JUNE, 1962 35 CENTS

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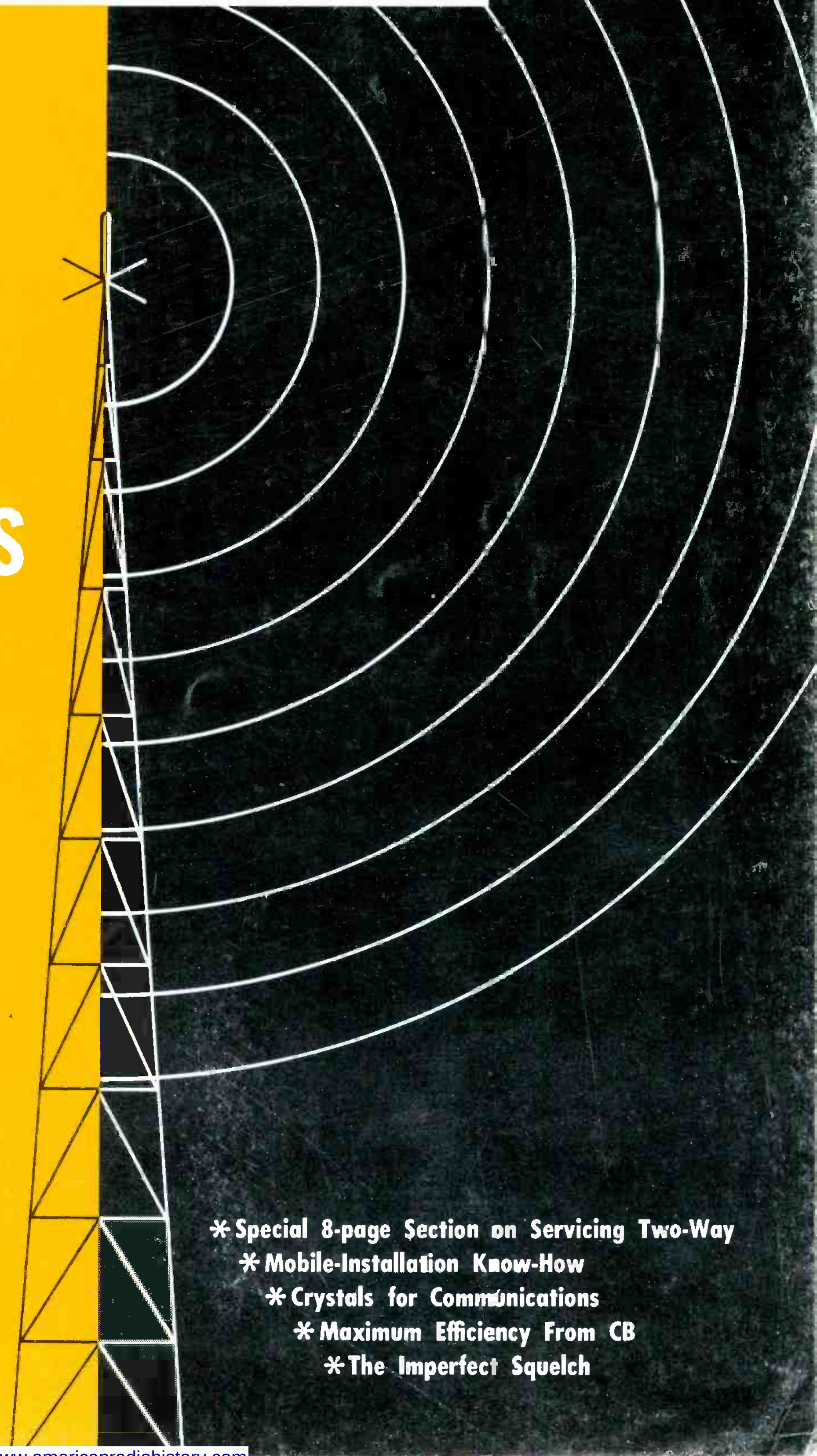

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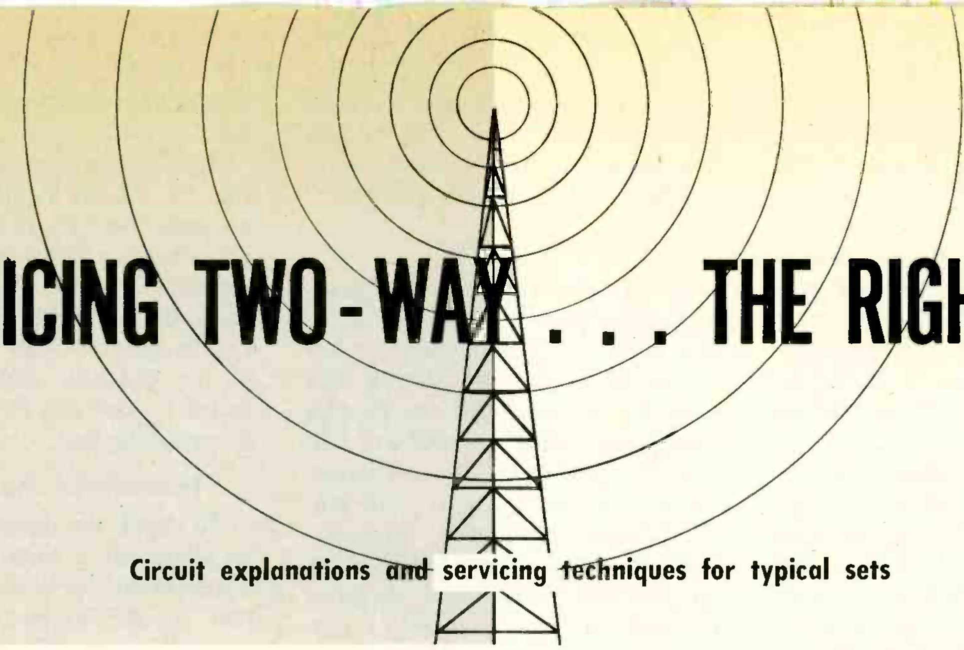

SERVICING TWO-WAY . . . THE RIGHT WAY

Circuit explanations and servicing techniques for typical sets

The best approach to servicing commercial two-way radio equipment is to proceed in a series of prearranged, logical steps. If the serviceman can begin each job with a clear pattern in mind for isolating trouble—first to a particular section, then to an individual stage, and ultimately to the faulty component or components — he can successfully repair practically any transmitter or receiver.

There is much similarity between two-way servicing and TV servicing, but we are more concerned here with the differences involved. Perhaps the most striking difference has to do with performance checks and routine maintenance. Whereas a TV set is not usually brought to the technician until a disabling trouble has developed, communications equipment must be subjected to periodic tests and adjustments in order to insure reliability and conformity with FCC specifications. A check of frequency, modulation, and power output is often sufficient. At times, however, complete servicing of the equipment may be necessary in order to return the set to peak operating condition.

A thorough knowledge of operational theory and alignment techniques will enable a technician to locate and repair any troubles that may arise in the equipment. Experienced servicemen have found that a comprehensive alignment of the transmitter and receiver is an excellent means of troubleshooting a two-way radio set. A defective section will immediately disclose itself by lack of response to alignment. This method of servicing is especially effective with two-way units, since the greater portion of both the transmitter and the receiver consists of tuned stages.

A systematic procedure for alignment and troubleshooting is aided by the type of construction normally used in two-way radio equipment. The transmitter, receiver, and power supply are each built on an individual chassis, and are then interconnected to form the completed unit; therefore, it is rather easy to confine a service problem to one of these major sections.

Power Supplies

Many complaints of apparently "weak" transmitters and receivers are caused by low output from the B+ source, and so it is a good practice to check the power supply before doing anything else. A 12-volt mobile radio should be tested at 11.5 volts and again at 13.5 volts, because certain troubles appear in the unit only when the input voltage is abnormal. Final alignment should be completed at the working voltage of the unit, however, since incorrect input voltage can affect circuit operation enough to cause inaccurate tuning.

Fig. 1 shows a typical transistorized power supply. Here, two transistors are used in a self-excited switching circuit to provide AC voltage, which is stepped up to a higher voltage by a toroidal-wound transformer. The AC is then rectified, filtered, and fed to the transmitter and receiver. Older sets usually have vibrator power supplies, similar to those used in auto radios, and a few use dynamotors (motor-driven generators) to supply the transmitter power.

The power supply shown in Fig. 1 is designed to operate from a 12-volt DC source with either positive or negative ground; however, it is important to establish proper polarity of the voltage fed to the transistors. Polarity reversal is accomplished by interchanging the power-input leads at the two binding posts marked (+) and (—) on the power-supply chassis.

When power is applied to the system, more current will flow in one of the collector circuits than in the other, because the two transistor circuits are not perfectly symmetrical. This greater current, flowing in one-half of the collector winding of T1, will induce a current in the base winding on the same core. This induced current biases the conducting transistor in such a way as to increase its conduction, and at the same time biases the other transistor to cutoff. This portion of the cycle continues until saturation occurs. At this point, the collector current in the conducting transistor no longer rises, and therefore no current is induced in the base winding. The cutoff bias is then removed from the other transistor, allowing it to start conducting. This reverses the bias on the two transistors, and the first one is cut off suddenly, while the other proceeds to build up conduction. As might be expected, the output of this type of oscillator is virtually a square wave, which is very easily rectified and filtered for B+ voltage.

There are two outputs from this power supply. Low B+ (230 to 250 volts DC) is applied to the receiver and certain stages of the transmitter, while high B+ (approximately 450 to 500 volts DC) supplies the higher voltage required for the power amplifier tube in the transmitter.

The low B+ is developed by a half-wave voltage doubler connected across one secondary winding of T1. The rectified voltage is filtered by capacitors C2 and C3 and choke L1.

The high B+ is also developed by feeding an AC output from T1 to a rectifier circuit of the half-wave voltage-doubler type. The 500-volt DC output is applied to the final power amplifier (PA) of the transmitter through a relay that is activated by the microphone *push-to-talk* switch. This relay also transfers the low B+ from the receiver to the transmitter.

Vibrator supplies are usually found in 6-volt equipment. Some sets include a tube or selenium rectifiers in the B+ circuit; in other units, a synchronous vibrator rectifies the AC voltage as well as interrupting the DC input voltage. In the latter type of circuit, the polarity of the vibrator is important; so, when servicing one of these units, be sure it is connected to the primary power source with the proper polarity.

Trouble In Power Supplies

When there is trouble in the power supply, it usually results in no B+ in one or more circuits, or low B+ in all circuits. In vibrator supplies, the vibrator and the rectifier are the most common causes of failure. Transistorized power supplies (such as shown in Fig. 1) are generally more dependable. However, transistors can short, usually blowing fuse M8; furthermore, defective rectifiers can cause excessive current or insufficient voltage output. In both types of power supplies, defective filter capacitors can — and often do—cause insufficient voltage.

Certain types of faults will leave the no-load voltage normal. However, when a load is applied (for instance, by keying the transmitter), the output drops very low. Therefore, when checking any power supply, make voltage measurements under all operating conditions. If the power supply appears normal, proceed to the other sections of the unit.

The changeover relay (M7 in Fig. 1), usually located in the power-supply chassis, should be checked periodically. Resistance sometimes develops between the contact surfaces; this condition can be detected by checking voltages on both sides of the contacts, and can be corrected by cleaning the contacts with a burnishing tool.

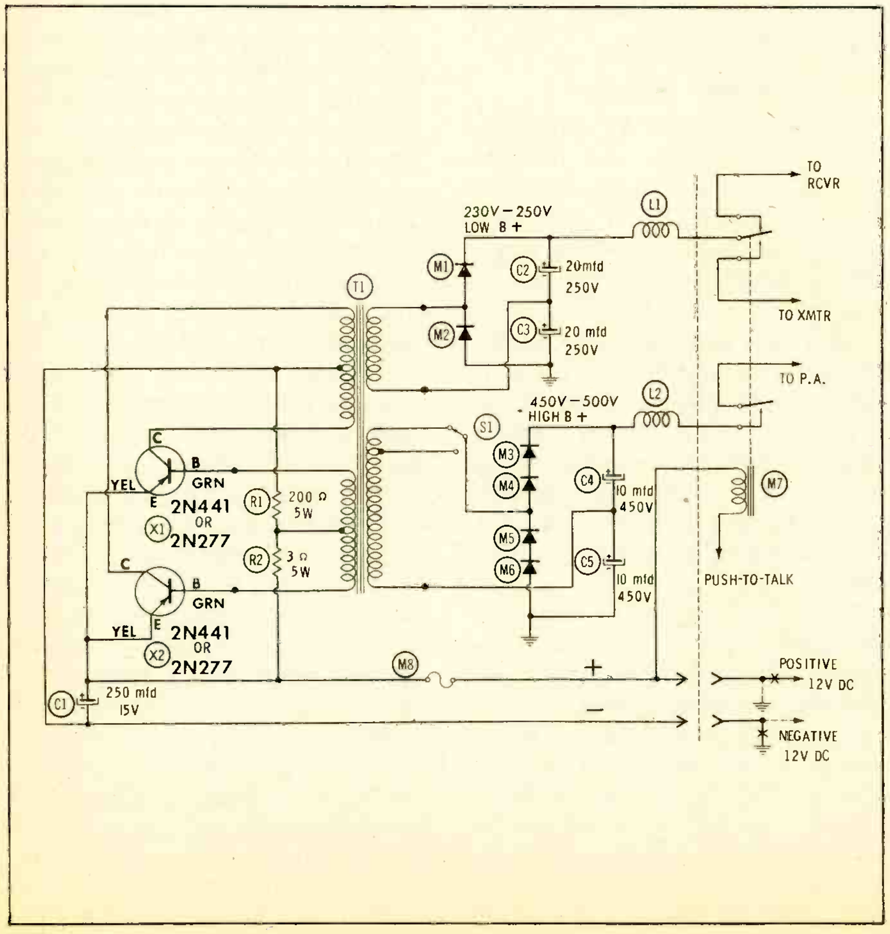

Fig. 1. Transistorized power supply of recent-model two-way mobile radio.

Transmitter Maintenance

To check the results of transmitter alignment, a VOM, a VTVM, or a special test set is needed. In addition, an RF wattmeter or a field-strength meter will aid in properly adjusting the output circuits. If it is necessary to check the carrier frequency and modulation, a frequency and deviation meter is also required. It should be noted here that FCC regulations prohibit anyone without at least a second-class commercial radiotelephone license to tune a transmitter. However, anyone who is technically competent to adjust a transmitter can do so under the direct supervision and *responsibility* of a second- or first-class license holder.

Fig. 2 is a schematic of a nine-tube FM transmitter typical of those operating in the 144- to 174-mc range. Let's go through a complete test procedure for this unit, to illustrate the methods commonly employed in two-way transmitter servicing.

Before starting work, connect the RF output to a 50-ohm dummy load, or to a wattmeter in series with a load. It is also best to let both the test equipment and the transmitter warm up thoroughly before proceeding.

You should first check the low and high B+ voltages—often designated as the B+ and B++, respectively. Lowered supply voltages can cause a variety of troubles; therefore, make sure the voltages delivered by the power supply are reaching the circuits. A convenient point to check B+ is at the screen of driver tube V5; B++ can be measured at the screen of V6.

Alignment

The next step is an alignment check of the transmitter. Before going ahead with this operation, set the transmitter oscillator to the correct frequency. The FCC stipulates that this measurement must be made whenever any transmitter is serviced, so that this is a good time to take care of it.

Using a frequency meter as a standard, C1 is adjusted until the carrier oscillator is precisely on the assigned frequency. Varying this trimmer normally changes the crystal frequency by slightly altering the load capacitance presented to the crystal. If the correct adjustment cannot be attained, C1 or the crystal may be defective. Faulty operation of the crystal oven could also make it impossible to adjust C1 correctly.

When the frequency has been properly set, you can proceed to align the transmitter—remembering that if any of the tuning adjustments fail to show a definite peak, you can assume there is trouble in the associated stage. Two-way units customarily contain provisions for metering the grid current in each transmitter stage, to furnish an indication of proper tuning. Many sets use an 11-pin metering socket into which a test set can be plugged. Others, such as the transmitter in Fig. 2, simply use individual pin jacks located at various points on the chassis. With this type of testing arrangement, a VOM or VTVM can be used for metering purposes. Begin by inserting the DC probe of a meter into the *Mult-1* jack, and connect the common lead to chassis ground. Place the *Tune-Oper* switch in the *Tune* position, key the transmitter, and read the voltage present at the socket. This is a measure of the class-C bias developed by V2B as a result of RF energy transferred from oscillator V1.

The plate of V1 is not tuned, in this transmitter, so no adjustment is necessary. A negative DC reading of between 1 and 2 volts indicates proper operation of the oscillator. If a low reading is obtained, check the oscillator activity directly at the grid of V1. The reading should be at least minus 3 volts DC; if the voltage at this point is low, an inactive crystal, a weak oscillator tube, or a bad component may be the cause. Substitute a good 6BH6 tube and a known good crystal, and once again check the grid-voltage reading. If it is still low, the trouble is probably being caused by a defective resistor or capacitor in the circuit; these components can be pinpointed by additional voltage or resistance measurements.

If the reading at *Mult-1* is low, but the reading at the grid of V1 is normal, oscillator tube V1 still might be the answer; so try another new one. If this doesn't help, leave the new tube in, and try a new 6U8. With both tubes and the crystal known to be good, and if the *Mult-1* reading is still low, the trouble is undoubtedly in one of the other oscillator components.

If the reading is normal at *Mult-1,* move the probe to *Mult-2* and again key the transmitter. A reading of minus 1 to minus 2 volts DC should be obtained here, too. Tune A1 for a peak reading at *Mult-2*. If tuning doesn't give a sufficient reading, try a new 6U8 doubler and a new 6BH6 tripler; then retune A1 for a peak reading.

Next, plug the probe into the *Mult-3* jack and check the RF drive to V4. The voltage at this grid should read between minus 1.5 and minus 2 volts. Tune A2 and A3 for a maximum reading; if the voltage is insufficient, go back and retune A1. If the *Mult-3* voltage is still below normal, try changing V3 and V4, and repeak A2 and A3. If this helps, also go back and touch up A1 again. In many sets, V4 is extremely sensitive to changes in shielding; therefore, be sure the tube shield is in place during tuning and troubleshooting, or the meter readings at *Mult-3* and *Mult-4* will be undependable.

After you have peaked all the readings up through *Mult-3* to your satisfaction, move on to *Mult-4*. Here you should measure minus 1.5 volts DC or better. Alternately tune A4 and A5 for a maximum indication. If necessary, replace V4 and doubler-driver V5, and retune A4 and A5 until the desired reading is obtained. Now, go back and touch up A3.

To align the driver-multiplier stage, insert the DC probe into the *PA Grid* jack and tune the *Driver Plate* and *PA Grid* trimmers for maximum drive. If trouble is indicated in this stage, try a new tube and retune both trimmers.

You'll notice a slight negative reading at the *PA Grid* and *Mult-4* jacks, even with the transmitter off. This is a protective fixed bias that keeps the driver and PA plate currents within safe limits in case the drive to the input of either stage is lost.

Plug the DC probe into the *PA Cath* jack, and switch the meter to read positive voltage. Key the transmitter, and tune the *PA Plate* capacitor for a minimum reading.

The final adjustments to the *PA Plate* trimmer, the *Antenna Tuning* trimmer, and the *Antenna Coupling* control must be made with the antenna connected. Set the coupling for minimum, and switch the *Tune-Oper* switch back to *Oper*. Leave the meter connected to indicate the PA cathode current.

Retouch the *PA Plate* capacitor to assure that the cathode current is at minimum. Increase the antenna coupling until a slight rise in cathode current is noticed. Then tune the *Antenna Tuning* trimmer for maximum cathode current. Redip the *PA Plate* tuning control. Continue this procedure—*Coupling* for slight increase, *Antenna Tuning* for maximum, and *PA Plate* for minimum—until you can scarcely notice the dip in cathode current as you adjust the *PA Plate* tuning trimmer. This is the point of critical coupling, which *should not be exceeded*.

As a finishing touch, you can use an RF wattmeter or a field-strength meter to check the RF output, while you retouch the *PA Plate* capacitor *just slightly* for maximum output. Now, compute the input power for the entry in the FCC log book: Measure the plate voltage (at the end of the plate tank nearest the B+ source) and multiply it by the plate current.

Modulation Adjustment

Modulation control R1 limits the amount of audio fed into the grid of modulator tube V2A. This control should not be touched unless the

PF REPORTER for June, 1962, Vol. 12 No. 6. PF REPORTER is published monthly by Howard W. Sams & Co., Inc., 2201 E. 46th St., Indianapolis 6, Indiana. Second-class postage paid at Indianapolis, Indiana. 1, 2 & 3 year subscription prices: U.S.A., its possessions, and Canada: $4.00, $7.00, $9.00. All other countries: $5.00, $9.00, $12.00. Current single issues 35c each; back issues 50c each.

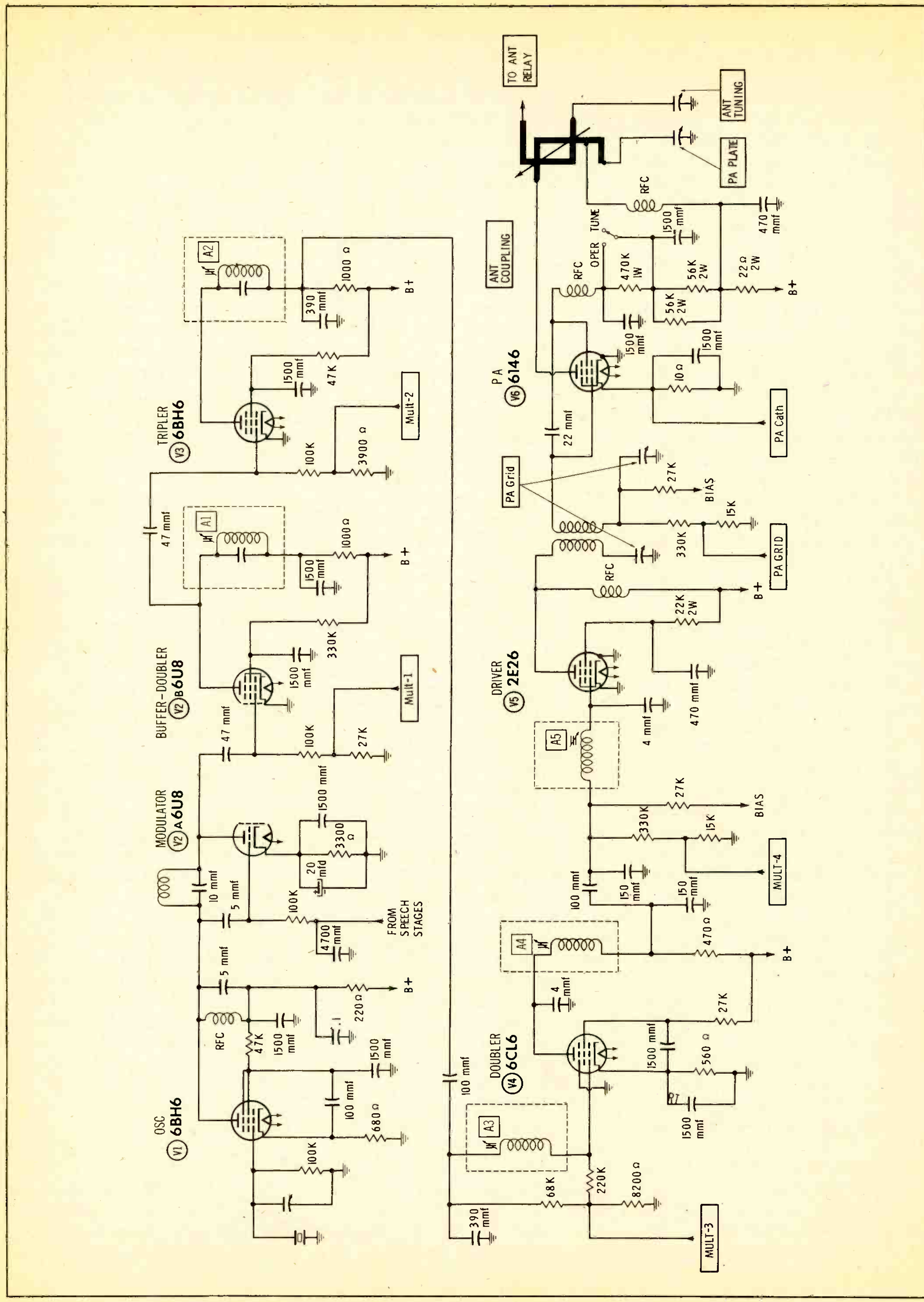

Fig. 2. Most transmitter stages include metering points to aid in alignment.

modulation-deviation reading (the FM equivalent of modulation percentage) is too high or too low. If it should be necessary to adjust R1, do not exceed a total modulation deviation of ±5 kc for the new narrow-band transmitters, or ±15 kc for wide-band systems. In order to set the frequency deviation, whistle loudly into the mike while monitoring the signal on a deviation meter.

If weak or distorted modulation is apparent in the transmitter, first try a microphone known to be good. Next, try substituting the amplifier and limiter tubes, as well as the modulator tube. If neither of these remedies is effective, put the old tubes back in the sockets and get out your oscilloscope. Feed an audio signal (400 to 1500 cps) into the mike input, key the transmitter, and with a .01-mfd blocking capacitor in series with the scope probe, take readings right down the audio string, beginning with the mike jack. Check the waveforms in the amplifier and limiter stages for any unusual changes. This waveform should remain very nearly a pure sine wave from the input jack to the modulator. Any undue distortion of this signal will show up on the scope.

As a general rule, FM communications transmitters are all pretty much the same, each consisting of speech amplifiers, an oscillator, a modulator, frequency multipliers, and a final power amplifier. Some makes differ in chassis layout, but not drastically. Once you get the "feel" of aligning a transmitter (and this doesn't take long), you can confidently tackle any troubleshooting job.

Receiver Maintenance

Like transmitters, two-way radio receivers contain metering points which simplify troubleshooting. In some units, these points are brought out to individual pin jacks; in other sets, special multiple-pin sockets are used for metering.

The typical receiver diagrammed in Fig. 3 has six key check points connected to an 11-pin socket M1 on the front of the chassis. A special test set can be plugged into this socket for metering, but any meter with a 50-ua movement can be used just as well. Pin 11 of M1 is connected to ground, and the remaining terminals are wired to test points in the circuits. Pin 1 goes to the grid of the third amplifier in the low (455-kc) IF strip; pin 2 connects to the grid of the first limiter; pin 4 is wired to discriminator load resistors; pin 5 provides for monitoring the amount of signal present at the input of the discriminator; and pin 6 permits measuring the activity of the local oscillator. The positions just mentioned are monitored with the meter on the negative scale—except pin 4, where the voltage may read zero, plus, or minus. Position 7 has a B+ voltage (approximately 200 volts) on it, so the meter must be set accordingly. Pin 8 is not used in this model, but positions 9 and 10 carry audio signals for an external speaker.

An RF signal generator, a voltmeter (or a test set, as described on page 82 of this issue), and a speaker are all you really need for checking and aligning the receiver in Fig. 3. The RF generator is used to inject a signal into the antenna receptacle of the radio. If an AM generator is used, the modulation should be kept off, or distortion will occur. If an FM generator is used, the deviation should not exceed the bandpass limits of the receiver.

When a signal generator isn't available for alignment, a transmitter on the same frequency as the receiver can provide an accurate signal. Generally, the transmitter to be used should be terminated in a dummy load, in order to prevent interference with other stations on the same channel. If the signal is so strong that it drives the receiver limiters into saturation, the units must be moved farther apart. In some transmitters, the final amplifier can be operated at reduced power if necessary, by simply flipping the *Tune-Oper* switch.

The amount of RF signal needed at the input socket for the most accurate alignment depends on the condition of the receiver. The best way to determine the optimum signal level is to use the limiter grid (pin 2 on socket M1) as an indicator. The signal should be just sufficient to cause the meter reading to rise. When an increase in signal input fails to increase the meter reading, the limiters have become *saturated*, and less signal voltage should be used.

The limiter reading is generally used throughout the alignment procedure as an indication of the effects of tuning; as the gain of the receiver increases, the limiter reading likewise increases. In the event the limiter becomes saturated, the signal input should be reduced, or pin 1 instead of pin 2 on M1 should be metered during the rest of the tuning procedure.

Alignment

The first step in alignment is to set the discriminator for a center frequency of precisely 455 kc; this circuit can then be used as a reference to set the signal generator for subsequent steps. When a very accurate 455-kc signal is loosely coupled to the grid of the first low-IF stage, the meter reading at pin 4 of M1 should read *zero* if the discriminator is on frequency. If this circuit is slightly out of adjustment, the voltmeter reading will be either positive or negative; in this case, carefully adjust the secondary of the discriminator transformer to obtain a zero reading. This procedure is known as *calibrating* the discriminator. If the reading is zero, the discriminator adjustment is okay.

Next, move the signal-injection point to the grid of the second mixer, and tune the low-IF stages for maximum voltage at pin 2 of the test socket. If the limiters go into saturation, causing the reading to "flatten out" or show little response to tuning, remember to reduce the signal level from the generator. An unusually flat tuning response, if not caused by saturation of the limiters, may mean trouble in the low-IF section. Try replacing the tube preceding and the tube following any coil which fails to align properly. If this doesn't cure the trouble, search for a component fault in the associated circuits, including the coil itself—it might be the defective part!

The next step is to align the RF and high-IF coils. These adjustments must be made with an input signal tuned precisely to the station frequency. A signal of the required accuracy can be obtained by using the station transmitter, or by using

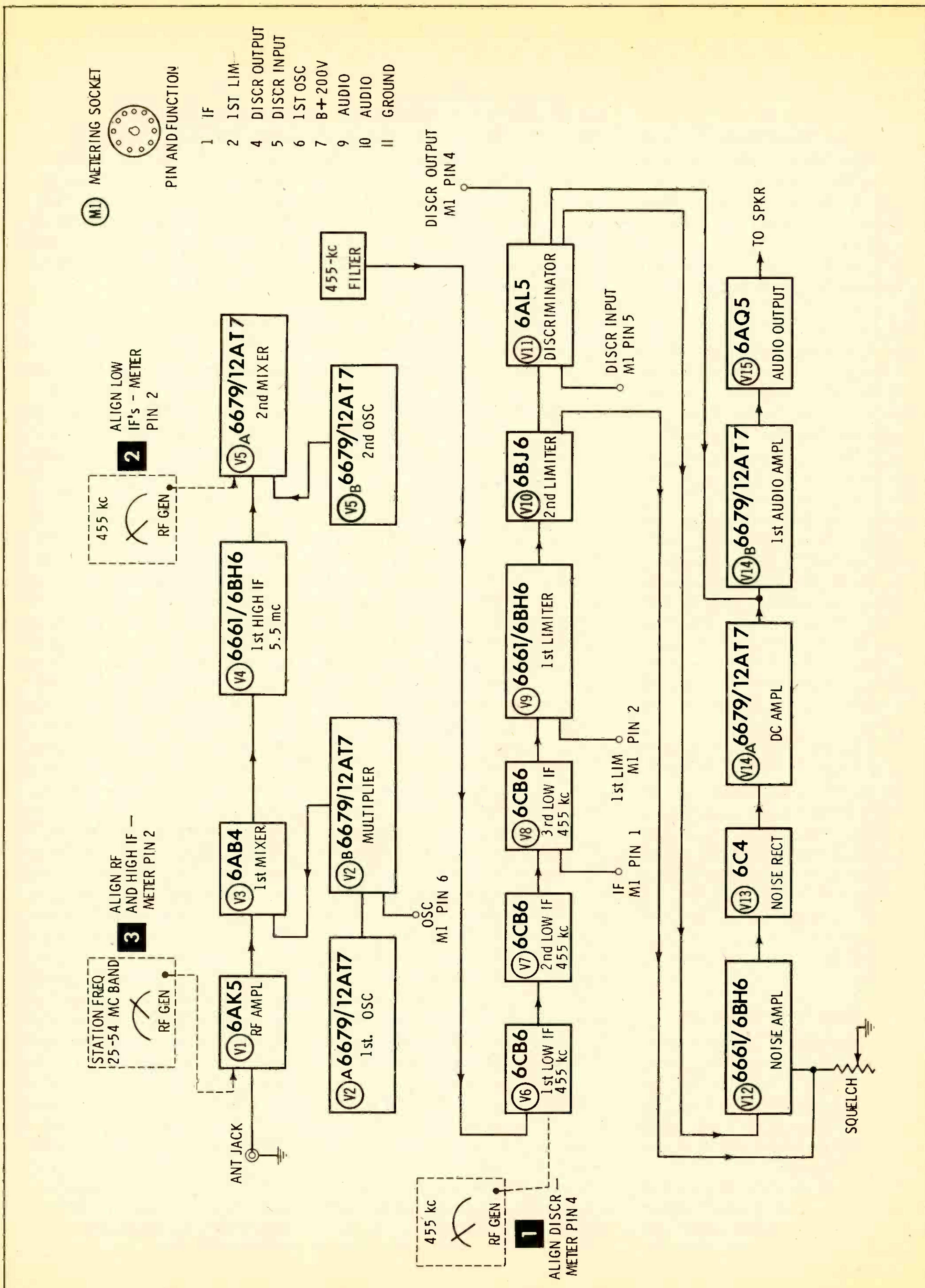

Fig. 3. Test connections for aligning double-conversion mobile receiver.

the radiation from an accurately adjusted heterodyne-type frequency meter.

The signal is fed into the front end of the receiver via the antenna jack. Meter the discriminator at pin 4 of M1, and adjust the signal generator for an exact zero reading. Then, move the meter to pin 5, and while feeding in a strong enough signal to saturate the limiters (pin 2), peak the primary of the discriminator transformer. With the meter at pin 4, readjust the secondary winding for zero again, if necessary. Now the signal generator and the receiver are exactly on frequency.

Connect the meter to pin 2 again, and reduce the input-signal level to a point where the limiters are not saturated, so that the effects of tuning the RF and high-IF coils will be noticeable. Begin with the coil in the grid circuit of the second mixer and work back to the RF input circuit, tuning each coil in succession. Be sure to tune all three coils in the first oscillator-multiplier circuit, adjusting each one for a maximum reading at pin 2. This completes the alignment.

To check the sensitivity of the receiver, you'll need a generator with a calibrated output-level control. Connect the generator as for alignment, and set it exactly on frequency, using the pin-4 reading as an indicator. Connect the test leads of an output meter to pins 9 and 10 of M1 for measuring the audio output of the receiver. Reduce the generator-signal level to zero. Adjust the volume control of the receiver for approximately 10 volts of circuit noise, as measured by the meter; then advance the output control of the signal generator until the quieting action of the signal reduces the noise level to 1 volt. This operation produces a 20-decibel reduction in the noise, or *20-db quieting*. Read the signal level on the generator, which tells the number of microvolts of signal needed to quiet the receiver by 20 db.

A normal receiver will exhibit a sensitivity on the order of 0.5 microvolts. If more signal is required to quiet the set, its sensitivity is too low, and careful retuning and checking of the RF and high-IF stages is in order.

Squelch Circuits

The high-gain receiver of a two-way radio generates considerable circuit noise, and also greatly amplifies the noise caused by atmospheric interference. However, this noise is not heard during reception of a signal, because it is suppressed by the FM limiters. On the other hand, when no signal is present, the noise is stopped by the action of a *squelch* circuit in the receiver.

In Fig. 3, this circuit is composed of V12, V13, and V14A. Noise is amplified, rectified, and applied to the grid of the audio amplifier, to bias it into cutoff during times when no signal is being received. When a message arrives, the noise voltage disappears, and no rectified DC is applied to the audio stage; the audio amplifier then "opens up" and passes the signal.

Servicing the squelch circuit consists simply of tracing the noise signals, checking the DC voltages developed by the noise rectifier, and making certain they are properly applied to the audio amplifier. A very comprehensive analysis of squelch circuits, along with procedures for troubleshooting defects in these stages, is presented in "The Imperfect Squelch" in this issue.

Control Section

In many installations, the unit is mounted in a location away from the operator, such as in the trunk of an automobile. A control box is provided and mounted in the driving compartment so the driver can control the equipment. A multiconductor cable connects the control head with the unit proper.

In a typical control box (Fig. 4), on-off switch S1 energizes control relay M1, which applies power to the main unit. Indicator lamp M2 then lights, signifying that the unit is on. The other lamp, M3, is lit when the push-to-talk switch of the microphone is depressed, indicating that the transmitter is on the air. Also mounted on the control head are the 20-ohm volume control, which adjusts the audio fed to the speaker, and the 15K-ohm squelch control, which completes the ground return for the noise amplifier in the receiver.

Some transceivers are equipped for two-channel operation. In these sets, the control box contains a switch marked F1-F2 which completes the cathode connection for one of two first oscillators in both the transmitter and the receiver.

Intercabling and Control Relays

Notice in Fig. 4 that the control unit and the transceiver are interconnected by a multiconductor cable, which is usually run underneath the floor mat from the dashboard to the trunk of the car. The antenna lead-in is generally run from the transceiver to the roof of the car between the headliner and the metal top.

Power-control relay M1 is mounted under the hood near the battery; its contacts apply the battery voltage to the mobile unit. One end of the relay coil is connected to the battery, while the other end goes to on-off switch S1 in the control unit. When the switch is thrown, the ground circuit is completed, energizing this relay.

When the microphone switch is depressed, it connects pin 2 of mic jack M4 to ground, energizing *transmit-receive* relay M5. This relay disconnects B+ from the receiving tubes, and applies it to the transmitter. At the same time, it completes the A+ circuit to antenna-changeover relay M6, changing the antenna connection from the receiver input to the transmitter output.

Troubleshooting Hints

In a two-way radio there are many possible causes of trouble, and some of the most difficult troubles to isolate are those which occur in the control system. The contacts of M1 can become corroded and pitted over a period of time, causing a noticeable voltage drop across them. This, of course, means that full voltage will not reach the transceiver, resulting in lowered efficiency in both transmitter and receiver. This trouble is best found by measuring the battery voltage, and then checking the A+ present at the transceiver.

Loose connections on the relay terminals and the fuse block can also account for a loss between the battery and radio. In addition, the fuse clips that hold the 30-amp fuse often become dirty, and the fuse makes poor contact. Occasionally, a fuse will become corroded internally, and voltage is dropped across it. This is easily spotted by feeling the fuse after a long period of operation—the case will be warm.

In the older transceivers, the contacts of relays M5 and M6 often become pitted and worn. If this happens, B+ to the transmitter and/or the receiver is apt to be erratic, and the antenna changeover is not always accomplished properly. If the antenna-relay contacts are bad, the transmitter and receiver range will be greatly reduced.

The symptoms of a shorted or open antenna are the same—that is, poor receiver sensitivity and little or no transmitter range. The automobile-mounted antenna may open or short at its base, or its lead-in cable may open or short at the connector that fits onto the transceiver. This last trouble is often caused by a poor soldering job at the time of installing. For maximum transferral of RF power from the transmitter to the antenna, a good solder connection is a must at this connector.

Conclusion

The commercial two-way radio user is a businessman. interested primarily in how much money his radio system can earn or save him. He is therefore willing to pay more for *skilled* service on his equipment than a TV owner would pay to get his television set repaired. If the technician takes the time to do a good complete job when repairing a two-way transceiver, he will find the two-way user quite satisfied to be charged a fair price for this work. Generally, the service shop that has built a reputation for high-quality repair and maintenance work will have little trouble finding complete two-way radio systems to maintain. ▲

As a reminder of the steps which should be taken to thoroughly service and repair a two-way radio, the following chart is provided:

1. **Check power supply.**
2. **Check transfer relays.**
3. **Check power to transmitter circuits.**
4. **Check and adjust frequency.**
5. **Align transmitter amplifiers.**
6. **Dip plate tuning, increase coupling, tune antenna, and finally, peak plate tank for maximum output.**
7. **Measure PA input power. Log.**
8. **Adjust modulation deviation.**
9. **Check receiver audio stages.**
10. **Align discriminator, low IF.**
11. **Align high-IF and RF stages.**
12. **Align oscillator doublers.**
13. **Check squelch circuits.**
14. **Check mobile installation.**

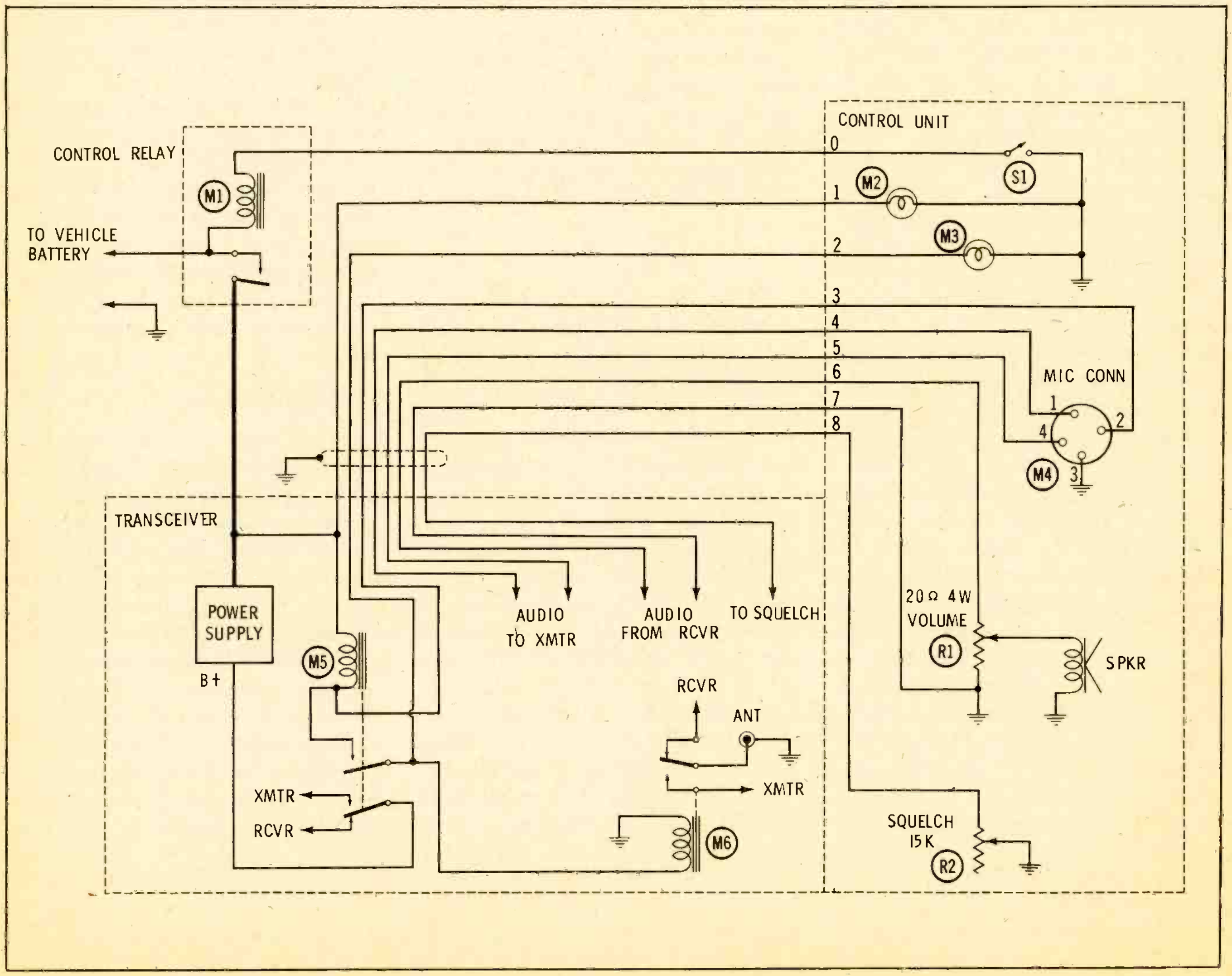

Fig. 4. Operating controls and speaker are in separate, dash-mounted control unit.

