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September, 1968/75c

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the magazine of electronic servicing

Elusive Sync is Solved Quicker with the Scope, page 4

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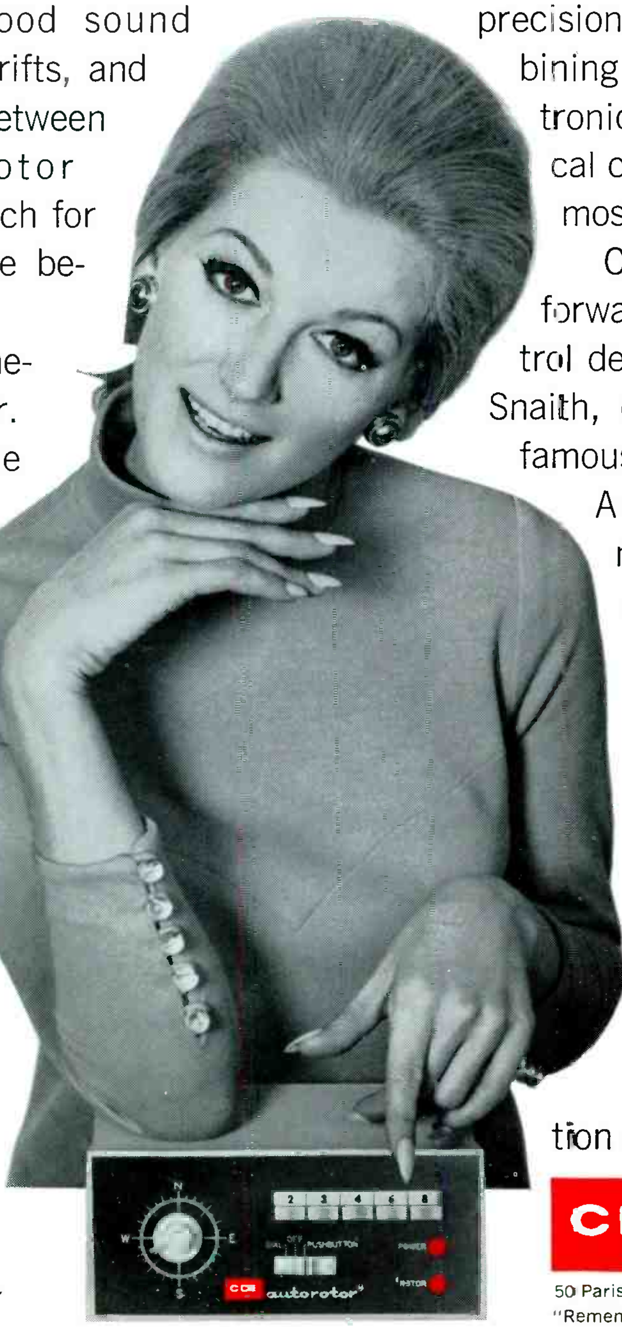

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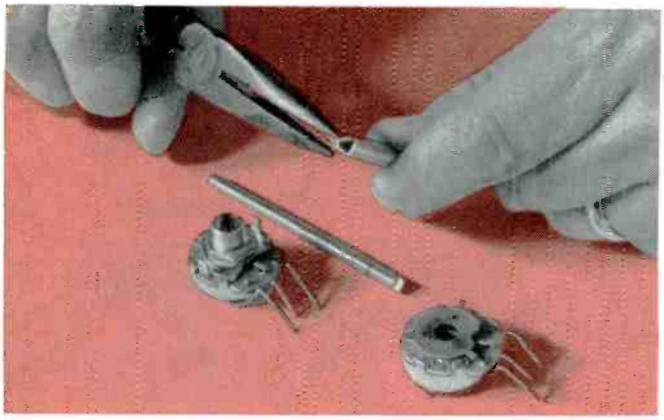
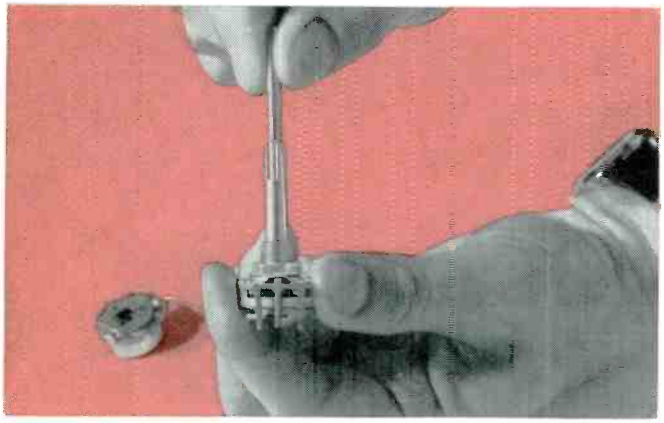
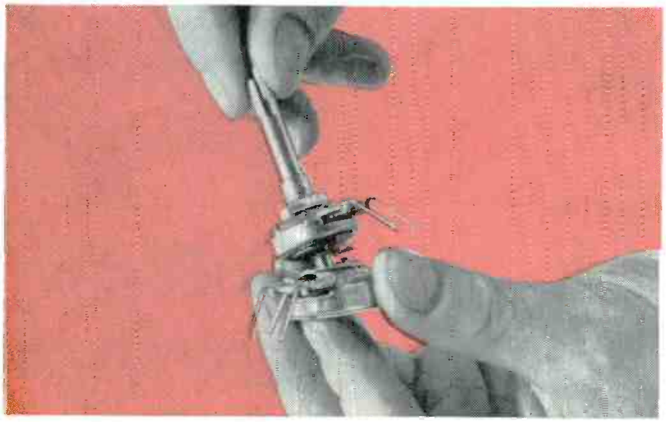


First, squeeze the end tines of the outer shaft together (the tines on the end of the shaft that go into the control) with a pair of pliers, until the tines just touch. Then insert the outer shaft into the front control section.



Next, insert the inner control shaft through the outer shaft from the front. You'll have to apply some pressure to force the inner shaft through the squeezed tines of the outer shaft. As you do this, the outer shaft will lock in place in the front control section.



Now push the inner shaft through the front control far enough so you can slide the rear control section in place on the shaft. Finally, attach the rear control section and snap it into place.

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September, 1968 • Volume 18, No. 9

PF Reporter

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the magazine of electronic servicing

in this issue...

ABOUT THE COVER

The service technician on this month's cover is using the proper technique for solving sync problems—the scope and waveform analysis.

DEPARTMENTS

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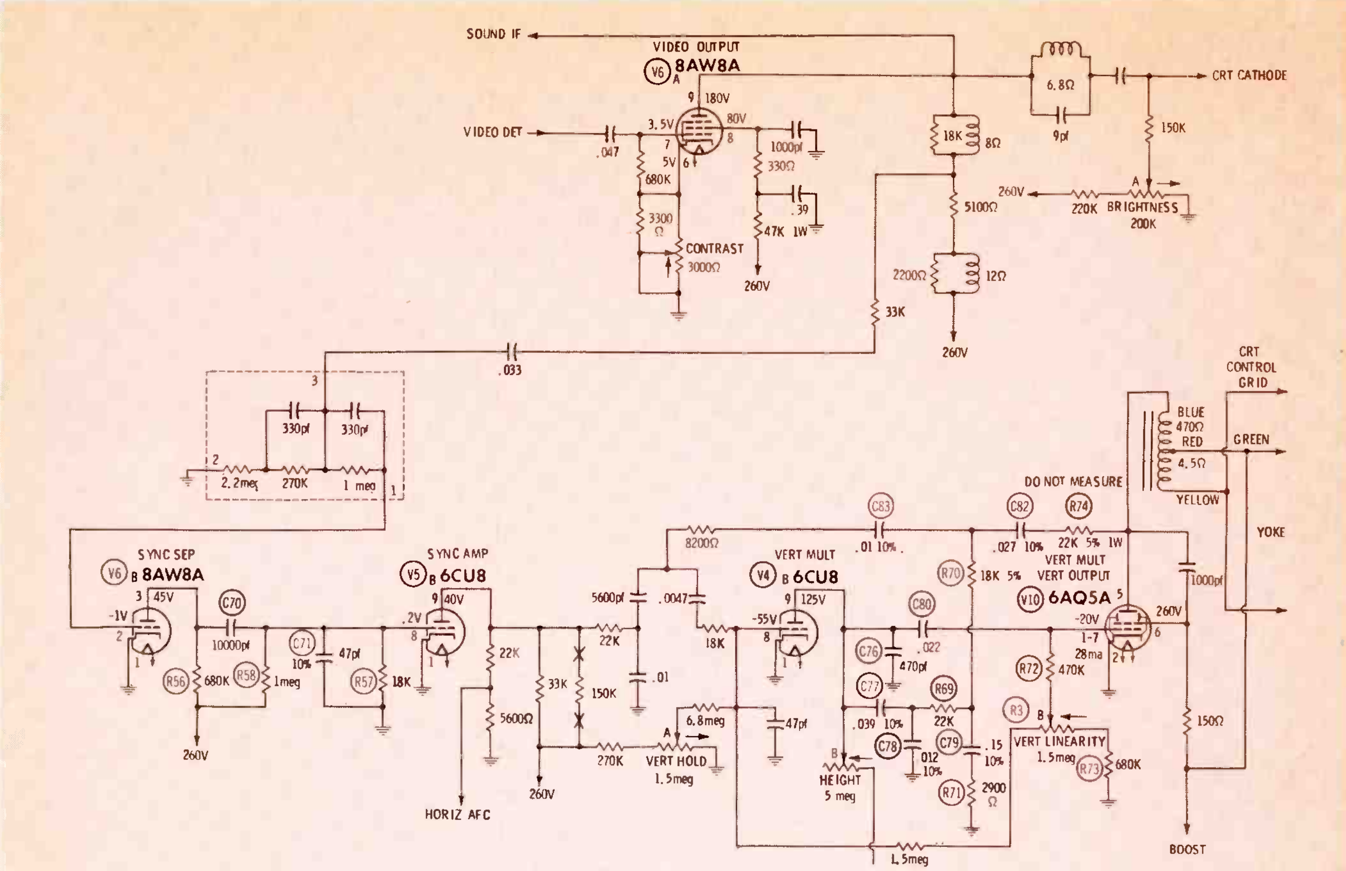

