power supplies are available as optional equipment. Measuring only 3½" high, 11¼" wide, and 8" deep, the unit lists for $149.50.

Code Beacon (60A)

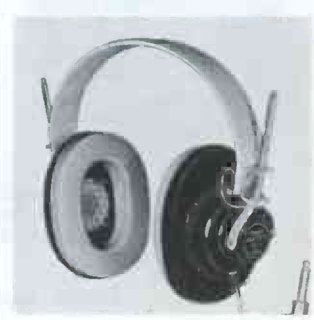


Used as a warning light for protection of aircraft, the **Rohn** Model B-1 300 MM Code Beacon is designated for use on TV, microwave, transmission-line towers, or other high structures. These units meet all required FAA and FCC specifications. Also available are beacon flasher units and accessories, used in conjunction with either single or double obstruction lights.

Light-Dependent Resistor (61A)

Designed to operate directly from a 115-volt source, the **Delco** Model LDR-25 light-dependent resistor has continuous current-handling capabilities of ½ amp. This unit is intended for use in medium-to-high power switching and control applications, where turn-on and turn-off times in tens of milliseconds are fast enough to be tolerated. Constructed of a thin layer of sintered semiconductor applied to an aluminum-oxide substrate, the unit has a cell resistance of 400 ohms at 10 foot-candles, and a minimum dark resistance of 500K ohms.

Stereo Headphones (62A)

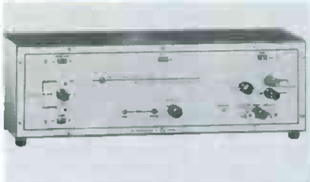


For stereophonic music listening, **R-Columbia** offers a 7-oz high-fidelity headphone set with soft vinyl-covered ear cushions. The left and right drivers, as well as the headband, are replaceable separately. The frequency response of this Type A set is 20 cps to 17 kc, and its impedance is 8 ohms. List price is $17.95. A similar unit, the Type A3, is designed for use in language laboratories.

Twin-Beam Light (63A)

This twin-beam flashlight, powered by rechargeable nickel-cadmium cells, is the **Channel Master** "Bright-Mite." With a size of 1⅞" x 1⅜" x 1", and weighing only 2 oz., the unit can be used in many hard-to-reach places. Unconditionally guaranteed for two years, the light comes in either crimson-and-gold or ebony-and-silver. The unit, together with the recharger, carries a list price of $6.90.

Stereo Generator (64A)

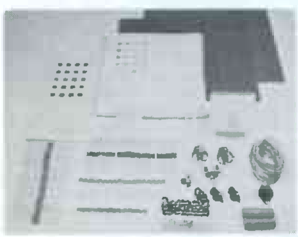


An instrument for use in aligning and testing the multiplex circuits in stereo-FM receivers is the Model E-490 Stereo Generator by **Precision Apparatus Co.** The unit can supply L + R, L – R, and composite stereo signals, with single- or dual-channel modulation, and with or without a pilot carrier. The output is continuously variable from 0 to 12 volts peak to peak. The set has cabinet dimensions of 17" x 5½" x 5¼", a shipping weight of 14 lbs, and a list price of $229.00.

PA Speaker (65A)

Immune to rain, snow, and humidity, the **University** Model CLC outdoor speaker is designed to be used in concert halls, at sports stadiums, on sound trucks, at pool or patio or other outside locations. Having an impedance of 8 ohms, a frequency response from 55 cps to 14 kc, a maximum power output rating of 30 watts, and a weight of 23 lbs., the unit lists for $69.95.

Digital Transistor Kit (66A)

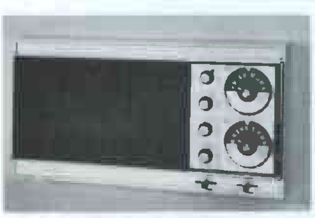


For students of modern computer electronics, the **Tesla Research Foundation** Model DI-TR kit contains more than twenty transistors, ten diodes, many resistors, capacitors, potentiometers, switches, hardware, and a zero-center 100-ua meter. An instruction manual describes the eight computers that can be built from the kit, and another booklet explains computer logic, circuits, computing networks, and matrices. List price of this "laboratory in kit form" is $59.50.