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Indexed in Lectrodex.
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PF REPORTER

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VOLUME 12, No. 6 — JUNE, 1962

CONTENTS

Servicing Two-Way—The Right Way — 1
A special 8-page feature on understanding and troubleshooting modern communications radios.

Letters to the Editor — 16

Communications Service Pricing Guide — 26

Mobile-Installation Know-How — *Forest H. Belt* — 28
The expert way to arrange equipment, route cables, and mount antennas.

Speaking of Stable Sync . . . — *Thomas A. Lesh* — 30
. . . could you use some help in figuring out a system for pinpointing sync troubles?

The Imperfect Squelch — *Patrick M. Craney* — 32
Receiver noise can get very annoying if this circuit has trouble.

Color-Alignment Setups — *George F. Corne, Jr.* — 34
Quicker Servicing—How to use the VSM method of checking chroma-bandpass response.

Blueprints for Service Benches (Part 2) — 36
Here's an efficient setup with roll-out bench sections and built-in test facilities.

Crystals for Communications — *Jim Galloway* — 38
Different types of "cuts" and how they control oscillator frequency.

The Electronic Scanner — 49

Maximum Efficiency From CB — *Edward M. Noll* — 50
This low-powered equipment can't tolerate careless maintenance; here's how to reach that extra distance.

Handling Credit On Your Own — *K. V. White* — 58
Dollar and Sense Servicing—Advice on evaluating credit references and improving collection efforts.

Testing Transmitters — *Keith Bose* — 66
Techniques for upholding performance standards that will satisfy both the user and the FCC.

Notes on Test Equipment — *Forest H. Belt* — 76
Lab reports on the Precision Model 650 Tube Tester, Sencore Model RC121 Substitution Unit, and Philmore Model FS-1W Field-Strength Meter.

More on the Universal Test Set — 82
Circuit revisions for improving the two-way radio metering instrument introduced in the December, 1961 issue.

The Troubleshooter — 84

Radio-TV Service Puzzle — 94

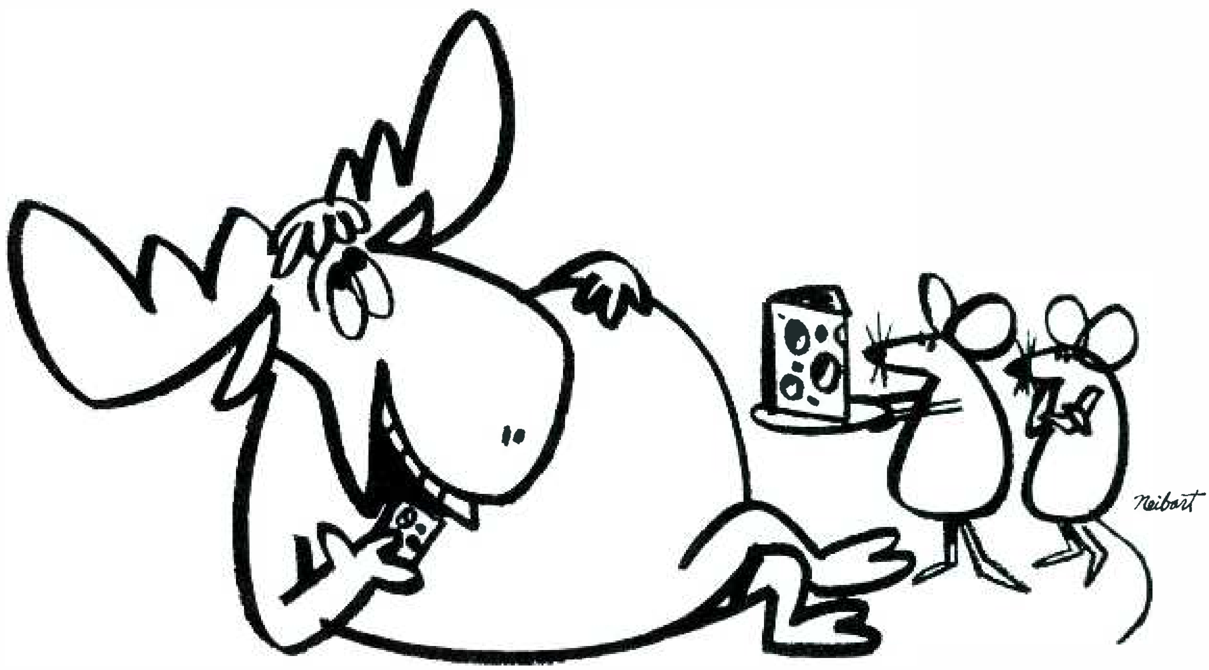
Product Report — 102

Free Catalog & Literature Service — 104

Monthly Subject Reference Index — on free literature card

ABOUT THE COVER

Are you "in the dark" about the many opportunities open to independent servicemen in two-way radio maintenance, or is the message reaching you? This month's special issue answers the growing interest in communications radio expressed by many of our readers.



The Moose and The Mice

(A fable for Service Technicians)

ONCE upon a time, there was a Moose who liked cheese.

But, being a Moose, he had a hard time getting it. A Moose can't sneak into houses, or stores, or cheese factories. So the poor Moose went cheese-hungry until, one day, he had a brilliant idea.

"Mice can get cheese with the greatest of ease," he said to himself. "Perhaps I can get some mice to help me." So off he went to the nearest Mouse colony.

"Look, Mice," he said. "I've come to do you a favor. I want to be your protector against cats and foxes and any other varmints that trouble you."

The Mice were interested. "But what do you want in return?" they asked.

"Cheese!" said the Moose. "You can pay for my services in cheese."

"Cheese! That's a breeze!" cried the Mice. "Go ahead; start protecting." So the Moose did.

He hung around the Mouse colony and whenever a cat or a fox or a weasel appeared, the Moose ran him half-way out of the county. The Mice were grateful and happy, and they paid off the Moose with huge quantities of the finest Cheddar and Roquefort and Gorgonzola. The Moose ate and ate, and grew and grew, and before long he was so fat and lazy that all he wanted to do was to eat and sleep. Naturally, his protecting went to pot.

The Mice began to complain. "We're your *customers,*" they protested, "but you treat us like bill collectors. Get on the job and give us some service!"

The Moose snorted disdainfully. "You *need* me," he told them. "I'm the Big Wheel in these woods. You're *lucky* to be my customers!"

"Oh, yeah!" cried the Mice. "Don't try to be a big deal when you're full of cheese. We're taking our business elsewhere!"

So the Moose was left without a market. To get cheese, he had to take employment with a cheese merchant, who sawed off his antlers to make him look like a horse and put him to work pulling a cheese wagon. And, instead of getting prime ripe cheese, he had to be satisfied with the rinds and scrapings of cheeses that had spoiled.

MORAL: It's all right to grow big provided your *head* doesn't!

Some people save $400 a year right here.

$800 in 2 years.

$1,200 in 3.

Every penny of it in gas stations.

(Of course, you have to have the right truck.)

Volkswagen owners who do 25,000 miles a year tell us their former trucks ran them about $800 annually in gas alone.

And that they cut this in half when they changed to our Volkswagen.

It isn't surprising.

Almost all our trucks get over 20 miles a gallon. Some even get 30.

24's average.

(Regular gas, of course. A Volkswagen never touches the strong stuff.)

But gas isn't all you save on.

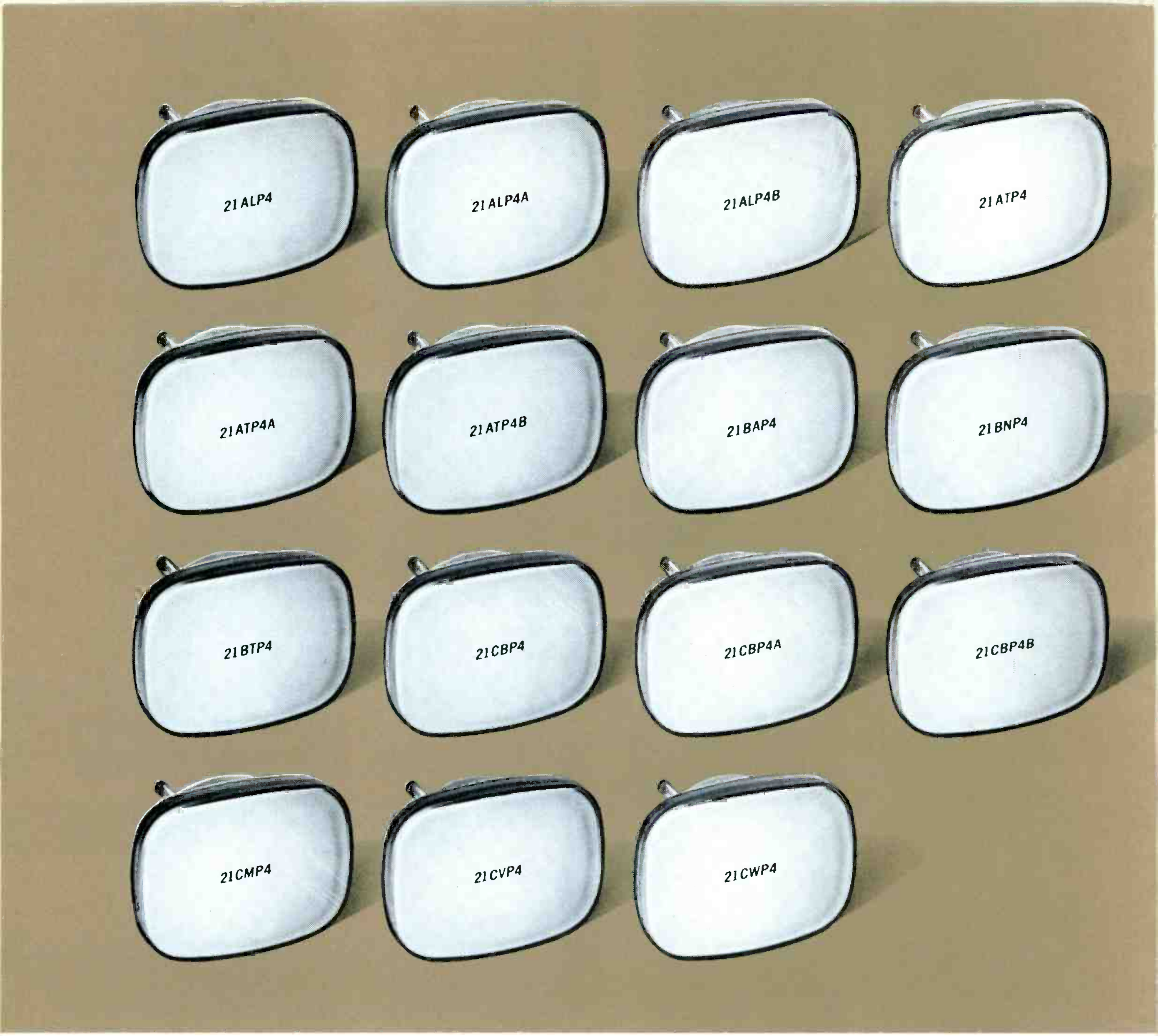
Tires on Volkswagen Trucks go about 35,000 miles.

And maintenance usually runs only half the cost you pay with standard trucks.

Nor is this the end of the nice things.

Our truck's only $1,895* to begin with.

So you save a few hundred before you even get off the premises.



Why stock all these...

when one does the job

Theres
NEW POWER
in Westinghouse tubes!

New Westinghouse Universal (type 21FLP4) is the picture tube you've been waiting for! It replaces 15 other tube types. It drastically cuts your inventory . . . simplifies your ordering . . . makes stock control far easier . . . keeps you from "losing out" in on-the-spot tube replacements. Saves time and work on service calls, too; the Westinghouse Universal is a low-voltage electrostatic focus tube—needs no ion trap.

Now—you share in the profits! With the new Westinghouse Profit Sharing Plan you get a bonus on every tube you sell. Each tube comes with a Golden Profitab good for many valuable gifts—rifles, outboard motors, watches—scores of others. Each picture tube Profitab is worth 64 points; receiving tubes, 4 points. Start participating now! For complete details—and your free gift catalog—call your Westinghouse Distributor or write your nearest Sales Office. *You can be sure . . . if it's* **Westinghouse**

LETTERS TO THE EDITOR

Dear Editor:

Regarding the trouble Ray D. Ellis of Erie, Pa. has been having with "temperamental sound" (December *Troubleshooter*), you gave him the runaround! In the same column in December, 1959, you recommended changing the ratio-detector transformer to cure the same trouble in a similar Hotpoint set. That answer was right; in fact, it's the only cure for this trouble in the G-E 24C182 series. We have changed plenty of these babies.

This time, you recommended isolating the trouble with a chilling chemical, but the spray can't reach the trouble spot—a 120-mmf capacitor in the base of the can.

TOM MORAN
Rucki's, Inc.
Holyoke, Mass.

"The Troubleshooter" says he'd understood that Mr. Ellis had tried all of our previously published solutions to this problem, and therefore suggested an approach which would help determine what other component might be at fault. We're glad to know, however, that you have found replacement of the transformer to be the only cure for "temperamental sound" in this chassis.—Ed.

Dear Editor:

How can a serviceman work on the new 20-kv TV chassis at close range in the shop without risk of "soft" X-ray radiation exposure, and just how harmful is this radiation?

RUDY SCHMITT
Calumet, Mich.

You won't need a lead suit! All available evidence indicates virtually no danger to TV men from X-rays, as we pointed out in "Report on TV Radiation Hazards" (December, 1960 issue). In the preparation of this article, we undertook a series of laboratory tests in collaboration with Nuclear Measurements Corp. of Indianapolis. Using sensitive radiation-measuring equipment, these tests were conducted on receivers with anode voltages measuring as high as 23.5 kv. Quoting from the report,

"Although absolute limitations on radiation exposure cannot be stated at this time, we concluded from our tests and medical references that even if a technician remained in direct contact with a radiating picture tube for 40 hours a week, the dose received would still be unlikely to exceed the present-day safety rating. Another encouraging point is that radiation intensity is inversely proportional to the square of the distance from source to object; for example, if we had simply moved our detector probe back 6" from any given spot on the tube's glass, the radiation intensity would have been approximately ¼ that previously obtained."

It is also reassuring to note that the soft X-rays generated by voltages in the 20-kv range have difficulty in penetrating even the outer layer of the skin. Thus, TV radiation appears to be something we can safely live with from day to day.—Ed.

Dear Editor:

I sure liked the special transistor edition in March—very good coverage! But I would hate to have something come in wired as shown in Fig. 11 on page 7; it really could be a tough dog.

MERLE F. BARKER
Barker Electronics Service
Concordia, Kans.

Wow! We sure fouled up the schematic symbol for X2, the lower transistor in the push-pull pair. The circuit will be correct if you will substitute an NPN for a PNP symbol, and turn it upside down (with emitter at top).—Ed.

Dear Editor:

I read with interest George Pratt's prattling in the March issue, and would like to state my feelings.

I first became acquainted with you through the September-October, 1951 issue of PF INDEX, and have on file all issues to date. I've tried them all, and have settled on PF REPORTER and one competitor. If Pratt dislikes your magazine, they sure must have some whiz-bang publications in Oregon that we don't have here.

HOWARD Z. DEHLINGER
Buffalo, N.Y.

Dear Editor:

Mr. Pratt (March *Letters*) must be a doctor or a dog catcher . . . or just doesn't give a darn for good magazines. I've taken all the radio and TV magazines—but yours is the only one I take now.

AL HART
Griffith, Ind.

Thanks, fellows, for the vote of confidence. On account of your long-standing loyalty, Howard, we'll forgive you for helping support one competitor.—Ed.

Dear Editor:

In the chart of transistor-tester specifications on page 26 of the March issue, I was disappointed to find no mention of the Sencore Model TR115, which checks leakage, shorts, and actual DC beta of transistors (including power types), and also checks diodes. Also omitted was the fact that the Model TR110 is capable of making in-circuit transistor tests. Incidentally, both testers include a PNP-NPN selector switch.

R. H. BOWDEN
President
Sencore, Inc.
Addison, Ill.

The editor who left the TR115 out of the chart has been put on bread and water for a whole week. For complete data on the TR110 transistor tester, see the "Notes on Test Equipment" column

• *Please turn to page 20*

*(Original Equipment Quality)

BECAUSE...

QUALITY COMES FIRST WITH

The same careful craftsmanship, materials and designs are used in every Clarostat control—whether for the most critical original equipment manufacturer or for replacement needs. There is only a single standard at Clarostat—the best quality possible.

It's a fact—replacement controls are run on the same production line, receive the same inspection and are the same quality as original equipment at Clarostat. This fact assures you of top performance every time you use a Clarostat control ... so, always ask for Clarostat quality in that well-known green box . . .

- A complete line of wire-wound controls meeting all replacement needs.
- The right single or dual carbon control for every radio and TV need.
- Factory-assembled RTV replacement controls to save you time and troubles.
- Uni-Tite field assembled duals—first to provide easy, fast assembly.
- Push-pull switches, sound system controls—and a host of others to fill every servicing need.

CLAROSTAT

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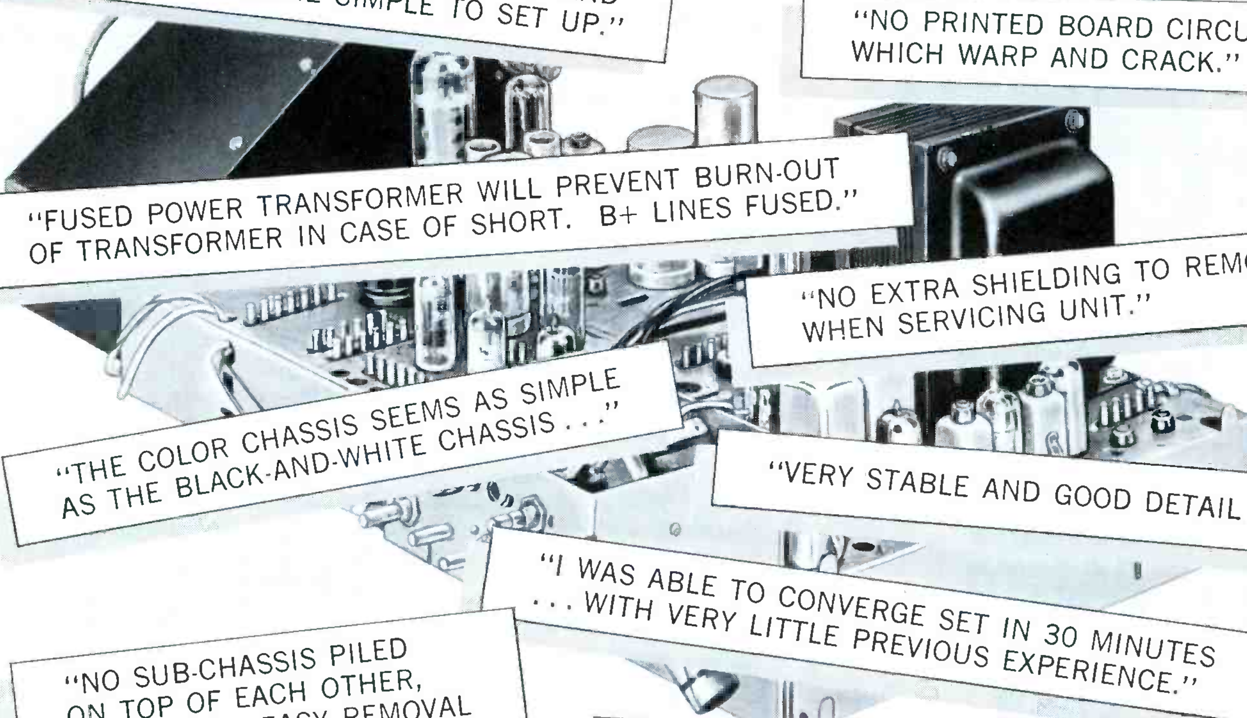
In their own words, Independent

NO MECHANICAL
ZENITH HANDCRAFTED



"REMOVAL OF CHASSIS FROM CABINET WITHOUT DISTURBING ELECTRICAL OR STATIC CONVERGENCE."

"... EASIER TO LOCATE TROUBLE AND DEFINITELY MORE SIMPLE TO SET UP."

"NO PRINTED BOARD CIRCUITS WHICH WARP AND CRACK."

"FUSED POWER TRANSFORMER WILL PREVENT BURN-OUT OF TRANSFORMER IN CASE OF SHORT. B+ LINES FUSED."

"NO EXTRA SHIELDING TO REMOVE WHEN SERVICING UNIT."

"THE COLOR CHASSIS SEEMS AS SIMPLE AS THE BLACK-AND-WHITE CHASSIS ..."

"VERY STABLE AND GOOD DETAIL ..."

"I WAS ABLE TO CONVERGE SET IN 30 MINUTES ... WITH VERY LITTLE PREVIOUS EXPERIENCE."

"NO SUB-CHASSIS PILED ON TOP OF EACH OTHER, MAKING FOR EASY REMOVAL FROM CABINET."

"... MADE WITH THE SERVICEMAN IN MIND."

EVERY ONE OF THESE QUOTES FROM A SERVICEMAN WHO SERVICES COLOR TV!

Letters

(Continued from page 16)

on page 50 of the May, 1961 issue, which describes the capabilities of this tester at considerable length.—Ed.

Dear Editor:

I'm having difficulty in my attempts to secure parts for *Kent* transistor radios. (This brand is not included in the list you published in your January issue.) My main concern is for volume controls and tuning capacitors; since these are particularly small items, available substitutes will not fit into the allotted space.

W. F. STAMM

Riverdale, N. J.

The importer of these sets is Kent Overseas, 14 W. 23rd St., New York, N. Y. We suggest contacting them for further information.—Ed.

Dear Editor:

I can't help being amazed at the difference in people from various parts of our country. With 12 year's experience in this town, I don't see for the life of me how Mr. Art Margolis ("Coping With Callbacks," April issue) gets by with holding customers' TV sets for six hours after repairing them.

How can I "cook" a TV when the customer comes back for his set before I can get it back in the cabinet? Some even bring their sets in and stand there while I do the repairs. The way it generally goes is, "I'm not in a hurry, so take your time—as long as you can have it fixed in 30 minutes."

We always tell customers that we haven't had time to see if anything else is wrong with the set. The answer is always the same: "We'll take it home and play it; if it isn't all right, we will bring it back." Sure—I'm supposed to fix another trouble at no additional charge!

On service calls, if we're not at some customers' homes within 20 minutes, they call someone else.

JERRY JACKSON

Paris, Ky.

Perhaps the city fathers would consider putting tranquilizers in the public water supply!—Ed.

ODE TO FRUSTRATION

The TV sound went up and down;
the owner was dismayed.
Technician hauled it to the shop;
it played and played and played.
Technician hauled it home again;
no difference had he made.
He probed and cursed
and checked and prayed—
The thing played on,
no bug displayed—
So back it went for one last try;
all week no money made.
The intermittent sound was in
the owner's hearing aid!

JACK DARR

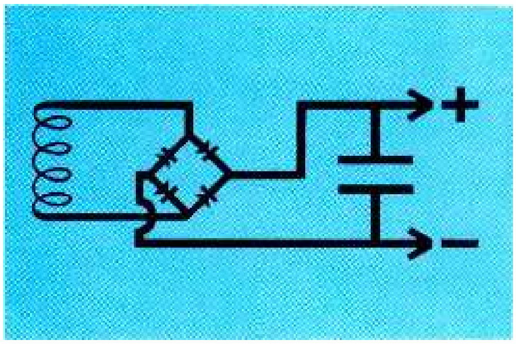
Mena, Ark.

"Intermittent's hard to find,
Fifteen dollars for my time."
To the serviceman's dismay,
All the owner said was, "Eh?"—Ed.

Tips for Technicians

Distributor Division, P. R. Mallory & Co. Inc.
P. O. Box 1558, Indianapolis 6, Indiana

Hints on Reducing Hum . . .



In high fidelity sound systems . . . and in many kinds of commercial and industrial electronic equipment . . . reduction of 60-cycle hum is one of the toughest problems that a technician has to tackle. Most hum comes from 60-cycle voltage sneaking into the signal circuit. There are, of course, many well-known precautions that should be observed . . . using shielded or coax cable between major components, keeping cables short especially in the low-level portion of the system, making sure connectors are tight. Here are some other thoughts that may be useful.

Power supplies in sound systems . . . hi-fi or commercial . . . generally operate at higher temperatures than those encountered in radio or TV. So it pays to be particular about filter capacitors. It pays to use electrolytics rated at 85° C. Those rated at only 65° C start to run into trouble. Then too, because of the added heat, the vent construction is important. In other words, "How good is the seal?" Our tip is to always use Mallory FP-WP electrolytics . . . voltage ratings are conservative and dependable . . . they have excellent stability at high temperature . . . and they all have *etched cathode* construction. This latter is extremely important in avoiding hum. We covered the reasons in a previous TIP (remember?).

Here's another source of hum . . . filament circuits. Many of the highest quality sound systems use a DC filament supply in the preamplifier. It's easy to add this refinement to any system. All you'll need is a Mallory FW-50 "packaged" silicon rectifier circuit. It's encapsulated in a tiny plastic block and takes up very little space. Simply connect the FW-50 to the circuit, add a WP-042 electrolytic and filament hum disappears permanently. If you want more specific information, write and ask us.

Another tip: call on your Mallory Franchised Distributor for prompt service, at sensible prices, on Mallory capacitors, switches, silicon rectifiers, controls, and batteries . . . and for any other parts you may need.

RCA COLOR PARTS AND DISPLAY RACK STOCK No. 11A1014

• Convenient • Compact

Because of the ideal size of this rack, it lends itself very well to mounting on the wall or on the service work bench.

126 ESSENTIAL COLOR PARTS FOR SERVICING RCA COLOR CHASSIS TYPES CTC 10 & CTC 11

A complete color service center.

SEE YOUR RCA DISTRIBUTOR NOW!

PARTS & ACCESSORIES

new

RCA COLOR TEST JIG

#11A1015

A **must** for any serviceman now servicing or planning to service Color TV receivers ■ Make a one man service call out of a costly two man cabinet pulling job ■ Eliminate possibility of damage to the customer's set when transporting to and from his home ■ Eliminate the need to reconverge the customer's set when the chassis is returned ■ Professional Appearance—Finish matches that of RCA Test Equipment ■ Partial Assembly—Safety glass and kine mask assembled at factory ■ Components Kit furnished with Test Jig includes all necessary components, hardware and Instructions for installation of an RCA Tri-Color Kinescope ■ Convergence control panel supplied provides dynamic as well as static convergence for the CTC-10 and CTC-11 chassis ■ Instructions included with test jig provides data for utilization with CTC-4, 5, 7 and 9 chassis and lists extension cables required ■

CONTENTS OF PARTS KIT SUPPLIED WITH TEST JIG

Description	Quantity	Stock No.
Cushion—Plastic, for kinescope mounting	2	105033
Shield—Plastic, for anode contact	1	105034
Lead—Anode lead	1	105539
Resistor—Fixed Comp. 56K± 10%, 2W	1	—
Spring—For anode resistor	1	105028
Yoke—Deflection yoke	1	109457
Convergence assembly	1	—
Ring—Purity magnet	1	79604
Magnet—Blue beam lateral	1	103172
Clamp—For convergence cable	1	—
Screw—For mounting convergence assem.	3	—
Lead—Ground lead	1	—
Clip—For ground lead	1	—
Tool kaddy	1	—

see your RCA distributor for details

RCA parts & accessories/camden, n. j.

act now for the color season

RCA The Most Trusted Name in Color Television

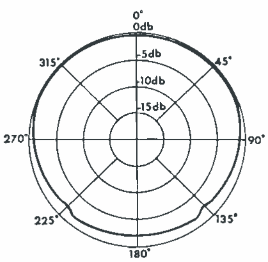
RADIO CORPORATION OF AMERICA

Now, after over 2 years of field testing, the 644 has thoroughly proved its ability to solve sound jobs previously thought impossible! If you haven't yet tried the 644, pick the job that other microphones couldn't "reach"... then find out for yourself why the 644 is the brightest new idea in microphones!

those "impossible" sound jobs!

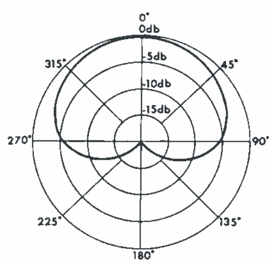
compare polar patterns yourself

NON-DIRECTIONAL



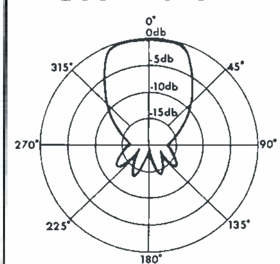
NON DIRECTIONAL MICROPHONE

CARDIOID



CARDIOID UNIDIRECTIONAL MICROPHONE

SOUND SPOT



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- Four times greater working distance than the best cardioids, depending on acoustics
- Greatly reduces feedback
- Retains "on-mike" presence despite extended working distance
- Excellent outdoors . . . less wind noise
- Priced low to fit most budgets
- Lasts a lifetime

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Trenton—Nidisco-Trenton, Inc., 985 Princeton Avenue
Union City—Nidisco Jersey City, 2812 Hudson Blvd.

NEW MEXICO
Albuquerque—Sound Equipment & Hi Fi House, 3011 Monte Vista Blvd., NE

NEW YORK
Albany—Audio-Video Corp., 324 Central Avenue
Albany—Fort Orange Radio,904 Broadway
Albany—Seiden Sound, Inc., 355 Central Avenue
Bethpage, L. I.—S & R Electronics, 4020 Hempstead Turnpike
Binghamton—Morris Distributing Co., 195 Water St.
Brooklyn—National Radio Parts Distributors, 572 Albany Avenue at Rutland Road
Buffalo—FM Sound Equipment, 1241 Main Street
Buffalo—Genesee Radio and Parts, 2550 Delaware
Buffalo—Radio Equipment Corp., 312 Elm Street
Carle Place, L.I.—E. J. Korvette, Incorporated Glen Cave Road & Westbury Avenue
East Meadow, L.I.—Sound Service Engineers, 1788 Hempstead Turnpike
Elmira—Stack Electronics, 306 Railroad Avenue
Hempstead—Newmark and Lewis, 43 Main Street
Hempstead—Standard Parts, 277 North Franklin St.
Jamaica—Lafayette Radio Electronics, 165 Liberty Ave.
Middletown—Certified Electronics, Incorporated Wickham Avenue Ext., Route 84
Mineola, L.I.—Arrow Electronics, 535 Jericho Turnpike
New York City—Airex Radio Corp., 85 Cortlandt St.
New York City—Audio Unlimited, Inc., 190 Lexington
New York City—Florman & Babb, 70 West 45th St.
New York City—Harvey Radio Co., 103 West 43rd
New York City—Leonard Radio, 69 Cortland Street
New York City—Mogic-Vue Television, 323 E. 13th St.
New York City—Midway Radio & TV, 60 West 45th
New York City—Murray's Audio Center, 12 East 42nd
New York City—Sam Goody, Inc., 235 West 49th St.
New York City—Sonocraft Corp., 115 West 45th St.
New York City—Terminal Hudson, 48 West 48th St.
Rochester—Rochester Radio Supply, 600 East Main St.
Troy—Trojon Electronic Supply, 15 Middleburgh St.
Tuckahoe—Boynton Studio, 10 Pennsylvania
Utica—R. & H. Audio Visual Co., 227 Columbia Street
Yorkville—Valley Electronic Labs, Truck Route 5A

NORTH CAROLINA
Asheville—Freck Radio & Supply Co., 38 Biltmore Ave.
Durham—Womack Electronics Supply, 601 Ramseur St.
Gastonia—Stroup Hi Fi Center, 112 Green Drive
Raleigh—Southeastern Radio Supply, 414 Hillsboro St.

NORTH DAKOTA
Fargo—Wolter Electronics Co., 402 North "P" Avenue

OHIO
Akron—Electronic Engineering Co., Div. of Solsound Industries, Inc., 362 West Bowery Street
Canton—Burroughs Radio, Inc., 2705 Fulton Road, NW
Canton—Walkeradio, 1546 Fulton Road, NW
Cincinnati—Economy Electronic Distributing, 629 Elm St.
Cincinnati—Steinbergs, Inc., 633 Walnut Street
Cincinnati—Trout Company, 4815 Whetsel Avenue
Cleveland—Audiocraft Company, Inc., 2915 Prospect
Cleveland—Broadway Electric Supply Company, Inc., 6207 Broadway Avenue, SE
Cleveland—Grossman Music Corp., 740 Bolivar Road
Cleveland—Olson Electronics, 6813 Pearl Street
Cleveland—Olson Electronics, 2020 Euclid Avenue
Cleveland—Pioneer Electronic Supply, 5403 Prospect
Cleveland—Progress Radio, 565 East 185th Street
Cleveland—Progress Radio, 13310 Miles Avenue
Cleveland—Progress Radio Supply Co., 415 Huron Rd.
Cleveland—Winteradio, 1468 West 25th Street
Columbus—Anderson Hi Fi Center, 2244 Neil Avenue
Columbus—Electrical Contractors, 1343 Holly Avenue
Columbus—Electronic Supply Corp., 814 West 3rd Ave.
Columbus—Hughes-Peters, Inc., 481 East 11th Street
Columbus—Olson Electronics, 142 North High Street
Columbus—Thompson Radio Supplies, 182 E. Long St.
Columbus—Whitehead Radio, 124 North Grant Ave.
Dayton—Custom Electronics, 1918 South Brown Street
Dayton—Srepco, Inc., 314 Leo Street
Dayton—Stotts-Friedman Co., 108 N. Jefferson Street
Elyria—El-A-Company, 235 Lodi Street
Lima—Hutch and Son, Roberts at Lenore
Lima—Lima Radio Parts Co., 600 North Main Street
Middletown—Hinkles Electronics, 5021 Roosevelt Ave.
Parma—Winteradio Electronic Supply, 5373 Ridge Rd.
Toledo—Jamieson's Hi Fi Specialists, 3417 Dorr Street
Toledo—Toledo Radio Specialties, 1215 Jackson St.
Toledo—Warren Radio Company, 1002 Adams Street
Youngstown—Armie's Electronics, 320 West Federal St.
Zanesville—Thompson Radio Supplies, 110 South 6th

OKLAHOMA
Oklahoma City—Trice Wholesale Electronics, 4701 North Stiles
Tulsa—S & S Radio Supply, 537 South Kenosha

OREGON
Pendleton—The Town Shop, 142 South Main

PENNSYLVANIA
Altoona—Altoona TV Supply, Inc., 1720-22 Union Ave.
Braddock—M. Leff Radio Parts Co., 223 Braddock Ave.
Clifton Heights—Delaware Valley Electronics Supply, 224 Baltimore Pike
Cornwells Heights—Bucks County Sound and Recording Laboratory, 2002 Newportville Road
Johnstown—Cambria Equipment, 17 Johns Street
McKeesport—Barno Radio Company, 927 Walnut Ave.
Philadelphia—AC Radio Supply, 1539 W. Passyunk
Philadelphia—Almo Radio Company, 913 Arch Street
Philadelphia—Barnett Brothers Radio, 622 Arch Street
Philadelphia—Friend's, 614 Arch Street
Philadelphia—Radio Electric Service Company, NW Corner 7th and Arch Streets
Pittsburgh—Comcor Electronics, Inc., 937 Liberty Ave.
Pittsburgh—Hamburg Brothers, 213 Galveston Avenue
Pittsburgh—Radio Parts Co., Inc., 6401 Penn Avenue
Pittsburgh—South Hill Electronics, 1420 West Liberty
Pittsburgh—Tydings Electronics, Inc., 3337 Penn Avenue
Reading—George D. Barbey Co., 333 North Fourth St.
Wilkes Barre—Communications Engr., 41 N. Franklin
Wilkes Barre—General Radio and Electronic Co., 396 South Main Street

SOUTH CAROLINA
Charleston—Radio Labs, 475-477 East Bay Street
Columbia—Dixie Radio Supply Co., 1628 Laurel St.
Florence—Southern Electronics, 355-65 North Irby St.

SOUTH DAKOTA
Aberdeen—Burghardt Radio Supply, 102 South Second
Rapid City—Burghardt Radio Supply, 726 Jackson
Sioux Falls—Burghardt Radio Supply, 208 N. Weber
Sioux Falls—Warren Radio Supply, 196 E. Sixth St.
Sioux Falls—Warren Supply Co., 115 S. Indiana Ave.
Watertown—Burghardt Radio Supply, 621-4th St., SE

TENNESSEE
Memphis—Hirsh Electronics, 1658 Union Avenue

TEXAS
Corpus Christi—Wicks Radio Equipment, 513 Staples
Dallas—Adleta Company, 1907 McKinney
Dallas—Chandler Sound Equipment, 3407 Ross Avenue
Dallas—Crabtree's Wholesale Radio, 2608 Ross Ave.
El Paso—Midland Specialty Co., 500 W. Paisano Drive
Fort Worth—Clifford Herring Sound Equipment, 1705 West 7th Street
Houston—Busacker Electronic Equipment, 1216 W. Clay
Houston—Sterling Electronics, Inc., 1616 McKinney
San Antonio—Vandergrift Audio, 4106 San Pedro Ave.

UTAH
Ogden—Ballard Supply Co., 3109 Washington Blvd.
Ogden—Tri State Electronic Supply, 2763 Washington
Salt Lake City—Deseret Book Co., 44 East S. Temple
Salt Lake City—Electronic Sales, 175 Social Hall Ave.

VERMONT
Burlington—Radio Service Lab, 703 Pine Street
White River Junction—Electronics Supply, Inc.

VIRGINIA
Danville—Womack Radio & Supply, 513 Wilson St.
Hampton—Buckroe Electronics, Inc., 815 Buckroe Ave.
Norfolk—Cain Electronics, 14th and Monticello Avenue
Norfolk—Electronic Engineering, 4201 Hampton Blvd.
Norfolk—Priest Electronics, 6431 Tidewater Drive
Richmond—Radio Supply Co., 3302 West Broad Street
Roanoke—H. C. Baker Sales Co., Ltd., 19 Franklin Road

WASHINGTON
Seattle—Western Electronic Supply, 717 Dexter Ave.
Seattle—Seattle Radio Supply, 2117 2nd Avenue
Tacoma—C & G Electronics, 2502 Jefferson Avenue
Yakima—Loy & Nord, 112 South Second Street

WEST VIRGINIA
Charleston—Electronic Specialties Company, Delaware at Randolph
Huntington—Electronic Supply, Inc., 422 11th Street
Wheeling—General Electronics Dist., 735 Main Street

WISCONSIN
Appleton—Valley Radio Distributors, 518 N. Appleton
Madison—Satterfield Electronics, 1900 South Park St.
Milwaukee—Allied Radio, 5314 N. Port Washington
Milwaukee—Taylor Electric, 4080 N. Port Washington
Sheboygan—J. J. Koespell, South 9th at Commerce

Communications Service Pricing Guide

Many newcomers to the communications service business are curious as to present pricing practices around the country. We were, too, so we made numerous inquiries and found a number of pricing arrangements being used.

The most prevalent of these is the *monthly maintenance contract*. There are variations of this practice, but it generally takes the form of a fixed price per unit, paid by the system licensee, in return for which the communications technician provides all necessary service, adjustments, tests, *and parts*, on a monthly basis. The periodic tests required by the FCC are included in this plan.

As indicated in the chart (Table I), monthly service contracts are usually divided into two types—the 8-hour and the 24-hour plan. Under the 8-hour plan, emergency service is provided during regular working hours; with the 24-hour plan, the technician is on call for emergency service at any time of the day or night. Naturally, the 24-hour plan is priced somewhat higher. In practice, system owners often place the base station on the 24-hour plan, and split the mobile units between the two plans, paying extra for only those units which are used day and night.