Fig. 2. Schematic of circuitry under discussion.

Sync is simple... almost

An analysis of waveforms pinpoints the cause of a sync problem.

by Stan Prentiss

When broadcast sync pulses and the output of the receiver sync oscillators fail to mesh there is always trouble.

Here is an example. An older receiver, an RCA 17PD8094, had a shorted RF amplifier that burned a 270-ohm current limiting resistor connected to B+. In addition, a misplaced audio tube (a 4AU6 can be substituted for a 4DT6) produced buzzing sounds. After these troubles were eliminated we were ready to tackle the sync problem: intermittent vertical roll accompanied by intermittent shrinkage of the raster.

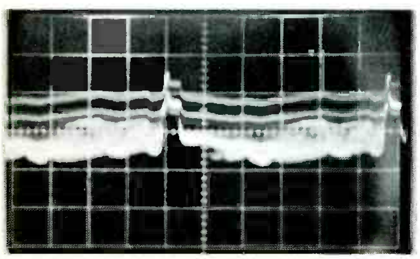

Fig. 1. Signal at plate of video amplifier.

This receiver is one of the first printed-circuit portables with a combination video and sync chassis separate from the remaining circuitry. The video-sync chassis is securely fastened at right angles to the hand-wired horizontal output and high- and low-voltage supplies that are attached to an upright metal plate which is parallel to the CRT. Screws secure the perpendicular video-sync chassis. There are also numerous solder points hidden beneath a bolted and soldered shield plate that covers the entire bottom. Therefore, investigations or repairs from the underside of these circuits can be difficult.

The best approach to both tubes and components was from the top. The chassis and the CRT had to be pulled from the cabinet. After attaching an isolation transformer (the set has one side of its AC power input connected to the chassis), B+ was measured and found adequate, as was B+ boost. With these two voltage sources eliminated as possible causes of the trouble, the next problem was getting at the tubes to make voltage and waveform measurements. This was accomplished with 7- and 9-pin tube mounts that fitted in the several tube shields housing the video amplifier, the sync separator and the vertical oscillator-output stages. All mounts were secured so there was no excess wiring capacitance.

The next step was to apply the oscilloscope, which employed a set of DC and AC amplifiers with a triggered sweep time base calibrated to within 5 percent. With the centimeter values shown for each waveform, the AC peak-to-peak value for each signal and its DC operating voltage level could be quickly determined. This also gave an accurate time base reference. Triggered sweep held each waveform steady throughout the entire voltage and frequency investigation. Since sine T=1/f and F=1/t, the use of the time base allowed seconds to be conveniently converted

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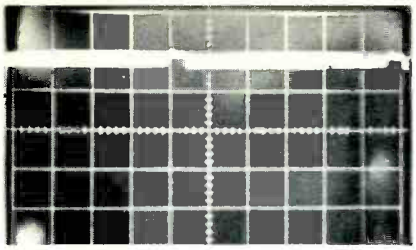

Fig. 3. AC voltage measured with the vertical amplifiers of scope on DC.

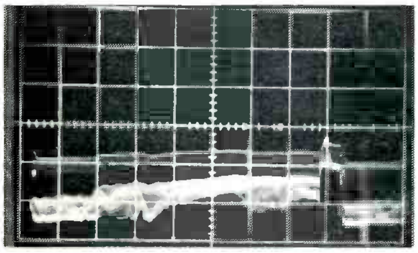

Fig. 4. Waveform with negative tip was obtained at grid of sync separator.

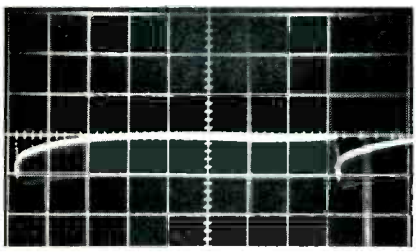

Fig. 5. Amplified signal at plate of sync separator appeared inverted.

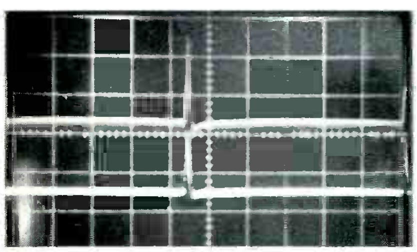

Fig. 6. Plate waveform of sync amplifier at p-p value of 40 volts.

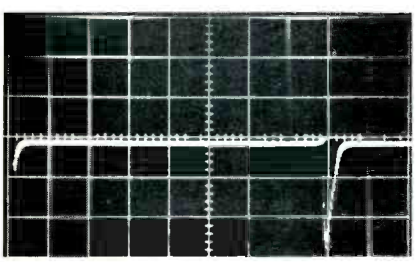

Fig. 7. Waveform at grid of vertical oscillator with plate shorted to ground.

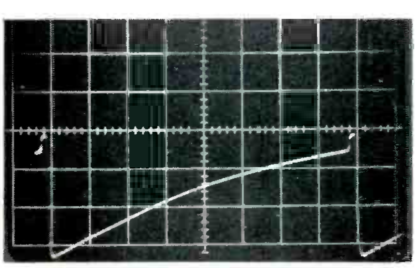

Fig. 8. Waveform less than 200 volts p-p.

to cycles per second, milliseconds to kilohertz and microseconds to megahertz. In estimating the repetition rate of a 3.5-MHz sync signal in a color set, timing a 19-KHz sinewave in a stereo receiver, or doing industrial digital or analog work, this extra facility is almost a necessity. This timing will be demonstrated later.

Investigating the associated waveform showed obvious defects that helped pinpoint the cause of the trouble. The signal shown in Fig. 1 was obtained at the plate of the video amplifier (V6A, Fig. 2) that supplies both the CRT and the sync section. With the contrast control set at mid range, the video measured about 40 volts p-p. In the waveform in Fig. 3, this same AC voltage was measured with the vertical amplifiers on DC and was shown riding at about 170 volts DC. Checking the schematic showed both levels within tolerance and, even with the sync plateau a little higher than the remainder of the waveform, it passed as a satisfactory AC and DC voltage.

Connecting the scope probe to the grid of the sync separator (V6B, Fig. 2) produced the waveform shown in Fig. 4. It was noticed that the waveform's tip was negative one or two volts and its amplitude varied between 10 and 20 volts, depending on the incoming signal from the video amplifier. The video at this point was stripped from the sync signal by a combination of grid biasing and low plate voltage. The amplified signal appeared inverted at the plate of the sync separator, as shown in Fig. 5. The amplitude was 22 volts and was hanging at a DC level of 60 volts. This waveform must swing to considerably more than the 45 volts DC illustrated on the schematic, and the signal amplitude should be at least 35 volts to correspond to that at the grid of the sync amplifier, V5B. This was the first defect to be investigated.

Keeping Fig. 5 in mind, the remainder of the sync and vertical circuits were checked. Fig. 6 showed the plate waveform of the sync amplifier at a peak-to-peak value of 40 volts (plus 40 volts more for the vertical spike) and riding at a DC level of 35 volts. This did not seem unusual considering the signal input and voltage tolerances.

In Fig. 7 the plate of the vertical oscillator had been shorted. The 6-volt negative spike of voltage at its grid was a couple of volts off and may have been significant.