Low-Cost Color Generator (67A)

A new, low-priced color-bar and pattern generator, **SENCORE** Model CG126, provides not only a keyed-rainbow signal but also white dots, crosshatch lines, vertical bars, and horizontal bars. Signals are ordinarily fed to the antenna terminals of the receiver on channel 4, but a different low-**VHF** frequency can be selected by adjusting a slug located on the rear of the cabinet. This set weighs less than 10 lbs, has a size of 11" x 8" x 6", and is priced at $99.50.

Transistorized Intercom (68A)



For servicemen who want to extend their service business to include the installation of intercoms, this fully transistorized system is being manufactured by **NuTone.** AM or FM programs can be played in one room while leaving all other remotes, as well as the master station, free for room-to-room intercommunication. The 8-wire distribution cable is wired from station to station instead of from each station back to the master, thus making installation reasonably simple. The master unit, with a 6" x 9" speaker, is available for wall mounting in either silver or copper finish, at a list price of $194.50. Special remote units for the system include one with a 5" speaker, an 8" speaker hi-fi unit with a detachable remote control, a front-door speaker, and an 8" patio speaker.

JUNE, 1963

ANTENNAS & ACCESSORIES

1A. *ANTENNA SPECIALISTS* — Complete brochure listing outstanding features of Model M-103 combination CB-AM mobile and *Magnum* M-81 base-station antenna (27 mc).

2A. *BLONDER-TONGUE* — Quick-reference index for all types of home antenna products: signal amplifiers, UHF converters, matching transformers, traps, etc. Also 16-page reference manual for master TV systems.*

3A. *JERROLD* — Descriptive brochure showing why *Ultra-Vista* UHF converter Model UVC-7083 is especially suited for MPATI and translator areas.*

4A. *JFD*—Specifications and operating information on *Transis-tenna* and newly-designed, long-range *LPV* log-periodic TV antennas. Illustrated brochure showing entire line of indoor antennas and accessories for TV and FM.*

5A. *STANDARD KOLLSMAN* — Technical bulletin giving specifications and application ideas for new line of UHF converters.*

6A. *WINEGARD*—Illustrated layout and installation instructions for master antenna systems in 16-page *Fact-Finder* booklet No. 232. Also similar booklet No. 235 on economical "K" series antennas.*

AUDIO & HI-FI

7A. *ADMIRAL, National Service Div.* — Recently published catalog listing replacement parts and accessories, with special cross-reference guide to phonograph needles and cartridges.

8A. *ATLAS SOUND, Div. of American Trading & Production Corp.*—Illustrated catalog No. 562 containing specifications of microphones and loudspeakers for use in public address, commercial, or industrial installations.*

9A. *EUPHONICS* — Four informative brochures illustrating ceramic phono cartridges and microphones; cartridge cross-reference index is included.*

10A. *PERMA-POWER*—Descriptive literature on battery-operated, portable sound systems: *Roving Rostrum* and *Diplomat*.*

11A. *SARKES TARZIAN*—"Lower the Cost of Fun With Tape Recording," a large 32-page booklet containing information about tape recorders. Ways of using recorder as a notebook, for tricks, for recording unusual sound sources, are all explained in this informative booklet.*

13A. *SONOTONE*—Brochure with helpful information on rechargeable sealed-cell battery modules; lists types available, with chart of voltages, number of cells, size, and weight.*

15A. *ZENITH* — Important features of automatic record changers are described in brochures PSF-1079 and PSF-1080, illustrating the *Stereo Professional* and *Stereo Precision* models, with additional facts on *Micro Touch 2G* tone arm.

COMMUNICATIONS

16A. *CADRE*—Detailed information on 5-watt Citizens-band units, and on new 1.5-watt hand-held transceiver.