A variation of the monthly maintenance contract is the *plus-parts* contract. Under this arrangement, the technician provides service exactly as under the usual plan, but the system licensee is billed extra for any parts used in maintaining the equipment. Since the technician isn't taking a chance on the number of defective parts that may develop, the monthly price is correspondingly less than for the ordinary plan. Even so, the plus-parts contract is generally less popular.

Contracts usually are signed for a term of one year, and are paid in monthly installments. Table II shows the pricing section of a typical contract, based on the prices in Table I. Prices vary widely over the country, and even among communications technicians within a given area; but those shown in Table I are representative, and show relationships between prices charged for differing types of units under the various plans.

Another type of contract which has found some acceptance is the *inspection* contract. This contract merely stipulates that for a specified amount (paid either quarterly or monthly) the technician will inspect, repair, and adjust the equipment four times yearly, and perform the FCC checks when required. This contract includes no parts, but provides the licensee with a certain amount of periodic maintenance which will help to prevent breakdowns of equipment. Emergency maintenance between inspections is provided at a predetermined rate—sometimes a flat rate per unit, and sometimes an hourly rate. All parts, of course, are billed as usual.

For systems not on contract, most communications service shops have a flat-rate labor charge for overhauling a unit. This price applies to a unit brought to them for service, and they overhaul the unit completely—including the FCC checks. They also have a price for performing the FCC checks separately. A charge for travel time and mileage is added to the basic charge for servicing equipment which is not brought to the shop by the customer.

While the prices stated in the charts are merely representative, they will serve as a guide to the technician just entering the field of communications. Specific charges can be set by the individual for the area in which he is located.

Table I

Type of unit	General Contract 8-hr.	General Contract 24-hr.	Plus-parts (8-hr.)	Inspection type (per quarter)
Mobiles				
Up to 30-watt	$ 7.00	$10.00	$ 5.00	$12.50
60-watt	8.00	11.00	6.00	15.00
100-watt	9.00	12.00	7.00	17.50
Base Stations				
60-watt	15.00	22.00	12.00	30.00
AC Utility	12.00	16.00	9.00	22.50
100-watt	22.00	28.00	18.00	45.00
250-watt	27.50	35.00	22.00	55.00
Remote Controls	3.50	6.00	2.00	5.00

Hourly rates: $5.00 to $6.50 per hour for service during normal business hours; time-and-one-half usually charged for nights and weekends.
Overhaul flat-rate price: generally between double and triple the monthly rate shown in the Plus-parts column. Parts are extra.

Table II

Licensee: ABC Taxi Service
Address: Anytown, USA

Contractor: Two-Way Service Shop
Address: Anytown, USA

Contract date: June 1, 1961 Expires May 31, 1962

	Description	Monthly Payment	Total
1	**XYZ-1 Base Station**	22.50	22.50
10	**XY-12 Mobile Units**	9.00	90.00
5	**YZ-2 Mobile Units**	10.00	50.00
1	**Remote-Control Console**	3.00	3.00
4	**Standby Units (spares, at half-price)**	4.50	18.00
		Contract Total	$183.50

To be paid 1st day of each month, in advance

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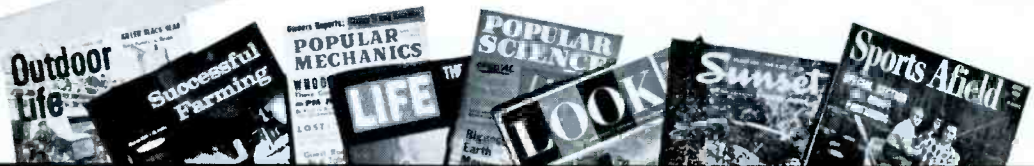
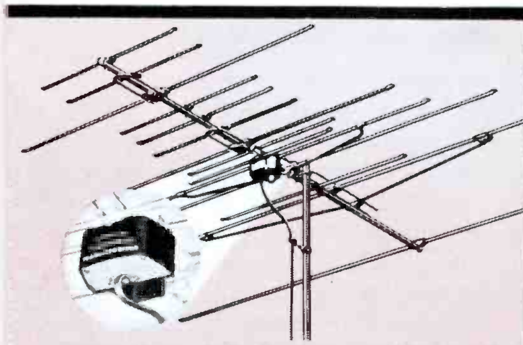
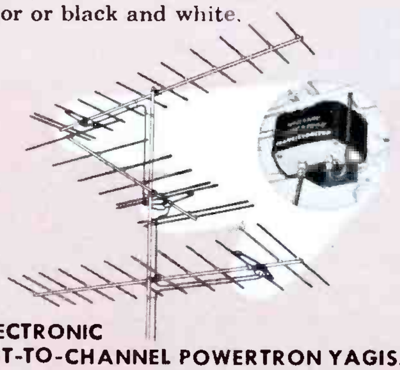
7 Winegard Electronic Products to Improve TV and FM Reception—nationally advertised month after month after month in magazines, newspapers & TV.

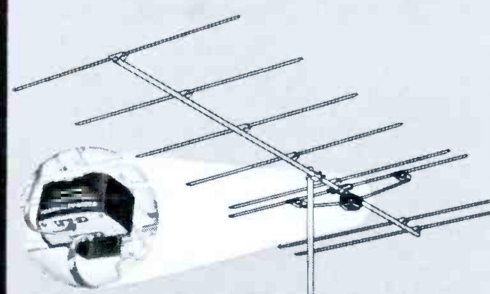




WINEGARD ELECTRONIC POWERTRON TV ANTENNAS—TUBE AND TRANSISTOR MODELS. World's first and most effective electronic TV antennas. More Winegard Powertrons have been installed than all other amplified TV antennas combined. Choose from 3 transistor or 3 tube models. Transistor models for FRINGE areas (nearest TV or FM station some distance away). Tube models for MIXED signal areas (locations with TV station close to set, and other stations far away). Both Powertrons come complete with built-in amplifiers, all AC power supply. Patented antennas have exclusive "Tapered T" driven elements, electro-lens director system. Six models, GOLD ANODIZED from $74.95 to $104.95 list. Excellent for color or black and white.

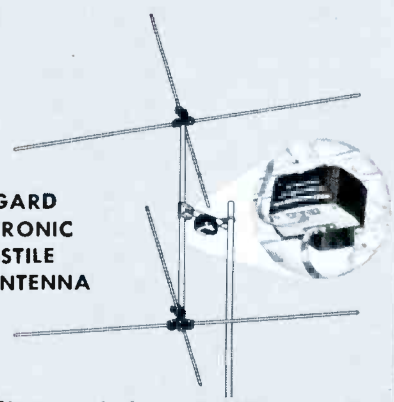


ELECTRONIC CUT-TO-CHANNEL POWERTRON YAGIS. Where you require the finest installation, motels, hotels, hospitals, institutions, deep fringe locations, there is no antenna made that compares to Powertron cut-to-channel yagis. Highest gain (28 DB), powered by transistor amplifier peaked for perfect results. Six (8 element) cut channel and broad low band models—eight (12 element) cut channel and high band models. Run up to 8 antennas from one power supply. ALL MODELS GOLD ANODIZED. Perfect for color or black and white. Write for models no's. and prices.



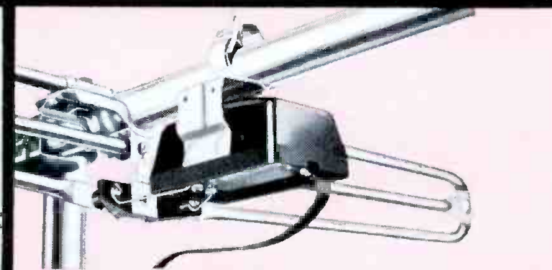
WINEGARD ELECTRONIC STEREOTRON FM ANTENNAS. For the ultimate in long distance FM and STEREO, Stereotron is world's most powerful FM antenna. Comes with power supply and built-in transistor amplifier. Guaranteed to bring in 85% of all FM stations in a 200 mile radius over normal terrain with rotor. Has minimum gain of 26 DB over folded dipole. Recommended for use where signals are from 1 to 20,000 microvolts. GOLD ANODIZED. **Model PF 8 (300 ohm) or PF 8C (75 ohm), $64.25 list.**

WINEGARD ELECTRONIC TURNSTILE FM ANTENNA



Non-directional, has 16 DB gain, receives in all directions to 125 miles . . . no rotor needed. Has built-in transistor amplifier and comes complete with power supply. GOLD ANODIZED, built to last for years of service. Complete with two 300 ohm terminals on amplifier; one for down-lead connection to the set and one for connection to a Powertron antenna.

Model PF-4 (300 ohm). $55.80 list



WINEGARD TENNA-BOOST. Mounts on any antenna. Excellent antenna amplifier mounts on antenna, mast or wall. Has 19 DB gain. All AC power supply built-in two set coupler. Next best thing to Winegard Powertron.

Model MA-300, $34.95 list.

WINEGARD "BOOSTER-PACK" Single Set Amplifier or Home System Amplifier. Demonstrate right at set with unique "convincer" switch that switches from antenna only, to half power and full power. See the picture improvement with the touch of a switch. Takes only a couple of minutes to install. Has 16 DB gain on low band and 14 DB on high band. Transistorized, costs only 27c a year to operate. **Model AT 6X, $34.95.**

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MOBILE-INSTALL

Practical instructions for equipping

Installing two-way radio systems has almost become a field all its own. Many service shops have a man who specializes in this one phase of two-way radio, and it is an important function. But in a one-man operation, the technician must perform the entire job—installation, tune-up, and any subsequent servicing. For this reason, he must be familiar with installation techniques as well as servicing procedures.

Mobile units are generally classified into two general styles: dash-mounted and trunk-mounted. The dash-mounted set is completely self-contained, in that the controls and speaker are mounted in a panel on the front of the unit. The only cables usually involved in this form of installation are the power cables. This type of unit is used in trucks quite often, since they have no trunk in which to mount the set.

The trunk-mounted unit is used in automobiles so as not to clutter the driving compartment. The speaker, the microphone and a control head are mounted in the front. The control head is used for manually adjusting on-off, volume, and squelch, and for indicating standby and transmit functions. It necessitates a control cable in addition to the usual power cables. The very nature of these two types of mountings causes each to have its own peculiar installation problems.

Starting the Job

The two-way radio manufacturer furnishes the materials necessary to install his mobile package neatly — the unit and its housing, the interwiring cables, the control head and microphone, the antenna, fuse block, control relay, and even the hardware.

The tools needed are a drill (the ½-inch size is best), a set of bits, hole saws (for antenna-mounting holes), screwdrivers, adjustable pliers, and an adjustable wrench. An electrician's fish-tape is occasionally helpful, although a stiff wire such as a coat-hanger can do the same job. Unusual tools, such as special Allen wrenches, antenna-tightening tools, and similar items are normally included in the installation package.

The first important decision facing the installation technician is where to mount the housing — the container for the main unit. Important considerations are convenience for servicing, accessibility of controls to the operator (in dash mounts), keeping cables out of the driver's way, and durability of the mounting. Possible locations vary with the vehicle, but in trucks the unit can be mounted under the seat, behind the seat, hanging by brackets from the rear or ceiling of the cab, and sometimes in weatherproof housings outside the cab. Fire engines and other compartmented trucks sometimes have the two-way radio unit in one of the cabinets. If the unit can be mounted in the cab, a dash mount is best, since the controls are on the front panel of the unit. For other locations, and in automobiles, a trunk mount is generally used, and a separate control head is provided.

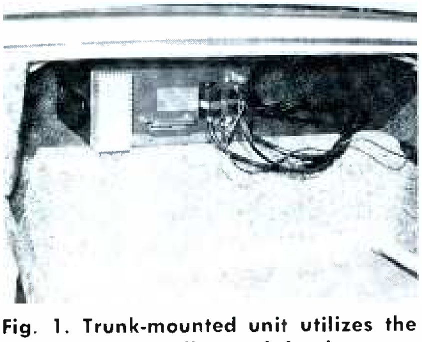


Fig. 1. Trunk-mounted unit utilizes the space not normally used for luggage.

Installing a Trunk Mount

The trunk-mounted unit can be installed on either the floor or the deck of the trunk (see Fig. 1). It is best located where it will not interfere with luggage. The mounting shown in Fig. 1 is an excellent method, if the car trunk is suitably constructed. When possible, bolts should be used to mount the housing, instead of the usual sheet-metal screws; a more substantial installation will result.

If the unit is to be placed in a compartment of a truck, be sure to plan some means of running the control and power cable out of the compartment; you may have to drill a hole for this. If so, be sure to use a grommet to protect the cable from chafing. (You'd be surprised how fast a cable covering will wear through!) A grommet can be installed easily by cutting it on one side, placing it around the cable (which it has already been run through the hole), and working it into place in the hole.

In an automobile, one cable connects the trunk-mounted unit and the control head, while another (sometimes a pair) is connected to the battery through the control relay and fuse block.

Fishing the cables from the trunk into the rear-seat area is sometimes a problem. You can usually work them through in the corner, after removing the rear seat. On occasion, a length of stiff wire will open the way; a hook on the end can be used to pull the cable through. In unusually difficult situations, the seat back can be removed. The fastening — usually a few screws or metal tabs — can be found behind the cardboard liner in the trunk.

ATION KNOW-HOW

vehicles with two-way radio . . . by Forest H. Belt

Usually, the cable is run beneath the floor mat. A metal plate at the bottom of the door opening holds the edge of the floor mat in place. Removing a few screws will loosen this plate so that the mat can be rolled back to permit the cable to be worked underneath. The cable will be less noticeable if it is run alongside the drive-shaft "hump" in most cars. In addition, this will bring it out near the center at the front, close to the usual control-head mounting position.

The power cables are run alongside the control cable as far as the front of the driving compartment. Then the power cables are routed through the firewall (usually, close examination will reveal that a hole is already provided) to the engine compartment. The relay and fuse block are mounted under the hood, either on the firewall or on a convenient fender wall, using sheet-metal screws.

Some vehicle owners prefer not to have the cables under the floor mat. In this case, the cables must be run underneath the car and up into the engine compartment. The control cable will then be run through the firewall into the driving compartment to reach the control head. To protect the cables from road grime, tar, and moisture, the cables are generally placed inside a protective sheath. This covering can be flexible exhaust pipe, large BX armor, or rubber tubing.

The installing technician must fasten the flexible tubing securely to the frame of the vehicle. Several forms of cable clamps are available, but whatever type is chosen must be carefully installed. If the tubing were to drop loose, it would probably snag on something, and pull the cable loose at one end or the other.

The end of the tubing should be brought up into the trunk compartment, so as to prevent moisture from entering. This necessitates drilling a hole of sufficient size with a hole saw. In the engine compartment, the tubing should be well anchored somewhere on the firewall, high enough to prevent splashes of water from entering. Some technicians even use sealing putty to safeguard the cable.

Inside the driving compartment, the control head and microphone hanger are usually mounted at the driver's right, below the dash panel. Left-handed persons might prefer that the units be mounted to the left of the steering column. In either case, be sure the mic cord does not dangle in such a way as to interfere with either the arms or legs of the driver. In trucks, sometimes the driver prefers to have the control head and mic mounted overhead — in the sun-visor area — or to the rear, just above the seat back. If this is the case, be sure that nothing is placed where it will interfere with the driver or distract him.

The speaker unit is usually mounted on the firewall, out of sight beneath the dash panel. However, it can be mounted almost anywhere the user desires. In some four-door automobiles and station wagons, it is mounted by the door post, just behind the driver's seat. In trucks, it is sometimes mounted in a corner of the cab.

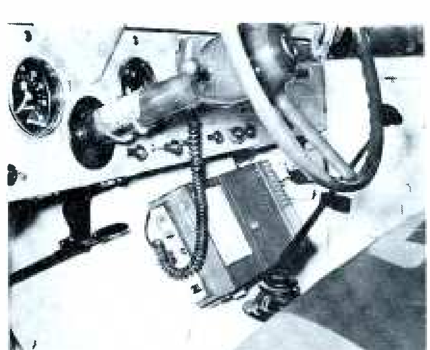


Fig. 2. Dash mount eliminates need for a control head and control cables.

Dash-Mount Units

Dash-mount installations are less complicated. The front panel of the unit contains the speaker and the operating controls, so there are no control cables to run, no control head and speaker to mount, and seldom even a power relay. The only items to be installed are the unit, the power cable, and the fuse block. Of course, the antenna must be installed, but we will cover that in a section all its own.

Choosing a place to mount the unit can develop into a problem. It must be out of the driver's way, yet the control panel must be within easy reach. It is commonly mounted under the dash of the vehicle (as its name implies), but since it takes so much space it is seldom used in autos. In trucks, however, it can be suspended from the ceiling, mounted over the back of the seat, or placed in the seat beside the driver. It can also be located just in front of the seat (providing it does not interfere with shifting or with the hand brake). Fig. 2 shows a typical truck installation.

Brackets are usually furnished to mount the unit solidly in place. If some unusual mounting is desired, the installation technician can hire a welder or metalworker who will fabricate a substantial bracket, usually at a nominal cost.

The power cable is routed into the engine compartment, or wherever the vehicle battery is mounted. The fuse block is placed very near the battery, for protection of the entire system.

Wiring the Units

Once the housing, unit, power

• *Please turn to page 91*

SPEAKING of STABLE SYNC...

. . . Here's a new slant on an old familiar TV-service problem.

by Thomas A. Lesh

Sync troubles are a sticky problem. No other type of TV fault can lurk in so many different stages of a receiver. As often as not, the trouble isn't in the sync section at all. It can frequently be traced to some prior stage—video amplifier, detector, IF, tuner, or AGC. As a complicating factor, a high percentage of sync troubles do not appear suddenly, but develop gradually as components deteriorate. Such faults, in their early stages, are likely to affect *only* vertical or *only* horizontal sync — rather than both at once. This casts some doubt as to whether the trouble is due to a loss of sync signal, or to a fault in a sweep oscillator.

Since over half of the circuits in a set are potentially involved in a sync problem, you need to make the fullest possible use of simple operating checks which will help you "zero in" on the trouble area.

If the trouble affects horizontal, but not vertical sync (or vice versa), manipulate the appropriate hold control. The picture may not even approach the lock-in point at any setting of the control; when you see this "one-way sync" effect, it indicates an off-frequency oscillator rather than a loss of sync signal. Positive lock-in of the picture at some control setting means the sync pulses are probably okay. If sync doesn't stay locked in at this setting, you'll know that the sweep-oscillator frequency is drifting.

As you turn either hold control, the picture may "slide through" the normal condition and show no sign of locking in. This means the sync pulses aren't reaching the sweep circuits, and you must check further to find out if the signal is being lost *before* or *after* it enters the sync section. Most picture-circuit troubles which distort the sync pulses also produce side effects such as excessive contrast or buzz in the sound. Watch for these symptoms as you adjust the contrast and AGC controls, or as you switch the tuner from a strong to a weak channel. If you're alert, you'll see clues to the nature of the trouble.

The quickest isolation test is a close inspection of the vertical blanking bar in the picture. Since the sync circuit and the picture tube both receive the same input signal (Fig. 1), any distortion of the sync pulses in this signal will show up quite plainly on the CRT screen.

The blanking-bar test is based on the fact that the CRT is biased farther into cutoff by the vertical sync-pulse tip than by the vertical blanking pulse. The change in bias is great enough that a definite "sync bar" can be brought into view within the vertical blanking bar.

Here's how to make this pattern visible: Adjust the vertical and horizontal hold controls to settle down the picture as much as possible. Then manipulate the vertical hold so that the blanking bar stays in view, preferably near the center of the screen. Then turn up the brightness till the sync and equalizing pulses become visible in the blanking bar. (They will form a narrow, dark stripe with a small thick area in the center.) Reduce the brightness until the sync pulses are just black.

Under normal conditions, the rest of the blanking swath should then be gray, and objects in the

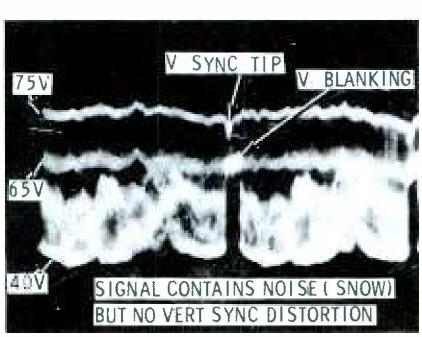


Fig. 1. Blanking-bar test is based on difference in sync and blanking levels.

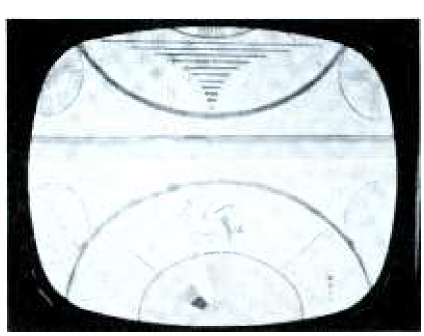


Fig. 2. Light color of blanking bar is tip-off to distortion of sync input.

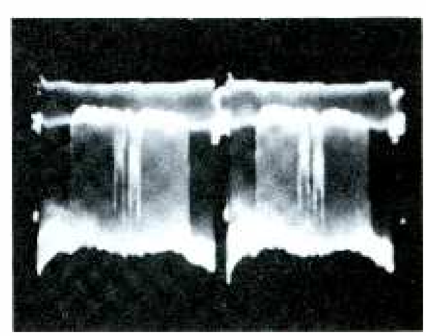


Fig. 3. This slight fault in video signal would cause horizontal instability.

picture should range from white to gray. The darkest picture element must be no darker than the gray shade of the blanking bar. Any other pattern of shading in the blanking bar indicates trouble. For example, in Fig. 2, the sync pulse is darker than the rest of the bar, as it should be. However, note that the sync-pulse portion of the bar (except at the upper edge) is lighter than the dark circles in the test pattern. This telltale sign proves that the vertical sync and blanking pulse, except for the leading edge, is being pushed down to an abnormally low voltage level—making it impossible for the sync circuits to separate the vertical sync signal from the picture signal. It's no wonder this set had vertical instability! The cause of this particular trouble was a partially open AGC filter capacitor, but it could have been any other picture-circuit defect that would discriminate against the low-frequency vertical pulses.

Blanking-bar observation could also serve as a clue to the similar, but milder video-waveform distortion shown in Fig. 3. More than a casual observation would be necessary, though. The sync pattern inside the blanking bar would look nearly normal, and the only real sign of trouble would be that *the blanking bar would appear lighter than the darkest picture elements.* Vertical sync would not be much affected by this distortion, but the picture would have a tendency to wave or bend, because the abnormally high peaks of the video signal (reaching into the sync portion) would be difficult to separate from the horizontal sync pulses.

Sync Separation

Clipping the sync pulses off the top of the video signal is the focal point of sync-circuit operation. Any additional processing of the sync signal just cleans up the waveshape and compensates for slight defects in separation.

To give the sync separator a fair chance to do its job, at least the top 25% of the input signal should be composed of sync pulses rising above the voltage level of the blanking pulses. This percentage often amounts to more than 25%, since the video-to-sync coupling circuits in many sets modify the signal to favor the sync pulses. But any condition which reduces the sync below the 25% mark is likely to cause incomplete separation, resulting in poor stability.

As previously mentioned, the input signal to the sync separator should look a great deal like Fig. 1, and must always have positive-going sync tips. This waveform was taken with the scope operating at a horizontal sweep rate of 30 cps, in order to view the vertical sync pulses. For a better look at the horizontal pulses, the scope can be set to 7875 cps, as in the case of Fig. 4. The top of the pulses in this photo are somewhat sloping, because a rather narrow-band scope was used. However, this shortcoming does not make the waveform any less useful for trouble analysis.

The positive tips of this signal cause the sync-separator tube to draw grid current and develop considerable grid-leak bias. As a rule, the negative grid voltage builds up to about three-fourths of the peak-to-peak voltage amplitude of the incoming signal. This high bias, in combination with a low plate voltage (sometimes 50 volts or less) keeps the separator tube cut off during the times when the picture portion of the signal is present on the grid.

When the signal voltage rises to the black (blanking) level at the end of each line and frame, it pushes the grid voltage to a less-negative value, but does not quite bring the tube out of cutoff. However, the vertical and horizontal sync-pulse tips drive the grid voltage slightly positive, and make the tube conduct heavily. The resulting pulses of plate current develop an output across the plate-load resistor as shown in Fig. 5. It ordinarily has no greater over-all amplitude than the input signal, but it's all sync — the picture-signal elements are almost completely removed if the separator is working properly.

Since the amount of grid-leak bias voltage is proportional to the input-signal amplitude, the separator can adjust itself to moderate changes in grid-signal level as long as the sync-to-video ratio is correct. If the sync pulses fail to rise to a normal height above the positive video peaks (as in Fig. 3), the grid-leak bias arrangement will still work, but some of the video will be able to drive the separator into conduction. When picture information finds this way of seeping into the separator-output signal, the first sign of trouble is usually horizontal bending.

Defects ahead of the sync separator, if severe enough to cause a total loss of sync, generally distort the separator-input waveform so badly that the sync pulses are mashed nearly flat—as in Fig. 6. The output then contains practically nothing but scrambled video.

I remember a case of this kind in a Silvertone Model 7100. The

• *Please turn to page 98*

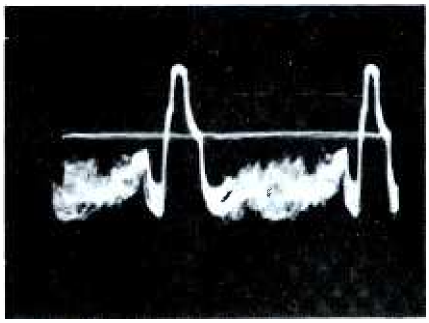
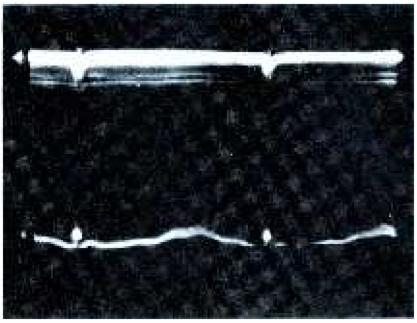
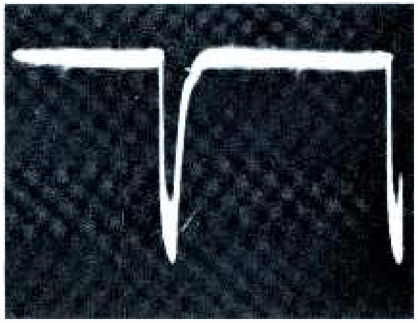


Fig. 4. Input signal to sync separator viewed at 7875-cps sweep frequency.



(A) At 30-cps scope frequency.



(B) At 7875-cps scope frequency.

Fig. 5. Sync-separator plate signal.

THE ImpErFect

All FM communications receivers generate considerable circuit noise. In addition to mixer stages (a troublesome source of noise, as you know), they have very sensitive RF amplifiers. Because of the high gain in communications IF and audio stages, noise developed in the radio circuits or picked up by the antenna is heard in the speaker as a loud, irritating hiss.

When a signal is received, the action of the limiters causes the set to "quiet," thus eliminating the circuit noise during communications. Between times, however, this continuous roar is most unnerving. Therefore, a means of stopping or "squelching" the no-signal noise is desirable.

One way to stop it would be to disable the speaker, perhaps with a switch, or to simply turn the volume down. However, this is totally impractical, for the operator would have no way of knowing when he was being called. Instead, the *squelch* circuit has been developed to automatically disable the audio amplifier when no signal is present and thus quiet the disturbance. Fig. 1 shows a squelch system typical of most modern two-way radio receivers.

This method of stopping *squelch noise* (as it is commonly called) makes use of the circuit noise to bias the audio amplifier into cutoff. This bias is developed by rectifying the noise and applying the resulting DC voltage to the control grid of the audio amplifier. Since the noise is suppressed by the limiters when a signal enters the receiver, the DC bias is interrupted; the audio amplifier then conducts, and the incoming signal is heard. When the communication is ended, the audio is again cut off by the rectified noise signal. The *squelch control* varies the amount of noise voltage applied to the rectifier, thus controlling the operating point of the squelch system.

Since the squelch system controls the audio circuit, certain symptoms are easily recognizable. Common complaints involving squelch circuits are: "The noise can't be stopped without turning the volume down." "The audio is choppy and garbled." "There is no setting of the squelch control where noise *does* occur."

The first condition is a simple case of no squelch action. Some fault is preventing the squelch system from having any control over the audio amplifier.

The second complaint indicates the squelch circuit is acting intermittently. This could be caused by insufficient noise to properly actuate the circuit, not enough signal to open it, some intermittent component, or even an incorrect setting of the squelch control.

The third complaint is usually more difficult to pin down. If an audio defect were to block the audio amplifier or output, no squelch noise would be heard in the speaker. And, of course, adjusting the squelch control would have no effect, thus giving rise to the symptom described. Luckily, simple tests, which we shall describe presently, will isolate the trouble source.

Symptom	Possible Faults
Continuous squelch noise (no signal present)	Bad V3 or V4. Open squelch control. Open C9 or C10. Open R15.
Choppy audio (squelch circuit tries to cut off audio)	Bad V3 or V4. Shorted C9 lets audio cause V3A to conduct intermittently. X1 fails to deemphasize high frequency audio, which looks like noise to C9 and is coupled to V3A.
Squelch circuit blocks audio	Bad V3 or V4. Defective squelch control keeping V3A cathode at ground. C10, C12, C14, or C15 shorted or leaky. R16 open or increased in value.

How It Works

Fig. 1 shows a portion of a mobile receiver, including the limiters, discriminator, squelch, and audio stage. In this system, noise signals from discriminator V2 are coupled by C9 to the control grid of noise amplifier V3A. The value of C9 is chosen so as to pass only the higher-frequency noise signals, blocking the audio (which is lower in frequency).

The gain of noise amplifier V3A is adjusted by the 10K-ohm squelch control. As the cathode of the tube (at the junction of the

SQUELCH

Noise driving you mad?

CHECK THE SQUELCH CIRCUIT!

by Patrick M. Craney

control and R10) is placed nearer to ground potential, it becomes less positive, decreasing the bias and increasing the gain of the tube.

During no-signal operation, with the control set to *squelch* the speaker noise, V3A strongly amplifies the inherent circuit noise. The output is then fed by C10 to V3B (a diode-connected triode) where it is rectified. A positive voltage appears at the cathode of V3B, and is applied to V4A through 4.7-meg resistor R15.

The grid of V4A is subject to the influence of three separate voltages. First, it develops a certain amount of self-bias because of its very high-resistance grid load — R15, R12, R13, R14, and R3. Secondly, it receives a negative voltage from the grid of limiter V1B; the function of this voltage will be understood in a moment. Finally, V4A is affected by the voltage developed at the cathode of DC rectifier V3B. In the squelched condition, the latter is the most predominant voltage, overriding the others and causing conduction in V4A.

The increased current flow through V4A lowers its plate voltage, and the change is direct-coupled to the grid of V4B, the audio amplifier. The grid and cathode of V4B are normally held at fixed potentials by B+ voltage dividers — R20, R19, and R18 for the cathode, and R20, plate-load resistor R21, and R16 for the grid. The voltage change across R21 — caused by the increased conduction in V4A — lowers the grid voltage of V4B, biasing the tube beyond cutoff. This effectively kills the audio by preventing V4B from amplifying.

The Signal Arrives

When the receiver picks up a signal, limiter action diminishes the noise, and the discriminator suddenly has very little noise in its output. When no noise appears at the grid of noise amplifier V3A, no rectified positive voltage develops at the cathode of V3B.

As before, the grid of V4A is being acted upon by three voltages. This time, however, very little positive-going voltage is being developed by V3B to override the negative voltages, and the DC amplifier is cut off. The negative voltage developed at the grid of limiter V1B

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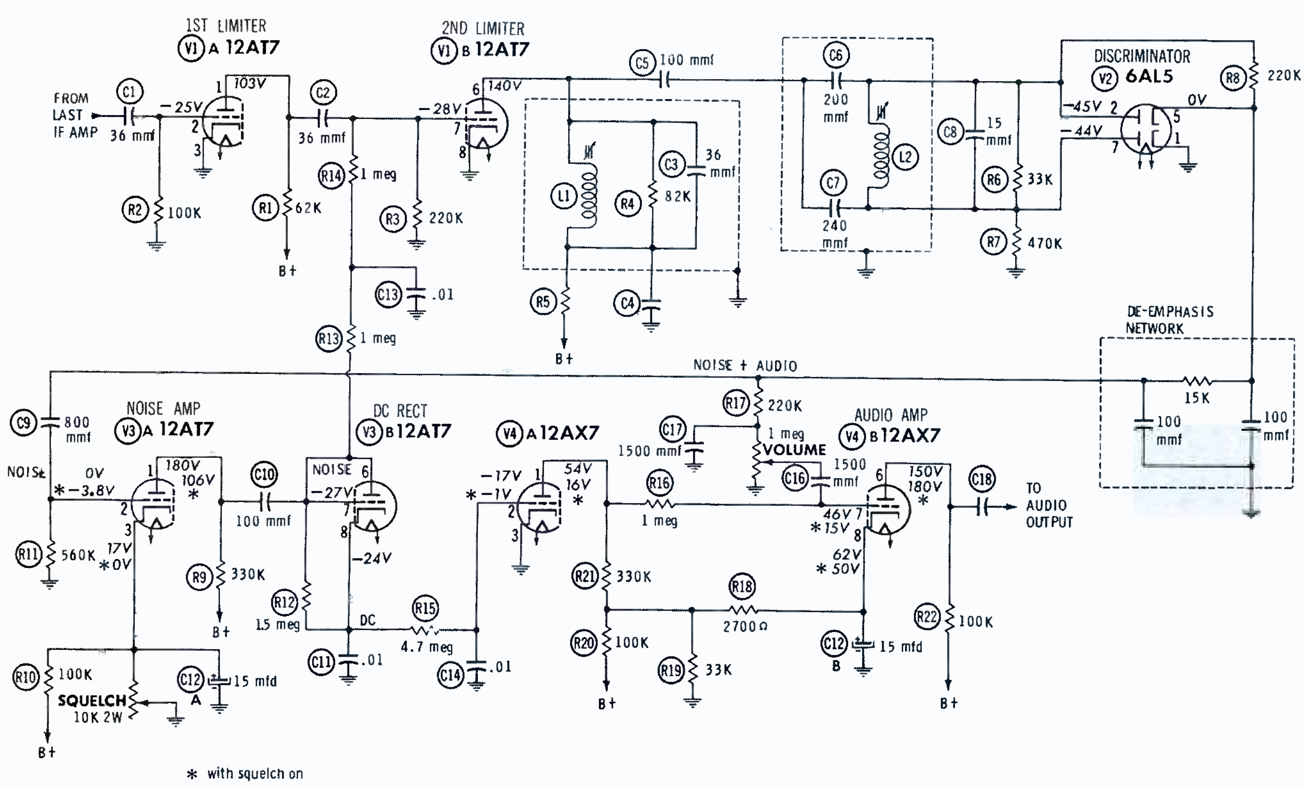
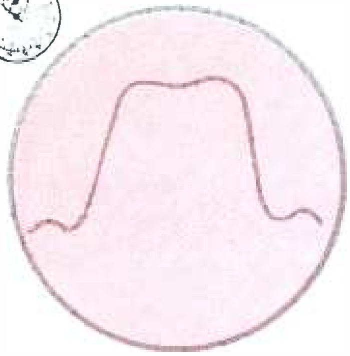


Fig. 1. Typical squelch system uses rectified noise voltage to block audio amplifier when no signal is present.

by George F. Corne, Jr.

COLOR ALIGNMENT SETUPS



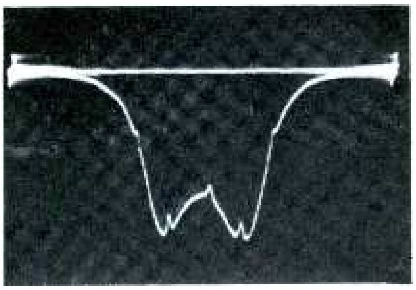


Fig. 1. Hash on an alignment waveform due to horizontal-sweep interference.

To the average serviceman, chroma-bandpass alignment of a color TV set may seem to be a complicated undertaking. Actually, it's much simpler than the RF/IF alignment procedure required for most black-and-white sets! But since an unfamiliar test setup is involved, just reading the instructions may leave one in the dark about the exact method to use, or the results to expect. Clearing up the elusive points in the color-TV alignment procedure requires more than a casual look at the service data.

Video Sweep Method

To check the *true* response for the RF/IF, detector, and chroma circuits of most color receivers, a special method known as *video-sweep-modulated* (VSM) alignment must be used. The VSM signal is derived by amplitude-modulating an RF carrier signal with a sweep signal about 3 mc wide at a center frequency of 3.5 mc. The sweep signal then covers video frequencies between 50 kc (.05 mc) and 5 mc. An RF-modulator unit (such as the RCA WG-304B) is used to mix the two signals, and the resultant output is then fed to the antenna terminals of the receiver. This procedure not only reveals the combined response of the RF/IF amplifiers, but also takes into account the frequency response of the second-detector load circuit and the video-frequency stages that follow.

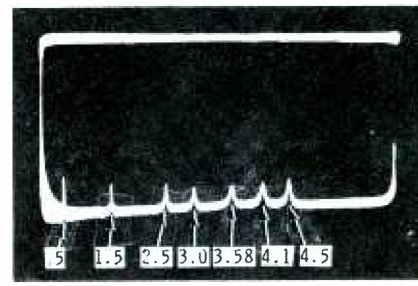


Fig. 2. "Notches" are placed in video-sweep response curve by multimarker.

In the usual method of over-all

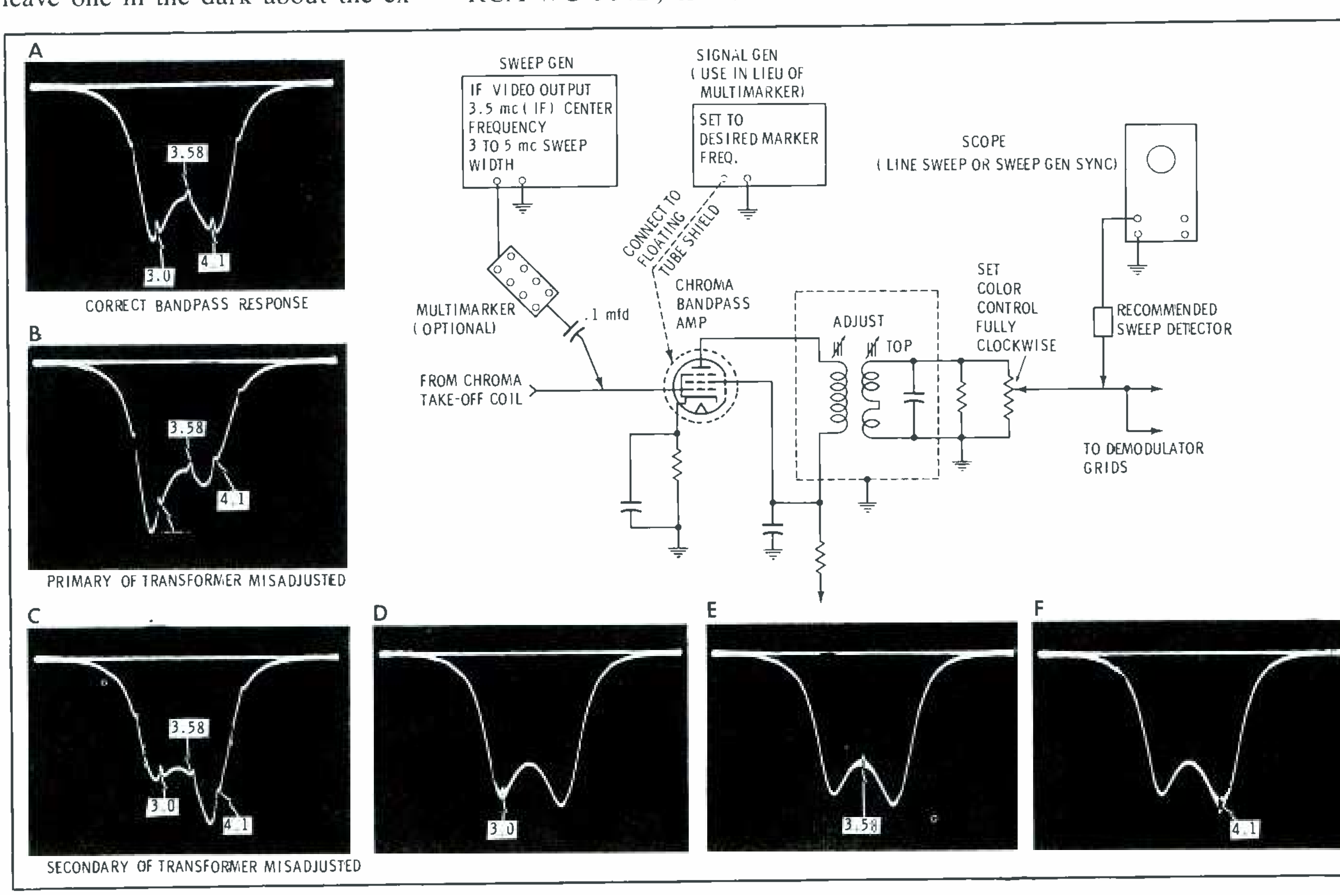


Fig. 3. Basic equipment setup for the preliminary chroma-bandpass alignment.

sweep alignment used for black-and-white sets, the video detector and amplifier stages are generally disregarded, since they have a fixed frequency response. The demodulated sweep signal which appears at the detector output is a simple 60-cps waveform, having no video-frequency content; thus, its shape is not affected by the frequency response of the detector.