The waveform in Fig. 8, however, had two noteworthy peculiarities: It was less than 200 volts p-p and its sync tips were not quite at the zero reference level. This, then, was the next probable fault. The plate of the vertical oscillator (V4B, Fig. 2) was riding high at 180 volts, but the shape of the waveform (Fig. 9) was normal, and the plate voltage could be adjusted by the height control, R4B. Following the path to the vertical output stage, the grid waveform, Fig. 10, looked acceptable and the DC level was at just about—25 volts, within tolerance.

Returning to the plate of the sync separator, R56, R58 and C70 were investigated. R56 measured 1.2 megohms instead of 680K ohms, and R58 measured between 30K ohms and 40K ohms instead of 1 megohm. The sync separator tube was pulled and the 260-volt line grounded to make sure the 1.2-megohm reading for R56 was accurate. (Current through a resistance is the IR drop, which is how an ohmmeter makes its measurement.) C70 and C71 might have retained a charge. To check R58, the junction at that point was grounded with a shorting clip to remove any charge. The measurement across R58 was now 30K ohms, and this looked suspicious. As another check, the 260-volt bus to the chassis was grounded and the junction of C70-C71 was checked to see if R57 was actually 18K ohms. This was also a check to see if C71 was leaking badly. The measurement indicated that C71 was okay. But what should be the DC reading at the junction of R58 and R57? Since this is a series filament string set, pull any tube and the DC bus should immediately rise from 260 to 350 volts.

$$Eo = \frac{Ein \times R1}{R1 + R2} = \frac{350 \times 18K}{1\text{ meg.} + 18K}$$

$$= \frac{350 \times .18 \times 10^5}{1.02 \times 10^6} = 6.2 \text{ volts.}$$

This voltage divider measured 7 volts and was working correctly. The reason the 1-megohm resistor could not be measured in-circuit was that the small current in the

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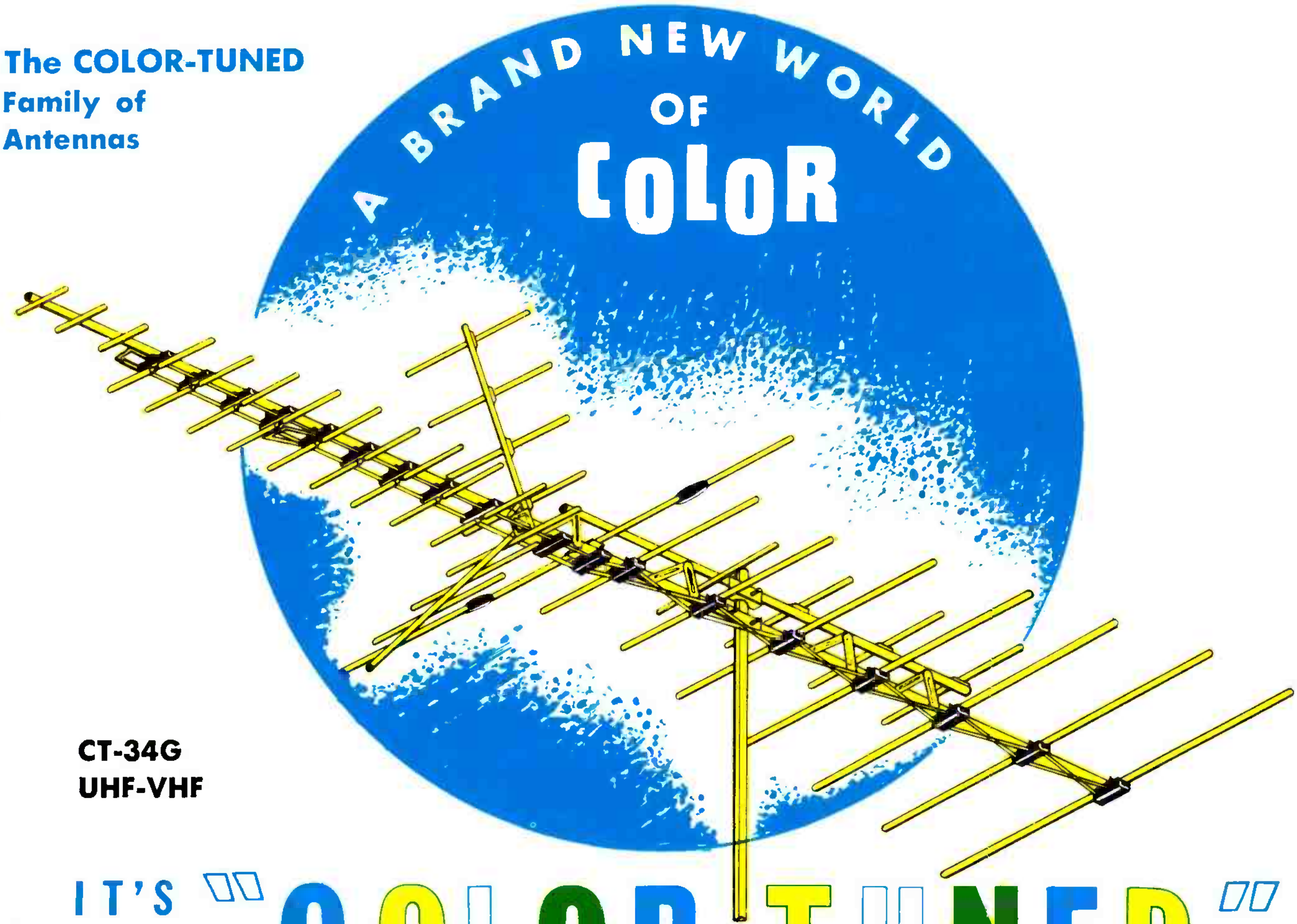

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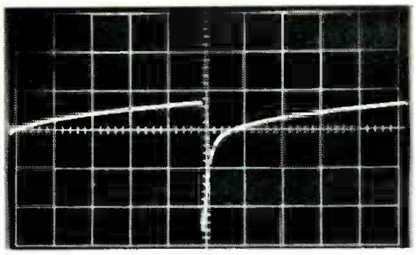

Fig. 9. Waveform at plate of vertical oscillator was normal, but reference level of 180 volts was high.

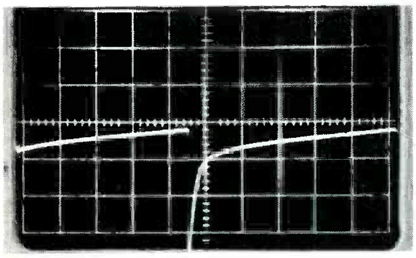

Fig. 10. Normal waveform at grid of vertical output stage.

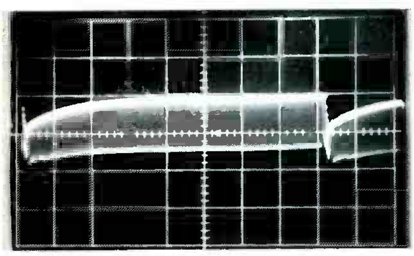

Fig. 11. Waveform with DC level almost 80 volts and AC amplitude 35 volts.

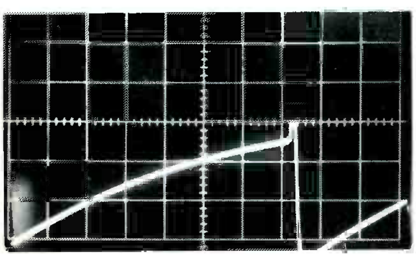

Fig. 12. Amplitude of waveform at grid of vertical oscillator about 200 volts p-p.

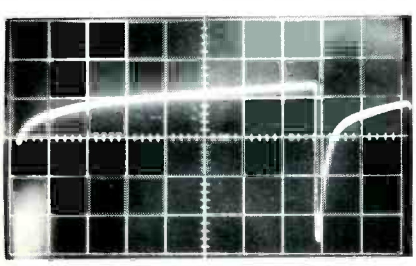

Fig. 13. Waveform with 200-volt DC level at plate of vertical oscillator.

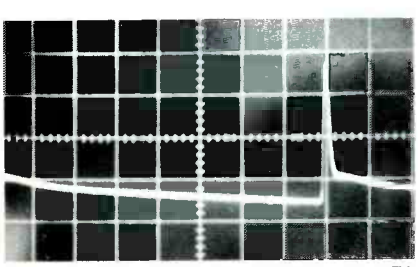

Fig. 14. Waveform at junction of R70, C82 and C83 in feedback network.

voltmeter divides through R57 and R58, or back into the power supply, and there was no positive reading. Without making a single disconnection, a little probing and reasoning established that R56 was defective.

To check C70, the 350-volt bus was jumpered to pin three of empty tube mount V6B and a check then made to see if there were more than 7 volts DC on the other side. The reading (DC level) remained at 6.2 volts, which was correct. More voltage at this point would have indicated that C70 was leaking. R56 was replaced by dexteriously positioning the little shielded chassis, first on one end and then on the other. The appearance of the waveform in Fig. 5 then more closely resembled that shown in Fig. 11. It was hanging at a DC level of almost 80 volts and its amplitude was just about 35 volts, exactly where it should be. So the first fault was corrected and a more usable sync signal was then available to the vertical and horizontal oscillators.