COMPONENTS

17A. *BUSSMANN* — 12-page booklet (SFUS) listing replacement data on the entire line of *Buss* and *Fusetron* small-dimension fuses, including size, type, type of holder required, and list prices.*

18A. *SPRAGUE*—Hang-up wall catalog No. C-457, a ready and complete listing of TV and radio replacement components.*

19A. *TRIAD* — New catalog TV-63/64 lists many replacement items for radio, TV, and hi-fi.*

SERVICE AIDS

20A. *CASTLE*—How to get fast overhaul service on all makes and models of television tuners is described in leaflet, which also contains a comprehensive list of universal and original-equipment tuners.*

21A. *CHEMTRONICS* — Brochures illustrating dozens of chemical products for TV and radio use. Includes information on new *Jet Spare* aerosol-spray compound that seals tire punctures and re-inflates tire in one operation.

22A. *ELECTRONIC CHEMICAL CORP.* — Catalog listing chemical sprays for cleaning and lubrication in all types of electronic equipment.*

23A. *PRECISION TUNER* — Literature supplying information on complete, low-cost repair and alignment services for any TV tuner.*

24A. *YEATS*—The new "back-saving" appliance dolly Model 7 is featured in a four-page booklet describing featherweight aluminum construction.

SPECIAL EQUIPMENT & SERVICES

25A. *ACME ELECTRIC*—Complete specifications and applications for control-type magnetic amplifiers with capacities from 5-1000 watts and voltage ranges from 24-160 volts.*

26A. *AMPEX*—A special issue of the informative booklet on instructional television describing the *Videotape* recorder for educational use.

27A. *ARROW FASTENER*—Leaflet describing new Model T-18 staple gun for speeding cable installations.

28A. *ATR*—Descriptive literature on selling DC-AC inverters for operating 117-volt PA systems, tape recorders, and other electronic gear in vehicles such as automobiles, boats, aircraft, etc.*

29A. *COLMAN*—New 1963-64 catalog on complete line, including new products.

30A. *ELECTRO PRODUCTS* — Descriptive folder ECS-363 listing specifications and information on DC power supplies. Includes cross-reference *Selection Guide* PS-562R to aid in choosing correct unit for any application.*

31A. *GC ELECTRONICS*—Giant-sized catalog FR-65 contains 330 pages, forming the most complete listing yet published of new products and equipment offered by all company divisions.

32A. *GREYHOUND*—The complete story of the speed, convenience, and special services provided by the Greyhound Package Express method of shipping, with rates and routes.

33A. *PRECISION ELECTRONICS* — Special catalog containing information on popular PA and professional-type sound equipment.

34A. *SEMITRONICS*—New, updated 16" x 20" wall chart CH7 lists replacements, with substitution data, for 2000 U.S. and foreign transistors.

35A. *SWITCHCRAFT* — Product bulletin No. 130 describes new *CV Jax*—coaxial jacks for 75-ohm video circuitry.*

36A. *TERADO*—Sheet depicting wide line of 60-cps mobile power inverters and several types of battery chargers.

37A. *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; includes complete specifications on line of trucks.

TECHNICAL PUBLICATIONS

38A. *CLEVELAND INSTITUTE OF ELECTRONICS* — "Pocket Electronics Data Guides" with handy conversion factors, formulas, tables, and color codes. Additional folder, "Choose Your Career in Electronics," describes home-study electronics training programs, including preparation for FCC-license exam.