A response check of a black-and-white video amplifier — sometimes desirable for isolating troubles that cause frequency distortion —can be made by feeding in a video-frequency sweep signal across the video-detector load circuit and scoping the output of the video amplifier. Here, again, the response of the detector load does not affect the results, because the load circuit is shunted by the low-impedance output circuit of the sweep generator.

Now, let's look at a color receiver! The chroma-bandpass stages, operating at video frequencies, are located at a point beyond the video detector and amplifier circuits; thus, they are *directly affected* by the frequency response of the detector and amplifier. It's possible that the RF/IF and chroma-bandpass circuits could both be properly aligned, and yet the over-all response could be incorrect. For this reason, we need an input signal which will evaluate the RF-IF, detector, and video-amplifier stages all at once. VSM alignment uses a signal of that type.

The VSM signal passes through the RF/IF amplifiers, and the detected response is the video-sweep modulation —modified by the response of the RF/IF stages and the detector-load circuit. As the signal continues through the video (luminance) and chroma stages, its characteristics are further modified by the frequency response of these circuits. In effect, the frequency-response curve of the *entire receiver* can be viewed.

A complete VSM alignment of a color set includes three major steps. The RF/IF stages are first aligned (or checked) in the conventional manner, using an RF sweep and marker generator. Next, a video-frequency sweep signal is fed in at the input of the chroma section, and the bandpass-amplifier plate transformer is adjusted for correct response. Finally, the VSM setup is used to check the over-all response from the antenna terminals to the chroma demodulator, and then to align the chroma take-off coil.

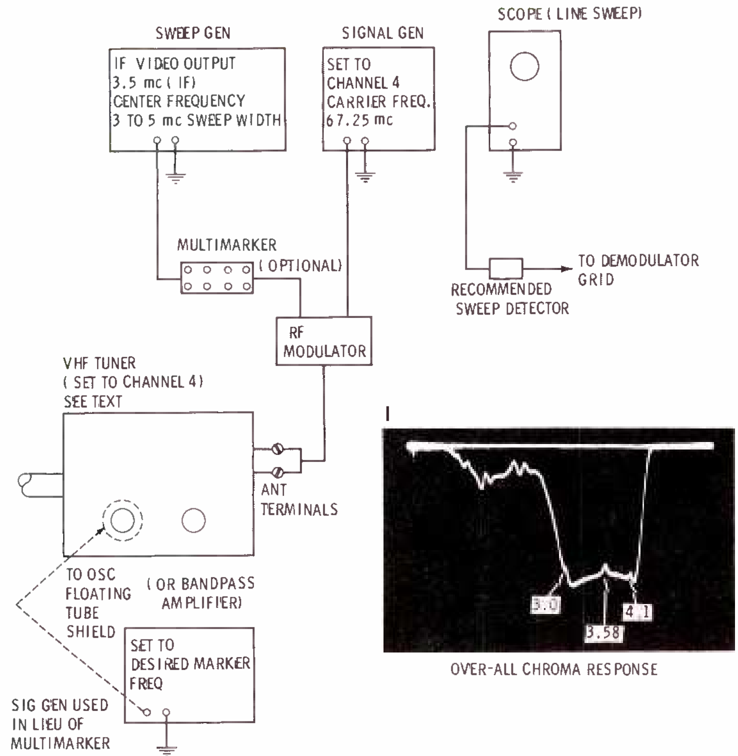


Fig. 4. This setup is used for an over-all check of RF/IF/chroma alignment.

Details of the second and third steps in this procedure are given in Figs. 3, 4, and 5. These illustrations, showing equipment connections, operating frequencies, and typical response-curve waveforms, were prepared using an RCA CTC9 color chassis as a "guinea pig." This chassis is similar to those in most late-model color receivers, so the alignment procedure given here can be applied to many other models with a minimum of changes.

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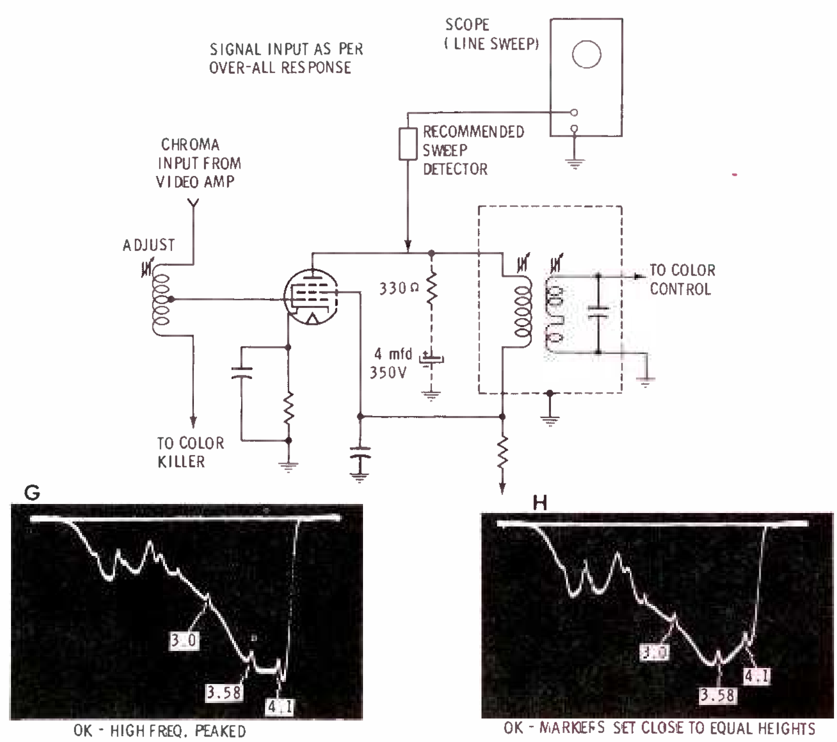
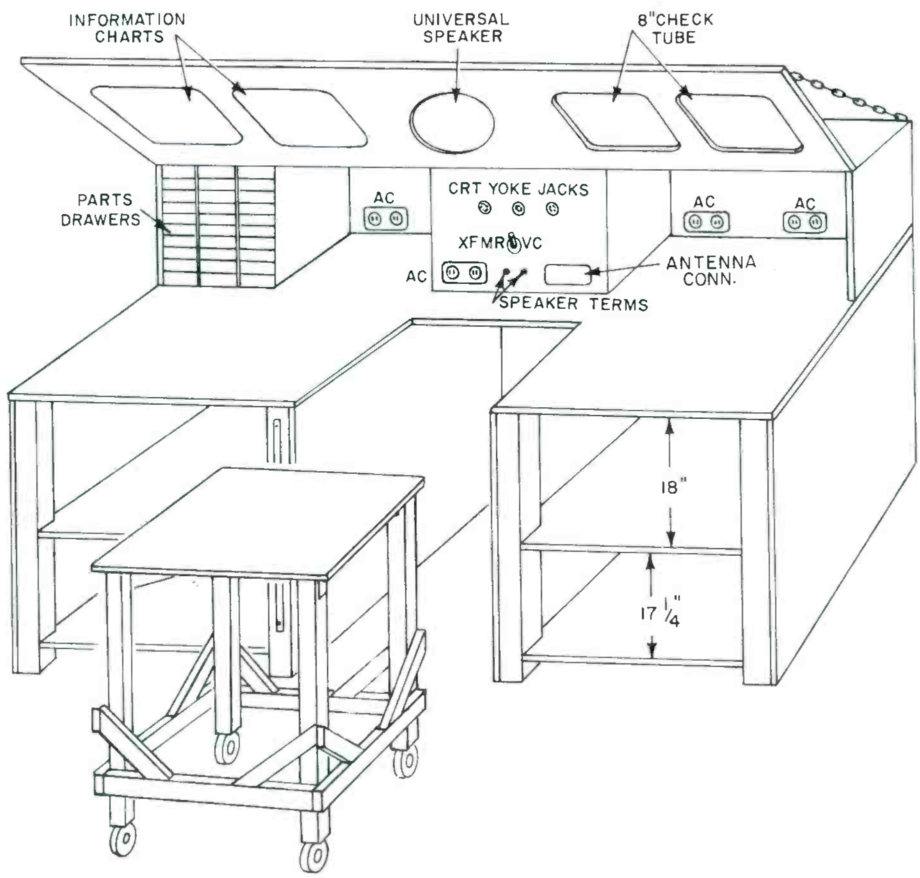


Fig. 5. To adjust grid coil, scope is moved to plate of bandpass amplifier.

Blueprints for Service Benches

part 2



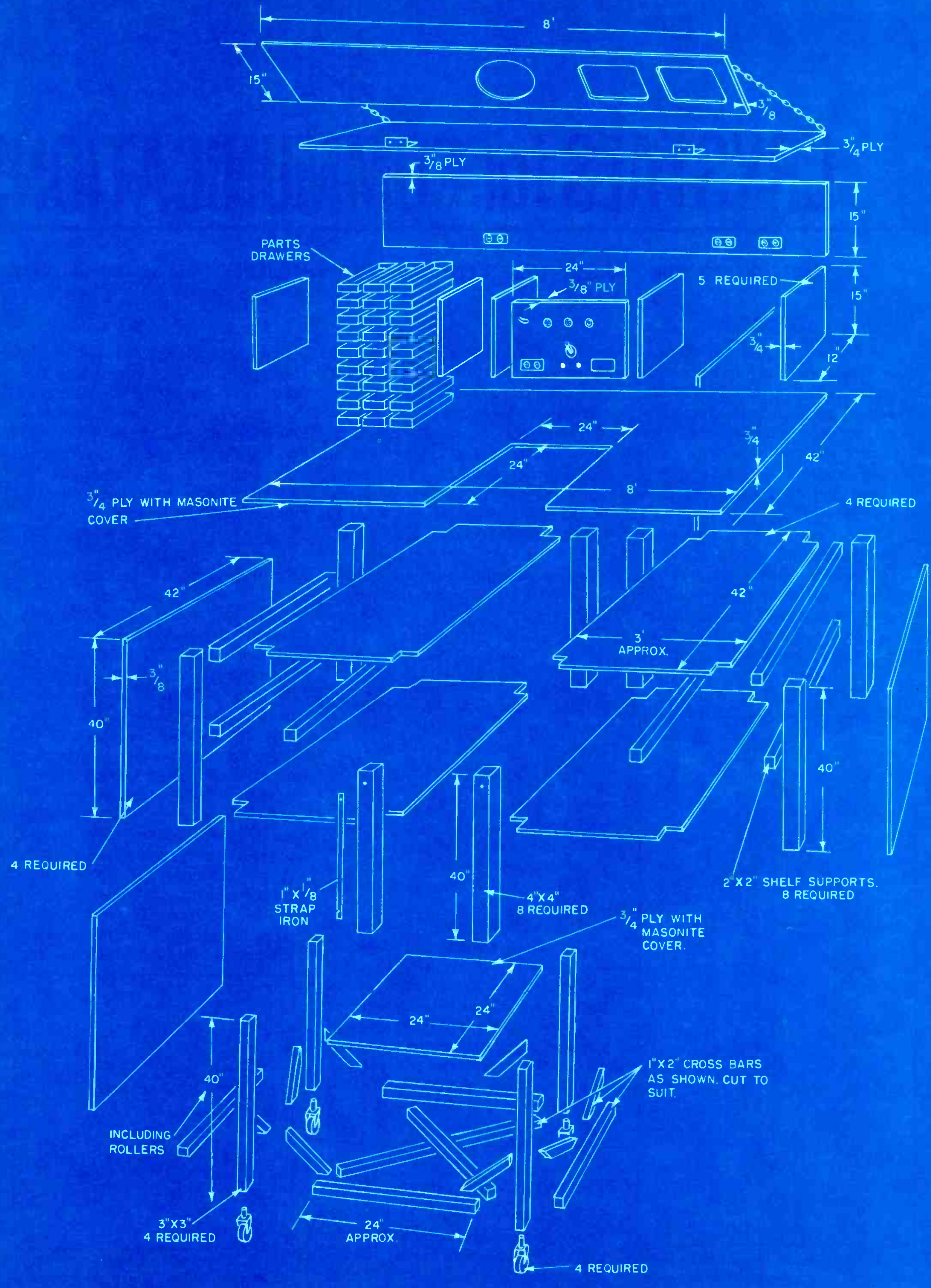
If you're tired of lugging TV sets around the shop, you may want to build this versatile workbench. The key to easy set handling lies in the unique roll-out sections. Chassis placed on these carts can be moved in and out of the service position with relative ease. The cart can be held in place by a long metal bar placed across the opening: the top of the cart is flush with the bench top so that sets can be moved around on the bench top, if necessary.

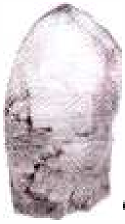
The hinged top panel contains 70° and 110° test CRT's (each equipped with a universal yoke), speaker, and space for service charts. Chains at each end allow the panel to be adjusted to any desired angle.

A test panel provides convenient terminals for connecting a chassis to the speaker and CRT test units. A meter and a scope can be placed on either side of the center panel; tools can be placed in a tray near the end of the bench.

The benches can be built individually, or several can be combined into one long, multiple-position bench. Shelves at each side make plenty of storage space. while the design of the carts allows leg room for the service technician.

At least three carts for each bench position will be enough to take advantage of the efficiency of this arrangement. An extra cart can be modified to contain alignment equipment or other less-often-used instruments; the equipment can thus be moved easily from one service position to another.


8'
15"
3/8"
3/4" PLY
3/8" PLY
15"
PARTS DRAWERS
24"
3/8" PLY
5 REQUIRED
15"
3/4"
12"
24"
3/4"
42"
24"
8'
3/4" PLY WITH MASONITE COVER
4 REQUIRED
42"
42"
3' APPROX.
3/8"
40"
40"
4 REQUIRED
2"X2" SHELF SUPPORTS. 8 REQUIRED
40"
1" X 1/8" STRAP IRON
4"X4" 8 REQUIRED
3/4" PLY WITH MASONITE COVER.
24"
24"
40"
INCLUDING ROLLERS
1"X2" CROSS BARS AS SHOWN. CUT TO SUIT.
3"X3" 4 REQUIRED
24" APPROX.
4 REQUIRED



CRYSTALS for COMMUNICATIONS

FACTS ABOUT THE "ROCKS" THAT KEEP RADIOS ON FREQUENCY . . . by Jim Galloway

The frequency of a communications transmitter or receiver must be highly stable; therefore, a crystal-controlled oscillator is commonly used. Just why a crystal oscillator is more stable than other types can best be understood by examining the properties of crystals, and then looking at the methods employed to utilize these properties in electronic applications.

To use the term *crystal* in referring to an oscillator-controlling element is slightly erroneous. Actually, only a thin slice taken from inside the crystal is used.

In its natural state, a perfect quartz crystal has the form of a hexagon with pointed ends, as shown in Fig. 1. The properties of such a crystal are best illustrated by referring to three axes—X, Y, and Z. The first or X axis passes through the corners of the crystal and is called the *electrical* axis. The second—the *mechanical* or Y axis—lies in the same plane as the X axis, but is perpendicular to the X axis and to the faces of the crystal. The Z axis passes through the length of the crystal and is called the *optical* axis.

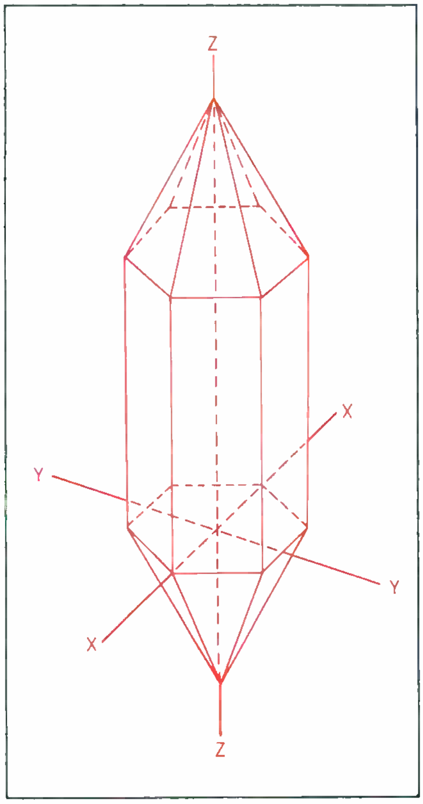


Fig. 1. Ideal shape of quartz crystal—hexagonal with sharply-pointed ends.

How They Work

When an electrical force is applied to a crystal in the direction of the X axis, a mechanical force is produced along the Y axis at a 90° angle to the applied force (see Fig. 2). Conversely, a mechanical force applied along the Y axis will cause an electrical force along the X axis. This interaction between electrical and mechanical forces within a crystal is called the *piezoelectric effect*.

The polarities of the two forces are directly related; therefore, if the applied force is alternating, the resultant force will do likewise. An alternating voltage will thus cause the crystal to vibrate. If the physical size and shape are chosen in correct relationship to the frequency of the applied voltage, the mechanical vibrations will be very intense. In this condition, the crystal is said to be at resonance.

What Are Crystal Cuts?

The term *cut* refers to how the crystal slice is taken from the master crystal. There are a variety of different cuts in crystals, and several factors determine which cut should be made. First, the resonant frequency of the crystal must be considered. The resonant frequency is normally determined by the thickness of the slice and its surface area: the smaller it is, the higher its resonant frequency will be. Crystals above a certain frequency limit are impractical because of their fragility. The upper limit for crystals operating on fundamentals has been found to be between 15 and 20 mc.

Another factor in choosing a crystal cut is the *temperature coefficient*. This is a measure of the amount of frequency drift produced by a temperature change. A *negative* temperature coefficient means that the resonant frequency of the crystal decreases with a temperature increase. If the resonant frequency increases with temperature, the crystal is said to have a *positive* temperature coefficient. Of course, a *zero* coefficient signifies that the crystal frequency is stable within certain temperature limits.

It is desirable, in most applications, to obtain a temperature coefficient as close to zero as possible.

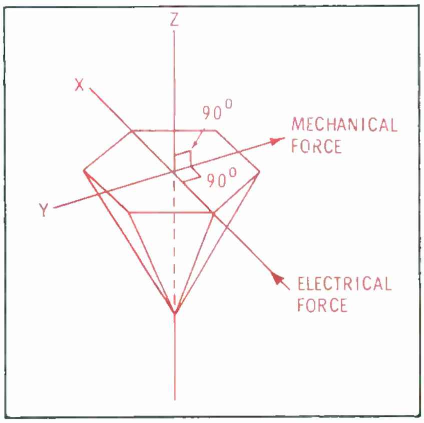


Fig. 2. Electrical-to-mechanical energy conversion takes place in crystals.

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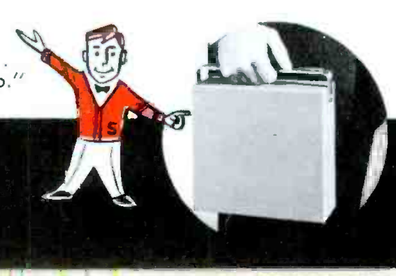

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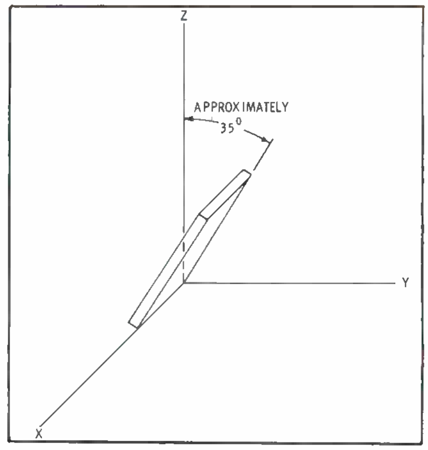

Fig. 3. AT plates are used extensively in commercial two-way transceivers.

However, if the crystal is operated under controlled temperatures, a certain amount of tolerance is permissible.

The crystal cut also has a bearing on the crystal *activity*—the strength with which the crystal will vibrate when a specified voltage or signal is applied. Its efficiency in an oscillator circuit depends on this characteristic.

Common Cuts

One of the most common cuts is designated as the *AT*. One side of this cut lies along the X axis, and its surface makes an angle of approximately 35° with the Z axis —as in Fig. 3. Crystals made from this cut are normally used in the range from 500 kc to 10 mc.

This cut is characterized by a very high degree of activity. Its temperature coefficient is practically zero for a particular operating point; the exact value is determined by the precise angle between the cut and the Z axis. Most modern two-way radio transmitters and receivers, as well as some Citizens-band units, use AT-cut crystals.

When a voltage is applied across the flat sides of the plate (a procedure known as *exciting* the crystal), vibrations will *displace* the crystal in the manner shown in

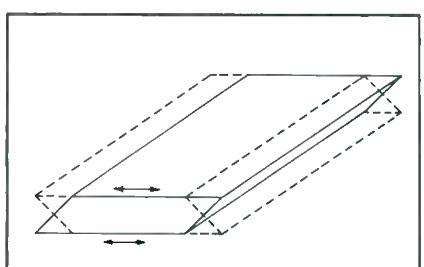

Fig. 4. At resonance, the AT-cut plate vibrates and is displaced laterally.

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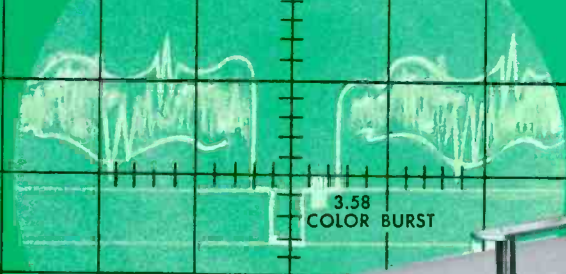

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Here it is, the scope that technicians, engineers and servicemen from coast to coast have been demanding. A portable wide band scope that can be used on the job anywhere, yet has the highest laboratory specifications for shop or lab. Cumbersome color TV sets, remote audio and organ installations and computers are just a few of the jobs that make owning a scope of this type so essential. Why consider a narrow band scope, when for only a few dollars more, this professional wide band sensitive scope equips you for any job.

• The PS120 provides features never before offered. Only two major controls make the PS120 as easy to use as a voltmeter. Even its smart good looks were designed for functional efficiency. New forward thrust design, creating its own shadow mask, and full width calibrated graph increase sharpness of wave form patterns. A permanent chromed steel carrying handle instead of untidy leather strap and a concealed compartment under panel for leads, jacks and AC line cord make the PS120 the first truly portable scope combining neatness with top efficiency.

• Electrical specifications and operational ease will surpass your fondest expectations. Imagine a wide band scope that accurately reproduces any waveform from 20 cycles to 12 megacycles. And the PS120 is as sensitive as narrow band scopes . . all the way. Vertical amplifier sensitivity is .035 volts RMS. The PS120 has no narrow band positions which cause other scopes to register erroneous waveforms unexpectably. Another Sencore first is the Automatic Range Indication on Vertical Input Control which enables the direct reading of peak-to-peak voltages. Simply adjust to one inch height and read P-to-P volts present. Standby position on power switch, another first, adds hours of life to CRT and other tubes. A sensitive wide band oscilloscope like the PS120 has become an absolute necessity for trouble shooting Color TV and other modern circuits and no other scope is as fast or easy to use.

SPECIFICATIONS

WIDE FREQUENCY RESPONSE:
Vertical Amplifier—flat within ½ DB from 20 cycles to 5.5 MC, down —3 DB at 7.5 MC, usable up to 12 MC.
Horizontal Amplifier—flat within —3 DB from 45 cycles to 330 KC, flat within —6 DB from 20 cycles to 500 KC.

HIGH DEFLECTION SENSITIVITY:

	RMS	P/P
Vertical Amplifier—Vert. input cable	.035V/IN.	0.1V/IN.
Aux. vert. jack	.035V/IN.	0.1V/IN.
Through Lo-Cap probe	.35V/IN.	1.0V/IN.
Horizontal Amplifier—	.51V/IN.	1.44V/IN.

HIGH INPUT RESISTANCE AND LOW CAPACITY:

Vert. input cable	2.7 Meg. shunted by approx. 99 MMF
Aux. vert. input jack	2.7 Meg. shunted by approx. 25 MMF
Through Lo-Cap probe	27 Meg. shunted by 9 MMF
Horiz. input jack	330 K to 4 Meg.

HORIZONTAL SWEEP OSCILLATOR:

Frequency range—	4 ranges, 15 cycles—150 KC
Sync Range—	15 cycles to 8 MC-usable to 12 MC

MAXIMUM AC INPUT VOLTAGE:

Vertical input cable— / Aux. vert. jack— / Lo-Cap probe—	1000 VPP (in presence of 600 VDC)
Horiz. input jack—	approx. 15 VPP (in presence of 400 VDC)

POWER REQUIREMENTS:

Voltage—	105-125 volts, 50-60 cycle
Power consumption—	On pos. 82 watts Stby. pos. 10 watts

SIZE: 7" wide x 9" high x 11¼" deep—weight 12 lbs.

The PS120 is a must for color TV servicing. For example, with its extended vertical amplifier frequency response, 3.58 MC signals can be seen individually.

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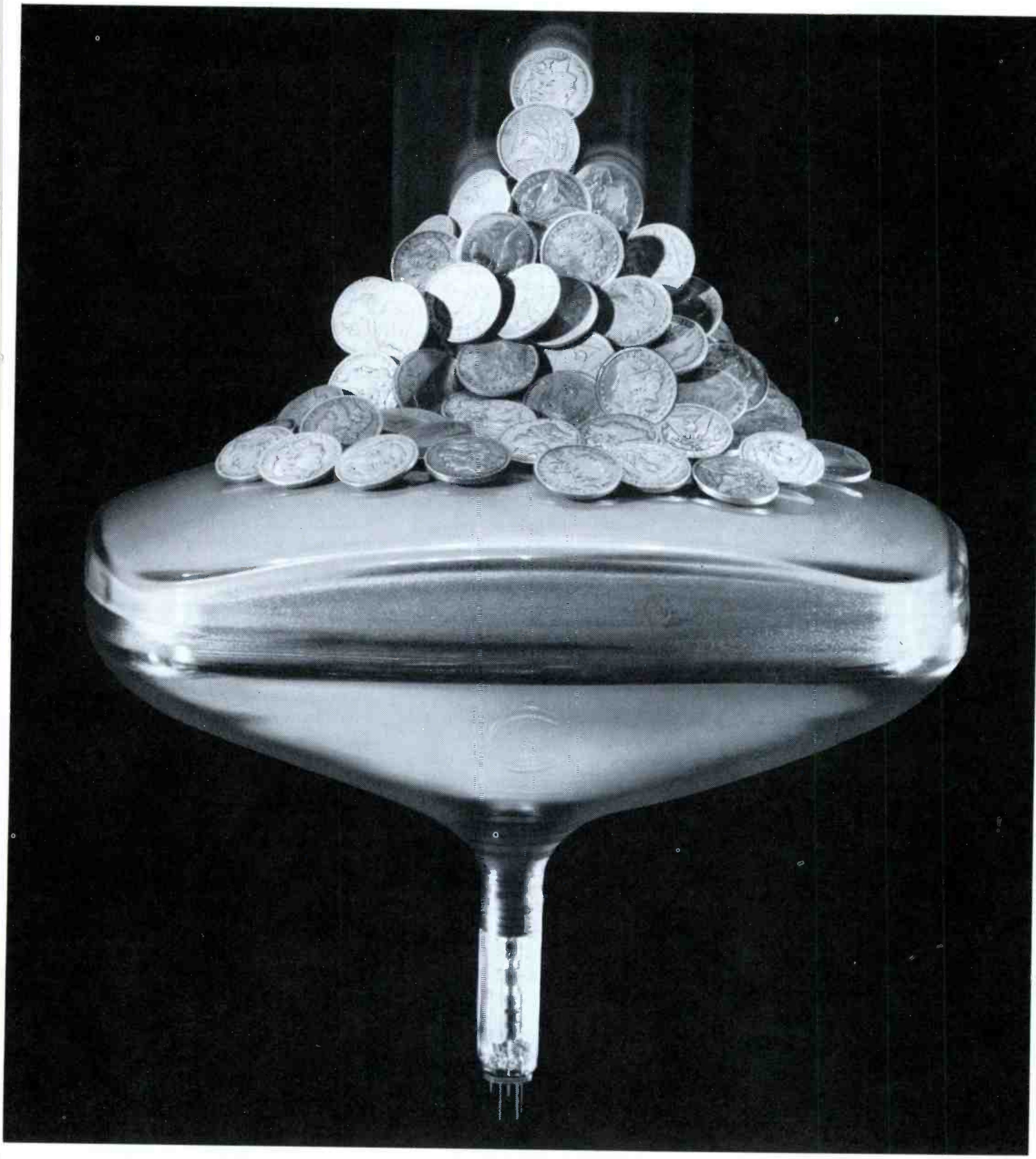

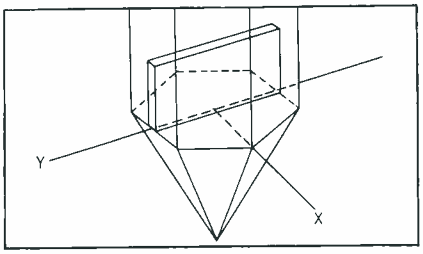

Fig. 5. X-cut plates are sectioned so that one side lies along the Y axis.

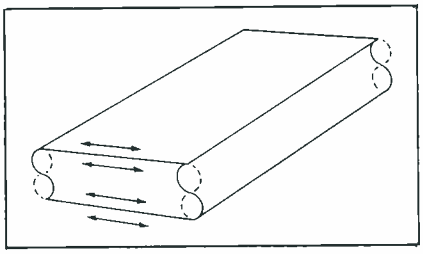

Fig. 6. Overtone crystals have complex displacement emphasizing harmonics.

Fig. 4. To meet strict frequency-tolerance requirements, the plate can be brought to resonance at an exact frequency by either of two method: Altering the *bevel* of the edges controls the tolerance to some extent; *plating* will correct the frequency even further.

CT-cut plates are similar to *AT* types, but have larger surface areas. When excited, they tend to have a very active displacement characteristic at frequencies below 500 kc. The resonant frequency of CT plates is determined mainly by the surface area, and can be brought within tolerance by grinding near the center of the edges of the crystal surface.

The temperature coefficient of CT-cut plates can be made almost zero at room temperature if extreme care is exercised in selecting the angle of cut.

The *X*-cut plate is formed as shown in Fig. 5. When a voltage is applied to the faces of this plate, it causes longitudinal vibration at either or both of two natural frequencies. This cut normally has a negative temperature coefficient of about 20 parts/million/°C. However, if the plate is cut to special dimensions, the temperature coefficient can be made almost zero. The X-cut plate has a lower activity than some of the other types. This, and certain other poor qualities, cause it to be used rather seldom in modern equipment.

Y-cut plates were once used extensively, but they too are seldom seen today because of some inherent bad qualities. The worst of these is that they have several resonant frequencies, making it difficult to find the correct operating frequency.

Other cuts which have been developed are not often used because of their complicated frequency spectrum and relatively high cost.

Overtone Crystals

To minimize the need for frequency-multiplier stages in transmitters, special crystals known as *overtone* types have been developed. Their output is actually an odd-order harmonic of their apparent fundamental frequency. Crystals for 12 mc or higher are usually of this variety. These are used quite often in Citizens-band sets, and to some degree in two-way.

A special plate known as a DT cut is beveled and shaped in such a way as to accentuate its harmonics. Compare the resulting displacement pattern (shown in Fig. 6) with that diagrammed in Fig. 4. This peculiar action gives the overtone crystal excellent activity at high frequencies. Recent improvements

Fig. 7. Thermostatically - controlled ovens keep crystal temperatures even.

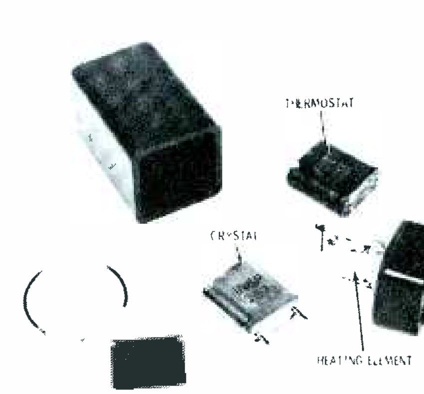

Fig. 8. View of a disassembled crystal oven showing the various components.

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Belden Trademarks and Patents . . U.S. Patent No. 2782251 and 2814666 †Belden Trademark—Reg. U.S. Pat. Off. 8-3-2 in overtone-crystal design have resulted in stability nearly equalling that of fundamental crystals.

Crystal Mountings

The method of mounting a crystal depends on the type of crystal, the vibration mode, and the conditions of its use. In ordinary communications equipment, where the crystal is likely to undergo relatively rough treatment, a rigid mounting is desirable. This is usually accomplished by placing two metal electrodes against the sides of the crystal and holding them firmly under spring tension.

In another type of mounting, the crystal rests on the lower electrode and doesn't quite touch the upper one. Special spacers are used to fill the gap.

Crystal Ovens

Even the best temperature coefficient is not always good enough to produce the desired degree of oscillator stability. If the frequency tolerance is extremely small, such as in commercial communications and broadcast work, the crystal is usually housed in an oven of the type pictured in Fig. 7. The oven is thermostatically controlled to keep the temperature within certain limits (from one or two degrees to as little as 0.01° C). Originally, various manufacturers had different ideas about the correct oven temperature. Units were available ranging from 60° C to 85° C or even higher. Now, most ovens operate at a standard 85° C.

Fig. 8 shows a disassembled oven with the various parts labeled. This type of oven is commonly used in two-way units, especially in mobile service where temperature extremes are likely to be encountered. The necessary stability for Citizens-band service can normally be obtained simply by using a crystal with a low temperature coefficient.

Crystal Performance

In certain oscillators, the crystal takes the place of the tuned grid tank, as in Fig. 9. In others, such as the circuit in Fig. 10, the crystal acts as the feedback element. For this reason, crystals are rated in terms of load capacitance; this factor must be borne in mind when a replacement is chosen.

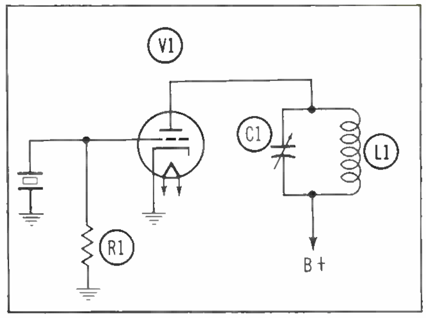

Fig. 9. Crystals replace grid tanks in tuned - plate tuned - grid oscillators.

Regardless of the type of oscillator circuit being used, best frequency stability is attained by tuning the plate tank to a frequency slightly higher than that of the crystal. This presents an inductive load to the normally capacitive circuit, and helps sustain oscillation.

The power output of crystal-controlled oscillators can be as high as 15 watts. However, the crystal stability decreases as the load increases, so some sort of compromise is generally necessary in oscillator design.

Stability is always the most important criterion of crystal performance. It depends to a great extent on the Q of the crystal, which is many times that of an LC circuit. Some commercial crystals have a Q of 30,000 and certain laboratory models have much higher values.

As the communications bands continue to become more crowded, it will be necessary to maintain even closer frequency tolerances. The serviceman will be expected to choose correct crystal replacements — according to frequency, tolerance, operating temperature, and circuit capacitance — and to carefully and accurately adjust the circuits in which they're used. ▲

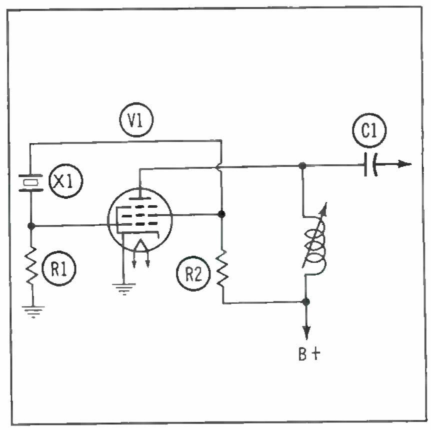

Fig. 10. Feedback for sustaining oscillation is furnished by the crystal.

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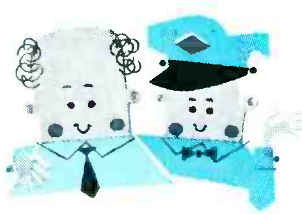

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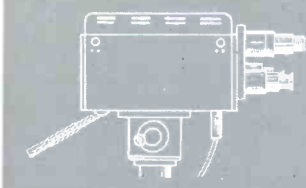

The Electronic Scanner

Report on Color Training Program

According to Frank Smolek, national service director for **Zenith Sales Corporation,** more than 10.000 servicemen have participated in the company's color TV service training program since its inception last April. Mr. Smolek has expressed Zenith's appreciation to independent servicemen throughout the country who have made the program such a success. The company hopes that thousands of additional dealers and technicians will take advantage of the training offered.

Eighty-one Stations Broadcast Stereo

Forty percent of the nation's population, about seventy million people, are now within range of at least one FM station which is broadcasting stereo. The consumer products division of the **Electronic Industries Association** has recently completed a survey which revealed these and other facts. Another point disclosed by the study was that equipment manufacturers, after a slow start, are keeping abreast of this newest form of home entertainment. It is estimated that 300 stations will be broadcasting FM stereo by the fall of 1962.

Window Posters Promote Service

Five suggestions on how they can save money on TV repairs are given to TV owners when they read this shop-window poster offered by **Sprague.** Consumers are warned against "bargains" and are advised to contact a reputable service dealer at the first sign of trouble. The posters are priced at ten cents each.

Trademark to be Abandoned

The **General Electric Co.** has taken steps to abandon its trademark "Compactron" and to dedicate the term to the public. The decision came about as a result of general public acceptance and use of the name. "Such public usage has caused the term to lose its significance as an indication of the origin of goods," according to L. Berkley Davis, vice president and general manager of the company's components division.

Millionth CB Crystal Produced

Shown celebrating the millionth CB crystal produced by **Texas Crystals** are: (left to right) John Erasmus, Engineer; L. H. Whan, President; B. N. Armstrong, Vice President; and R. A. Wells, Vice President, Engineering. The company supplies natural quartz crystals for private commercial and military use.

Free Watches Offered in Dealer Promotion

With each purchase of **Duotone** needles, dealers and service technicians will receive a gold-tone, slim-line men's or ladies' wristwatch from their distributor. The watches, which are electronically timed, are Swiss made and have lifetime mainsprings. The new promotion was recently announced by Stephen Nester, president of the company. "Every dealer," said Mr. Nester, "will be proud to own one of these handsome watches, and will want additional ones as gifts."

New Packaging Program Announced

Transparent acetate blister packaging will be featured in the 1962 **Walco** Accessory Program. In addition, to help the dealer in merchandising, the company has produced a rotary wire rack which occupies about twelve inches of counter space and displays the entire accessory line. Racks are available to those dealers buying certain amounts of merchandise.

MAXIMUM EFFICIENCY FROM CB

How to make the most of a *5-watt* power input.

by *Edward M. Noll*

Class-D Citizens-band units must be kept in peak operating condition to give a satisfactory return on their modest five-watt investment of DC input power. A slow deterioration in performance, sometimes unjustly blamed on conditions such as increased crowding of CB channels, can often be corrected by routine tube checks and an occasional alignment touch-up. CB service stations, in their advertising, would do well to emphasize the wisdom of regularly-scheduled equipment checkups.

To obtain the greatest benefit from this periodic maintenance, precise test methods must be employed. Experimentation and testing on the air wastes time, produces indefinite results, and causes interference to other CB'ers. Variable conditions of propagation and reception can make it difficult to decide whether or not a specific step in servicing has made any difference in system performance. A more positive and conclusive procedure is to make an off-the-air check, using suitable test equipment and accessories (Fig. 1). A dummy load, with impedance equal to that of the antenna, allows making all transmitter adjustments (except a final touch-up) without radiating a signal.

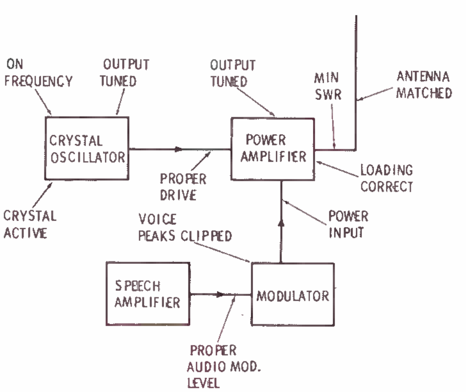

Fig. 1. The arrows indicate points to be checked in servicing CB equipment.

Transmitter Adjustments

The first step in checking out a transmitter should be a very careful measurement of the operating frequency. A slight error—even less than the .005% allowed by the FCC—can cause inefficient performance. You cannot assume that crystal control of the oscillator automatically insures perfect accuracy, since a crystal has characteristics which could easily change, causing it to operate off frequency. (For a more detailed explanation, refer to "Crystals for Communications" in this issue.) Furthermore, it is very important to use the type of replacement crystal specified for the model of CB unit you are repairing.

The oscillators in a few CB sets include a frequency-adjusting capacitor or inductor which occasionally needs resetting after a tube or other component has been replaced, or when a crystal has been changed. *No frequency adjustments should be made without using a frequency meter which has an accuracy well within the FCC tolerance specified for CB equipment. Furthermore, no frequency adjustments may be made except by licensed second-class or first-class radiotelephone operators.*

Drive Adjustments

The crystal oscillator stage must supply sufficient drive signal to the final amplifier. If the driving power is inadequate, maximum RF output cannot be delivered by the final stage even though the latter may be drawing its rated DC input power of five watts. The most common cause of reduced drive, other than a weak oscillator tube, is a decline in the activity of the crystal. This condition may develop spontaneously, even when the crystal is not in use.