The waveform in Fig. 12 showed that the amplitude of the waveform at the grid of the vertical oscillator was then about 200 volts p-p and the sync tip had reached a —20 to 0 volts—a solid conduction level for this particular oscillator. The biggest change was at the plate of the vertical oscillator, where the waveform also measured 200 volts p-p and was riding at about 200 volts DC, as shown in Fig. 13. A bar generator indicated that the vertical scan was linear and the vertical hold seemed to be normal with one exception: It was near the end of its range. Vertical linearity and height adjustments, however, soon cleared this. But the schematic indicated that the DC level at the plate of this oscillator should be approximately 125 volts.

The AC and DC voltages at the grid of the vertical output tube were still correct, as they were in the beginning. The linear vertical scan showed black at the top and bottom of the picture immediately following the overflight of an aircraft. To see if the flutter caused by signal change was the result of defects within the sync circuits, the capacitors in these circuits were checked.

First the circuit was examined. From the schematic it was apparent the vertical oscillator was being driven very hard with considerable plate voltage in order to operate satisfactorily. This plate supply is coupled through the height control from the 570-volt boost source, which is generated in the flyback transformer and damper circuits. The plate supply measured normal and the height control correctly increased and decreased this voltage. The linearity control (the grid return for the vertical multivibrator) rotated through its range without skips, so it, too, was satisfactory. The output of the oscillator was shaped by C80, R72, R3 and R73 and then fed to the grid of the vertical output stages. Since there seemed to be no problem with either the DC voltage at the grid of V10 nor the waveshape, these components were assumed to be functioning properly. Once more, the receiver was turned off for a few minutes, turned on again, and the height and linearity controls adjusted for a symmetrical picture. The vertical hold control was in the center of its range, as it should have been.

To solve the shrinkage problem the defective capacitor had to be isolated. Before printed circuit boards, one could unsolder a half dozen of the plate and dielectric capacitors associated with such circuits and test them individually for leakage. However, in a chassis such as this there was no room to get into the board to do this, or time for a protracted job of troubleshooting.

The capacitors in the feedback and lower plate-circuit network (C78, C79, C82 and C83) were heated while monitoring the waveform developed at the junction of R70, C82 and C83 in the feedback network (Fig. 14). A positive spike of 300 volts AC was showing; however, this waveform was riding on 150 volts of DC. Tracing the waveshaping circuit through R70, C79, R69, C77, etc., it was discovered that this was a closed AC circuit and there should be absolutely no DC in it. The voltage on one side of R69 was about the same as that on the other side. Either C77 or C82 was leaking. Shorting either capacitor caused the picture to fold severely from the bottom and elongate from the top. Shorting C82, however, had less effect than shorting C77, so C82 was checked first.

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Since this 0.027-mfd unit was a vertical tubular capacitor and rather difficult to reach, the end of R74 was raised and the entire capacitor was bypassed by a new one to the junction of C83 and R70. The DC level of the waveform then returned to zero (Fig. 15). The DC level of the waveform at the plate of the vertical oscillator (Fig. 16) increased to 125 volts—exactly what it should be. Thus, the receiver was returned to normal operation after replacing only one capacitor and one resistor.

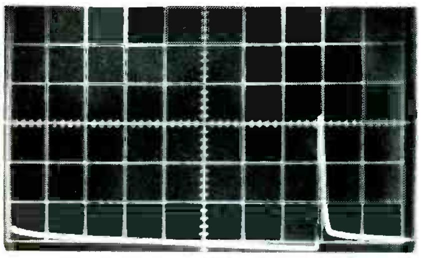

Fig. 15. DC level returned to zero.

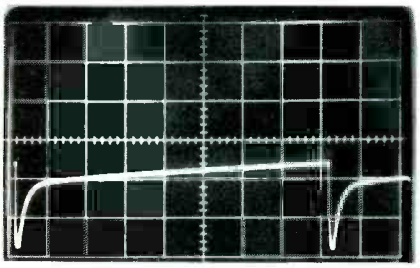

Fig. 16. DC level of waveform at plate of vertical oscillator increased to 125 volts.

Determining Frequency

In checking the repetition rate or frequency, look at the waveform in Fig. 8. The calibrated oscilloscope interval is 2 milliseconds per division. This takes almost exactly 8.2 divisions. Therefore,

$$F = \frac{1}{8.2 \times 2 \times 10^{-3}} = 0.061 \times 10^{3} \text{ or } 61 \text{ Hz.}$$

It is within 2 percent of the 60 cycles per second scanned in each complete picture waveform. Figs. 2 and 3 were also taken at 2 milliseconds per centimeter. The divisions occupied by each cycle is roughly 5.8. Use the same equation:

$$F = \frac{1}{t} = \frac{1}{5.8 \times 2 \times 10^{-3}} = \frac{1}{11.6 \times 10^{-3}} = 86 \text{ Hz.}$$

The different findings could be the result of an uncalibrated scope. ▲

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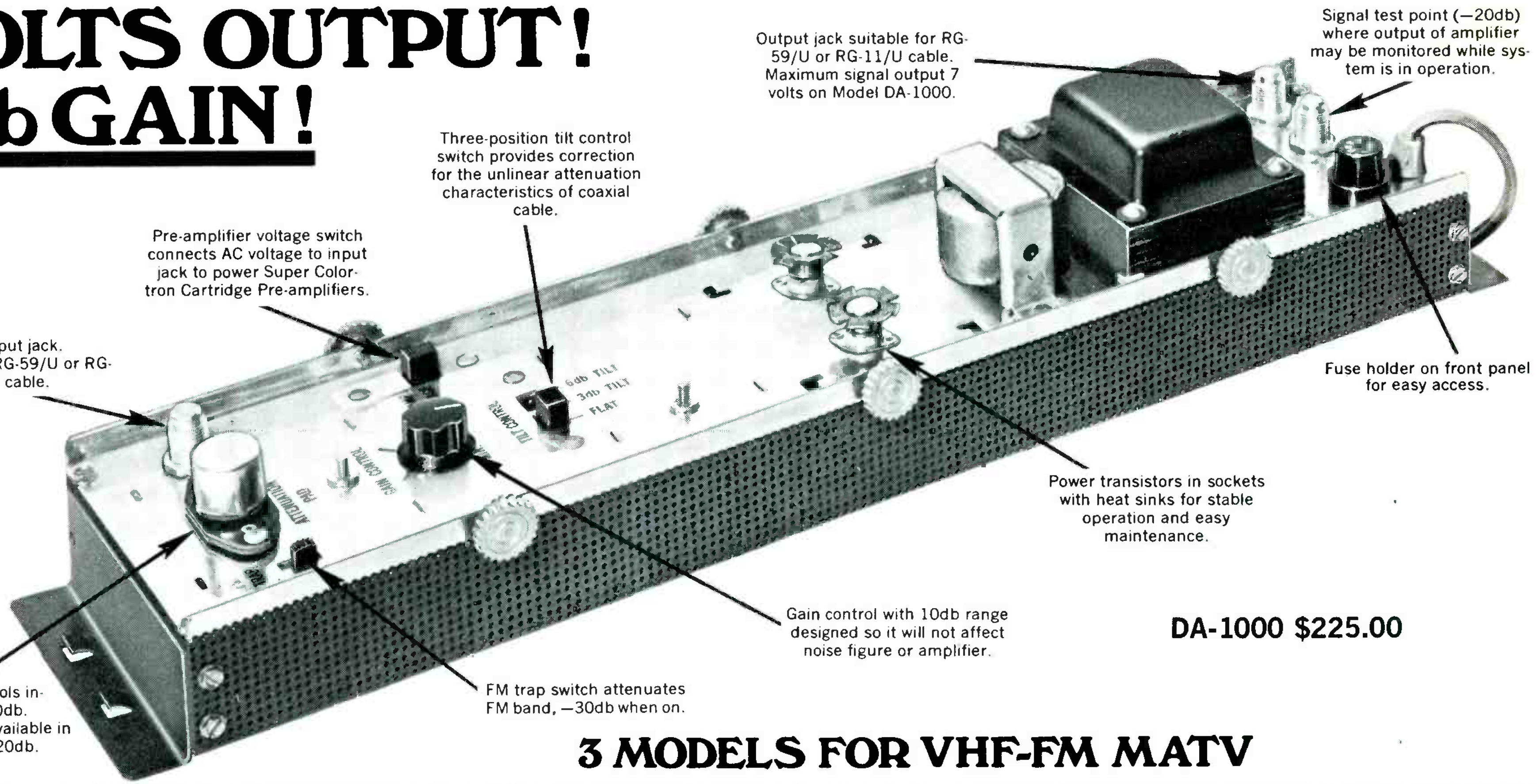