39A. *HOWARD W. SAMS* — Literature describing popular and informative publications on radio and TV servicing, communications, audio, hi-fi, and industrial electronics; including special new 1963 catalog of technical books on every phase of electronics.*

TEST EQUIPMENT

40A. *B & K*—Catalog AP20-R describing uses for and specifications of Model 850 *Color Analyst*, Model 960 *Transistor Radio Analyst*, Model 1076 *Television Analyst*, Dynamatic Model 375 VTVM, *V-O-Matic* Model 360 VOM, Model 625 *Dyna-Tester*, Models 600 and 700 *Dyna-Quik* tube testers, Models 420 and 440 CRT Tester - Reactivators, and Model 1070 *Dyna-Sweep* Circuit Analyzer.*

41A. *EICO*—New 32-page catalog of low-cost kits and ready-wired equipment: test equipment (including new Model 902 IM/Harmonic Distortion Meter and AC VTVM), stereo and monophonic hi-fi, Citizens-band transceivers, ham gear, and transistor radios. Also included is helpful information on kit-construction procedures and two free booklets—"Short Course for Novice License" and "Visutronic Teaching Aids."*

42A. *HICKOK*—Complete descriptive and operating information on Model 661 *Chrom-Aligner* standard NTSC color-bar generator.

43A. *SECO*—Informative data sheet describing new Model 806 *Vari-Volt* light and heat control for applications up to 1000 watts.*

44A. *SENCORE*—Special, newly released data on color test equipment, including the entirely new, low cost CG126 Color Generator, the CA122 *Color Circuit Analyzer*, and the PS120 *Wide-Band Scope*.*

TOOLS

46A. *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, and on *ION* adjustable "beam bender" for CRT's.*

47A. *ENTERPRISE DEVELOPMENT* — Time-saving techniques in brochure from Endeco demonstrate improved desoldering and resoldering techniques for speeding up and simplifying operations on PC boards.*

48A. *XCELITE*—Folder S960 describes and illustrates straight-noise (42H) and curved-nose (43H) *Seizers*, with snap-lock device, for protecting delicate components.*

TUBES AND TRANSISTORS

49A. *AMPEREX*—Catalog specifically devoted to extensive line of silicon planar epitaxial transistors. Describes applications for different types, with their basic specifications.

***Check "Index to Advertisers" for further information from this company.**

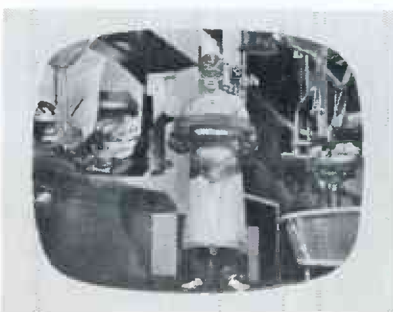
Critical inspections assure highest quality screen for RCA picture tubes

Because your customers judge a picture tube by its face, RCA makes certain that every Silverama® picture tube has a matchless complexion. Super-critical inspections at various stages of manufacture assure the virtually blemish-free television viewing surface your customers expect in an RCA Silverama.

At the screen inspection station in our Marion, Indiana picture tube plant (above), for example, an inspector uses transmitted light to check for pin-holes and other flaws in newly applied phosphor screens. The most minute imperfection—even the slightest variation in screen texture, color or smoothness—is cause for rejection of the bulb.

Screen inspections using both ultra-violet and transmitted light are but one phase of the exhaustive battery of visual, mechanical, and electrical quality control tests each Silverama must pass. The object: to maintain a product you can recommend and install with confidence in your customers' TV sets.

Envelope inspection. Picture tube envelopes are polished, and given a series of acid baths prior to re-use that delicately etch the interior of the glass to restore it to the peak of its optical capability. Then they are thoroughly inspected to meet the standards of the original new envelope.



Screen Inspection. Every completed Silverama is re-inspected for screen quality and sharpness of focus at this special automatic testing station near the end of the production cycle. Each Silverama undergoes as many as 26 inspections before it is released for sale to your customers.

RCA ELECTRON TUBE DIVISION, HARRISON, N. J.

RCA® The Most Trusted Name in Television

BIG PACKAGING

SEE ~~BREAK~~THROUGH

Now you can see and check at a glance! Inventory Control is much easier with the Littelfuse "see-through" plastic cover fuse box– Another Littelfuse <u>first</u>.

LITTELFUSE DES PLAINES, ILLINOIS