When a tube or other component in the oscillator circuit is replaced, normal drive should be restored by repeaking the tunable output circuit of the oscillator (and also the buffer resonant circuit, if a buffer stage is used). A VTVM, connected to the grid circuit of the final amplifier, is used as an indicator. Different CB manufacturers suggest various connection points for the meter. Some recommend inserting an isolation resistor between the grid and the probe tip, while others provide connection facilities via a voltage divider in the grid circuit. Alignment instructions for certain units simply require that the VTVM be connected directly to the grid of the final stage. However, it is advisable to place the meter probe on the low side of any RF choke which may be in series with the grid resistor, in order to keep RF out of the meter circuit.

The output circuit of the oscillator should be tuned slightly to the high-frequency side of exact resonance, as a precaution against sluggish starting of the crystal oscillator when the transmitter is keyed. As the slug is tuned through resonance, a peak in the VTVM reading will be noted, with a slower decline on one side than the other. The final setting should be just barely below the peak, on the side which shows the more gradual decrease—i.e., the high-frequency side. To insure that the circuit will be tuned above the frequency of every channel being used, the oscillator adjustment should be made on the highest operating channel.

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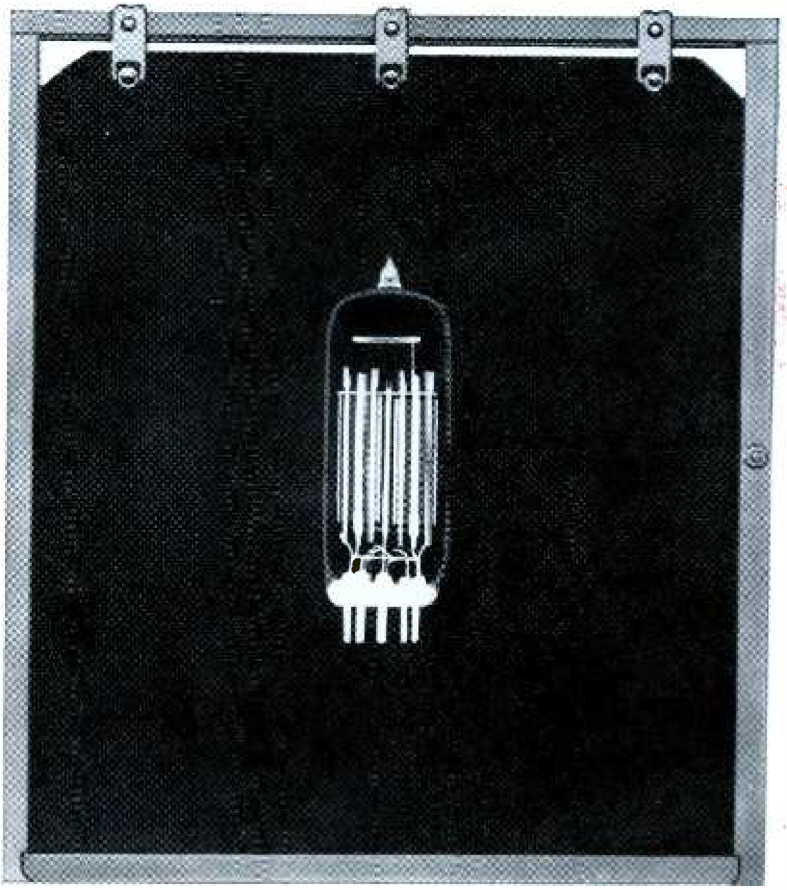

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the transmitter is operating, you should be able to measure the output in watts. Some wattmeters available for this purpose also serve as matched dummy antennas, and certain instruments are further equipped to measure modulation percentage. Therefore, it is possible to make all but the last-minute touch-up adjustments on the output circuit before an antenna is connected.

Four types of output circuits used in CB equipment are shown in Fig. 2. The pi-network output circuit in A is popular because it can be used for impedance matching as well as resonant tuning. It is particularly appropriate for matching the output circuit to the low-impedance antenna systems used in CB installations.

In most alignment procedures, the LOAD capacitor is initally set for minimum loading. The tank circuit is then resonated by adjustment of the TUNE capacitor. The loading is increased a little at a time, and the tuning is readjusted at each step so as to maintain resonance. Although these adjustments interact with each other, the input or TUNE capacitor has the greatest influence on the plate tuning, while the output or LOAD capacitor predominantly affects matching or antenna-system tuning.

During this procedure, a 50-ma meter should be placed in the plate circuit for monitoring the DC plate current. Many CB units have a jack for convenient insertion of this meter. Multiplying the current reading by the plate-supply voltage of the output stage gives the DC input power to the transmitter.

An input power greater than five watts may indicate that the transmitter has been tuned incorrectly. In the class-C output stages used in CB units, a dip in the plate-current reading should occur at resonance, even under a normal load. Inability to "dip" the plate current sometimes results from detuning the output stage or coupling the load too tightly to it. This can cause the input power to be more than the five-watt maximum allowed by FCC.

On the other hand, a DC input power of significantly less than five watts could be an indication that the RF loading is too light, or may be a sign of a transmitter defect

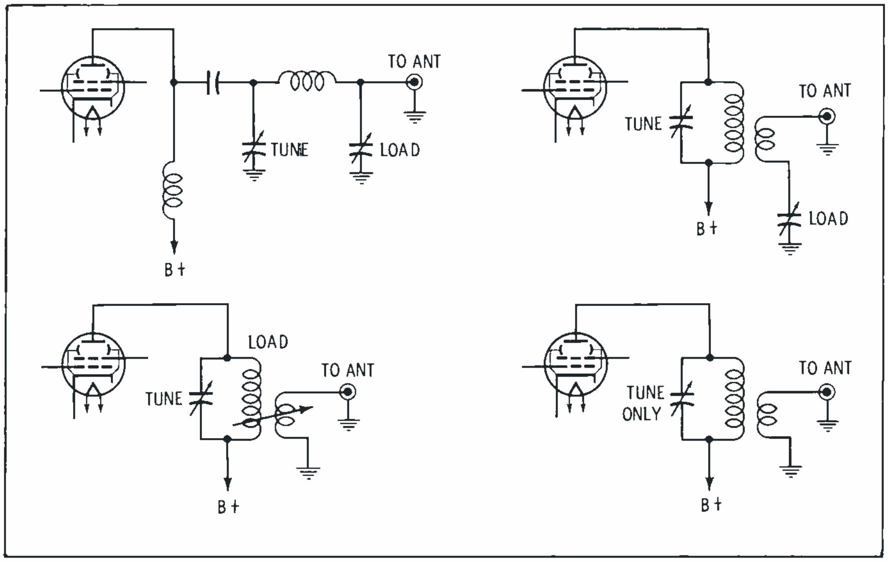


Fig. 2. Four types of circuits used for coupling transmitter to antenna.

such as a weak tube or low supply voltage.

When the RF wattmeter indicates maximum output, and the DC input power is very close to five watts, the dummy load should be disconnected and the regular antenna system attached for a final check. If the antenna system is at resonance and is reflecting the proper 50-ohm load to the transmitter, little change in the tuning and loading should be necessary. However, slight retouching of these adjustments should be attempted while the strength of the actual RF radiation is measured. Some transmitters include a simple neon-lamp RF indicator. For more precise indications, a field-strength meter can be placed near the antenna.

Since even the best dummy antenna does not have exactly the same characteristics as a normal antenna system, the final "on-the-air" touch-up of the tuning and loading adjustments may well increase the RF output. A slight increase in DC input power is also normal during this procedure, and care must be taken to avoid increasing the power beyond the five-watt limit.

Neutralization

The output stages in many class-D units—even some of those using multigrid tubes — require neutralization. This procedure usually involves a rather noncritical adjustment. In the most common method of neutralizing a CB power amplifier, a VTVM is connected to the grid, and a trimmer is adjusted until it is possible to vary the plate-circuit tuning through resonance with little or no change in the grid-circuit reading.

Modulation

The modulation level has much to do with the efficiency of a CB system. If it is too low, the range of transmission is seriously reduced. An error in the opposite direction causes overmodulation of the transmitter, which produces distortion and causes spurious signals to be radiated—in violation of FCC rules. In most CB transmitters, there is no adjustment of modulation level except that the operator can talk louder or softer, and can speak into the microphone from a varying distance. Therefore, if the proper modulation level is to be sustained, the audio system must be kept in excellent operating condition.

A modulation meter (included in many RF wattmeters) is a useful test instrument for spotting audio discrepancies. Some are able to measure both positive and negative modulation levels. For normal use, the average level should fall between 60-80%.

A few CB transmitters have a speech-level control which can be used to set the modulation level by varying the audio amplitude. In making such an adjustment, an audio tone of a specified strength is applied to the input of the audio section. A modulation meter is then connected to the transmitter output, and the modulation control is adjusted to produce an output with a given percentage of modulation. For more information about this procedure, see "Testing Transmitters" in this issue.

Receiver Efficiency

The receiver is as important as the transmitter in determining the effectiveness of a CB system, and should receive its share of regular maintenance. Tubes should be checked on a routine basis, and alignment should occasionally be peaked to compensate for frequency drift—especially in mobile units, which are subject to continual vibration.

The alignment procedure differs little from that employed for broadcast receivers. Generally, the best practice is to tune the last IF stage first, and then to work toward the antenna input. The output indicator is usually a VTVM connected into the AVC or noise-limiter circuit, or an output meter connected across the loudspeaker voice coil.

The most common IF frequency is 455 kc, but some units have a higher IF (such as 1680 kc), and a very few receivers are of the double-superheterodyne type. The RF section may be either crystal-controlled or continuously tunable.

In crystal-controlled types, the oscillator frequency depends upon the choice of the proper "receive" crystal for each channel to be used. A few units include a trimmer which can be used to set the crystal oscillator precisely on frequency; however, there are no provisions for this adjustment in most CB equipment. If the crystal happens to be slightly off frequency, reception may be weak, and may even be distorted. This fact gives added emphasis to the importance of installing only the crystals recommended by the manufacturer for his particular unit.

In the alignment of a continously-tunable RF section, a signal of a prescribed frequency (usually near the center of the band) is applied to the antenna-input terminal, and the tuning dial of the receiver is set to this specific frequency. First the local-oscillator alignment control, and then the other RF trimmers, are adjusted for maximum output.

Efficient Antenna Systems

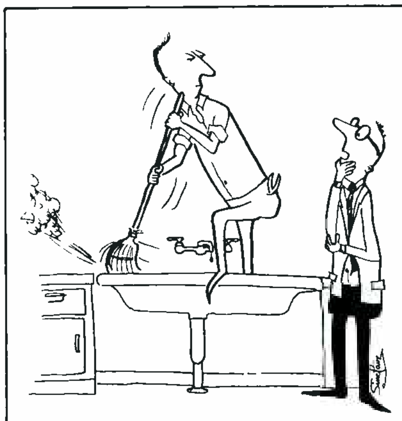
Antennas should preferably be cut to the exact length required for resonance, but this is sometimes not practical in vehicular installations. If a mobile antenna is shorter than an electrical quarter-wavelength, it should be properly loaded. It is advisable that the transmitter have a loading control to compensate for design variations among antennas and the influence of nearby obstacles. For best results, mobile antennas should be mounted to take full advantage of the possibilities for using the car body as a ground plane (see "Installation Know-How" in this issue).

The base-station antenna should be mounted high and clear of obstructions; furthermore, a good ground should be provided. A low-loss transmission line encourages the transfer of maximum energy to the radiating surface. The antenna should radiate ample power at low angles to the horizon, where high field strength is most greatly needed.

This concern about the antenna installation is important to reception as well as to transmission. Since CB systems depend on reception of very weak signals, except at extremely short range, as much signal as possible should be transferred to the receiver input.

Since a highly sensitive receiver is quite helpless to receive these weak signals when electrical noises exceed the incoming signal level, the importance of effective noise suppression in mobile units cannot be overemphasized. "Mobile Installation Know-How" also has some pointers on eliminating noise.

In summary, peak CB efficiency cannot be obtained by concentrating on only one segment of a system. Transmitters, receivers, antenna systems, and installation practices all require careful attention. ▲



"No-o-o, I think I said, 'check the sync and sweep' not 'sweep the sink.' "

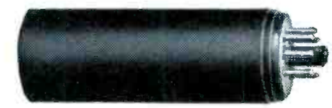
S-5018—replaces 5AU4, 5AW4, 5AZ4, 5T4, 5U4, 5V4, 5W4, 5Y3, 5Z4, 5931, 6087, 6106

S-5207 replaces 6X4

S-5130—replaces 866, 866A, 3B28

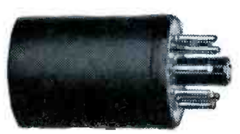
S-5367—replaces 8020

S-5343—replaces 816, 836, or 3B28 and 866 at reduced voltage



S-5033—replaces 6AU4, 6AX4, 6BL4, 6W4, 12AX4, 17AX4, 25W4, 6U4
S-5019—replaces 5R4

S-5011A—replaces 80, 82, 83, 83V, 5Z3
S-5017—replaces 0Z4, 5X4, 5Y4, 6AX5, 6X5



S-5251—replaces 5U4, 5AU4, 5AW4, 5AZ4, 5T4, 5V4, 5W4, 5Y3, 5Z4

Illustrations approximately ½ size

S-5347 replaces 12BW4, 6BW4

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Now $75.55
in 1 to 9 quantity

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These standard Tarzian tube replacement rectifiers are directly interchangeable with over 95% of all popular vacuum tube rectifiers. Although they are generally smaller and more compact than the tubes they replace, their dc current ratings are as much as three times as high.

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by K. V. White

HANDLING CREDIT ON YOUR OWN

"No doubt about it, credit and collections are getting to be big problems for most of us," commented the owner of a Midwestern TV sales and service firm. "Ten years ago, almost everybody paid cash for TV repairs. Now, they demand credit — and we have to give it to them to stay competitive.

"I've found that we are frequently asking for trouble when we open a charge account. We can't really afford a collection agency when an account goes bad on us, but we almost have to use one. There must be a sensible solution to these problems — but what is it?"

This businessman was voicing the same thoughts that have bothered many others in recent years. With the tremendous growth of credit purchases since World War II, no business can be completely independent of the customer who seeks credit. For the comparatively small business, this trend can create almost overwhelming problems.

One solution, described at length in the May PF REPORTER, is to turn your credit affairs over to outside agencies (such as charge-plan associations and finance companies) who can furnish the needed capital, and can also assume the burden of collections. However, using outside credit sources is not necessarily the best plan for every service dealer; you may come out ahead by taking full responsibility for all your own credit transactions. To see if you should consider this alternative, ask yourself the following questions:

1. If I use credit reports to help decide whether or not to extend credit to a customer, will I receive the information I need? Can I get the same information for myself?
2. When an account becomes delinquent, can I make an adequate collection effort before resorting to a collection agency?
3. What can I do within my own organization to minimize credit and collection costs, and to assure myself of effective results?

If you can make satisfactory responses to these questions, chances are good you can safely undertake your own credit transactions.


APPLICATION FOR CREDIT

Name ______ Age ______
Address ______ Telephone ______
Married __ Single __ Husband's or wife's first name ______
Occupation ______ Employer ______
Employer's Address ______ Telephone ______
Nearest Relative ______ Address ______
Credit References (please give three, if available)

Personal References (Please give two)

Date ______
Signature ______

Fig. 1. Short-form credit application provides adequate data for collections.

Offer Credit to Whom?

You can avoid many eventual collection problems by making intelligent decisions when first considering whether or not to extend credit to a customer. There are three important factors in making such decisions:

1. Are the statements on the customer's credit application accurate?
2. Does the customer handle other accounts in a satisfactory manner?
3. Is the customer able to assume additional financial obligations?

The easiest way to get an answer to these questions is to call the local credit-reporting agency. However, remember that a credit report normally will cost you from $1.50 to $5.00, or more, and may contain information which is actually of no value to you in making a sound credit decision.

If you decide to develop the credit report on your own, the brief application form shown in Fig. 1 should provide sufficient data to go on. Anyone in your organization can make a few telephone calls to check the references and verify the employment of a potential credit customer. If that person pays his other accounts well, chances are good that he will pay you in the same manner. This basic information is really all you need to answer the above questions. Extraneous items of information (such as details of the customer's marital status or religious affiliations) are of no value in determining the financial reliability of an individual.

In those cities that have an accurate credit-rating guidebook, it will usually provide all the information you need, except for a check of the person's employment.

Collection Methods

When an account becomes delinquent, the path of least resistance is to call in a collection agency right away. However, the dollar cost of such a procedure may be high.

As can be seen from the sample

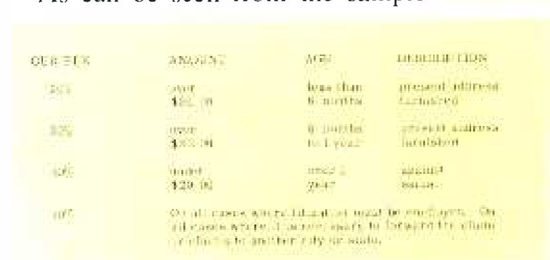

Fig. 2. Sample collection-agency rate chart. Fees range from 20% to 50%.

FINEST MONEY-MAKER FOR Professional Servicemen

Multiple-Socket Speed with Gm Accuracy

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TESTS All TV and Radio Tubes —Old and New

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TESTS for True Dynamic Mutual Conductance (Gm)

TESTS Nuvistors and Novars

TESTS the New 10-Pin Tubes

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Model 700
DYNA-QUIK
DYNAMIC MUTUAL CONDUCTANCE TUBE TESTER

See your B&K Distributor or Write for Catalog AP20-R

TESTS BOTH OLD AND NEW TUBE TYPES—SELLS MORE TUBES PER CALL

All over the nation, thousands of professional servicemen rely on the "700". Once you use it, you'll be as enthusiastic as they are. *Everyday use has proved its speed . . . its accuracy . . . its efficiency.* This up-to-date, obsolescence-proof tube tester is designed for maximum use *today and tomorrow.* Provides multiple-socket section to quick-check most of the TV and radio tube types the *true dynamic mutual conductance way—plus* simplified switch section to check new tube types in Dyna-Quik emission circuit. Also includes provision for future new sockets.

Makes test under set-operating conditions. Checks each section of multi-section tubes separately. Checks for *all* shorts, grid emission, leakage and gas. Makes quick "life" test. Exclusive *adjustable* grid emission test provides *sensitivity to over 100 megohms.*

Makes complete tube test in seconds. Checks average set in a few minutes. Discovers weak tubes that need replacement. *Satisfies more customers. Sells more tubes. Saves call-backs. Insures your reputation. Pays for itself over and over again.* Net, $\$169^{95}$

Time-Saving, Money-Making Instruments Used by Professional Servicemen Everywhere

Model 960 Transistor Radio Analyst

Model 360 V O Matic Automatic VOM

Model 375 Dynamatic Automatic VTVM

Model 1076 Television Analyst

Model 440 CRT Rejuvenator Tester

NEW TUBE INFORMATION SERVICE
Available every 3 months, on subscription, for all B&K Dyna-Quik Tube Testers

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Division of DYNASCAN CORPORATION
1801 W. BELLE PLAINE AVE. • CHICAGO 13, ILL.
Canada: Atlas Radio Corp., 50 Wingold, Toronto 19, Ont.
Export: Empire Exporters, 277 Broadway, New York 7, U.S.A.

Mr. John Someone
83 Peabody Street
Somewhere, U. S. A.

Dear Mr. Someone:

It appears that there has been no payment made on your account with us in the past two months. I am quite sure that this is merely an oversight on your part, but if you have a complaint about the service we have given you, I would certainly like to hear about it.

We have appreciated having you as a customer, Mr. Someone, and we certainly hope to be able to maintain our cordial relations.

Sincerely,

Signature

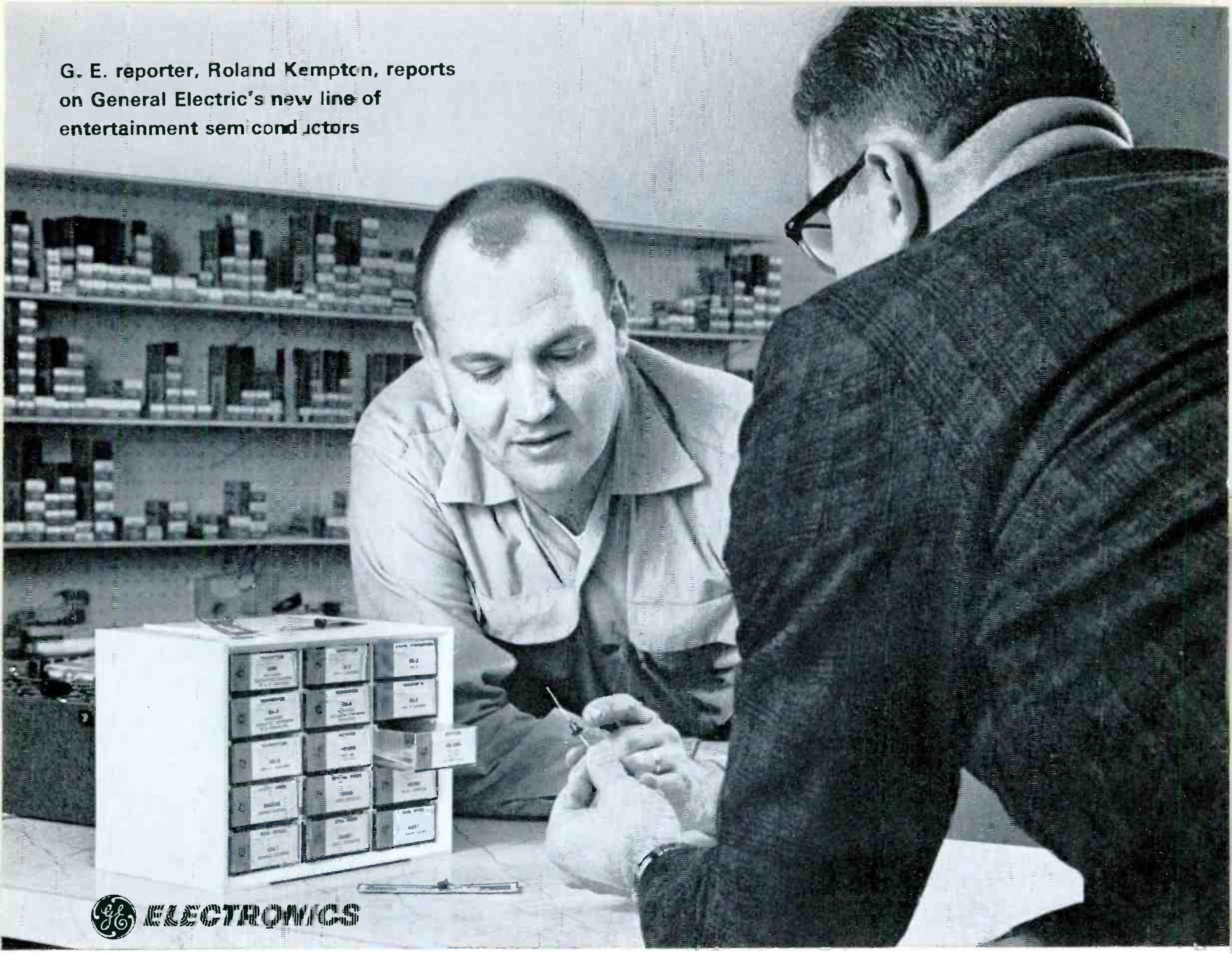
Fig. 3. Mildly-worded collection letter for accounts only slightly overdue.

rate chart in Fig. 2, fees usually range from 20% to 50% of the gross amount collected by the agency on an account. These fees can eat up profits quickly, if a collection agency is used indiscriminately.

The intangible costs of using a collection agency should also be given careful consideration. A carelessly-selected agency may very well use premature or indiscriminate collection methods in your name, thereby creating unnecessary friction between you and the debtor. Such techniques as the threat of a garnishment can only arouse resentment and resistance in his mind. Worse yet, unpleasant stories of such actions travel quickly. You may not be concerned with your relations with a particular delinquent customer; however, once that customer criticizes you in front of his friends, neighbors, and relatives, you may well find that it has affected your relations with other, nondelinquent customers. Such criticism by a customer would probably not include an admission of his delinquency, but would far more likely concern the quality of your work or the price you charge—even though he would have no legitimate complaint in these areas.

Certain collection agencies offer "commercial plans" which are purported to reduce collection costs. If you are approached about participating in such a plan, you should thoroughly examine the details first. A typical commercial plan entails the payment of a membership fee of $50 to $100, which is usually guaranteed to be recovered through the collection activities of the agency.

The user of the plan turns over a list of his delinquent accounts to the agency, which, in turn, sends form notices to the debtors at seven-day intervals for a three-week period. If



Marvin Kleine figures he can fill 80% of his replacement needs from new G-E *SERVICE-DESIGNED* entertainment semiconductor kit

We gave Marvin Kleine, manager of ROGERS HORNSBY TV SERVICE, St. Louis, a preview of General Electric's new line of Service-Designed entertainment semiconductors. He saw several immediate advantages: "One of the main things in this business is *one time on the bench*—being able to put a set on the bench, check it out, fix it and get it out with a minimum of handling. These Service-Designed semiconductors will help because in about 80 percent of the cases I'll have the replacement right here in the shop. Should speed up our service and save a lot of shopping around for exact replacements. The blister-pack on cards makes a lot of sense, too, and I'm glad to see you've included interchangeability data. Saves us the trouble of looking it up."

If you still have to shop around for entertainment semiconductor replacements, it will pay you to check G.E.'s expanded new Service-Designed line, including:

GE-504 "Universal" Silicon TV Rectifier—a universal replacement for all silicon, germanium and selenium rectifiers used in TV receivers. It features a 45 amp. max. surge rating which eliminates the need for a limiting resistor as is necessary with ordinary silicon rectifiers. 750 ma DC output; 400 PIV.

8 "Universal" Transistor Types—including 2 power transistors for auto radios—Service-Designed to replace over 600 types used in original equipment.

4 Crystal Diodes—Service-Designed to replace approximately 98% of all diodes used in entertainment applications.

A Replacement Guide and Catalog of entertainment semiconductors is available at your G-E distributor. Ask for ETR-2982 or write to: General Electric Company, Distributor Sales, Electronic Components Division, Room 1710A, Owensboro, Kentucky.

Progress Is Our Most Important Product

GENERAL ELECTRIC

Mr. John Someone
83 Peabody Street
Somewhere, U. S. A.

Dear Mr. Someone:

On February 30, 1962 we wrote to you concerning your account with us. Surely you must know that your account is now three months past due. The amount involved is currently $33.00.

I can no longer carry this account without some action on your part, Mr. Someone. Yet, I certainly do not want to go any further than this letter to have you bring the account up to date. May I expect a remittance not later than next Monday?

Cordially,

Signature

Fig. 4. If gentle reminder is ignored, next letter should be more emphatic.

the debtor pays during this period, the account is subject to a service charge of 5%. If the account goes past the three-week period without activity, it is automatically placed in the regular fee category, and is subject to the rates shown in Fig. 2.

Of course, the majority of collection agencies are highly ethical, but because of the amounts involved, it is well to choose one carefully. Here are some questions to ask a collection agency you may be considering for selection as your representative:

1. What are your primary methods of collection? How effective are they?
2. What assurance do I have that sums collected in my name will be transmitted to me in full?
3. What assurance do I have that you will not threaten unusual or intemperate action in my name without permission?
4. If I should decide to withdraw one or more accounts, how can this be accomplished in an orderly manner?
5. Will you transmit payments made on my accounts as soon as they are collected by you? (Many agencies will object to this procedure initially. However, it's your money, and you can use the operating capital as well as they can.)
6. Are you bonded, and what protection is this for me?

When an account becomes seriously delinquent, and an outside agent must be used, consideration should be given to turning the account over to an attorney. The fee charged by an attorney is usually no higher than that assessed by a collection agency. There is little difference in the eyes of the debtor, since a collection agency is likely to threaten legal action in the normal course of its procedures.

January 2, 1962

ACCOUNT	ACTION	RESULT	TICKLER DATE
WILLIAMS (#2694)	TP	CB	Jan. 7
SMITH (#3030)	L		Jan. 7
CAREW (#2730)	P	PP	Jan. 7

January 7, 1962

ACCOUNT	ACTION	RESULT	TICKLER DATE
WILLIAMS (#2694)	TP (CB)	PP	Jan. 10
SMITH (#3030)	NA	T	Jan. 9
CAREW (#2730)		PAID $47.60	

CODE: T - Telegram TP - Telephone L - Letter
P - Personal Call PP - Promise to Pay
CB - Call Back NA - No Answer

Fig. 5. Entries on cards in "tickler file" help you keep track of collections.

Your Own Collection Efforts

If yours is a typical service-dealer organization, there is a good deal you can do to minimize the cost of your credit and collection activities, by improving the efficiency of your internal procedures.

At first, most people object to making collection calls, either on the telephone or in person. Overcoming this attitude is largely a matter of exposure and training. Your employees will discover after a few calls that most debtors will be happy to discuss a legitimate debt in a temperate tone, and will respond rather well if handled maturely.

Consistency is the key to success in any collection activity. If a debtor promises to make a payment on a given date, and that payment is not received, he should be called immediately. If promises to pay are repeatedly broken, you should personally call the debtor. This call will probably enable you to determine whether to give him additional time, or to turn the account over to an attorney or collection agency.

If there is no one in your organization capable of making an effective collection call, you should write letters to the debtors. (See Figs. 3 and 4 for suggested forms.) These letters should be sent separately from the regular statements, so that the debtor senses some urgency about the matter. Even so, a letter is easily ignored, and is never as effective as a personal contact.

Although it is comparatively expensive, a delivered telegram will attract the attention of a reluctant debtor as nothing else will. This method would normally be reserved for extreme cases, because of the cost.

A daily tickler file should be kept of all calls (telephone or personal), letters, telegrams, promises to pay, and callback dates. (See Fig. 5 for sample tickler cards.) This file should be checked periodically to be sure it is kept up to date. If you use ledger cards for your accounts, credit and collection information may be noted on these cards, provided that they are filed by date. When there is some collection activity on the account, the card should then be set forward to the indicated date of the next action. Experience has proven that a separate tickler file is usually easier to handle than a ledger and collection cards combined.

Once in a while, you will find that a debtor has disappeared without a trace. Discreet inquiries among the debtor's friends, relatives, neighbors, school or church officials, and former employers will usually produce a clue to his new location. Fig. 6 provides some other helpful suggestions. When everything else fails, a registered letter sent to the debtor's old address (return receipt requested, showing address where finally delivered) will often produce results.

1. CITY TELEPHONE BOOK
   And dial INFORMATION, too.
2. CITY DIRECTORY
   The bigger hotels and libraries have them.
3. POST OFFICE
   Especially with a friend on the force.
4. RELATIVES OR FRIENDS
   Often happy to put debtor on spot.
5. EMPLOYER or FORMER EMPLOYERS
   Debtors write back around tax time.
6. FELLOW EMPLOYEES
   Debtors brag about the new job.
7. SCHOOL AUTHORITIES - PTA GROUPS
   Transcripts, grades sent to new school.
8. FARMERS UNION OR OTHER CO-OP MEMBERSHIP LISTS
   Debtor wants his share money back.
9. LABOR UNION MEMBERSHIP LISTS
   Good union men transfer union cards.
10. CHURCH, CLUBS OR LODGE MEMBERSHIP LISTS
   Joiners pay dues first, debts last.
11. OTHER CREDITORS
   Man who owes you owes others.
12. FORMER LANDLORD OR NEIGHBORS
   "Puts duns in basket, good stuff to us."
13. INSURANCE AGENCY
   Especially life policies.
14. LOCAL NEWSPAPER
   When it happens to former resident, it's NEWS.
15. LOCAL BARTENDERS
   On whose broad shoulders men have always cried.
16. POLICE AUTHORITIES
   Who know more about you and I than we think.
17. SELECTIVE SERVICE
   "I'd like to write to my friend in the service."
18. HIS CAR
   Write Dept. of Motor Vehicles, giving debtor's name and ask for license number and new address.
19. LOCAL BANKS, especially the DEBTOR'S BANK
   Pay local banker for long distance to phone out of town banks.
20. MAIL
   Send registered letter, return receipt requested - showing address and where delivered. See local postmaster for further information.

Fig. 6. Twenty ways to locate a debtor who has "skipped" to a new address.

Some of the suggestions in this article may sound elementary to you; but one businessman in Columbus, Ohio, having installed a system based on these suggestions, was able to show an 11% reduction in his credit and collection costs within a six-month period. At the same time, his percentage of collections from within his own organization rose a dramatic 23%. Obviously, not every firm could show such favorable results in so short a time, but even a fraction of these improved profits would mean more money in the till.

There is only one sure way to show excellent results in the credit and collection activities of your organization: You must insist, and continue to insist, that employees involved in credit and collection be cost-conscious, use mature judgment, and, above all, be consistent in their relations with those accounts that develop into a collection problem. ▲

Mercury offers you MORE for your TEST EQUIPMENT DOLLAR!

Model 1000 MUTUAL CONDUCTANCE TUBE TESTER

A TRUE DYNAMIC MUTUAL CONDUCTANCE TUBE TESTER AT AN AMAZINGLY LOW PRICE!

$79⁵⁰ Net

Here, for the first time is a true dynamic mutual conductance tube tester that sells for less than a hundred dollars . . . in fact it bears a price tag of only $79.95 . . . *truly, the greatest value in test equipment* to come your way in a long time. Even more important is the fact that the Model 1000 is one of the most up-to-date mutual conductance tube testers available today, as it accommodates all the very latest tube types.

FEATURES

• Tests for true dynamic mutual conductance (GM) . . . shorts and leakage between any tube elements . . . grid emission and gas • Tests black and white picture tubes • Also tests foreign and hi-fi tubes, voltage regulators, battery type tubes, auto radio hybrid tubes, thyratrons and most industrial tube types • Two point test principle overcomes obsolescence caused by new base pin arrangements or new internal jumpers in tubes • Automatic line voltage regulation • Built-in 7-pin and 9-pin straighteners on panel • Long lasting phosphor bronze tube sockets • Handsome two-tone etched aluminum panel • The most complete tube chart conveniently located in cover • New tube listings subscription service available • Housed in handsome, sturdy leatherette case with convenient compartment for cables • Small compact size: 14"x9½"x4¾".

- *Faster, easier servicing to make every day more profitable*
- *Most advanced engineering designs to assure long-life dependable performance*
- *Sets new standards in quality and value*

Model 1100 TUBE TESTER

COMPACT IN SIZE... BUT A WHALE OF A MONEY MAKER!

$39⁵⁰ Net

Here is the answer to aggressive-minded technicians who seek a dependable, professional performing tube tester at a minimum cost. Although low in price, the Model 1100 has a range of operation that will outperform more expensive testers. The speed and accuracy achieved in testing tubes is so great that you will find it profitable to check all tubes when repairing a TV set. Not only will it increase tube sales, but it will enable you to detect hard-to-find weak tubes and thereby avoid time consuming call backs.

FEATURES

• Tests all tubes for dynamic cathode emission, shorts and leakage, grid leakage and gas content • Also tests battery type tubes, auto radio hybrid tubes, voltage regulators, foreign and hi-fi tubes, thyratrons and most industrial tube types • Exclusive meter bridge circuit provides accuracy found only in the more expensive tube testers • Will detect any short in a tube, even where internal pins are tied or heater is tapped • Checks each section of multi-section tubes separately • Long lasting phosphor bronze tube sockets • Handsome two-tone etched aluminum panel • The most complete tube chart conveniently located in cover • New tube listings subscription service available • Housed in handsome, sturdy leatherette case • Compact size: only 10¾"x8¼"x3¼".

All MERCURY Tube Testers will test the new tube types including:

- NUVISTORS • NOVARS
- NEW 10-PIN TUBES
- COMPACTRONS

Model 500 COMPONENT SUBSTITUTOR

✔ A complete range of components at your fingertips for fast substitution

✔ No need to buy several different component substitutors . . . The Model 500 does the whole job!

$34⁹⁵ Net

All the *substitutes for electronic components* you want and need in your every day work are here in this advanced design component substitutor . . . *more than any other instrument of its type!* This compact unit saves you countless dollars as it does the work of several different component substitutor instruments. Its amazing scope covers a full range of resistors, condensers, electrolytics . . . and also contains many exclusive features covering the substitution of crystal diodes, power rectifiers, power resistors and bias voltages for AGC and transistor servicing.

FEATURES

• Subtsitutes for resistors from 33 ohms to 10 megohms • Substitutes for condensers .001 mfd to .5 mfd. • Substitutes for electrolytics from 4 mfd. to 330 mfd. • Substitutes for all power rectifiers up to 500 ma. • Substitutes for all diodes • Substitutes for power resistors . . . continuously variable up to 5000 ohms • Substitutes for bias voltages . . . continuously variable up to 15 volts either polarity • Etched aluminum panel always retains its handsome appearance • Housed in handsome hammertone steel case • Carrying handle swings back to serve as a support, so instrument can be used in a convenient tilted position • Size 5⅞ x 7¾ x 3½".

Other MERCURY profit-making instruments

- Model 201 Self-Service Tube Testers
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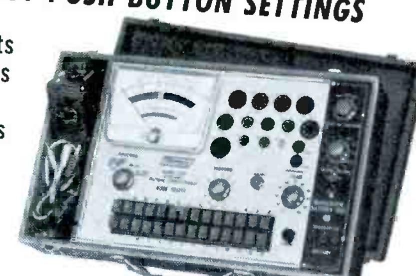
- Model AD-4 Tube Tester Adapter
- Model MP-1 Multi-Probe
- Model MH-1 Multi-Head

See your local electronics parts distributor!

Model 1200 MUTUAL CONDUCTANCE TUBE TESTER

Deluxe Dynamic Mutual Conductance Tube Tester with ***FAST PUSH BUTTON SETTINGS***

. . . also tests picture tubes transistors and batteries



$119⁹⁵ Net

Here is a new *high* in tube testing convenience. A dynamic mutual conductance tube tester with *push-button settings*. The simplicity of this unique set-up method can be compared with the ease of selecting a record on a juke box. This is just one of the extraordinary innovations found in the Model 1200. It also provides for transistor tests and battery tests. These unique features combined with the extreme accuracy and versatility of the Model 1200 make it truly one of the most advanced mutual conductance tube testers available today.

FEATURES

• Tests for true dynamic mutual conductance (Gm) . . . shorts and leakage between any tube elements . . . grid emission and gas • Also tests foreign and hi-fi tubes voltage regulators battery type tubes, auto radio hybrid tubes, thyratrons and most industrial types • Tests b/w and color picture tubes • Tests transistors (includes panel socket and clip leads) • Tests all popular type batteries used in transistor and portable radios, tape recorders, etc. • 28 push buttons provide complete versatility in accommodating all tube types and basing arrangements • Automatic line voltage regulation • Built-in 7-pin and 9-pin straighteners on panel • Long lasting phosphor bronze tube sockets • Handsome two-tone etched aluminum panel • The most complete tube chart conveniently located in cover • New tube listings subscription service available • Housed in handsome gray leatherette case with convenient compartment for cables • Size: 18¼" x 10¾" x 4¾".

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TESTING TRANSMITTERS

What steps to take, and what test equipment to use ... *by Keith Bose*

Each year, more and more two-way radio stations are going on the air; as a result, channels are being squeezed closer and closer together. Under such crowded conditions, wasteful practices such as frequency drift and transmitter overmodulation cannot be tolerated. The FCC has taken steps to prevent interference between stations by incorporating certain strict operating requirements into their Rules and Regulations; these restrictions are set forth in Subpart C of Parts 10, 11, and 16.

The Regulations specify that two-way radio transmitter *frequency, modulation* and *power* checks be made:

(a) When the transmitter is initially installed.

(b) When any repair or change in the transmitter may affect the frequency, the modulation, or the stability of either.

(c) At regular intervals not to exceed one year.

In addition, all transmitter adjustments, maintenance, measurements, and repairs must be performed under the direct supervision of a first- or second-class radiotelephone license holder. Owners of radio-equipped vehicles must obtain the services of a licensed technician or a qualified service agency; owners of large fleets sometimes employ their own licensed servicemen.

Maintaining these rigid specifications requires that all repairs, maintenance, and adjustments be performed with the utmost care; there is no allowance in FCC Regulations for careless work or poorly calibrated test equipment. To assure legal operation, the technician must undertake a systematic, periodic check and adjustment of all transmitters for which he is responsible. He will find that this added care will also result in greater system usefulness to the owner.

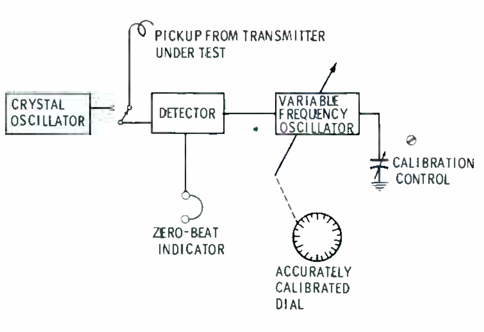


Fig. 1. Simplified diagram showing a common heterodyne frequency meter.

Frequency Measurements

The FCC demands a frequency stability of ±.002% for transmitters operating between 25 and 50 mc, and ±.0005% at frequencies above 50 mc. This means a 150-mc transmitter will not be permitted to operate more than 750 cps (0.75 kc) off its assigned frequency. Low-power equipment (less than 3 watts input) is permitted a slightly greater tolerance — usually ±.005%.

Obviously, careful measurement and adjustment of the transmitter frequency is required of the licensed technician. A frequency meter is used for this purpose, in one of two ways: either to check the actual frequency of the transmitter, or as a standard to which the transmitter can be adjusted.

Fig. 1 shows a simplified functional diagram of a typical frequency meter. The highly accurate crystal oscillator is used to calibrate the variable-frequency oscillator, assuring the accuracy of its dial markings. This is done by mixing the outputs of both oscillators in a detector and listening to the difference frequency on a set of headphones. A zero beat is used as an indication of resonance between the two circuits.