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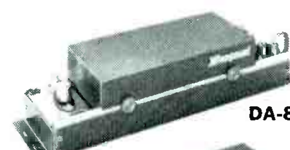
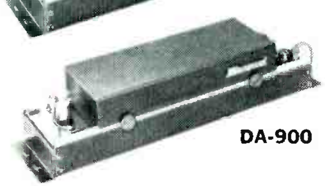


DA-800



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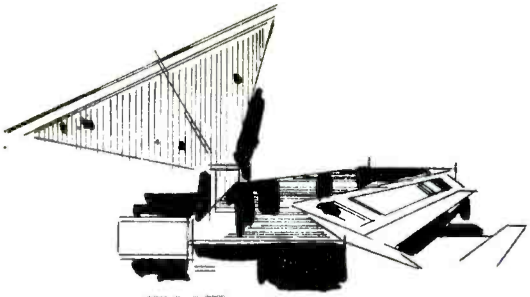


THE ELECTRONIC SCANNER

Mechanical Switching Eliminated in New Tuner

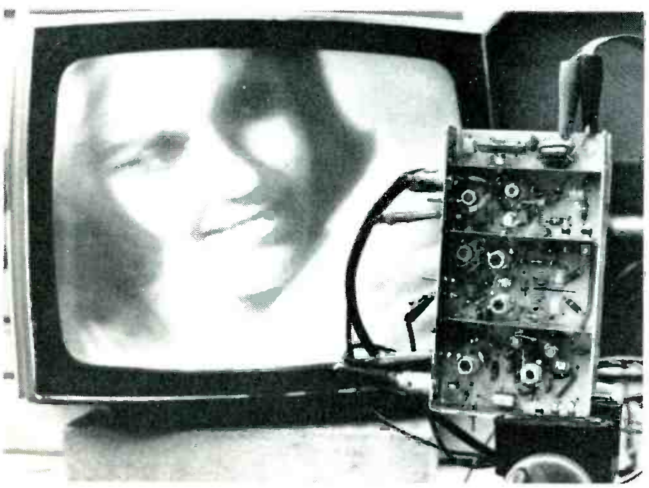
The industry's first fully solid-state television tuner substitutes varactor diodes for mechanical switching and tuning mechanisms. Production designs of the new solid-state tuner for VHF channels 2 through 13 have been completed at Standard Components Division of Standard Kollsman. Production engineering on a companion varactor tuner for UHF channels 14 through 83 will be completed in the near future. Both tuners are reportedly readily adaptable to the use of integrated circuitry.

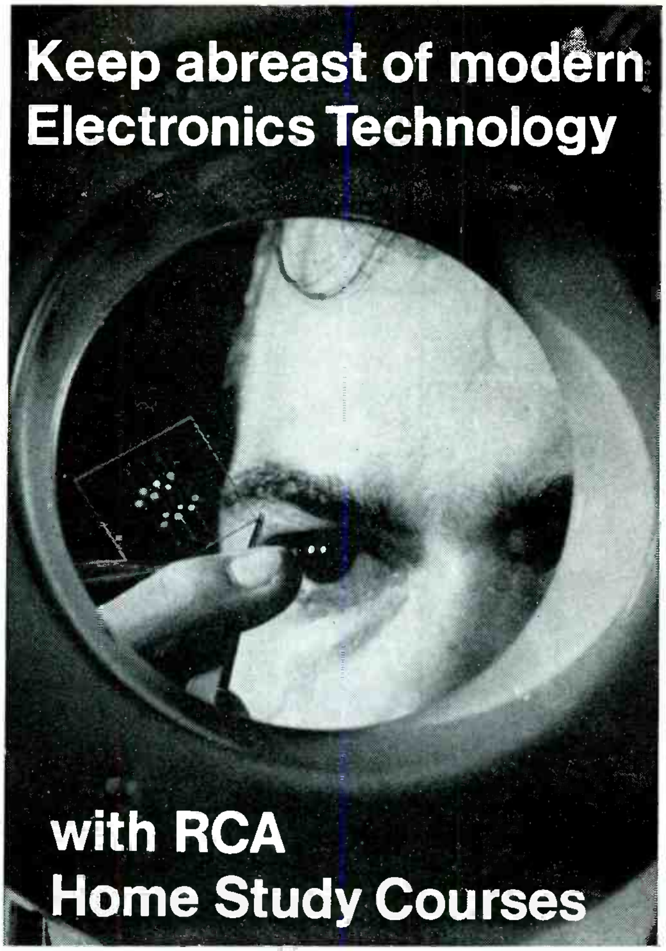
The varactor diodes in the new tuner use voltage-variable capacitance to tune RF amplifiers, oscillators and mixers to resonance. Other diodes, under forward biasing, short out part of the tank coil for bandswitching. The only mechanical switches in the system control direct current voltage, not signal.

Varactors are distant relatives of the transistor and of the "galena and cat's whisker" remembered by those who tuned in their first radio program more than 50 years ago. When voltage passes through a varactor diode from one direction, it acts like a conventional variable-capacitor tuner—from the opposite direction, it acts like a shorting switch.

Present-day VHF tuners, which succeeded the ganged-capacitor tuners of early television, are essentially electromechanical switches containing as many as 157 electrical contacts.

The new tuner replaces this electromechanical switching with solid-state varactors. Nothing moves inside varactors but electrons. In addition to its solid-state dependability, the patented varactor tuner is smaller than present-day devices.





This very tiny thin-film transistor is an important new semiconductor development.

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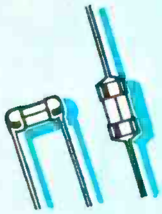

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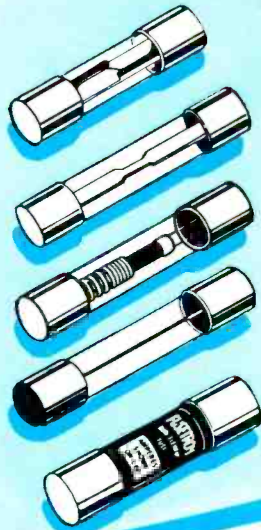

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Because it is electronic, varactor tuning can simplify remote control and automatic frequency control circuitry and permit additional options in the method of channel selection.

TEA Salary and Pricing Survey

The hourly pay of electronic service technicians ranges from a low of $1.75 for an outside technician to a high of $4.50 paid to top inside technicians. The foregoing figures were compiled from information submitted by 84 association members who responded to a recent survey by the Texas Electronics Association (TEA). According to the survey, the median salary of an outside technician is $3.00, while the top scale is $4.00. Inside technicians are reportedly better paid, with a low salary of $2.25 and a median of $3.25. Trainee pay was also a subject of the TEA survey, with the following results: top, $2.00; low, $.85; and a median of $1.50. Of the shop owners who responded, 67 percent employed two or less technicians, and 24 percent indicated they did not want trainees.

Service pricing information compiled from the TEA survey revealed that a wide range of pricing still exists. B-w home-call charges ranged from a low of $4.00 to a high of $9.95. Color TV home service calls were only slightly higher with a range of $5.00, low; to $10.95, high. An even greater variation in pricing was evident in the minimum charges for b-w in-shop repairs—low only $2.50 and high, $12.50. Another interesting fact revealed by the survey was that the median minimum charge for under-chassis work was $12.50 for both b-w and color TV, while the high for such charges varied by $10.75—$29.50 for color TV and $18.75 for b-w. The maximum price charged by any shop for setting up color TV was $25.00, as opposed to a low of $7.50—again, a considerable spread. Of the shop owners who responded, 445 said they charged extra for additional home time, while only 15 percent charged extra for installing tubes during a house call. Asked if they would raise prices in 1968, 56 percent replied yes; 32 percent, no; and 12 percent were undecided at the time of the survey.

—Merchandising Week

Electrohome to Supply TV for Olympics

Electrohome Limited has announced that it has been awarded a $250,000 contract to supply 1,000 TV sets to Mexico for the 1968 Olympic games in the fall.

The sets will be installed in the auditoriums of about 40 high schools in and around Mexico City so that persons who do not own a set or cannot afford a ticket for the games will be able to see the international spectacle.

The sets, which are b-w special educational models, were sold to a Mexican "Organizational Games Committee." Following the conclusion of the games, the sets will be retained in the schools for continued educational use.

Markets Selected for "Discover Color TV" Push

Fifteen basic metropolitan markets nationally have been selected for local action programs during the na-

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tionwide "Discover Color TV" promotion this fall sponsored by the Consumer Products Division of the Electronic Industries Association (EIA).

According to Jack Wayman, EIA staff vice president of the division, they represent 28 percent of the country's retail sales volume.

The 15 key markets are: Boston, Chicago, Dallas, Denver, Houston, Jacksonville, Los Angeles, Minneapolis/St. Paul, Philadelphia, Phoenix, Pittsburgh, Providence, San Francisco/Oakland, Seattle and Washington, D.C.

"Discover Color TV" is the first industry-wide promotion for consumer electronic products. It is mobilizing all elements of the industry for impact on the general public starting mid-September, 1968. Timing is keyed to the heightened interest in color TV, generated both by the season's programming as well as by manufacturer innovations in product lines.

"Discover Color TV" is the first in a year-round program of special promotions planned by the division. It will be followed in the spring of 1969 by a campaign built around portable televisions, radios, phonographs and tape equipment.

All-Electronic Remote

Remote operation of a variable control, such as volume, in past and present television remote control systems involved the use of a small DC motor mechanically coupled to the control. The motor rotated the control in response to a transmitted signal.

Motorola has recently announced the development of a new all-electronic system to replace the previously described electromechanical method of remote "variable adjustment." The heart of the new system is a memory module. A neon bulb acts as an electronic switch, isolating the critical capacitor timing circuit from the external charging circuitry when the function switches are closed. When either of the function switches is closed, the neon bulb conducts, allowing the capacitor charge to be varied up or down in response to the direction of control desired. The resultant DC control voltage is then used to control, or bias, a variable-gain amplifier in the audio section of the receiver.

The capacitor is a special low-leakage unit designed to minimize stray leakage resistance. The semiconductor device is an insulated gate field-effect transistor (IG FET) designed for maximum input resistance.

All devices employed in the memory module are carefully selected for high-resistance, low-leakage characteristics. The high resistance is maintained by encapsulation in a special Motorola compound material. Ultra-sonic cleaning of the assembly prior to encapsulation, plus vacuum wax impregnation after encapsulation protects the entire unit from the adverse effects of environment. The preceding manufacturing process is necessary since the ability of the device to "remember" voltage is dependent upon the capacitor retaining the desired charge over a long period of time. (Laboratory tests indicate that the unit is capable of retaining a high voltage level with less than a 5 percent change over a period of 1000 hours.) ▲

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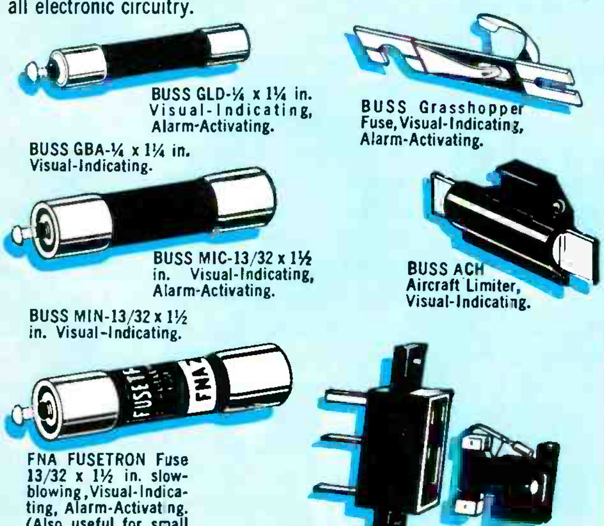

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BUSS MIN-13/32 x 1½ in. Visual-Indicating.

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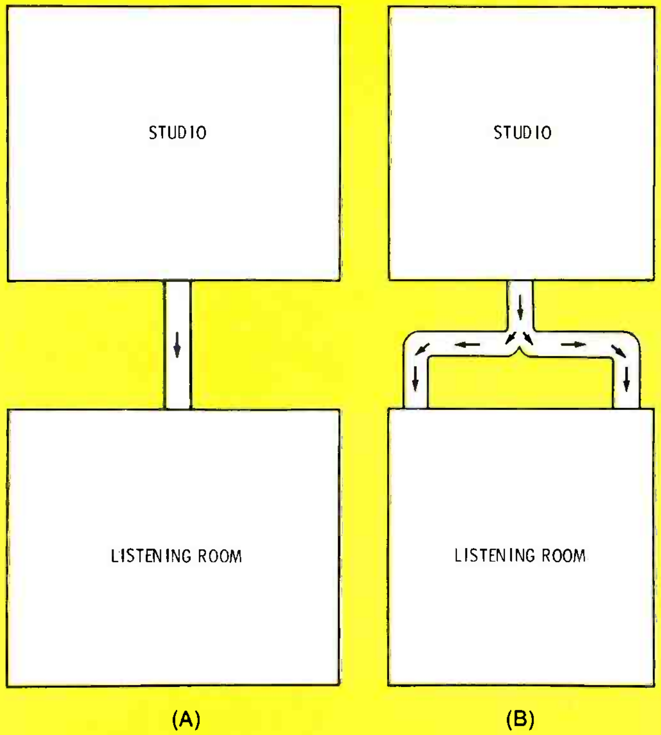
This thing called STEREO



A proper perspective of this form of audio reproduction will help you educate the layman.

by Norman H. Crowhurst

The people who at one time boasted a Hi-Fi now boast a Stereo. The real enthusiasts in audio reproduction see a fundamental difference between the two and for those to whom possessing a Stereo is mainly a matter of prestige, 'mono' is passé. From the technician's viewpoint, however, stereo is the latest form of what was formerly known as high fidelity.

The high-brow, component-type enthusiast is more concerned with what is in the system than the man who buys a stereo just for listening. However, both are seeking the same thing: realism in audio reproduction. All the changes over the years—improved speaker systems; improved recording techniques, such as microgroove; better pickup designs and improvements in the electronics—are steps toward this end: a sound that comes nearer the real thing.

The perfectionist defines his objective as being the re-creation of the original. If a recording was made in Carnegie Hall, he visualizes the perfect system as creating the illusion of being in Carnegie Hall listening to the original program. Much has been written about how this might be accomplished.

No system can transport the listener into the original environment where a recording was made or a live program originated. The best that can be achieved is a good illusion. Most of this article is oriented toward one or another's idea of how it can be done.

Why Stereo?

Some can remember back in the '20's when enthusiasts listened to radio on headphones and swore it sounded as if the performers were there in-the-room, and the old acoustic phonograph was accepted as a real marvel of realism. Some dismiss this memory as being a response prompted by imagination, because in those days **any** reproduction was a miracle.

As one listener who yet remembers those days, I don't believe that explanation is correct. Although frequency response and many other things that were lacking in those earlier efforts have improved, they did possess a realism of impression that has not always been present in some later efforts.

In early radio and records there was little, if any, bass. It may not have been missed as it wasn't heard, but what was heard sounded realistic. With the advent of moving coil speakers, particularly woofers, and electrical recording, which used a microphone instead of an acoustic trumpet, bass came into its own. Now the drums and the string bass were heard, which before had been inaudible.

As an A-B demonstration, the difference was impressive. The change definitely brought it in. What was often neglected was that the things already heard had lost something. The bass brought intermodulation troubles.

The notes from the bass instruments themselves were clear and stood out, but they produced a jarring effect in the sound from other instruments. Sometimes the sound became quite gargly.

The next dramatic improvement was not quite as dramatic as the claims promised. Adding the higher frequencies, by means of tweeters and supertweeters, did not make anything more audible than it was before unless it was the edginess of the wire brush used by the drummer or a particular realism about the cymbal. But again, the change needed to get these extra frequencies through was apt to present other problems.

Another kind of intermodulation, this time among the higher frequen-

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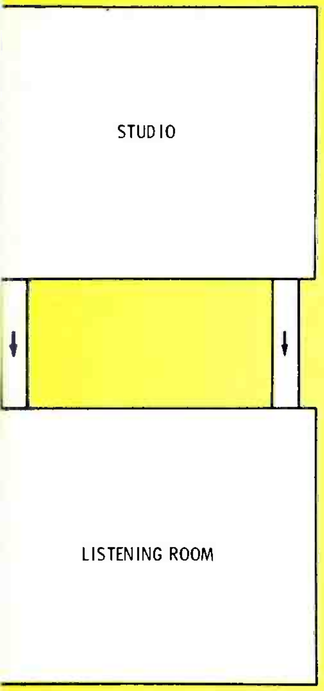

(C)

Fig. 1. Equivalent differences in listening conditions: (A) the old "mono" hi-fi, with a single speaker system, is like a single hole in the wall, through which you listen: (B) adding a speaker to a 'mono' system is like using a branching hole: still there is only one hole 'at the other end'; (C) stereo provides the equivalent of two holes, spaced apart, and increasing the communication capabilities tremendously.