Of course, the calibration will be only as accurate as the crystal oscillator. Therefore, it is wise to periodically check its accuracy against WWV, the National Bureau of Standards station near Washington, D. C. WWV broadcasts at frequencies of 2.5, 5, 10, 15, 20, and 25 mc, 24 hours a day. The usual method of checking the accuracy is to first calibrate the variable oscillator as usual, then compare it with WWV. If the crystal calibrator is correct, the variable oscillator will be accurate, too. If not, the technician can determine the exact crystal frequency by noting the amount of error in the dial setting; future calibration should be at the true crystal frequency.

It is well to remember that temperature will alter the crystal frequency, so the accuracy check should be made with the frequency meter fully warmed up. For greatest accuracy, it is recommended that a WWV receiver be kept handy to calibrate the frequency meter each time it is used to check a transmitter. Some instruments include such a receiver as part of the

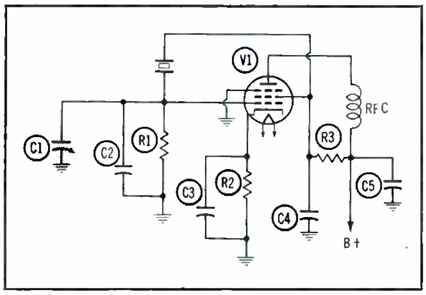


Fig. 2. Transmitter frequency can be adjusted to FCC requirements by C1.

frequency meter; these units seldom include a crystal calibration oscillator.

Once calibrated, the variable oscillator can be set to the frequency to be measured, or to one of its subharmonics. The transmitter output is then mixed with the oscillator signal in the detector, and the transmitter frequency control (C1 in Fig. 2) is adjusted for a zero beat in the headphones.

If the transmitter is a type in which the oscillator is not adjustable, its crystal must be checked to see that it is within frequency tolerance. This is done by first calibrating the meter as before, then coupling the transmitter to the detector. This time, however, the variable oscillator is adjusted until a zero beat occurs. The calibrated dial can then be read and the actual frequency of the transmitter determined. If it is off frequency by more than the designated tolerance, the crystal must be replaced.

Modulation Testing

The FCC specifies the modulation percentage for two-way communications equipment. In AM transmitters, the *peak-to-peak* value of the modulating voltage must not be greater than the *peak* value of the carrier; otherwise, it would exceed 100% modulation — the legal limit. In FM transmitters, on the other hand, 100% modulation is defined in terms of frequency swing (deviation) above and below center frequency. Two modulation values — 5 kc and 15 kc — are currently in use.

The station license designates which value is to be used in a particular system; most new licenses allow only ±5 kc deviation for 100% modulation. The *class of emission* is the key to the assigned deviation; 40F3 indicates a 15-kc deviation, while 20F3 means 5-kc deviation is to be used. It is illegal to exceed these modulation figures.

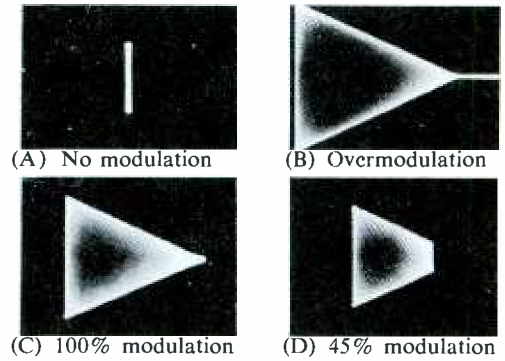
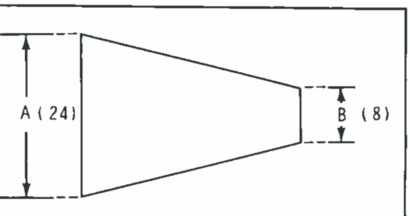


Fig. 3. Trapezoid patterns indicate modulation condition of AM transmitters.

AM Transmitters

The oscilloscope provides excellent means for measuring amplitude-modulation percentage by either of two methods. The *trapezoid* method consists of feeding the audio modulation to one axis of a scope and the modulated RF output to the other axis; during modulation, a



$$\% MOD = \frac{A - B}{A + B} \times 100$$

$$\% MOD = \frac{24 - 8}{24 + 8} \times 100$$

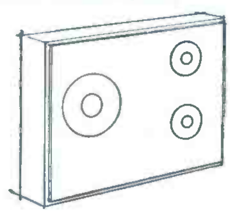
$$\% MOD = \frac{16}{32} \times 100$$

$$\% MOD = 50$$

Fig. 4. Calculating the modulation percentage by measuring AM trapezoid.

...slim-compact X-20

Here is unbelievably excellent sound quality combined with the ultimate in placement flexibility. Compact size (12⅞"H, 15⅜"W, 2⅝"D) takes little space on desk, table or shelf. The slim-compact X-20 is ideal for wall mounting with built-in brackets. Finish is oiled walnut. Convenient volume control on the side. There's a refreshing decorator touch in the two-tone harmonizing custom fabric on the front. 3 speakers—a woofer and 2 tweeters—provide smooth wide range sound. Perfect for FM Multiplex, very low cost stereo, other-room extensions.

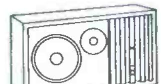


X-20 3-speaker 2-way system. Impedance, 8 ohms. Power rating, 6 watts. Adequate room sound with 1 watt to speaker.
In Oiled Walnut.... **$39.95**

...ultra-compact X-10

X-10 2-speaker 2-way system. Impedance, 8 ohms. Power rating, 6 watts. Adequate room sound with 1 watt to speaker.
In Oiled Walnut.................. **$29.75**

Today's most popular ultra-compact hi fi speaker system. A 2-way system set in attractive oiled walnut measuring only 7¼" H, 13" W, 4⅝" D.



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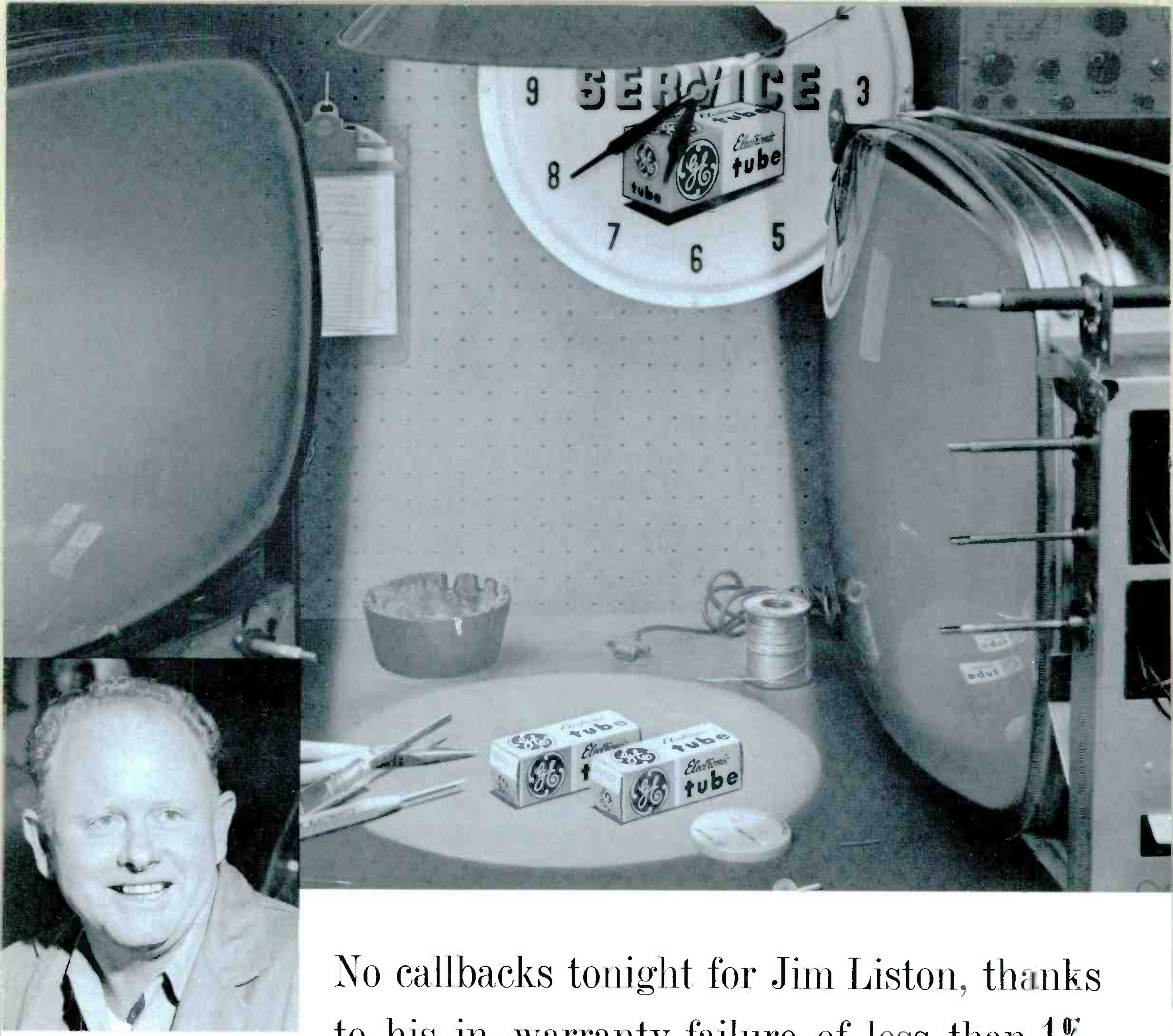

No callbacks tonight for Jim Liston, thanks to his in-warranty failure of less than 1% with G-E *SERVICE-DESIGNED* receiving tubes

"In this business, a reliable replacement tube can make you look like a hero . . . a callback due to in-warranty failure gives you a black eye, and wastes time and money. So, it's real simple, why I use G-E SERVICE-DESIGNED tubes in almost everything that comes into the shop. I can't afford callbacks."

Jim Liston is the owner of SOUTH CITY TV, South San Francisco, Calif. G-E SERVICE-DESIGNED "universal" replacement tubes help protect his profits—and his reputation. Here are just a few of their typical high-reliability features: **(1) Rhenium-tungsten heaters** increase tube reliability up to 4½ times. **(2) Three- and five-ply plate material** provides uniform heat conduction and radiation. **(3) Straight-sided bulbs** give more uniform heat dissipation. **(4) Tapered pins** prevent socket damage; save time. **(5) Tubes are interchangeable in all sets.** General Electric Company, Distributor Sales, Electronic Components Division, Room 1743A, Owensboro, Kentucky.

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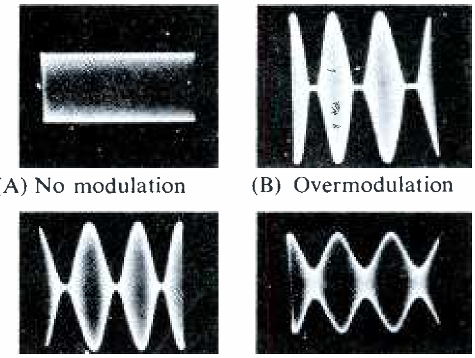


(A) No modulation (B) Overmodulation

(C) 100% modulation (D) 45% modulation

Fig. 5. Envelope method is simpler for checking AM under- or overmodulation.

trapezoid pattern is formed on the scope face (see Fig. 3). In practice, the connections are usually made directly to the deflection plates of the scope CRT; most scopes make provision for this connection. This is done for two reasons: First, the vertical - amplifier response would seriously attenuate the RF signal from the transmitter, and second, the output of most transmitters would overload the input circuits of the scope.

Fig. 3 shows the patterns obtained under four different carrier conditions: unmodulated, overmodulated, 100% modulation, and less than 100%. The percentage can be measured on the scope face, as diagrammed in Fig. 4. Any unit of measurement may be used—inches, centimeters, or the units on the scope graticule.

The *envelope* method is depicted in Fig. 5. This method is simpler to use in that it requires only one connection to the scope. The modulated RF signal is coupled directly to the vertical deflection plates, in order to bypass the scope's amplifiers. The internal scope sweep is adjusted for a display of a few cycles of the modulating audio frequency. Modulation percentage can only be estimated, but under- and overmodulation are easily spotted.

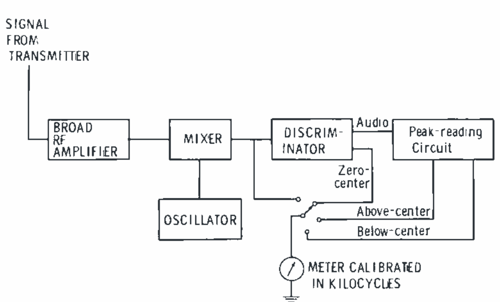


Fig. 6. FM modulation monitor is a superhet receiver with special metering.

FM Transmitters

Frequency modulation is usually measured with an instrument such as that shown in the functional block diagram of Fig. 6. The most common type of unit uses an accurately calibrated discriminator and a meter to indicate modulation deviation directly. The incoming signal is mixed with the output of the local oscillator, as in any superheterodyne receiver. The meter can be connected to the discriminator input (for course-tuning the receiver), switched to the discriminator output for a more accurate fine-tuning indication, and then placed in a peak-reading circuit to measure the modulation peaks. Special switching may also permit the technician to measure the deviation either above or below center frequency, to determine if the modulator balance is correct.

No matter what method is used for measuring modulation percentage, most (but not all) transmitters can be adjusted for the correct amount. The controls have various labels: *deviation control, microphone gain, modulation adjust, speech input level,* and others. These controls are adjusted for approximately 100% modulation while a loud voice tone, such as "ah-h-h-h-h," is spoken into the microphone. Some technicians like to whistle into the microphone; others prefer a tone generator connected to the speech-input circuit. Be sure that a transmitter which was adjusted using a sine-wave tone does not overmodulate on voice peaks, as sometimes happens.

Power Measurements

When a mobile-station license is granted, a certain power is specified. Upon installation, at least once a year thereafter, and when any service work is performed which might affect the transmitter power, a licensed technician must certify that the power does not exceed the limitation set forth in the license. FCC Regulations stipulate that this be checked by measuring the DC input power to the final RF stage, or power amplifier.

The simplest method of input-power measurement is by connecting meters in the plate-supply circuit, as in Fig. 7. Power input can be computed by multiplying the plate current by the plate voltage. Many transmitters provide test jacks for measuring input power; some even have built-in meters for continuous monitoring. The cathode current can be measured in order to calculate input power, but current drawn by the screen and control grids must be subtracted to obtain true plate current. The method used must be described in the station record or log book.

If the DC input power exceeds the legal maximum, the simplest recourse is to reduce the RF output. This is usually done by decreasing the coupling between the power-amplifier tank circuit and the antenna. Some transmitters include a control for altering the coupling; others are adjusted by repositioning the coupling link slightly — farther from the tank coil to decrease coupling. Changing the coupling usually requires that the final stage be retuned — a job which should be done carefully.

If it becomes necessary to *increase* coupling for any reason, much care should be used to avoid overcoupling. This could cause inefficient operation, spurious harmonic radiation, and even damage to the final-amplifier tube in some cases.

Other Tests

The compulsory tests which have been described so far do not necessarily check transmitter *radiating* efficiency. A simple field-strength meter can be used for this purpose. The *field-strength meter* is a detector combined with an input circuit that covers frequencies within the range to be measured — see Fig. 8. RF fields surrounding the transmitter antenna are induced into the small antenna of the field-strength meter and rectified; the resultant DC, filtered by C1, actuates the meter movement in proportion to the signal strength. The usual reading is only relative, although actual microvolt readings can be taken with an accurately calibrated instrument.

A field-strength meter (FSM) has two primary uses: testing transmitter tuning and checking antenna radiation efficiency. The advantage

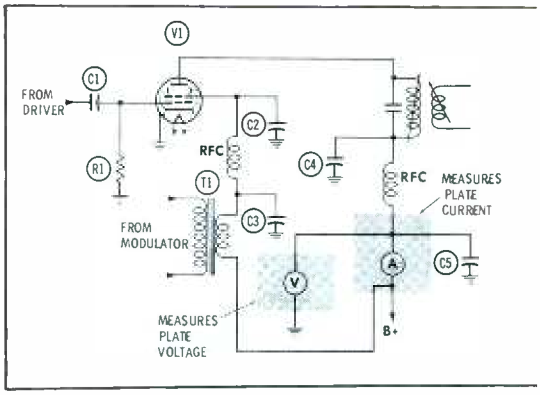


Fig. 7. Meters for checking DC input to final stage of typical transmitter.

of using such an instrument for transmitter tuning is obvious when you consider that no connection to the antenna system is necessary. The unit is merely placed near the transmitting antenna and adjustments to the final stages completed while the results are noted on the meter.

The correct procedure for tuning a transmitter while using a field-strength meter is as follows: The stages preceding the final output circuit are tuned as usual. The preliminary tuning of the output stage (power amplifier) is accomplished by adjusting the plate tank for minimum current (measured by any of the methods stated earlier), with the antenna disconnected. The antenna is reconnected and the field-strength meter placed near enough to obtain a reading. If the meter overloads, move it farther away, or shorten its antenna, so as to pick up less of the radiated energy.

The transmitter coupling is then increased from minimum to just below *critical* — the point where no further increase is noted on the meter. The plate tuning should then be retouched for maximum RF output, as this is often slightly different from the point of exact minimum plate current. If there is an *antenna matching* or *tuning* control, this can now be set for maximum indication on the FSM.

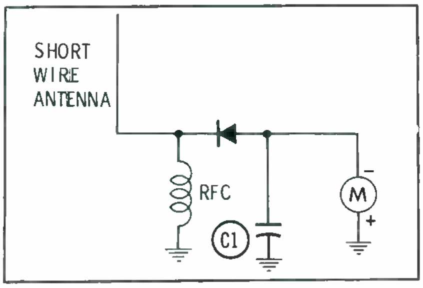
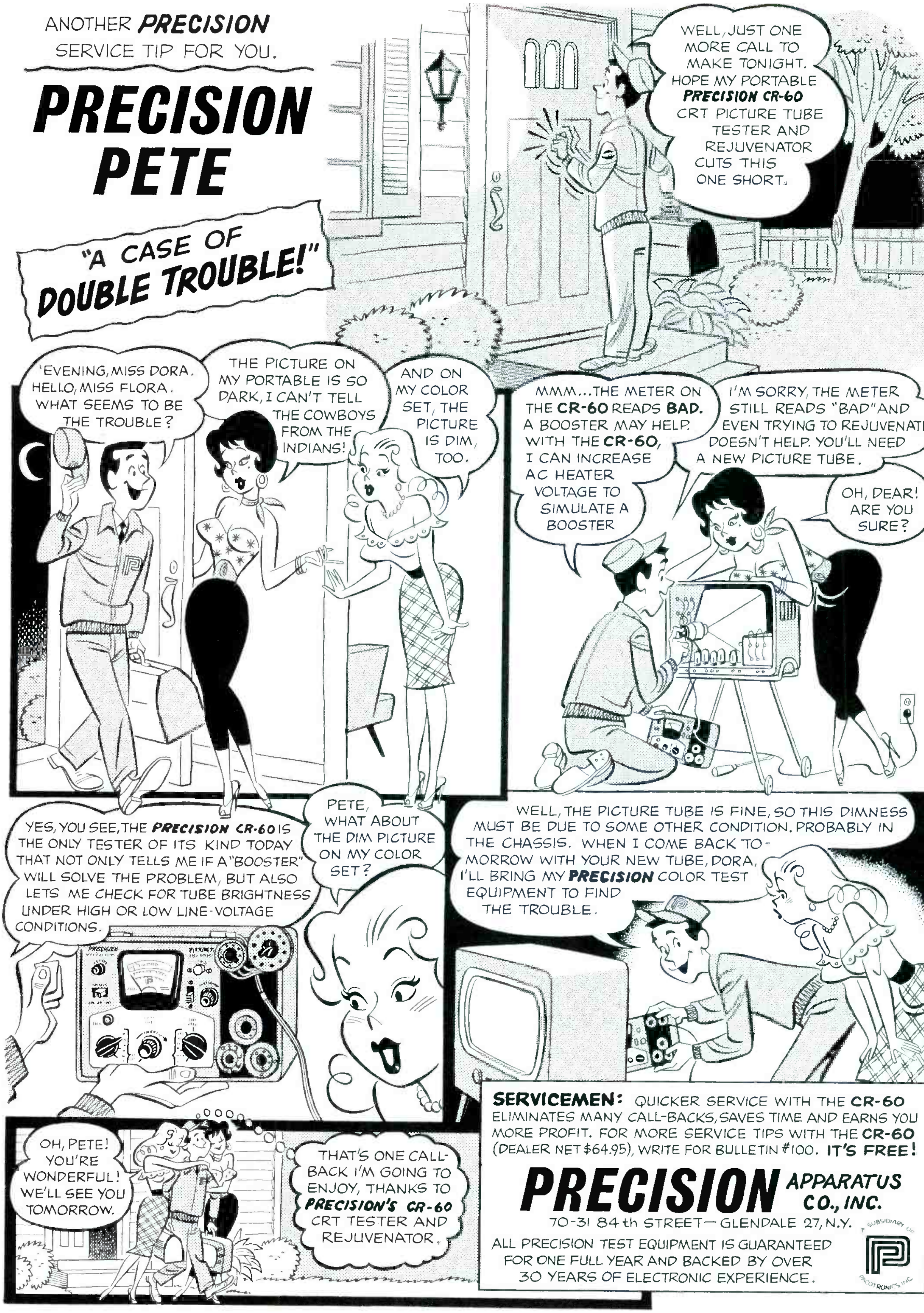


Fig. 8. Simple, broad-band FS meter.



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'EVENING, MISS DORA. HELLO, MISS FLORA. WHAT SEEMS TO BE THE TROUBLE?
THE PICTURE ON MY PORTABLE IS SO DARK, I CAN'T TELL THE COWBOYS FROM THE INDIANS!
AND ON MY COLOR SET, THE PICTURE IS DIM, TOO.
MMM...THE METER ON THE CR-60 READS BAD. A BOOSTER MAY HELP. WITH THE CR-60, I CAN INCREASE AC HEATER VOLTAGE TO SIMULATE A BOOSTER
I'M SORRY, THE METER STILL READS "BAD" AND EVEN TRYING TO REJUVENATE DOESN'T HELP. YOU'LL NEED A NEW PICTURE TUBE.
OH, DEAR! ARE YOU SURE?
YES, YOU SEE, THE PRECISION CR-60 IS THE ONLY TESTER OF ITS KIND TODAY THAT NOT ONLY TELLS ME IF A "BOOSTER" WILL SOLVE THE PROBLEM, BUT ALSO LETS ME CHECK FOR TUBE BRIGHTNESS UNDER HIGH OR LOW LINE-VOLTAGE CONDITIONS.
PETE, WHAT ABOUT THE DIM PICTURE ON MY COLOR SET?
WELL, THE PICTURE TUBE IS FINE, SO THIS DIMNESS MUST BE DUE TO SOME OTHER CONDITION. PROBABLY IN THE CHASSIS. WHEN I COME BACK TOMORROW WITH YOUR NEW TUBE, DORA, I'LL BRING MY PRECISION COLOR TEST EQUIPMENT TO FIND THE TROUBLE.
OH, PETE! YOU'RE WONDERFUL! WE'LL SEE YOU TOMORROW.
THAT'S ONE CALL-BACK I'M GOING TO ENJOY, THANKS TO PRECISION'S CR-60 CRT TESTER AND REJUVENATOR.
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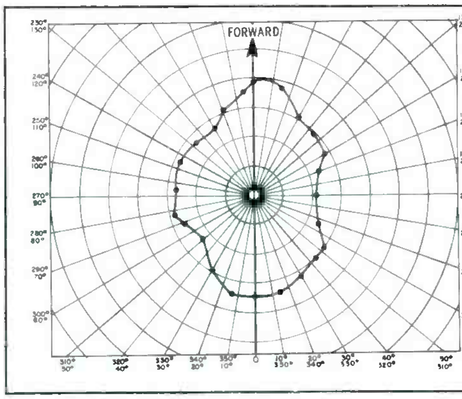

Fig. 9. Typical antenna radiation pattern taken with a field-strength meter.

Radiation Patterns

A field-strength meter is very convenient for determining if an antenna is truly omnidirectional — that is, if it radiates the same in all directions. At certain frequencies, it is difficult to get a good radiation pattern, especially in mobile installations.

A radiation pattern is charted in Fig. 9. The points are plotted by measuring the field strength at 10° or 15° intervals all the way around the antenna, maintaining a fixed radius — perhaps 15 feet away. In directions where the radiated energy is weaker, communications will be less effective. Of course, the ideal radiation pattern is a perfect circle, but this is rarely attained, since terrain, nearby objects, antenna design, and antenna mounting all affect the directional characteristics. The point is — it is well to know the system's limitations, and the user can make allowances for any directional quality in his antenna.

Conclusion

It is obvious from the foregoing that the two-way radio technician has two important responsibilities— one to the FCC and the other to the system licensee. The first is purely legal; the FCC holds the licensed technician strictly accountable for the accuracy and consistency of the required measurements. The last obligation is ethical; the serviceman owes it to his customer to keep the equipment operating at its best, and to be in a position to evaluate the performance that can reasonably be expected from a system. The equipment and techniques described will, if conscientiously applied, fulfil this obligation. ▲

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NOTES ON TEST EQUIPMENT

by Forest H. Belt

All Together, Now . . .

Fig. 1. New instrument substitutes components in many electronic circuits.

The components usually contained in three or four individual substitution boxes have been consolidated in one large unit, the Sencore Model RC121 *Substitutor* shown in Fig. 1.

Its specifications are:

1. *Carbon Resistors—twenty-four values: 10, 18, 33, 56, 100, 180, 330, 560, 1000, 1800, 3300, and 5600 ohms, at 1 watt; R x 1000, at ½ watt.*
2. *Wire-Wound Resistors—twenty values: 2.5, 5, 7.5, 10, 15, 25, 50, 75, 100, and 150 ohms, at 20 watts; R x 100, at 20 watts.*
3. *Capacitors—.0001, .0005, .001, .0025, .005, .01, .02, .05, .1, and .5 mfd, at 600 volts DC.*
4. *Rectifiers—500 ma., 800 piv silicon rectifier; simulated selenium rectifier; mounted on capacitor-selector switch.*
5. *Electrolytic Capacitors—20 values in 10 dual units, 2 mfd through 175 mfd, 450 volts DC; surge-protector test switch.*
6. *Terminals and Controls—four rotary switches for choosing values of components; two slide switches to choose ohms multipliers; one spring-return slide switch for use in testing electrolytics; separate pin jacks for each function, to permit simultaneous substitution of several components.*
7. *Size, Weight, Price—6½" x 10¼" x 4½"; approximately 4 lbs.; $51.95 wired, $37.95 kit.*

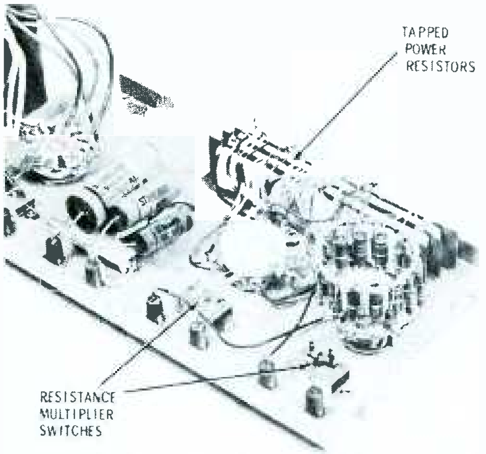


Fig. 2. Inside view of the RC121 shows switches, jacks and special parts.

This instrument is designed to combine the advantages of separate substitution boxes with the convenience of having them all in one cabinet. Separate test-lead jacks for each rotary-switch circuit make it possible to substitute as many as four different components (at the same time).

For example, we used the RC121 in the lab to substitute simultaneously for a badly-burned horizontal-output cathode resistor, a wire-wound screen resistor in the same stage, and an electrolytic filter capacitor in the low-voltage power supply. If we had also needed the silicon rectifier during this test, we could have used it—such is the versatility of the RC121.

The power resistors in the unit (shown in Fig. 2) are specially-designed components which are tapped at suitable points to obtain the proper values. A shorting-type rotary switch connects the test jacks to the values of resistance indicated on the panel, and a slide switch connects the jacks to resistances of 100 times the indicated values.

A few places where the power-resistor substitutor can be put to good use are the video-output plate circuit, horizontal-output screen circuit, and B+ bleeder network. Any single value can be chosen independently of the other functions of the instrument; there is no "common chassis" problem, since each function is completely isolated from the others.

The low-wattage resistor section contains twelve ½-watt and twelve 1-watt resistors. The values are so chosen that all the ½-watt resistors are exact R x 1000 multiples of the 1-watt values listed on the front panel; a slide switch on the panel is used to select either the higher or the lower resistance group.

The values range from a low of 10 ohms to a maximum of 5.6 megohms—enough to permit a near-value substitution of almost any resistor in a television set. In most circuits, it is not necessary to substitute a precise value; an approximate value will do. Certain critical circuits are exceptions to this rule, and cannot be accurately tested with the available values. But for most circuits, a substitution test is satisfactory, since it is merely a temporary check of circuit operation—not a permanent replacement.

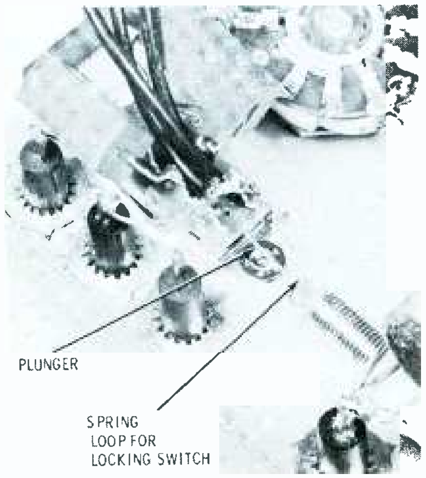
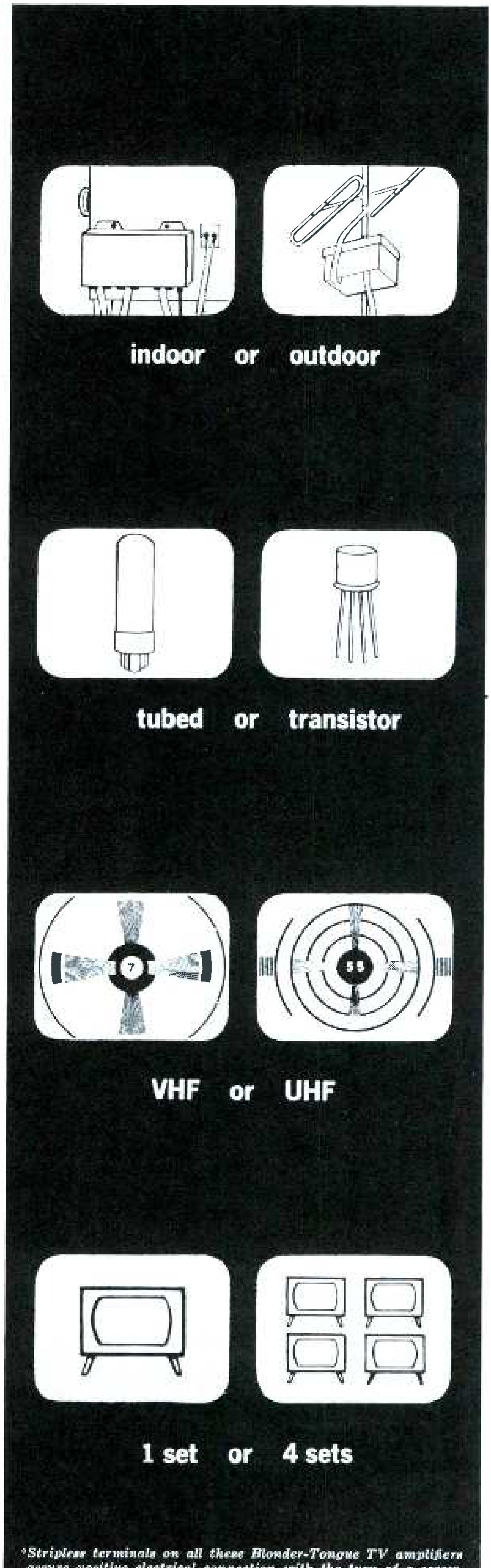


Fig. 3. Special plunger-spring arrangement permits locking switch for tests.



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When a new component is needed, an exact replacement value should be used.

The capacitor section contains the most-often-used values from .001 (100 mmf) to .5 mfd. As with resistors, approximate values can usually be substituted temporarily for the capacitors in a circuit; but care must be taken to be sure that the voltage in the circuit does not exceed the rating of the capacitors contained in the RC121. For example, in certain sweep circuits, capacitors with ratings of 1600 volts DC (or even higher) are required. If the 600-volt capacitors in the substitutor were used in place of higher-rated types—even temporarily—they might become damaged.

The rectifier-substitution devices are on the same range switch with the capacitors. The silicon diode is a 500-ma unit with a peak inverse voltage rating of 800 volts. This means that it can be used in any power-supply circuit which has an rms input voltage of 560 volts or less.

Substitution for selenium rectifiers is accomplished in the RC121 by switching a 47-ohm, 2-watt resistor in series with the silicon diode used for direct substitution. This takes into account the difference in surge characteristics of the two types of rectifiers, and prevents damage to the silicon diode in the instrument.

The electrolytic section consists of a number of dual units. Via the switching system, each section is connected to one of the two pin jacks on the panel, enabling the technician to connect them in parallel to obtain greater values of capacitance. By using paralleled sections, values up to 175 mfd are possible. All units are rated at 450 volts DC.

An unusual locking device, used in conjunction with the SURGE PROTECTOR switch in the electrolytic section, permits the user to place the spring-return slide switch in the TEST position and leave it there. Fig. 3 shows a closeup of the little plunger which, when depressed, catches in the loop of the switch-return spring, preventing it from returning to the normal position. The SURGE PROTECTOR switch is released by merely pushing it toward the TEST position, and then releasing it.

Load Up on Power

To satisfy the need for a combination field-strength meter and dummy load for use with Citizens-band transmitters, Philmore Mfg. Co., Inc. of Richmond Hill, New York has introduced the Model FS-1W Field Strength Meter—see Fig. 4.

Its specifications are:

1. *Frequency Range—from 25 to 30 mc; variable.*
2. *Sensitivity—500-uv signal at antenna for full-scale deflection (with* SENSITIVITY *control at maximum).*
3. *Wattmeter and Dummy Load—50 or 75 ohms, noninductive load; 5 RF watts; accuracy ±5% of full scale.*
4. *Panel Meter—50 ua sensitivity; reads directly in watts.*
5. *Controls and Terminals —* FUNCTION *switch ganged with* SENSITIVITY *control;* FUNCTION *slide switch;* IMPEDANCE *slide switch; UHF-type RF connector for antenna or connecting cable; monitoring jack on rear.*
6. *Size, Weight, Price — 4⅛" x 3" x 4½"; approximately 2 lbs; price not available.*

The Model FS-1W can be used for tuning base or mobile transmitters, for checking the efficiency of an antenna installation, or merely as a dummy load for Citizens-band equipment. Its frequency range also permits it to be used for

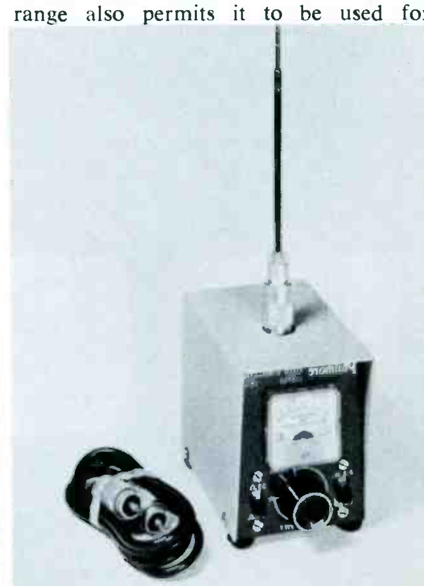

Fig. 4. Combination unit measures output power or radiated signal strength.

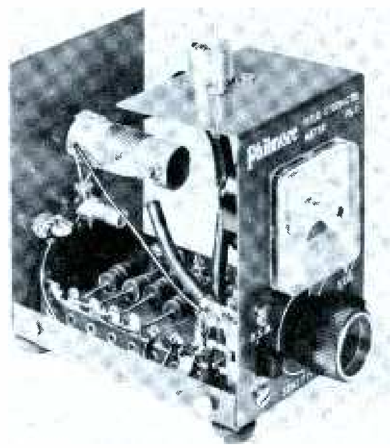

Fig. 5. Compact layout includes provisions for monitoring received signal.

tuning 10-meter amateur-band transmitters, although its use as a dummy load in this band is limited—most amateur transmitters are more powerful than the 5-watt capability of the FS-1W.

A 1N34 crystal diode is used to rectify the RF signals fed into the input connector by the telescoping antenna or via the connecting cable. On the rear apron of the cabinet, a miniature phone jack provides for attaching a set of headphones to monitor the AM signal picked up by the unit. In this way, positive identification of the signal being measured is possible.

When using the dummy load and wattmeter for CB transmitter-output measurements, remember that the output power of the transmitter is not the same as the input power; the FCC permits 5 watts of *DC input power* to the final stage, *not* 5 watts of *RF output power*. The output of the transmitter will vary between 2 and 3 watts, depending on the efficiency of the output circuits.

For field-strength measurements, the FS-1W was found to have excellent sensitivity. This is apparently due to the use of a sensitive meter movement and an efficient rectifier diode. The sensitivity control, the telescoping antenna, and the distance from the FS-1W to the transmitting antenna all affect the sensitivity of the instrument. If a transmitter is very weak, it may be necessary to extend the antenna to full length, set the sensitivity control to maximum, and place the FS-1W very near the radiating antenna. On the other hand, when a high-powered transmitter is being tested, it may be necessary to reduce the sensitivity-control setting, shorten the antenna, and move the instrument some distance from the transmitting antenna to prevent overloading.

In our lab, we adjusted transmitter stages for maximum output as indicated by the wattmeter. We found we could make a more accurate final adjustment of the antenna-matching control by using the field-strength meter function to test the *radiated* signal. This resulted in more efficiency from the transmitter installation —an important factor with low-power equipment.

Tube Emission and Grid Tester

The Precision Apparatus Model 650 portable tube tester (shown in Fig. 6) uses the cathode-emission method of tube evaluation, and has a number of worthwhile extra features.

Specifications are:

1. *Power Requirements—117 volts AC, 60 cps.*
2. *Tube Tests—Cathode emission; leakage, sensitivity over 100 megohms;*

"Your picture's flopping on the late late show and you wanna know what you can do with it? . . . I'll tell you what you can do with it . . ."

Fig. 6. The Model 650 Tube Tester also tests leakage in other components.

shorts, gas, detects grid current of 1 ua or more; grid emission.

3. *Tubes Tested — standard receiving types, novar, compactron, 10-pin noval, 5- and 7-pin nuvistors; separate tests for multisection tubes; CRT's (with adapter).*
4. *Panel Meter—face size 4½"; 1 ma, 160-ohm movement; scales — GOOD-?-REPLACE, numerical value comparison, gas and grid leakage, megohms, and CRT quality.*
5. *Controls and Terminals—five rotary switches:* FILAMENT, *A (meter-sensitivity potentiometer), B (test-voltage and load selector), C (used to isolate one pin of a tube that has one element connected to two or more pins), and D (control-grid selector and shorts tests);* GRID TEST-ZERO ADJUST *control;* CATHODE EMISSION *and* GRID EMISSION-GAS-GRID LEAKAGE *buttons.*
6. *Other Features — contains megohmmeter for external use; Model AD-65 adapter cable for testing picture tubes, available at extra cost.*
7. *Size, Weight, Price—9" x 13" x 4½"; approximately 9 lbs; $69.95.*

The primary feature we noticed in our lab analysis of the Model 650 was its extremely sensitive grid-circuit test, which utilizes a stable balanced-bridge 12AT7 VTVM circuit. The control grid of the tube being tested is connected to a negative voltage supply through a high-value resistance, and the cathode is connected to the positive supply voltage (see Fig. 7). If any gas, grid-emission, or grid-leakage current is present, it will be measured by the VTVM circuit and can be read on the meter.

It may be difficult to tell whether cur-

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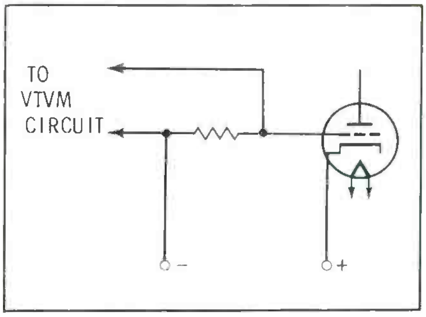


Fig. 7. New tube tester features sensitive circuit for testing grid emission.

rent is caused by the presence of gas, grid emission or leakage. Usually, it matters very little, since the tube should be replaced anyway. However, grid emission or interelement leakage can be distinguished from gas by observing the meter at the beginning of the test. The former condition gives an immediate indication, while gas tends to build up more slowly. When a tube is suspected of being gassy, it should be allowed to warm up for several minutes.

An interesting feature of the 650 is the built-in megohmmeter, which can be used to check for leakage in capacitors, in transformers, and across printed-circuit boards. It applies 70 volts to the component or circuit under test—more than in most instruments. This higher voltage causes the test to be more sensitive than those made with the 1.5 to 10 volts usually found in ohmmeters.

Tube-setup data is contained in a loose-leaf booklet. A number of listings by set manufacturer are provided, in addition to the usual listings. For example, if you have an Admiral set on the bench, the page headed "Admiral" contains setup data for all tube types found in late models of this brand. This feature enables you to check all the tubes in the set without having to turn several pages.