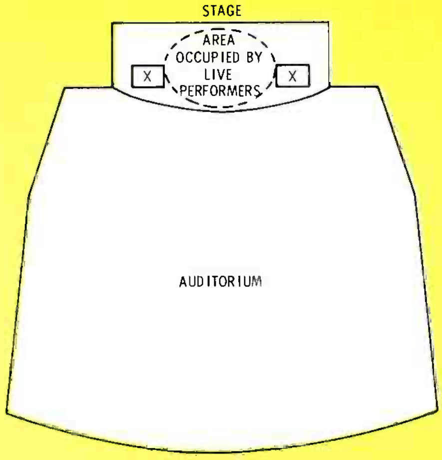

Fig. 2. A method of presenting stereo in an auditorium, such as Carnegie Hall: If an orchestra playing live is located in the dashed-line ellipse, and the same program reproduced is presented over the stereo speakers, marked 'X', an A-B test between them shows how good such a system can be.

cies themselves, produced spurious frequencies that were lower and more audible. At its worst, this intermod sounded like a buzz, particularly noticeable when two high notes were played together. Far less definite was a general sense of muddiness, or indistinctness, that the effect caused. The clarity that once made the listener feel the performer was in the room had slipped a little farther away.

This distortion can be aided by amplifiers, but all other parts, such as phonograph pickups (even the recording heads which put it on the record), tape heads and radio transmission links, can destroy that in-the-room realism.

By this time the advocates of stereo had noted that a reason for unrealistic sound was the limitation produced by crowding all the sound through one small loudspeaker. Adding tweeters did not help much because the main opening was not any bigger. Extra speakers were placed around the room, but this just became multi-hole listening.

Visualize the sound as being in another room (the recording studio or theater) to which the listener is connected by a hole in the wall (the loudspeaker); making two holes helps. But adding a speaker was not really like making a second hole, in this sense, because the sound was a duplicate of the sound from the first speaker, like a branching hole (Fig. 1).

To get a sense of the magnitude of the sound sources, orchestra, organ, combo, etc., you needed something to duplicate what our human hearing does: Listen with two ears. Thus the idea of stereo was born.

But was it worth all the extra to get a second channel? Even if you got all the program into one groove or on one piece of tape, which advancing technology has made possible, you still needed two amplifiers, speakers, etc., which was apt to cost twice as much. Some argued that stereo would not be worth the extra cost. For like the advent of bass and ultra-treble, stereo brought its own problems. Merely using two channels of sound did not automatically make things sound better.

The advocates of stereo did not help matters in the early days. They had a definite idea of what stereo was supposed to do. You had to hear separation. People listened for separation, so there just had to be separation.

Music was arranged for stereo, so one group of instruments would come over one speaker, and another group would answer over the other. People who really enjoy music and wanted better reproduction were reluctant to buy the ping-pong effect.

But spatial separation isn't the most important contribution stereo has to offer as an advantage over mono: separation, yes; but not necessarily spatial. We like to hear an orchestra as an assemblage of instruments all playing their parts in unison. We don't pay close attention to where they are located in the orchestra pit, but we like to hear the different groups come in to play their parts.

This was what our widening hi-fi had somewhat obscured unless we used a truly high-fidelity system which achieved very low distortion in all components from the microphone through the recording, playback amplifier to the speakers and into our own listening room. A few very good systems could give the impression of a real live orchestra, with realism in all respects. But the cost of such systems was beyond the average person's reach.

The advent of stereo provided separate channels over which different parts of the program came in varying proportions, to represent

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left, right, and in-betweens across the center. This gave a sense of separation or clarity not as easily possible by sheer purity of reproduction over only one channel. This was the place under the sun that the new stereo eventually occupied.

Once this was understood, stereo systems or packages could be made in the same price range as the older hi-fi packages had been. In the same price bracket, stereo can sound better than mono. But to do so, the system must be used properly, knowing what the objective is.

In the British Science Museum is a tremendous, correctly developed exponential horn, giving good response to quite a low frequency. Thirty years ago, listening to this gave one a strong feeling that the actual program source was actually concealed in the depths of that thing.

Horns are undoubtedly the most efficient means of converting electrical signals corresponding to sound into actual sound waves. But few modern living or recreation rooms can find room for such a monster horn, much less two of them. Even if an enthusiast should build one or two so it or they give out into the room, the room isn't suited to receive such big sound waves.

We have to create our illusions with smaller speakers, more or less of the bookshelf variety, designed so they reproduce all the relevant frequencies, if somewhat less efficiently. If we didn't accept this compromise, the majority would decide they couldn't afford to rebuild their houses just so they could enjoy hi-fi or stereo.

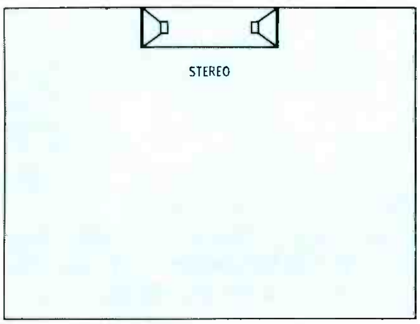

Fig. 3. One method of attacking the problem of the over-reverberant room: a package-type system where the speakers are mounted in the ends; this works because you utilize the sound reflections, rather than trying to avoid them.

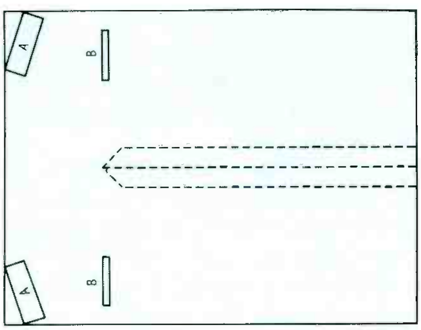

Fig. 4. Comparison of speaker placements: AA are concentional, close-back speakers; BB and an alternative (not to be used **with** AA) pair of open-back speakers. The closed-back type gives really good separation only down the center line represented by the heavy dashed line, and good stereo within the light, dashed-line enclosure. The open-back types cover virtually the whole room. However, closed-back speakers are better for acoustically well-damped (furnished) rooms.

Room Acoustics

Which brings us to some rather fundamental differences in stereo, in relation to the size of the listening room. If you have a large listening room, where sounds are propagated strictly according to textbook, such as an auditorium like Carnegie Hall, then you can take two horn-type, multi-way speaker units and do a terrific job (Fig. 2).

Mr. Briggs, of the Wharfedale Loudspeaker Company in England, has done just this, two or three times, in Carnegie Hall and other auditoriums around the world, to show that reproduced music can be almost indistinguishable from the original. He A-B's between live and reproduced and sometimes it's difficult to know which is which. But not many people have a Carnegie Hall for a living room.

Unfortunately, you can't make that kind of A-B test in your living room, because there is no way of getting the Carnegie Hall stage, complete with orchestra, into the living room for direct comparison. You can only compare one reproduction with another reproduction in the somewhat limited environment of your living room.

Different rooms have different acoustic properties apart from their size differences. The way to get stereo in a living room, furnished with wall-to-wall carpet, plush furniture and heavy drapes, differs considerably from the method needed in a recreation room with tiled floor, panelled or bare walls, and wrought iron furniture.

Any good, conventional speaker system, properly separated, will sound well in the acoustically damped room with all the furnishings. Put the same system in the highly reflective recreation room, and the result is audio confusion. A cheap imported transistor radio will probably sound just as good, for not much more than one hundredth the cost.

Good stereo can be obtained in this kind of room, however, by having the acoustics work for you. A stereo package unit with the speakers in the ends will do well by bouncing the sound off the walls (Fig. 3). Another useful trick is using the open-back speakers that work like dipole radiators. These should be placed differently from conventional, closed-back speakers (Fig. 4).

In fact, this kind of system installed in a recreation room can give more uniform stereo effect throughout the room than the more conventional system, for which only a central position in the room gives a really good illusion.

Stereo does something that mono never succeeded in doing. The mono system was responsible for the drive for ever larger powered systems but, to the enthusiast, more power was never enough to give realism. No matter how much power the system put out, it never sounded big. Using multiple speakers helped, but it still sounded 'limited'.

Stereo fills the space with separated sound thus giving the illusion of bigness even when played relatively quietly. Switching from mono to stereo (where a system provides this facility) will increase the apparent power, even though just as much is being delivered when switched to mono.

So the motivation to play excessively loud is gone though some have formed the habit, which may die hard. This may be partly because their hearing has been impaired by previous loud-playing. But the trend for more power has gone. It is no longer necessary to annoy the neighbors before it's loud enough to suit yourself.

Having put stereo into some perspective, we will discuss troubleshooting techniques for this fascinating medium in an article next month. ▲

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TRANSISTORS:

State of the art report

The final installment in this series discusses test equipment requirements and servicing techniques demanded by solid-state circuitry.

by Jack Darr

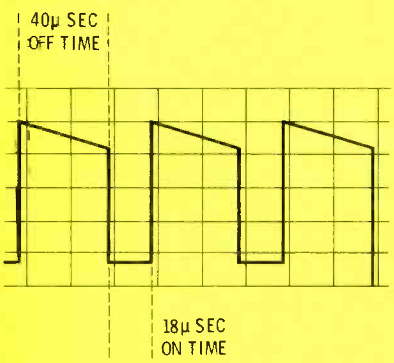

Fig. 17. Horizontal drive waveform of RCA KCS-153 showing ratio of on to off time.