We put the tester through its paces in the lab. First, we chose several of our known weak and defective tubes, and tested each one for shorts, leakage, and cathode emission. In every case, the 650 gave a reading which was in very close agreement with the known condition of the tube.

The tester seemed exceptionally sensitive to gas and leakage. Several tubes containing varying amounts of gas were tested, and the unit never failed to indicate the gassy condition. Tubes with shorted elements were quickly rejected by the "shorts" test. On the basis of these grid-current and "shorts" tests alone, the Model 650 could easily pay its way.

now in our lab . . .

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

B & K Model 700 Tube Tester
EICO Model 222 VTVM
Hickok Model 656XC Color Generator
Mercury Model 1000 Tube Tester
RCA Model WO-91A Oscilloscope

More on the Universal Test Set

Additional circuit features and parts information for the home-built unit we described last December . . . Thomas A. Lesh

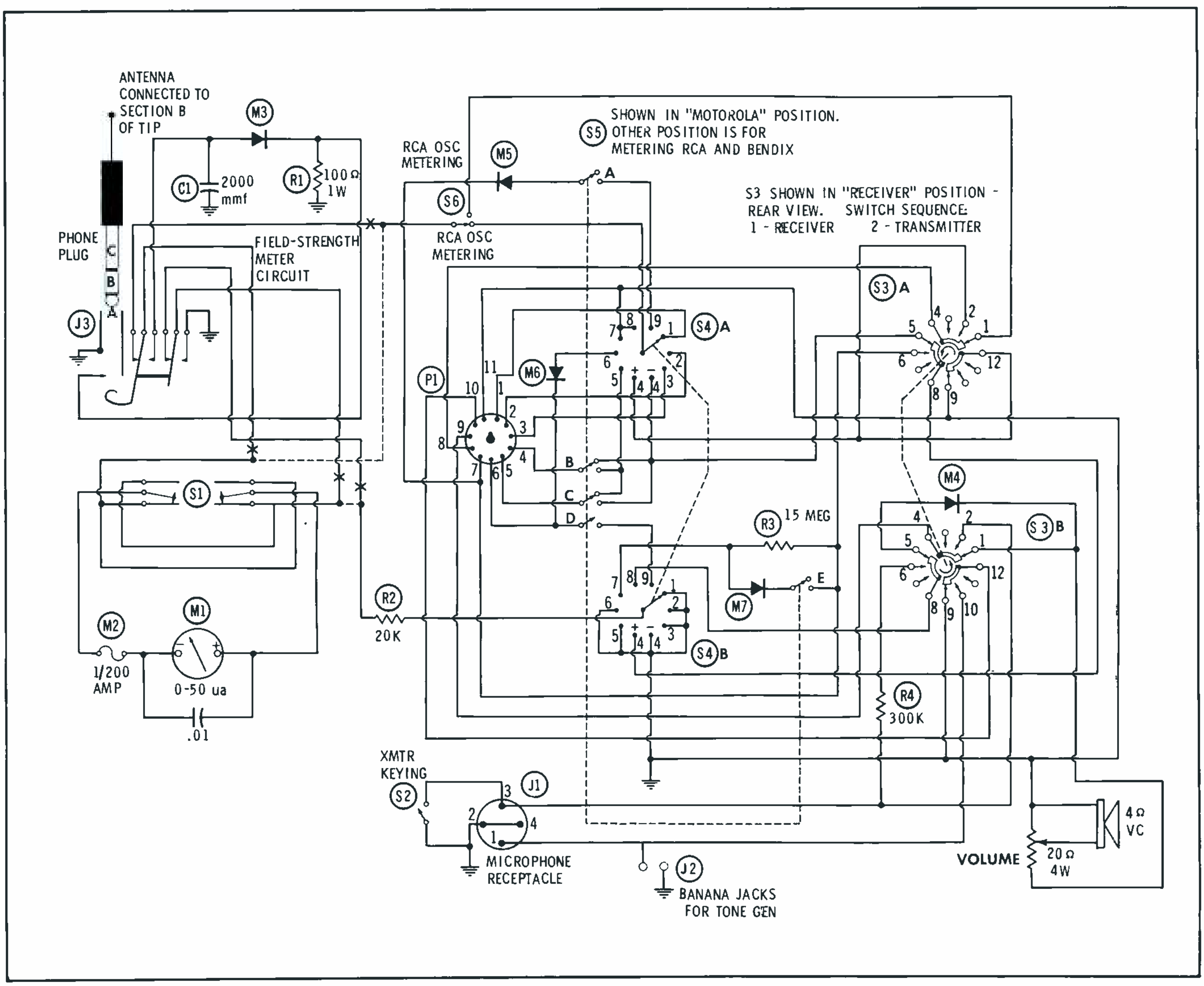
A number of readers have successfully built the two-way radio test set described on page 42 of the December, 1961 issue. Several users have suggested circuit modifications, and the best of these have been incorporated in the revised schematic presented on this page.

The most extensive change is in the wiring of S3. The special switch used in the original version has been replaced by another two-section, six-pole switch having a standard contact arrangement in both sections. Although the terminal connections are considerably different from the former hook-up, the functions of the switch are practically the same as before.

To expand the usefulness of the unit, switch S6 has been added to connect pin 8 of P1 to the negative side of the meter for measuring oscillator drive in RCA receivers. During the RCA oscillator check, S4 must be placed in position 1, 2, 3, -4, 5, or 6 in order to complete the circuit through the meter to ground.

A simple phone jack and a separate DPDT switch can be substituted for J3, if the latter is not readily available. However, this special jack has the advantage that the switch is automatically opened by insertion of the phone plug.

Various types of general-purpose diodes, including the 1N34A, 1N52A and 1N70A, can be satisfactorily substituted for the HD2149's used in the original design. Any alternate type to be used in place of the special 1N1224 diodes should have a peak-inverse voltage rating of approximately 750



COMPLETE PARTS LIST

RESISTORS		CONTROL	
R1	100 ohms, 1W	Volume -- 20 ohms, 4W	
R2	20K ohms, 1/2W	SPEAKER	
R3	15 meg, 1/2W	4-ohm voice coil	
R4	300K ohms, 1/2W	METER	
CAPACITOR		M1	0-50 ua
C1	2000 mmf, 500V	FUSE	
		M2	1/200 amp

DIODES

M3, M4	General-purpose type, 1N34A or equiv.
M5, M6, M7	High-voltage type, 1N1224 or equiv.

SWITCHES

S1	DPDT (meter-reversing)
S2	SPST (transmitter-keying)
S3	Dual-section, 6-pole (rec-trans)
S4	Dual-section, 10-pos (test selector)
S5	5-pole, double-throw (MOTOROLA-RCA)
S6	SPDT (RCA oscillator metering)

PLUGS AND JACKS

P1	11-pin, Amphenol "S" type
J1	Microphone receptacle, 4-terminal
J2	Banana jacks (2)
J3	Phone jack including DPDT switch

RECEIVER PIN NO:	MOTOROLA "MOTRAC" PIN NO.	
1	1	2nd 455-kc IF amp
2	2	3rd 455-kc IF amp
3	3	Limiter
4	4	Output } Discriminator
5	5	Input } Discriminator
6	6	1st oscillator
7		NOT USED
8		NOT USED
9	9	Audio output
10	14	Audio output
11	11	Ground

← TEST SET   RADIO →

TRANSMITTER	MOTOROLA "MOTRAC"	
1		NOT USED
2		NOT USED
3		NOT USED
4	4	Tripler grid
5	5	Driver-doubler grid
6	6	PA Grid
7	7	High B+
8	8	PA plate current
9	9	Push-to-talk
10	14	Audio
11	11	Ground

volts. Readers have reported success in using 1N1096's and 1N1544's.

When we introduced the test set last December, we included diagrams for adapter cables to extend the usefulness of the unit. One adapter permits metering of Bendix radios without requiring any internal modifications to the test set; another accessory makes it possible to meter General Electric, Comco, and other radios which use individual pin jacks as metering points. An additional set of cables—for metering Motorola's transistorized *Motrac* radios— is diagrammed on this page.

THE TROUBLESHOOTER

answers your service problems

Short-Time Vertical

Recently, I have discovered the same vertical-sweep difficulty in two separate RCA KCS129C chassis. Over a period of time, the top and bottom edges of the raster gradually close in. Replacement of the 6DR7 vertical-sweep tube fails to bring the raster back to normal height. The screen can be filled by readjustment of the height and vertical linearity, but the trouble recurs within a week or two. Upon checking components in the vertical circuits, I was unable to find any out of tolerance, and all the operating voltages checked normal. In one set, I replaced coupling capacitor C50 on a hunch, and the black edges did not reappear for over six months; but now they are starting to creep back, as before.

A third KCS129C chassis has the same trouble, except that its problem is intermittent and *pops* in and out.

J. L. BAKER

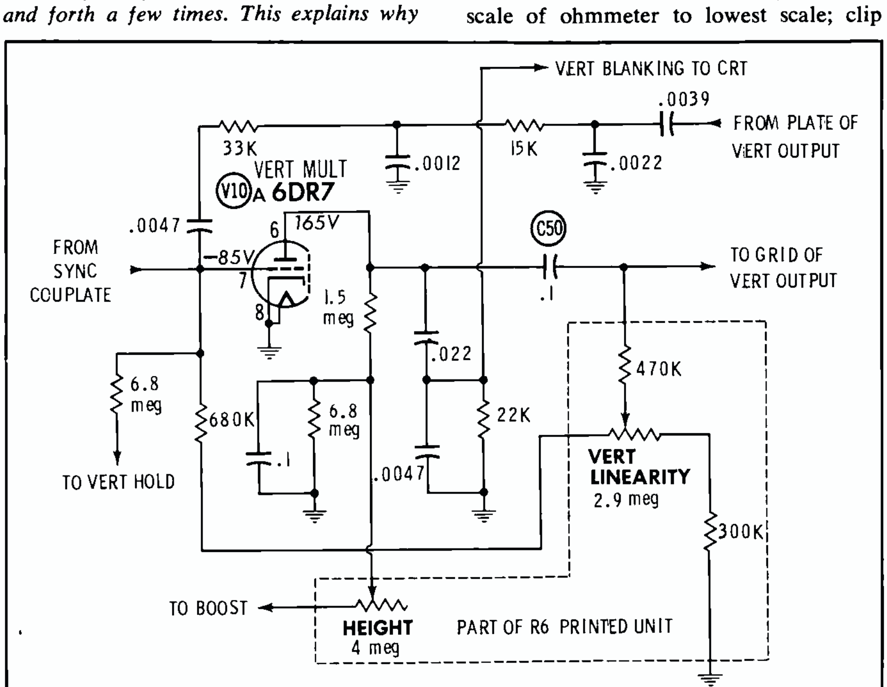
Wormleysburg, Pa.

In this set (covered in PHOTOFACT *Folder 463-2), the three-control unit R6 (AGC, height and vertical linearity) is most likely to be the defective component.*

The contact surfaces in this unit become oxidized over a period of time, causing intermittent operation. The height control is usually affected first.

A temporary cure, which will last for a short period, is to run the control back and forth a few times. This explains why the trouble cleared up when you adjusted the control during servicing. The best cure is to replace the complete unit.

The replacement units now available through your local distributor are an improved type which are designed to keep failures of this kind to a minimum.



Transistories

Most books and articles on basic transistor theory compare a junction transistor to a pair of back-to-back diodes with a very thin common or base section. These explanations do not specifically state that the diodes are symmetrical, but the implication is there. Nothing is said to account for the wide discrepancies in emitter-to-collector resistance readings, depending on the polarity of the ohmmeter battery. For example, a 2N43 PNP transistor shows a resistance of 1500 ohms with the negative lead of my meter on the collector and the positive lead on the emitter, but when I reverse the leads, the reading is 22K ohms. (Both measurements were taken with the meter on the R x 1K scale.) I'd appreciate your comments on this characteristic of transistors.

In addition, I'd like to know the theory behind the following test, which has been published by several companies as a method of determining approximate beta of transistors:

"To check a PNP transistor, set ohms scale of ohmmeter to lowest scale; clip positive lead of meter to emitter and negative lead to collector; place a 1000-ohm resistor between base and collector; read indication on meter scale; divide 1200 by the meter reading in ohms to determine the approximate beta. For NPN transistors, reverse meter polarity."

PAUL G. SMITH

New York Mills, N.Y.

Variations in measured resistance are normal, since the emitter and collector diodes in actual transistors are generally not symmetrical. If basic texts contain any implications to the contrary, these are unintentional.

The simplified beta test using an ohmmeter is similar to the procedure explained on page 130 of the Howard W. Sams book, "Practical Transistor Servicing" (PTC-1), which includes the additional feature of checking the relative amount of leakage between emitter and collector. Nothing is connected to the base during the leakage check, but the leads of an ohmmeter are placed on the emitter and collector terminals. It is important that the lead going to the positive side of the ohmmeter battery be applied to the emitter connection of a PNP transistor, or to the collector of an NPN. The resultant reading should be well over 50 ohms on the R x 1 scale. To determine relative beta, a 1000-ohm resistor is switched into the circuit between collector and base. It forms a voltage divider across the battery with the internal base-emitter resistance of the transistor, thereby applying a bias voltage to the base and driving the transistor into conduction. Additional current then flows in the emitter-collector circuit, reducing the ohmmeter reading. The higher the beta, the greater the current, and the lower the ohms indication.

This particular test is not recommended for transistors with a maximum power rating under 75 mw. Furthermore, the voltages delivered across the ohmmeter leads should not exceed 1.5 volts.

Here's the Trouble!

In reference to Mr. Ortman's letter in the April issue about his trouble with horizontal lines on a Silvertone TV, this trouble is probably caused by an open 4-mfd AGC capacitor. Could you please inform him?

C. H. TRIVETT

Damascus, Va.

In April *Troubleshooter*, the trouble with the Silvertone Model 4118 may be corrected by replacing AGC bypass C8, a 4-mfd electrolytic. It's probably opening intermittently. Rap on it with a screwdriver and see if the bars disappear.

G. R. LAMPE

Beatrice, Nebr.

. . . I think *The Troubleshooter* is looking in the wrong place. You will find that the 4-mfd AGC filter is open. It's located near the top left corner of the chassis.

G. H. MIDKIFF

Melrose Park, Ill.

This seems to be a common component failure in this set, and the suggested cure will be welcome news to servicemen throughout the country. Thanks a lot for the information, fellows.

Four-Sided Shrink

In my shop, being serviced, is a Zenith Chassis 17X20 (covered in PHOTOFACT Folder 306-14). After only a few minutes of operation, the raster shrinks on all four sides. Checking the horizontal circuit, I found the 8200-ohm screen resistor had decreased to a value of 3000 ohms. I replaced this resistor, the .047-mfd screen-bypass capacitor, and the .15-mfd boost capacitor. Soon after I fired up the set again, the same condition recurred. The voltage on pin 2 of the 5U4 rectifier gradually dropped to 150 volts, and then the raster disappeared.

I unsoldered all B+ lines at the input filter, and then proceeded to reconnect them, one at a time. The voltage stayed at a normal level until I connected the line to the horizontal-circuit fuse. Then the voltage started dropping once more and continued to fall until the raster was again lost. Incidentally, all horizontal - sweep tubes have been replaced.

F. P. DOHERTY

Dorchester, Mass.

The symptoms you describe indicate trouble in the damper and boost circuit. Of course, the fault may be in one of the circuits which receive their power from the boost source. The vertical and horizontal multivibrators, and the audio detector, all use this voltage. Disconnecting the feed lines to each of these will remove any loading caused by them. Also, check the resistor between the 245-volt line and boost.

Measure the cathode current of the horizontal output tube, which is normally between 105 and 120 ma. If this current is excessive, your trouble may be in the output circuit, the flyback transformer, or the yoke. Test the yoke throughly for shorts between the horizontal windings and the metal clamp; disconnect the windings to avoid erroneous readings.

A gassy rectifier tube could create the same symptoms, so try replacing the 5U4.

Hybrid Portable

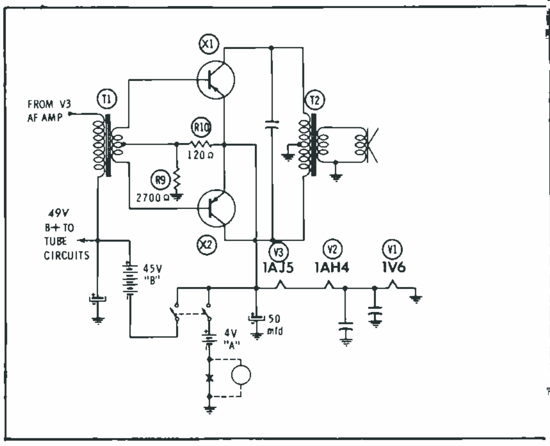
An Emerson Model 856 portable radio will play for about 30 minutes; then the sound starts fading very slowly, until the set finally goes dead. At this point, the grid voltage on the converter tube drops to zero. I have tested and substituted most of the parts in the entire receiver, with the exception of output transistors X1 and X2. Since these units are not available locally, I have not been able to try substitution. An ohmmeter check indicated that the transistors were okay.

Replacing the "A" battery (a 4-volt unit) will restore normal operation for another half-hour or so, until the new battery runs down. Any help will really be appreciated.

CUEVA'S TV

Waukegan, Ill.

From the symptoms you mentioned, it looks as if one of the circuits fed from the 4-volt "A" battery is drawing too much current; this accounts for the very short life of a new battery. Check the current drain by inserting a milliammeter in series with the battery. Under normal operating conditions, the reading should be 50 to



60 ma. Of this amount, 40 ma is required by the tubes used in the receiver, and the transistorized output stage draws the remainder.

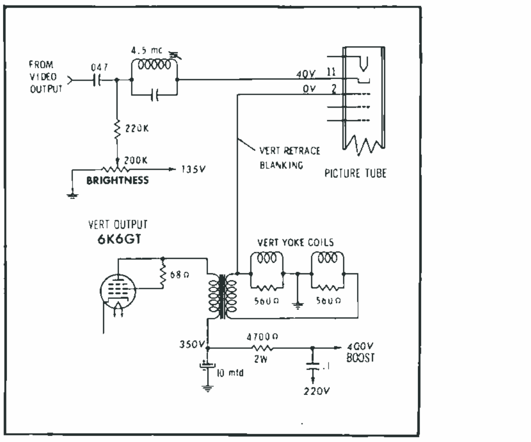
The output stage is your most likely suspect, and you should make a thorough check of all components in this circuit. Try removing the transistors, one at a time, and checking the current. (Be sure the power is off when you unplug or reinsert a transistor.) An obvious decrease in current will indicate a defective transistor. If either X1 or X2 needs to be replaced, PNP audio output transistors of practically any type can be used in this circuit, but it is well to use a matched pair.

Another output-stage component which should be carefully checked is T1. Also measure the values of bias resistors R9 and R10.

The voltage changes in the tube circuits probably result from lowered filament voltage as the 4-volt battery becomes weaker. As filaments cool, such circuits as the converter finally cease to function.

Not the Yoke's Fault

An Emerson Chassis 120235 (covered in PHOTOFACT Folder 304-7) was brought to my shop with a complaint of not enough height. When I fired up the set, I found that it had a trapezoidal raster. Substituting a new yoke did not cure the defect. After studying the schematic, I decided to see what would happen if I ungrounded the center tap of the vertical yoke windings. This operation restored normal sweep, but also caused vertical retrace lines to appear. Going over the schematic again, I began wondering about the retrace-blanking con-



nection between the vertical output transformer and the grid of the picture tube. There were no components in this circuit except the CRT itself. Knowing that the tube had been replaced only two months before, I thought, "No, it *couldn't* be bad already." But a quick ohmmeter check showed a short between grid and cathode.

Fortunately, the short was in the CRT socket. The grid wire was bent so that it touched the cathode lead. Changing the lead dress brought this set back to good working order.

FRED SCHONBACH
Fred's Radio & TV
Southampton, Pa.

The unusual retrace-blanking circuit set the stage for your trouble. Most other TV receivers have isolating capacitors and resistors in series with the blanking lead, and these would have prevented a short in the CRT circuit from having such a severe effect on vertical sweep.

Thanks for passing along the word about this tricky trouble.

Delayed Sync

In a General Electric Model 17C103, the picture takes several minutes to lock into horizontal sync when the receiver is first turned on.

NAME AND ADDRESS
WITHHELD BY REQUEST

We haven't received any field reports of chronic component failures which would cause the exact symptom observed in this model. Considering the age of the receiver, many components in various stages have probably deteriorated enough that they could be contributing to the problem. You shouldn't find it necessary to replace every marginal component, but you'll need to make sufficient repairs to eliminate the major trouble sources.

A common cause of the symptom you describe is slow warm-up or intermittent leakage in a tube, especially in the horizontal oscillator, AFC, or sync stages. Therefore, substituting for these tubes should be the first step in troubleshooting. If no improvement is apparent, your most pressing problem is to isolate the worst deficiencies to some specific stage. A detailed procedure for narrowing down the trouble area is presented in "Speaking of Stable Sync . . ." in this issue.

Since the trouble disappears after a short time, you can obtain your most useful clues by checking to see which voltages and waveforms undergo a change as the symptom clears up. Changes in either amplitude or waveshape of scope traces can be significant.

Some troubles are so complex or unusual that the results of your tests may not seem to fall into a logical pattern. In such cases, I'm glad to help you try to make sense of your problem, if you will supply me with enough pertinent facts to go on. The more information I have about the test observations you suspect of being abnormal, the closer I can come to pinpointing the trouble. Some of the most irrelevant-appearing clues may provide the missing piece of the puzzle. And, by compiling your test results in a systematic way, you'll find you can solve many "tough-dog" problems yourself.

SERVICE DEALER ADVERTISING PROGRAM

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

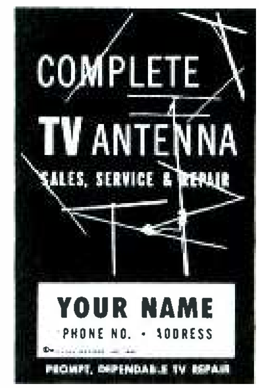
To make sure these ads will get results, the program has been carefully developed and field-tested. As a service to our readers, each month's selection of 5 ads is available *at cost* in two forms—durable newspaper mats at $1.75 per set, or high-quality reproduction proofs at only $1.00 per set. The latter will serve as finished artwork for offset printing of handbills, postcards, doorknob hangers, direct-mail pieces, etc. To obtain your set of this month's ads, or the entire series at a reduced rate, use the convenient order form on page 103. Your ads will be sent to you postpaid.

ES-6: 1⅞" x 4¾"

The down-to-earth approach of this ad sets things right for potential customers to call "The most dependable TV Bug-Killer in Town." You, of course!

ES-3: 1⅞" x 4⅞"

This ad proclaims your company to be "professional Ghost-Chasers" who can put new life back into a TV. Also, you get in a plug for your radio and hi-fi service.

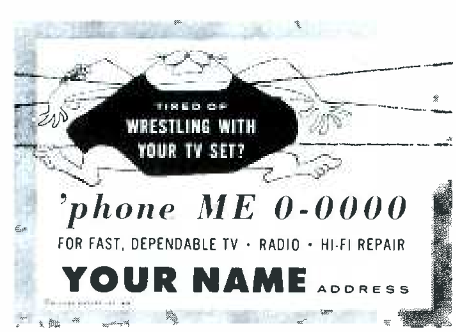


ES-36: 1⅞" x 3"

Warm weather is an ideal time for TV antenna installation and repair. This ad lets people know you are in the business.

ES-20: 1⅞" x 2¾"

Got an eye for selling TV service? This eyestopper carries a terrific punch for such a small package.



ES-10: 3¾" x 2⅝"

Comic cartoons and wrestling seem to go together. Here they blend to bring a "real gone" message to potential customers tired of wrestling with their TV.

The Imperfect Squelch

(Continued from page 33)

aids the squelch circuit in preventing random noise pulses from momentarily actuating the DC amplifier stage.

With the plate voltage of V4A at its normal or nonsquelched value, the bias on V4B is normal, and the audio is amplified and fed to the output stage. Thus, the signal has "opened" the squelch circuit.

Now, let's brifely examine two important points in the operation of this *noise-amplified squelch circuit*. First of all, why use this system anyway? There *are* simpler ways, involving fewer circuits, but these are seldom as satisfactory. In other types of squelch circuits, incoming noise bursts are treated much the same as a signal, and the squelch is likely to open, permitting unwanted disturbances. The noise-amplified squelch system is practically immune to external noises, and is used in most commercial two-way receivers.

The other important point to understand involves the effect of the squelch control on receiver operation. By controlling the amount of amplified noise applied to the rectifier circuit, the squelch control affects the amount of positive voltage on the grid of V4A. When the signal reaches a sufficient level, two things happen: The noise of the set is quieted, reducing the positive voltage developed in rectifier V3B. Also the increasing negative voltage at the limiter grid aids the change in rectifier voltage. Thus, the squelch control, by indirectly controlling the amount of voltage developed in rectifier V3B, determines the minimum signal level needed to open the squelch circuit.

Troubleshooting

When you are armed with a thorough understanding of squelch-circuit operation, troubleshooting becomes merely a matter of analyzing the complaint, isolating the circuit, and finding the faulty component. A few simple tests will isolate even the worst squelch "dog" that is likely to arise.

Let's re-examine the complaints listed earlier. "The noise can't be stopped at any setting of the squelch control." Analyzing this complaint, we realize that, for some reason, the squelch circuit is unable to block the audio amplifier. A voltmeter check at the grid and plate of DC amplifier V4A, while the squelch control is rotated, will reveal if voltage *changes* are taking place. If so, the trouble is probably in the audio stage itself; if not, the trouble is likely to be in the squelch circuits.

At this point, it is best to start at the input to the squelch system. If C9 is open, no noise is available to be amplified, no matter what the setting of the control. If some defect is preventing noise amplifier V3A from amplifying, there also will be no control action. A quick way to check this entire circuit is to use a VTVM (or VOM) to measure the noise voltages in the stage. The rms voltage scales will give usable indications even though the readings are not necessarily accurate. You can expect a small loss across C9, but you should find a definite gain in V3A, and rotating the squelch control should increase and decrease the noise voltages measured at the plate.

Next, if the noise amplifier is okay, measure the DC voltages on the cathode of DC rectifier V3B and on the grid of DC amplifier V4A. These, too, should vary with the setting of the squelch control in a normal receiver. (Don't overlook the possibility of some trouble in the limiter stage. Any excessive negative voltage at this point could hold the squelch open.) If the voltage on the grid of V4A is as it should be, and responds to the setting of the squelch control, measure the plate voltage. This should also vary with the setting of the control, and the variation should appear at the grid of V4B.

Intermittent Squelch

Some intermittent squelch troubles are similar to those usually found in other electronic circuits, but squelch stages have certain characteristics which make them *seem* intermittent on occasion. The operator sometimes complains of a sound resembling the puffing of a steam locomotive; it is caused by the squelch opening and closing, permitting bursts of noise to come through — sometimes rapidly, more often very slowly.

This symptom can be caused by the squelch control being set too near its *threshold*. When this is the case, slight voltage changes, or very weak signals, can open the squelch for short bursts. This trouble is cured by rotating the control a little past the threshold. However, if the control is near the end of its rotation, some trouble is causing the squelch system to be weak, and the system can be tested accordingly.

Squelch Blocking

This symptom, as mentioned earlier, is easily confused with a defective audio amplifier. A quick test will determine whether the defect is in the audio or the squelch. The cathode connection of DC amplifier V4A is usually convenient, and opening it will remove any effect on the grid circuit of audio amplifier V4B. If the audio is being blocked by the squelch circuit, disabling the DC amplifier will "release" it, and squelch noise (or signals) can once again be heard.

If the trouble is in the squelch system, reconnect the cathode lead of V4A. Set the control for "unsquelched" and check to see if any of the voltages on the DC rectifier or DC amplifier are abnormal. Once again, don't overlook the possibility of a limiter-stage defect causing trouble in this circuit. If for example, C9 were to become leaky, the positive voltage on the grid of V4A would cause the DC amplifier to conduct continuously. The less-positive voltage on the grid of V4B would cut the tube off. Troubles in the noise-amplifying section (ahead of the DC rectifier) will seldom cause blocking.

The circuit descriptions and troubleshooting procedures set forth in this article have provided you with enough information to figure out and troubleshoot almost any squelch system. You will seldom encounter a completely unfamiliar squelch circuit, for they all accomplish the same end — they cut off the audio stage when there is no signal, and open it up when the signal arrives.

As a final aid to troubleshooting noise-amplified squelch systems, we are including a symptom-and-fault chart. It will put you on the right track to solving any squelch trouble. ▲

Mobile-Installation

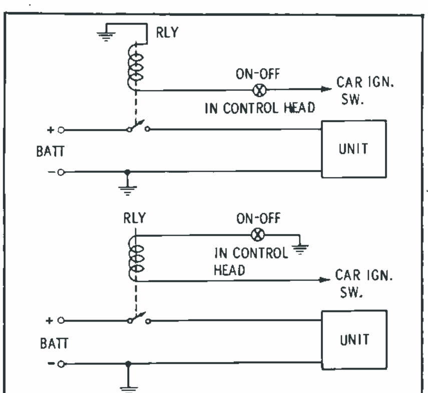
(Continued from page 29)

and control cables, power relay, fuse block, mic, and speaker are firmly mounted in place, the cable connections can be made. Start with the control cable connections, then plug in the speaker leads. The microphone is usually wired into the control head before the head is mounted.

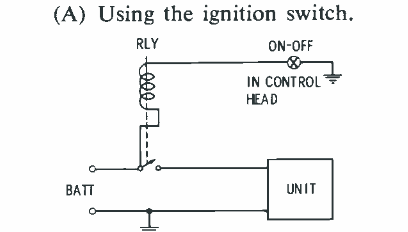
Next, the heavy power connections are completed. Fig. 3 shows typical wiring diagrams. The heavy wiring is installed from the unit to the fuse block, and from the block to the battery. If a power-control relay is used, its power contacts are connected between the fuse block and the main unit.

Fig. 3A shows two ways of wiring a power relay so that the entire system will be shut off when the ignition is turned off. Fig. 3B shows the system without ignition-switch control. Systems should be wired on the switch unless the operator will be using the unit extensively when the engine is not running. He should be warned, however, that he must be sure to turn the unit off when he leaves the vehicle, for it can discharge a battery rather rapidly.

Dash mounts seldom use power relays, so trunk mounts are the only ones which are usually controlled by the vehicle ignition switch. Of course, if the user desires, a power



(A) Using the ignition switch.



(B) Without the ignition switch.

Fig. 3. On-off switch in control head applies power by actuating the relay.

relay can easily be added to any installation.

Installing the Antenna

Antenna installations are logically divided into two general types: low-band and high-band. Low-band installations include antennas for use in the frequencies below 50 mc, and the high-band antennas are for use in the 150-mc range. The former usually consist of a ball joint, a spring, and a steel whip from 3′ to 10′ long, while the latter are short (around 15″) spring-wire antennas.

Electronically, the best mounting spot for any mobile antenna is in the center of the roof, since this gives a nearly omnidirectional radiation pattern (non-directional), and the broader expanse of metal all around the base of the radiating element creates a better impedance match.

In low-band installations, roof mounts are impractical for several reasons. Garages and low trees play havoc with roof-mounted whips. Also, the roofs of modern vehicles will seldom stand the stress without reinforcement. And, lastly, many people just simply don't like the idea of so large an appendage slapping along on top of their automobile. So, as a compromise, low-band antennas are mounted on a rear fender, or on the side or rear of the cab (on trucks). Occasionally, one will be mounted in the center of a trunk lid, but this is an unhandy barrier to opening the trunk.

High-band antennas are much simpler to locate. They do their very best job in the center of the roof, and do not stick up far enough to cause any trouble. They are not an

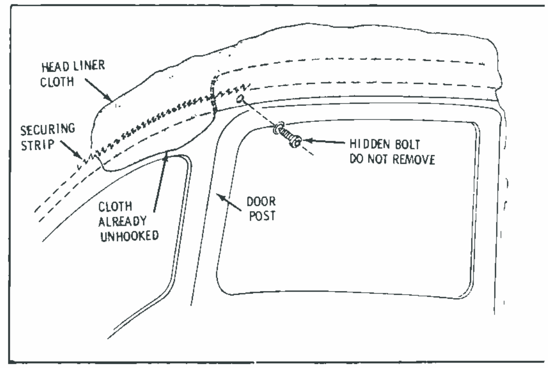


Fig. 4. Simplified sketch shows how automobile headliner can be loosened.

eyesore — in fact, they can seldom be noticed from a distance. However, some users prefer them on the rear deck somewhere, usually just behind the rear window.

Wherever the antenna is mounted, the lead-in must be routed to the unit. Some installation technicians prefer not to mount antennas on the roof, because they dislike to fish the antenna lead down. This *is* difficult, sometimes, but a few hints will help you solve most of these problems. Any competent technician can do the job in less than 30 minutes (including mounting the antenna) after doing it a few times.

First, drill the antenna hole (with a hole saw) very carefully, so as not to puncture the headliner. Locate the hole about six inches behind the dome light; be sure to get

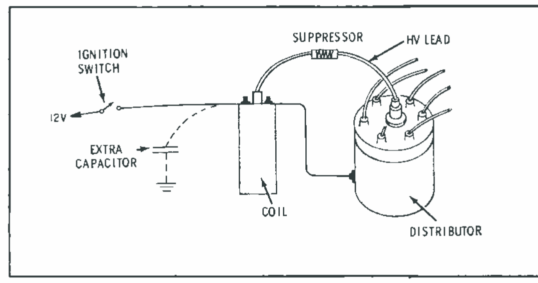


Fig. 5. Suppression of ignition interference is aided by use of capacitor.

the hole in the exact center (side to side), as an off-center roof antenna is certainly an eyesore.

Next, take the headliner loose on one side — usually the right — just about opposite the antenna hole, and loosen it for a couple of feet toward the rear of the vehicle. Fig. 4 shows how the headliner is fastened; it can be released by pushing upward on it (behind the edging) with a blunt screwdriver as you pull outward on the material. After a couple of tries you'll get the hang of it, and the rest will be easy.

Insert the antenna lead — minus the connector—into the mounting hole, and feed it down to the side where the liner is loose. If the liner has extremely heavy padding, a stiff wire can help. Pull the lead all the way down, until only a few inches remain exposed at the antenna end; now mount the antenna according to the directions furnished with it.

Feed the end of the lead-in — still without the connector — along the edge of the car top to the point where the liner is still intact. Now, by careful manipulating, you can push the end down inside the rear post, into the trunk compartment. From the trunk, pull the entire length tight.

Reinstall the headliner by carefully pushing the material back into place with the blunt screwdriver; it will catch on the hooks and hold in place. One word of caution; keep your hands clean while working with the headliner, for some of the materials used are very difficult to clean, once they are soiled. All that remains to be done is to install the connector on the end of the lead-in cable, and attach it to the set.

In an installation where the unit is to be mounted in the front, the same general procedure can be used to run the lead-in down the front post. It will come out behind the kick panel at the side of the firewall, and can be reached fairly easily.

Low-band antennas present few installation problems; you merely drill the holes and mount them. One precaution, however — be sure to leave sufficient space for installing the lead-in, since this is attached to the antenna base *after* the antenna is mounted. Since the unit and the antenna are usually mounted near each other, the lead-in for low-band equipment is very short.

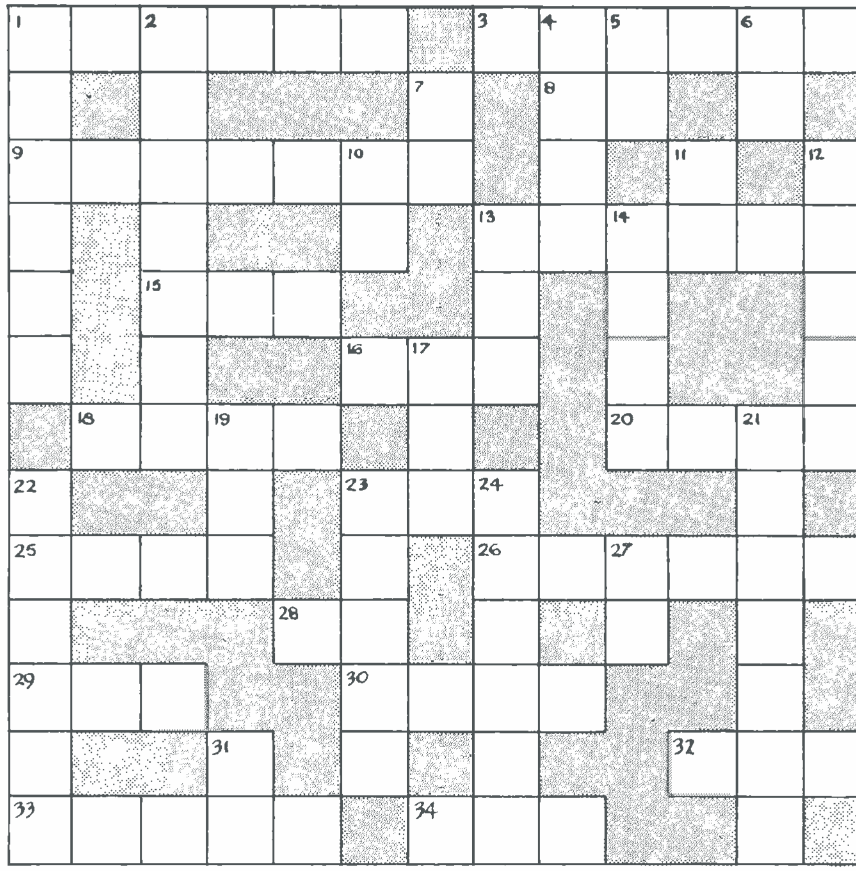
Finishing Up

The final step in a mobile installation is the suppression of unwanted engine interference. Most manufacturers of two-way radios include a generator capacitor, a suppressor for the center wire of the ignition coil, and an additional capacitor for installation wherever it seems necessary. Some technicians leave the extra capacitor off, while some automatically put it on the switch side of the ignition coil — see Fig. 5. Here, it will help bypass any interference which might be coupled along the switch wires.

One Final Touch

The installation is in, the antenna installed, and all the FCC checks made. It works perfectly with the base station, and a last quick check reassures that all cables are properly anchored and all connections tightened. Before the equipment is delivered, don't forget to attach the transmitter identification card (Form 452C)—the FCC considers it important! ▲

RADIO - TV service puzzle



ACROSS

1. A color TV adjustment.
3. Type of auto radio using transistors.
8. Alternating current (abbr.).
9. The emitting element of a vacuum tube.
13. Description of TV lead-in.
15. A volume compensating circuit (abbr.).
16. A frequency compensating circuit (abbr.).
18. A component's length of wire.
20. Type of waveform.
25. Eliminates unwanted frequencies.
26. Material used in the construction of PM speakers.
28. Power output (abbr.).
29. Unit of measurement for revolutions (abbr.).
30. A null.
32. A heavy uninsulated conductor used in radio and TV's.
33. Type of tube base and socket.
34. Cathode-ray oscilloscope (abbr.).

DOWN

1. A tone arm.
2. Return of a cathode-ray tube's beam.
4. Type of antenna.
5. Broadcast band (abbr.).
6. Letters symbol for plate current.
7. In transistor terminology, the letters symbol for common emitter power gain. (Also a famous manufacturer's initials.)
10. Unvarying current (abbr.).
11. Electroacoustic unit of relative power, current, and voltage (abbr.).
12. A vacuum tube's electron receiving element.
13. Radio-frequency choke coil (abbr.).
14. Fixed negative DC grid voltage.
17. Type of antenna.
19. Unit of current flow (abbr.).
21. The center of an atom.
22. Three-dimensional sound.
23. Short for phonograph.
24. Trimmer capacitor in a superhet.
27. Neon (abbr.).
31. Unit of current equal to 1/1000th of an ampere (abbr.).

Answer on page 97

Color Alignment

(Continued on page 35)

Preliminary Instructions

Bias voltages are not shown here, as the necessary values and connection points vary slightly from one chassis to another. The service data for any particular chassis will list the correct bias voltages under "Sweep Alignment for IF."

If interference from the horizontal sweep circuit produces excessive "hash" on the response curve (see Fig. 1), the sweep should be disabled. The suggested method is to remove the fuse which protects the horizontal sweep circuit, and then connect a 1500-ohm, 100-watt resistor (2000-ohm in some chassis) from the 385-volt source to ground. This resistor will load the B+ circuit to eliminate the rise in voltage which results when the horizontal sweep section is disabled. (The 100-watt resistor can be purchased from your local parts distributor for a couple of dollars.) A word of caution before killing the horizontal sweep: Make sure bias voltages are applied to all recommended points *before* the receiver is fired up! Some tubes obtain negative grid voltage from the horizontal output stage, and loss of this bias could possibly cause some components to be damaged.

Another way to disable the sweep is to remove the horizontal output tube. The same precautions must be taken as when removing the fuse, although in a few instances these will be unnecessary. A good check for any excessive rise in supply voltage would be to first obtain the waveform desired, with the horizontal sweep functioning; then remove the tube and inspect the waveform for any change in over-all shape or for any distortion not present in the first curve.

With the horizontal circuit properly disabled, your response curves will be much cleaner, and the danger of high-voltage shocks will be *nil.*

Equipment Requirements

VSM alignment calls for a sweep generator capable of delivering a video-frequency sweep output from .05 to 5 mc, as described earlier, plus a CW signal generator (with crystal-calibration provisions) covering the RF range from 40 to 150 mc. As mentioned before, an RF modulator unit is required for combining the outputs of the two generators, and a *multimarker* unit can be used to supply markers in the video-frequency range. This multimarker (RCA WG-295C) has seven absorption-type traps at the video frequencies of .5, 1.5, 2.5, 3, 3.58, 4.1, and 4.5 mc. The unit is connected in series with the sweep generator, and each trap absorbs a small amount of energy from the sweep signal passing through it. All the markers required in chroma alignment then appear simultaneously as sharp notches on the response curve, as shown in Fig. 2. Each marker can easily be identified by touching its corresponding contact button on the panel of the unit. This action detunes the trap and causes the marker to disappear from the response curve. If a multimarker unit is not available, a marker generator can be used to provide the necessary markers—one at a time.

Bandpass-Transformer Adjustment

The setup for checking the frequency response of the bandpass amplifier and its plate circuit is shown in Fig. 3. After supplying proper bias to the receiver, feed a video-frequency sweep signal, via the multimarker and a .1-mfd capacitor, to the grid of the amplifier. Connect the scope through the recommended detector probe (see alignment instructions in the service information) to the chroma-demodulator grid. Make sure the COLOR control is fully clockwise, so that all the available signal will reach the scope probe.

Next, adjust the double-tuned transformer in the amplifier plate circuit to place the 3-mc and 4.1-mc markers at equal heights on the response curve, as shown in waveform A. Waveform B shows the effect when the primary slug is misadjusted, while C shows the distortion that results when the secondary slug is set incorrectly. If an external marker generator is to be used, connect the output to a floating tube shield on the bandpass amplifier and tune the generator to 3, 3.58, or 4.1 mc as needed. Waveforms D, E, and F show markers obtained with this procedure.

An extra marker at the 3.58-mc point, unaffected by the generator tuning, may be very apparent on the response curve. Where does it come from? Remember that we have a 3.58-mc reference oscillator operating in a color receiver! Radiation from this stage will sometimes appear on the scope. If it causes no interference, leave it running; it's a good check point and provides the 3.58-mc marker needed. If you'd rather eliminate that marker, just pull the oscillator tube.

Move On to VSM

The setup for an over-all chroma-response check is shown in Fig. 4. The equipment connections are fairly self-explanatory, with the possible exception of one point: Why did we use the channel 4 picture-carrier frequency of 67.25 mc for our RF carrier? The answer is that the RF modulator unit, as purchased, is tuned to channel 4. If a TV station happens to occupy this channel in your area, the unit should be retuned to either channel 3 or 5. Instructions for accomplishing this change are given in the instruction pamphlet packed with the modulator.

With a sweep-modulated 67.25-mc signal being fed to the antenna terminals, you must adjust the fine tuning to set the local oscillator on exactly 113 mc, thereby making sure that the IF carrier output from the mixer will be precisely 45.75 mc. If this precaution is not observed, the frequency response of the VSM signal will be distorted as it passes through the video IF strip —giving a false impression that the chroma circuit is misaligned.

How to set the oscillator on 113 mc may be your next question. One good method is to set a crystal-calibrated signal generator to 113 mc, and run an insulated lead from the generator's RF input jack into the TV tuner (through a hole in the cover). With the lead placed close to the oscillator, energy from this circuit will be picked up by the lead and fed to the generator. Then you can turn the fine-tuning control for a zero beat between the generator and oscillator signals. Do not move the fine tuning, once it is set.

The method just outlined has the advantage of checking the RF-amplifier response in addition to that of the following stages. However, if you prefer to bypass the RF stage, you can couple the VSM input signal into the mixer grid instead of the antenna. In this case, you must use the input pad shown in the service information, and change the RF carrier frequency to 45.75 mc (IF).

After obtaining a viewable response curve on the scope, move the probe from the demodulator to the plate of the bandpass amplifier. Shunt the plate circuit with a resistor-capacitor network (to "swamp" its tuned response) as shown in Fig. 5, and then adjust the take-off coil in the grid circuit to place the 3.0- and 4.1-mc markers at equal heights on the curve. Waveform G in Fig. 5 shows the curve obtained after the plate was shunted. The position of the 4.1-mc marker shows that the grid coil is peaked slightly towards the high-frequency side. This bandpass is perfectly acceptable, and may provide a small amount of additional color in the picture; but it can still be improved. Waveform H shows the 3.0- and 4.1-mc markers after adjustment of the grid coil. Not all color receivers are designed for an identical response; so, when you align different models, check the alignment curves shown in the service information for the particular chassis you are aligning.

When the previously outlined adjustments are completed, remove the plate shunt and return the scope lead to the grid of the demodulator. A final touch-up of the top slug in the bandpass transformer should be all that's necessary to give a fairly flat response curve (Fig. 5, waveform I) and complete the alignment.

Quick Accounting

In these days of multiple taxes and narrow profit margins, it has become increasingly time-consuming to keep track of income, expenses, depreciation, and the many transactions which a modern business must record. For the busy technician-businessman, who often has no accounting experience, this bookkeeping can become a burdensome chore. Oelrich Publications has developed, with the aid of a certified public accountant, the No. 1800 *Profit Guard* system, which is specifically designed for the electronics service shop.

Entries are made daily (or weekly) in sections devoted to: Sales Receipts, Expenses, Payroll, Receivables, Cash, Bank, Depreciation, and Insurance. Monthly totals are computed and entered on a yearly summary sheet which is included in each section. A unique system of simple checks permits the technician (or his office assistant) to prove the accuracy of the entries and calculations.

A series of forms are provided which enable the user of the system to prepare a profit-loss statement from the information which has been entered in the various sections. Income tax forms can be prepared from the profit-loss statement. Sales taxes are accounted for in a group of memorandum columns in the Sales Receipts section.

Four of the sections can be omitted from the accounting procedures, to simplify the system even further. Instructions included in the book tell how each section fits into the system, and the user can judge whether he feels the optional sections will benefit him.

The *Profit Guard* system, if faithfully and methodically kept up to date, will provide the service shop owner with a current, easily-understood indication of where he stands financially. ▲

Answer to Crossword Puzzle

P	U	R	I	T	Y		H	Y	B	R	I	D
I		E				G		A	C		P	
C	A	T	H	O	D	E		G		D		A
K		R			C		R	I	B	B	O	N
U		A	V	C			F		I			O
P		C			A	F	C		A			D
	L	E	A	D		A			S	I	N	E
S			M		P	N	P				U	
T	R	A	P		H		A	L	N	I	C	O
E				P	O		D		E		L	
R	P	M			N	O	D	E			E	
E			M		O		E			B	U	S
O	C	T	A	L		C	R	O			S	

Stable Sync

(Continued from page 31)

primary symptom was no sync at all. However, as I maneuvered the hold controls to make the picture stand still, I noted the video was not too strong. It was there, but turning the contrast control up didn't bring out strong black and white tones.

Try as I might, I couldn't find a trace of a darker sync pulse inside the vertical blanking bar. The sync pulses were obviously being reduced to the blanking level. Taking a clue from the secondary symptom of poor contrast, I began examining the video circuits.

Voltage readings on the 6BH8 video output tube (Fig. 7) gave the following results: Grid, zero volts (correct); cathode, around 3 volts (also correct); plate, 35 volts (should be 170 volts!). I traced over to the other side of the sound take-off coil, and still found 35 volts; wherever the other 135 volts was being lost, it wasn't in the coil. Following the plate lead, I came to a peaking coil wound on a 15K-ohm resistor, and measured 175 volts on its far side. This peaking coil was open, and since all the plate current had to pass through the resistor, the plate voltage dropped so low that sync compression was taking place in the video-output stage. In some cases of this kind, the loss of sync may not be complete. The input waveform may still have a dip or notch where the vertical sync pulse should be, and the vertical oscillator may be able to lock in on this break in the signal. It'll be touchy, but it will hold!

Sync-Section Troubleshooting

Incomplete sync separation most often stems from video, IF, tuner, or AGC troubles that cause visible distortion in the vertical blanking bar, but the sync separator itself is occasionally at fault. Once you have isolated a trouble to this simple circuit, such basic procedures as resistance checking will point the way to the defective part.

Voltage readings can be helpful, too; but checking for voltages "within tolerance" is sometimes frustrating! Readings must be interpreted somewhat skeptically, because wide fluctuations are

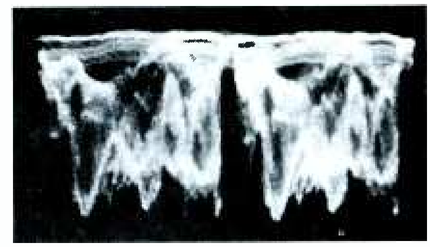


Fig. 6. Almost total sync compression due to an overloaded video amplifier.

perfectly normal under various operating conditions. Rather than slavishly following the voltage information in service manuals, simply ask yourself if the voltages make sense.

With no signal coming in, the grid voltage of a typical sync separator should be only a fraction of a volt negative with respect to the cathode. The tube should be conducting continuously, thereby producing a generous voltage drop across the high-value plate-load resistor and making the plate voltage much lower than the supply voltage.

An incoming signal should generate even more bias voltage. The amount may range from minus 10 to minus 50 volts (depending on set design), and should increase when a stronger signal is fed in. Since the tube is cut off most of the time when a signal is present, the plate voltage should rise—often to more than double the value measured without a signal.

To show how misleading some sync-circuit voltage readings can be, suppose you are servicing an unfamiliar chassis, and find a separator-grid voltage of nearly zero with no signal input. This is as it should be. With a signal applied, though, the grid voltage is less negative than in most other sets you have checked under the same circumstances. Does this mean positive voltage is leaking into the grid

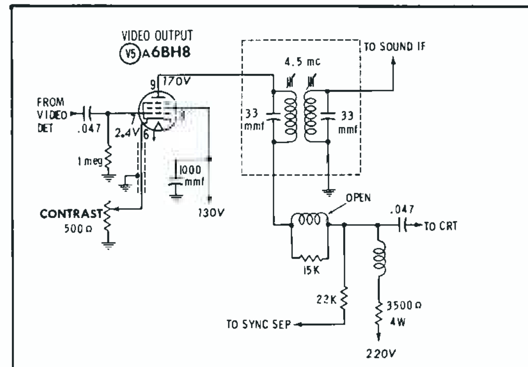


Fig. 7. Sync was altogether lost as a result of trouble in this video stage.

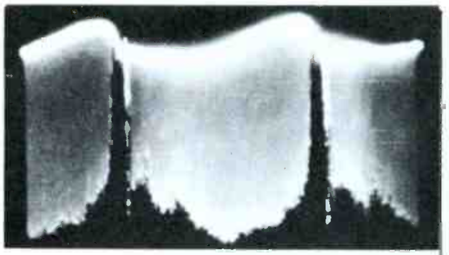


Fig. 8. Some frequency-selective conditions kill only the vertical pulses.

circuit from the video-output plate circuit through a faulty grid capacitor? Is the input signal weak? Or does this model normally develop less grid-leak bias than most sets? It's hard to tell, just from the voltage reading, whether or not there is any trouble in the separator.

The peculiar DC operating conditions in the separator — voltages somewhat critical, yet varying widely according to signal conditions—are also found to a great extent in other sync stages. This point explains why many experienced servicemen rely so heavily on the oscilloscope for sync troubleshooting. It can quickly settle any questions as to whether an off-value voltage actually marks a trouble spot, or whether it is just the result of signal distortion that has its roots elsewhere in the set.

Signal-Tracing With a Scope

With a low-capacitance probe attached to the vertical-input terminals of a scope, you can check any point in the sync circuits without concern for signal distortion due to circuit loading. You can lock in usable waveforms with the horizontal sweep (time-base) control of the scope set to either 30 cps (TV-V on some scopes) or 7875 cps (TV-H). Generally, though, you can secure more information in the 30-cps position; for instance, you can compare the vertical and horizontal sync-pulse amplitude, spot 60-cycle hum in the waveform, and see if the horizontal sync pulses maintain a constant amplitude throughout a complete frame of the transmitted signal. Sometimes you'll encounter an effect such as that in Fig. 8, which might not even be noticed at 7875 cps. In this case, a decrease in the value of the sync-separator input coupling capacitor squeezed the vertical pulses out of the signal, without having too much effect on the horizontal pulses.

Signal-tracing is a snap in most receivers built since 1955, which typically have only one or two sync stages. See if a waveform similar to Fig. 1 or 4 enters the grid of the stage labeled "sync separator," and note whether a reasonably clean negative pulse signal (of *approximately* the same amplitude as the input) appears at the separator plate. If a second stage follows the separator, the signal at its grid should be almost identical to the separator-plate waveform. In most late-model sets, this second stage (a *sync amplifier*) inverts the pulses, limits or clips the positive and negative peaks for more uniform amplitude, and gives the signal a moderate boost in amplitude. The resulting plate waveform is usually made up of clean positive pulses, but it may have a slight "fringe" of video along the base line (as in Fig. 9) without causing any trouble. If more than this amount of video is leaking through to the output of the sync section, scope back through the sync and picture stages to find out where the distortion is originating.

The second stage in some receivers is a phase inverter that produces a negative pulse at the cathode, as well as a positive pulse at the plate. If so, both pulses should have about the same amplitude.

Many older sets, and a minority of the newer ones, are trickier to signal-trace because they have additional stages—as many as five or six. But just keep in mind that the separator is still the "kingpin" of the circuit, and all the extra stages merely help the separator to do a better job.

Any "sync amplifier" *ahead of* the separator can be expected to have a composite video signal on both the input and the output side, with the sync-pulse tips always going positive in the signal which is finally fed to the separator grid. Beyond the separator, all waveforms should be simple pulse signals, and you should be mainly interested in learning whether or not the output signal of the last sync stage is of normal amplitude and free from video.

In checking a stage following the separator, you'll find it helpful to ask yourself, "Should the stage invert the signal? Should it amplify, or merely clip the sync pulses to obtain constant height?" Waveform photos in service literature will usually make the answers obvious; if not, you can predict the action of the stage by studying the schematic to see how the signal is fed in and taken out. For instance, a grid input and plate output would mean a signal inversion, whereas a cathode input and plate output would mean no change in polarity.

Noise-Inverter Circuits

Probably the most confusing sync-servicing problems spring from the noise-inverter stages in some older sets. Deteriorated components sometimes allow these stages to conduct erratically and make hash of the sync waveform. Noise inverter circuits are full of ingenious voltage-divider chains and parallel signal connections, and thus can be very hard to trace. Nevertheless, routine tests can still be effective in locating trouble in this type of circuit.

To cite an example, I once traced an intermittent vertical roll in a Philco Chassis TV-394 to the

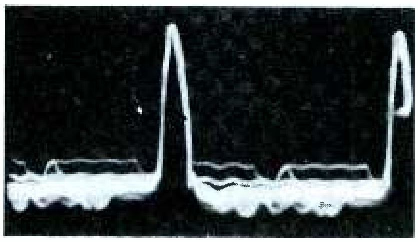


Fig. 9. A video "fringe" may be tolerable in output signal of sync section.

noise-inverter circuit (Fig. 10). The condition occurred sporadically about a dozen times an hour. The seizure would start with faint hum bars beginning to roll through the picture, and then the top of the picture squeezed downward. At the point of maximum compression, the picture began rolling vertically; after 30 or 40 fast flips, the picture settled down till the next attack about five minutes later.

After replacing the sync and sweep tubes to no avail, I pulled the chassis. At the bench, while waiting for the trouble to reappear, I scoped the sync section and found video mixed with the sync pulses. At the plate of the video output tube (the pentode half of a 6AW8), there was a good composite video signal. Moving the probe down to the sync take-off point, I found a normal signal also present there. As I followed the wire toward the sync section, I came to C51, a 1000-mmf coupling capacitor going to the grid of the noise inverter. I checked the waveform on the other side of this component. Aha! The composite-video signal was drastically attenuated, although the waveshape was still good.

I removed the capacitor and quick-checked it with an ohmmeter. A 300-megohm reading indicated slight leakage—enough to disturb the bias on the noise inverter and allow amplified video

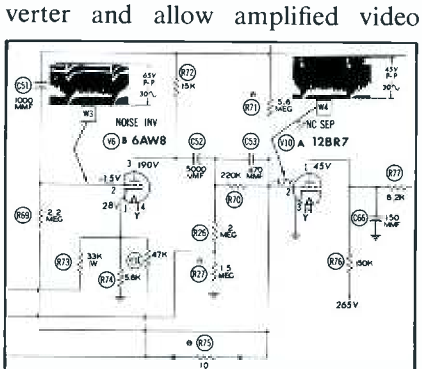


Fig. 10. Malfunction in noise-inverter circuit caused intermittent rolling.

to pass into the sync output. A new C51 cured the sync instability.

When conventional tests don't definitely prove or disprove the existence of noise-inverter trouble, you can save troubleshooting time by simply disabling the noise inverter. If this stage is defective, stopping its action will clear up the sync problem. The receiver can operate with the noise inverter disabled, because this stage is normally idle except when it is doing its job of cancelling noise pulses in the incoming signal.

There are various ways to put a noise inverter temporarily out of commission. In some sets, you can pull the noise-inverter tube without disrupting other circuits. A couple of other possibilities are to open the cathode circuit, or to feed in a bias voltage that will drive the tube into cutoff. If the cathode voltage is normally several volts more negative than ground, or if the grid is several volts positive, you may be able to halt tube conduction by just grounding the cathode or grid.

Once you've isolated a service problem to the noise inverter, it will usually yield to the same resistance and component checks you find helpful in pinning down simpler sync defects.

Summary

Sync problems can be deceptive since they can be due to faults in the antenna, tuner, IF strip, video amplifier, sync circuits, or sweep oscillators. This is quite a range of circuitry to check out. However, using prescribed techniques and test equipment, you can quickly spot the offending circuit. Don't fail to take advantage of the useful hint provided by the vertical blanking bar. If the vertical sync and blanking signals are properly reproduced on the picture tube, this means the trouble is past the sync take-off point, in one of the sync or sweep circuits. On the other hand, improper shading warns of trouble in stages before the take-off point. The latter type of trouble is usually accompanied by secondary symptoms, whereas the former is more likely to be a "pure" sync trouble. Notice the word "usually"—there are always exceptions! ▲

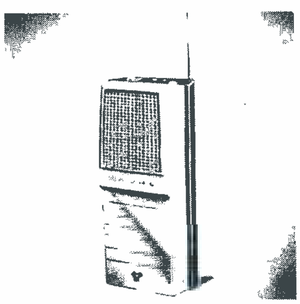
PRODUCT report

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

Handbook (450)

The newest edition of "Essential Characteristics," **General Electric's** handbook on receiving tubes, picture tubes, and replacement capacitors, also lists wrenches, wire strippers, soldering guns, and technical publications for the first time. The book includes typical characteristics curves, tube-outline drawings and circuit-application diagrams. Priced at $1.50, the handbook also gives construction data for loudspeaker enclosures.

CB Transceiver (460)



Printed-circuit modular construction is featured in **Cadre's** C-75 portable transceiver. Capable of a 1.5-watt output, the C-75 provides reliable communications over 5 miles and operates for at least eight hours on rechargeable batteries. Designed for 2-channel operation, the unit uses a built-in retractable antenna and weighs less than three pounds including batteries.

Radiation Suppression Kit (470)

Designed for use with Citizens-band, amateur, public service and commercial mobile-radio equipment, the **Sprague** Type SK-1 "Suppressikit" contains five basic components which are used to shield and suppress ignition-system radiation. Capacitors used in the kit are of a new design that effectively suppress RF up to and beyond 400 mc. Dealer net price is $17.85.

PC Control Kit (480)

A kit containing 36 components in a six-drawer stock cabinet is available from **IRC.** Complete assembly instructions enable technicians to replace many of the printed-circuit-board controls commonly encountered. In addition to the kit, a backup stock assortment is available which provides increased coverage. Suggested dealer net price for the kit is $15.95.

Fuse Adapters (490)

Regular-size fuses can be adapted to fit "C" and "N" type fuseholders by using **Workman's** Model FCN-5 fuse adapters. These small clips snap over the ends of regular fuses and allow the technician to replace most fuses without having to stock all available types. List price of a complete package containing five clips and one 3AG fuse is 70c.

Cleaner Kit (500)

TV tuner contacts can be cleaned and then lubricated with chemicals contained in the "Contacare II" kit by **Standard Kollsman.** The kit consists of a bottle of nonflammable cleaning solution, a lint-free cloth, and a tube of lubricant. Also included is a sheet describing a recommended step-by-step procedure for servicing tuner contacts. The lubricant may also be used on bearing points. Price is $1.25.

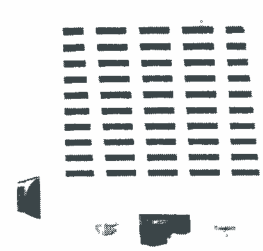
Hi-Fi Headset (510)

Employing dynamic (moving coil) drivers, **R-Columbia** Type A headphones have a frequency response from 30 to 15,000 cps, and are designed with impedances from 8 to 2000 ohms. The headsets weigh seven ounces and are intended for use in language labs, audio analgesia, aircraft and home entertainment equipment. List prices range from $15.95 to $19.95.

Interference Suppressor (520)

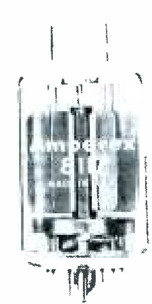
Designed for CB use, **Business Radio Co.'s** "Noistop" is an accessory that suppresses the effects of ignition interference originating in the user's vehicle as well as other nearby cars, trucks, busses or outboard motors. The complete package is supplied with installation instructions and is designed for universal mounting on either side, top or bottom of the transceiver. Wired and tested, the unit nets for $16.95.

Microphones (530)



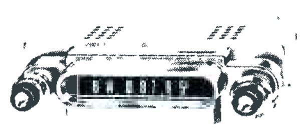
American Microphone has recently developed a series of high-efficiency crystal and ceramic microphones. The crystal unit has a frequency response of 40 to 8,000 cps at an output level of –51 db at 1,000 cps. The ceramic unit is rated at –58 db output at 1,000 cps. These nondirectional microphones are designed for use with inexpensive PA systems, home recorders and Citizens-band and amateur transmitters. List price of the crystal unit is $7.00; the ceramic unit sells for $7.50.

SSB Tube (540)



A twin tetrode designed for use as an RF linear amplifier in single-sideband systems, the **Amperex** 8117 may be used in mobile, airborne and base station VHF transmitters. The tube has a plate-dissipation rating of 30 watts per anode, and its PEP output is 141 watts. Its filament can be connected for either 6.3 or 12.6 volts. Either heat-sink or forced-air cooling should be employed when the tube is operated at maximum ratings.

Auto Radios (550)



Both transistorized and tube-operated models are featured in **ATR's** latest "Karadio" line. Models are available to fit most American cars and imports including compacts and trucks. The sets are hand-wired and are built to look and fit like original equipment. All models come equipped with tone controls, noise suppressors, and speakers.

Molded Coil Cords (560)

Developed for use as replacements for microphone cords used on amateur gear, Citizens-band transceivers, public address equipment and tape recorders, **Switchcraft's** coiled cords are 4′ long (extended) and consist of a neoprene-jacketed shielded single conductor. There are three cords in the series, differing only in the type of connector attached to one end. On all models the free end is stripped and tinned.

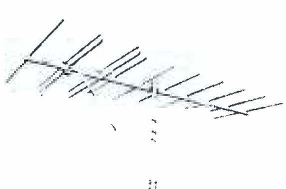
Communication Towers (570)

Five complete lines of "Rigid Tube" communication towers are offered by **Rohn.** Featuring triangular sections and all-bolted construction, the new towers permit antenna installations at heights up to 600 feet. These towers fill the needs of most microwave and communication facilities and are available either assembled or knocked down for easy transportation.

Multiplex Adapter Kit (580)

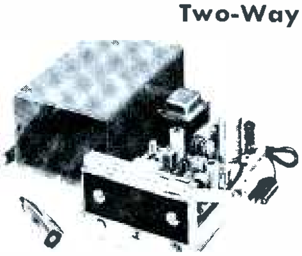
Owners of Dynatuner FM tuners will be able to receive stereo programs by adding the **Dynaco** FMX-3 Multiplex Integrator to their sets. Wholly automatic in operation, the FMX-3 provides identical monophonic signals from both channels or 30 db of separation when it is receiving a stereocast. A stereo program announces its presence by lighting up the word STEREO on the front panel. Price of the kit is $29.95.

Low-Band Yagis (590)



Three separate series of eight- and ten-element Yagi antennas designed to cover the frequency range of 43 to 112 mc are available from **TACO.** The Y-81 group is for use in the 50 to 66 mc range, the Y-101 series is for 66 to 112 mc, and the Y-104 group covers 43 to 88 mc. Consisting of 19 models in all, the new Yagis are designed to withstand adverse weather conditions over long periods of time.

Two-Way Units (600)



The "Messenger 202" is an industrial transceiver for use in the 25 to 50 mc range. Developed by **E. F. Johnson Co.** for use by public utilities, trucking firms, and police systems, the unit is self-contained and is installed with a universal mounting bracket. The transceiver has provision for addition of a selective-calling device which mutes calls except those from other units in the system. Price is under $200 per unit.

INDEX TO ADVERTISERS

June, 1962

Acme Electric Corp. 103
Antenna Specialists Co., The 56
Arco Electronics, Inc. 40
ATR Electronics, Inc. 16
B & K Mfg. Co. 55, 59
Belden Mfg. Co. 45
Berns Mfg. Co., The 88
Blonder-Tongue Labs 77
Bussmann Mfg. Div. 67
Cadre Industries Corp. 60
Castle TV Tuner Service 68
Centralab, A Div. of Globe-Union, Inc. 87
Chemtronics, Inc. 46
Clarostat Mfg. Co., Inc. 17
Delco Radio Div. (GMC) 75
Duotone Co., Inc. 92
EICO Electronic Instrument Co., Inc. 85
Electro-Voice, Inc. 24-25, 90
Electronic Chemical Corp. 88
Enterprise Development Corp. 74
Fisher Radio Corp. 74
Gam Electronics 92
General Electric Co. 53, 62, 63, 70, 71
Hallicrafters Co., The 97
Jackson Electrical Instrument Co. 104
Jensen Mfg. Co. 69
Littelfuse, Inc. 4th cover
Los Angeles Tuner Exchange 92
Mallory & Co. Inc., P. R. 21
Mercury Electronics Corp. 65
Mercury Tuner Service, Inc. 83
Merit Coil & Transformer Corp. 89
Miller Co., J. W. 80
Mosley Electronics, Inc. 94
Oelrich Publications 96
Perma-Power Co. 64
Philco Corp.—Parts and
Service Operations 48, 49
Planet Sales Corp. 99
Precision Apparatus Co. 73
Precision Tuner Service 96
Quietrole Co. 90
RCA Electron Tube Div. 93, 95, 3rd cover
RCA Parts & Accessories Div. 22-23
RCA Semiconductor Div. 47
RCA Special Products Dept. 83
RCA Test Equipment Div. 20
Rider Publisher, Inc., John F. 44
Rohn Mfg. Co. 79
Sams & Co., Inc., Howard W. 54, 61, 86, 98
Sargent-Gerke Co. (Electronics Div.) 100
Sarkes Tarzian, Inc.
Semiconductor Div. 57
Tuner Div. 52
Tuner Service 9
Seco Electronics, Inc. 91
Sencore, Inc. 39, 41
Sonotone Corp. 81
Sprague Products Co. 11, 12
Standard Kollsman
Industries, Inc. 2nd cover
Sylvania Electric Products, Inc.
Electronic Tube Div. 42-43
Techni-Parts Corp. 100
Terado Co. 101
Texas Crystals 101
Tung-Sol Electric, Inc. 51
V-M Corp. 78
Volkswagen of America, Inc. 13
Westinghouse Electric Corp. 14-15
Winegard Co. 27
Xcelite, Inc. 72
Zenith Sales Corp. 18-19

Latest Jackson Tube Test Data

MODEL 648

Tube Type	Fil.	D.	E.	Plate Test
4GK5	4.2	A234	A57	22 YZ
6BH3'	6.3	126	5	14 W
9A8	9.4	A129	AB358	54 V
	"	127	A46	20 YZ
17GJ5'	17.	123	AB459	18 W
50HK6	50	C12s	457	40 VW

SUPPLEMENTS LATEST ROLL CHART 648-25

MODEL 598

A.	B	C.	Fil. Cont	D	E	F	G.
4.2	3YZ	7	4	5	2		48
9.4	4YZ		5	6	2	3	69
"	4YZ			1	9		61
50	3YZ	6	4	7	2	5	35

SUPPLEMENTS LATEST ROLL CHART 598-3

MODEL 658

Tube Type	Sec.	Heater	Circuit H-K	Circuit P-G	Plate	Grid Test	Heater Current
4GK5	T	4.0P	123	a57	21R	5WY•	A8.5F Z300
6BH3'	D	6.4P	126	5	19U	V	
9A8	P	10.6E	129	ab358	40R	10WY•	
	T	"	127	a46	24S	15WY•	
17GJ5'	P	18.6H	123	ab450	22R	95VY•	A22.H Z450
50HK6	P	50.K	123	457	95	40WY•	

SUPPLEMENTS LATEST ROLL CHART 658-5

"For further information, see Tube Test Data in PHOTOFACT Folder No. 584."

CATALOG AND LITERATURE SERVICE

ANTENNAS & ACCESSORIES

1O. *JFD*—Descriptive and promotional literature plus sales aids for new *Transis-Tennas;* also complete set of specifications for outdoor and indoor TV antennas and accessories, including exact-replacement antenna data.

2O. *MOSLEY*—20-page catalog describing complete line of communications antennas and accessories — cables, connectors, etc. *See ad page 94.*

3O. *WINEGARD*—Brochure describing amplified and non-amplified FM antennas; also FM station-finder map and log. *See ad page 27.*

AUDIO & HI-FI

4O. *DUOTONE* — 1962 phonograph needle replacement guide and accessories catalog, containing cross-reference charts and conversion data. *See ad page 92.*

5O. *EICO*—New 32-page catalog of kits and wired equipment for stereo and monophonic hi-fi, test equipment, Citizens-band transceivers, ham gear, and transistor radios. Also Stereo Hi-Fi Guide," and "Short Course for Novice License." *See ad page 85.*

6O. *SONOTONE* — New phonograph-cartridge replacement manual containing cross-reference information. *See ad page 81.*

7O. *VIDAIRE*—Catalog sheet giving complete information on record changers, tape equipment, and accessories.

COMMUNICATIONS

8O. *COMCO*—Brochure describing *Fleetcom* series of mobile communications equipment; includes 25- and 75-watt high-band and 35- and 100-watt low-band units.

COMPONENTS

9O. *BUSSMANN*—Bulletin SFH-8 describing new GMW-HWA subminiature fuse and holder that can be mounted or soldered on PC boards. *See ad page 67.*

10O. *CENTRALAB* — Catalog sheet listing new stereo attenuators, expanded line of L and T pads, economy lever switches and associated hardware. *See ad page 87.*

11O. *CLAROSTAT*—Sheet giving information concerning Series 53 2-watt molded composition potentiometers for use in critical applications. *See ad page 17.*

12O. *RCA*—Form TK310, "RCA Color Parts and Accessories for Installation and Service," listing replacement parts and service aids for all RCA color TV receivers. Also Form TK-292, 28-page "TV Knob Directory," listing part numbers for all knobs used on 1955 through 1962 RCA TV receivers. *See ad pages 22-23.*

13O. *COMPONENTS SPECIALTIES, INC.* —Catalog listing universal replacement parts for transistor radios; also lists universal replacement tone arms.

14O. *SPRAGUE*—Chart C-457 (designed to hang on wall) showing all popular TV-radio-hi-fi replacement components. *See ad pages 11, 12.*

15O. *TEXAS CRYSTALS* — Catalog #962 containing list of distributors and prices on complete line of crystals; also story of how crystals are made. *See ad page 101.*

16O. *TRIAD*—Catalog TV-62 listing replacement transformers; also TR-62 transformer catalog including industrial types.

SERVICE AIDS

17O. *AKRO-MILS*—Catalog listing complete line of compact cabinets for small-item storage; also suggested uses for see-through parts drawers.

18O. *BERNS*—Data on 3-in-1 picture-tube repair tools, on *Audio Pin-Plug Crimper* that lets you make pin-plug and ground connections for shielded cable without soldering, and on *ION* adjustable beam bender. *See ad page 88.*

19O. *CASTLE*—Leaflet describing fast overhaul service on television tuners of all makes and models. *See ad page 68.*

20O. *ELECTRONIC CHEMICAL CORP.* Catalog sheet describing *No Noise* line of servicing chemicals; gives specifications and prices. *See ad page 88.*

21O. *KRYLON*—16-page catalog describing complete line of aerosol finishes, protective coatings, cleaners, and lubricants.

22O. *MULTICORE*—Sheet describing *Multicore* solder; gives technical advantages of multiple-core construction.

23O. *PRECISION TUNER*—Information on repair and alignment service available for any TV tuner. *See ad page 96*

24O. *SWING-O-LITE* — Two-color catalog sheet giving details on *Hi Mag* inspection light with miniature shade.

25O. *TENSOR*—Sheets describing complete line of work and utility lamps. Also information on stereo lighting.

SPECIAL EQUIPMENT & SERVICES

26O. *ATR*—Descriptive literature on *Karadio* line of auto radios; also information on DC-AC inverters for mobile PA use. *See ad page 16.*

27O. *BLONDER-TONGUE* — Catalog describing closed-circuit TV systems; also "Planning Master TV Systems" and a quick reference manual on master TV systems. *See ad page 77.*

28O. *CBC*—Information on electronic dimmer switches, color-gun killer, and three- and four-set couplers.

29O. *REA EXPRESS*—Brochure listing special decreased shipping rates for electronic parts, including rates between major cities.

TECHNICAL PUBLICATIONS

30O. *HOWARD W. SAMS*—Literature describing all current publications on radio, TV, communications, audio and hi-fi, and industrial electronics, including 1962 Book Catalog and descriptive flyer on 1962 Test Equipment Annual. *See ads pages 54, 61, 86, 98.*

31O. *MOTOROLA TRAINING INSTITUTE* — Literature describing two-way radio correspondence course available to qualified electronics technicians.

TEST EQUIPMENT

32O. *B & K* — Catalog AP18-R, giving data and information on Model 960 *Transistor Radio Analyst*, Model 1076 *Television Analyst, Dynamic 375 VTVM, V O Matic* 360, Models 600 and 700 *Dyna-Quik* tube testers. Models 440 and 420 CRT Cathode Rejuvenator Testers, Model 1070 *Dyna-Sweep* Circuit Analyzer, and B & K *Service Shop. See ads pages 55, 59.*

33O. *DON BOSCO* — Literature describing seven new accessories for the *Stethotracer*, including microwave demodulator, vibration pickup, telephone pickup, etc.

34O. *EMC*—Literature describing Model 212 transistor analyzer, Model 213 tube tester, and Model SA socket adapter used to modernize older tubes.

35O. *MERCURY*—Catalog describing complete line of test equipment and service aids; gives detailed specifications on each instrument. *See ad page 65.*

36O. *PACO*—1962 catalog listing test-equipment kits; also hi-fi and stereo flyer.

37O. *RCA*—New folder 1Q1071 giving full details on WV-98C, newest version of *Senior VoltOhmyst. See ad page 20.*

38O. *SECO*—Folder describing latest models of two-way radio test instruments. *See ad page 91.*

39O. *SENCORE*—New Booklet, "How to Use the SS117 Sweep Circuit Troubleshooter," plus brochure on complete line of *time-saver* instruments. *See ads pages 39, 41.*

TOOLS

40O. *ENTERPRISE DEVELOPMENT CORP.*—Literature from *Endeco* on improved de-soldering and re-soldering techniques for use on PC boards. *See ad page 74.*

41O. *VACO*—Catalogs on new tools, solderless-terminal kits, and reversible-screw-driver kit; includes new pocket-saver offer.

42O. *XCELITE*—Folder describing straight and curved-nose *Seizers. See ad page 72.*

TUBES

43O. *GENERAL ELECTRIC* — Lastest picture-tube replacement guide ETR702-G; also catalog ETR2982 of entertainment-type semiconductors. *See ads pages 53, 62, 63, 70, 71.*

44O. *SYLVANIA*—"Six Miles of Sylvania Craftsmanship," a 28-page booklet describing picture-tube manufacture. *See ad pages 42-43.*

NOW! Only 4 Picture Tubes can fill 50% of your replacement needs*

RCA 21CBP4A, 21AMP4A, 21ZP4B and 21YP4A Universal Silverama® Picture Tubes Replace 33 Industry Types

Now, four—*only four* RCA Universal Silverama types can take care of *half* your picture tube replacements. Think of what this means to you in terms of simplicity, economy and efficiency:

- **Fewer trips to the distributor.**
  You can keep these four types in your shop, knowing that you will quickly have use for them.
- **Faster service.**
  For half your picture tube replacements, you have the right tube on hand, in the shop. Saves hours of time picking up the proper tube or waiting for it to be delivered. The time saved gives you a competitive edge!
- **Picture tube replacements from your service truck.**
  It's simple to carry one of each of these Universal types on your service truck so you can make half of your picture tube replacements *right on the spot.*
- **Fewer types to take care of.**
  Think of the headaches and extra bookkeeping this simplification saves.

These four types are part of a growing family of RCA Universal Picture Tubes designed to help you fill the maximum number of sockets with the minimum number of types.

RCA Universal Silverama Picture Tube types are made with an all-new electron gun, the finest parts and materials and a high-quality envelope that has been thoroughly inspected, cleaned and rescreened prior to reuse.

Start now to simplify your picture tube replacement problems. See your authorized RCA Distributor this week about RCA Universal Silverama Picture Tubes.

*Based on EIA figures for the national movement of the picture tube types below.

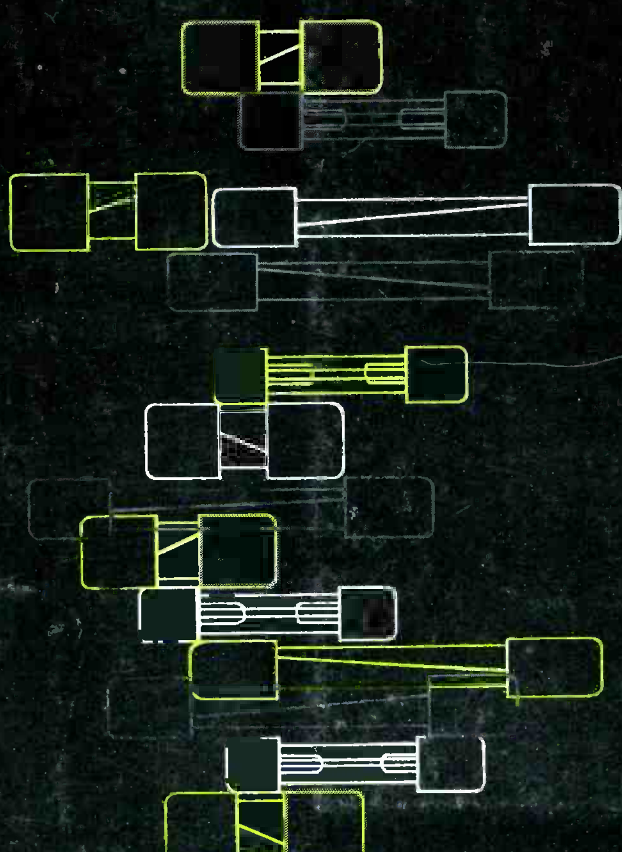
RCA Silverama "Universal" Type	Replacing		
21CBP4A	21ALP4 21ALP4A 21ALP4B 21ANP4 21ATP4 21ATP4A 21ATP4B	21ANP4A 21BTP4 21CBP4 21CBP4A 21BAP4 21BNP4 21CVP4	21CBP4B 21CMP4 21CWP4 21DNP4 21FLP4
21AMP4A	21ACP4 21ACP4A 21AMP4	21AMP4A 21AQP4 21AQP4A	21BSP4 21CUP4
21ZP4B	21ZP4	21ZP4A	21ZP4B
21YP4A	21YP4	21YP4A	21AFP4

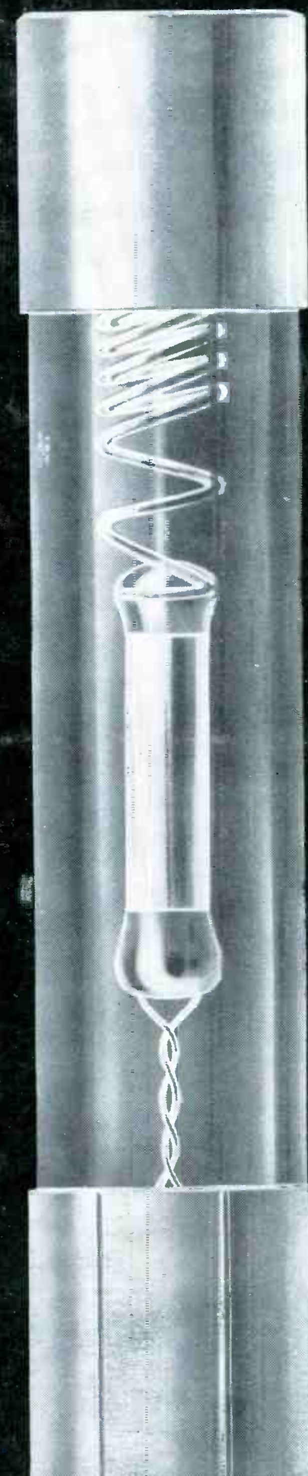
RCA Electron Tube Division, Harrison, N. J.

The Most Trusted Name in Electronics

WHAT'S IN A FUSE?

Only a fuse element, glass & caps?
No! Every fuse carries with it the skill and quality of its manufacturer. You can't reach out and touch or taste this, you can't even be sure it will do its job when needed except by purchasing from a company that has the know how of 30 years of manufacturing fine fuses.





BURTON BROWNE ADVERTISING

LITTELFUSE

1865 Miner Street · Des Plaines, Illinois