The appearance of the first transistorized equipment caused varied reactions among the service technicians. There was opposition to them, at first, and there still is. Printed circuits caused the same reaction when first introduced but have since been accepted. Transistor circuits will also be accepted.

A radical change had to be made in service thinking with the combination of PC construction and transistors. The successful technician must now be able to think his way through the circuit and locate the trouble with much more certainty, and efficiency.

Transistor circuitry is not difficult to correct, though the successful technician will have to make some minor changes in his service methods. He will not have to replace all of this equipment, but will have to learn a different way of using it to get the information he must have.

Equipment Needed

The main problem is the small size. PC board construction is almost universal, and most boards are badly crowded. This presents three major problems: location of parts, identification of parts, and testing.

In the first two problems detailed schematic diagrams, photographic illustrations, and complete service data are essential. Sams PHOTOFACT photographic illustrations of the chassis, with callouts showing the location of each resistor, capacitor,

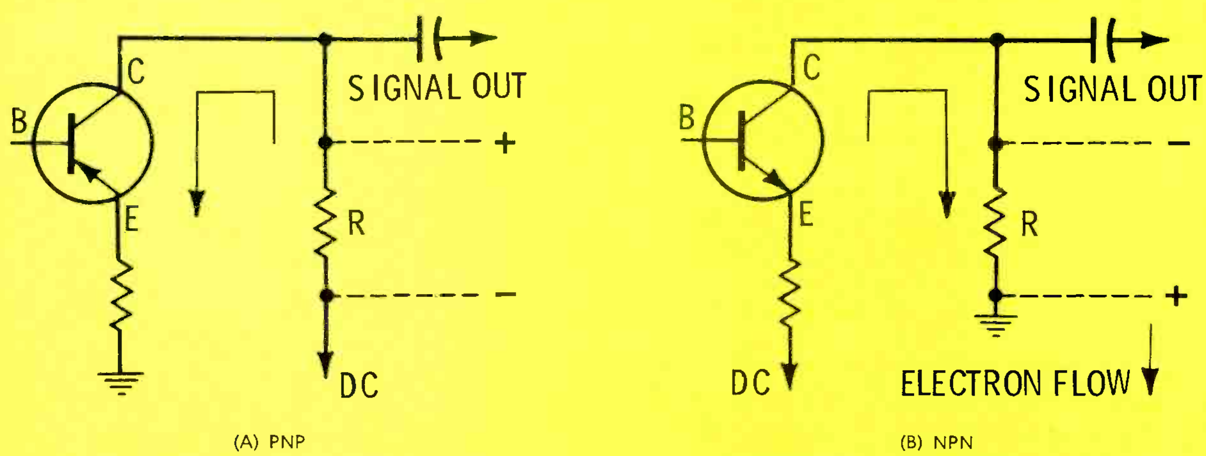

Fig. 18. Collector voltage developed by current through load resistor.

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etc., are invaluable for this work. The schematic plus the symptoms generally disclose in what stage or group of stages the trouble is located.

Tests are needed to locate the cause of the trouble. Only one item, a transistor tester, will be needed as a new piece of test equipment.

For many years voltage measurements have been relied on to pinpoint the cause of the trouble. Because of the inherent advantages of this method, it will still be the quickest. There are no circuit disconnections needed, and a test probe can always supply the information. While the transistor has been advertised as a current amplifier, there is no need to read currents directly, i.e., break the circuit and insert an ammeter. Voltage measurements can still be used—the voltage-drop developed across a known resistor will be directly proportional to the current flowing through it.

Long and involved calculations of this current are not needed, as the voltage readings will be given on the schematic. As long as these voltages are within tolerance, there is current.

Signal Tracing

A signal tracer is a set of tuned AC vacuum-tube voltmeters providing RF, IF, and audio circuits, as well as some of the first DC VTVM'S. It can read very small signals through any radio or audio amplifier and, with only a minor modification, can be used on some TV circuits.

In signal tracing, a stage or group of stages can be gone through to find where the signal stops. Then, voltage measurements, and sometimes even part-substitution, will give the answer in the least possible time. There are several different units that can be used for this kind of work, aside from the signal tracers: the scope, with a signal-generator; a good VTVM with appropriate probes; or anything that will give an indication of the signal level at the input of a stage.

Audio Signal Tracing

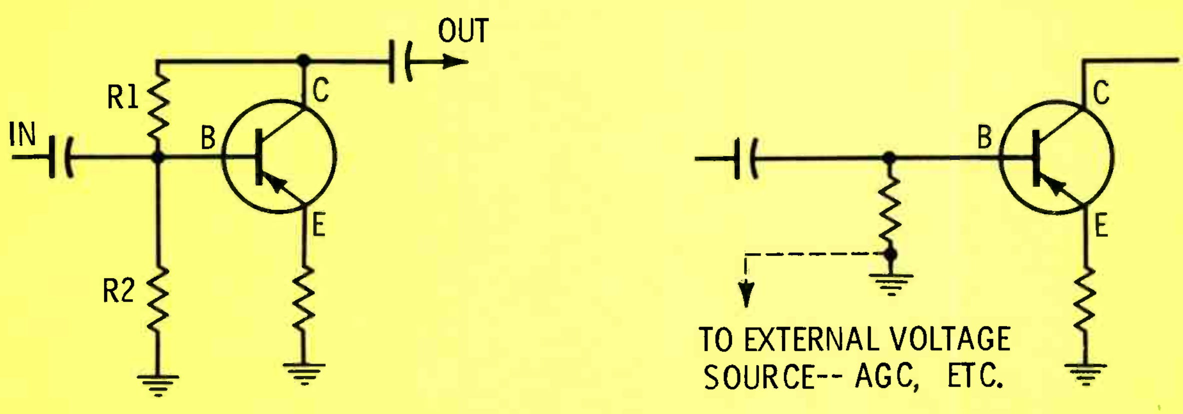
This is the simplest of tests. A test signal is fed in from an audio signal generator, a test record or tape, or an off-the-air signal. Then it is followed through the audio circuits until the stage which has input but no output is found. A number of the later amplifiers have stage gains shown on the schematic, however, this is not absolutely essential. After practice, it is possible to follow signals through any audio stage to find the trouble. In some cases there will be stages which have very low gain. This can be normal with transistor work. Some stages have very low load impedances so they can show small voltage gains but still have normal current gain. For a definite check, read the DC voltages around the stage to see if they are within tolerance. In most cases, the signal will not be low, but missing, thus making the location of the trouble obvious. Shorted transistors, open resistors, shorted capacitors, etc., will stop the signal entirely.

The Scope In Signal Tracing

The scope indicates whether there is a signal present in any kind of circuit. There is no need to lock the sweep to the signal to determine its amplitude as compared to the signal amplitude at the input of the stage. A higher blur at the output than is present at the input is no problem; this stage is amplifying the signal. Signal generators, test records, off-air signals or anything that will give an indication, can be used.

For signal tracing in RF and IF circuits, the scope works well. A crystal-demodulator probe will report the envelope (modulation) of the signal.

For tracing sync circuits the scope is the only reliable instrument. Even the simplest scope will show vertical and horizontal sync pulses, sawtooth waveforms, and video signals. In transistor circuits, where the drive frequencies are the same but the waveform is different, the scope is needed since the waveform of transistor drive signals is important.



(A) Voltage divider. (B) External source.

Fig. 19. Base voltage taken from voltage divider or from external source.

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Transistor horizontal-output circuits are driven by a flat-topped pulse, almost a square wave. The on-off ratios of these pulses are important, as shown in Fig. 17. These determine the efficiency of the stage, and they must be set correctly. This is done by adjusting the horizontal oscillator coils. The off time is twice the on time. This measurement can be made quite accurately by comparing the percentages. The off time covers two squares on the scope graticule, and the on time one. The horizontal oscillator must be locked to a TV signal when this is done, to use it as a standard.

Voltmeters and Ohmmeters

A late model VOM that measures 20,000 ohms per volt works well. The VTVM is highly useful, especially in sensitive circuits where there must be the least possible circuit loading: tuned circuits, high-impedance circuits (though these are less common), etc. The FET voltmeter is the ideal instrument for this work, since it has no connection to the AC line. Besides being more portable, this eliminates accidental damage to a transistor from induced voltages on the case, etc. However, the AC-operated VTVM can be used on most transistor circuitry.

The Transistor Tester

The one new instrument needed to service solid-state circuitry is a transistor tester. There are several on the market from all major test-equipment manufacturers. Those we have checked have done a fine job. Tests of transistors in-circuit show that these testers detect malfunctioning transistors in everything from an audio amplifier to a MATV line amplifer. Even with very low-resistance shunts in the circuit, they read the beta of a transistor with accuracy.

Most transistor testers can detect transistor leakage down to 1.0 microampere. This is invaluable especially in such circuits as AGC and sync separators. Collector-to-base leakage, (Icbo) is the most bothersome, since it upsets the bias. This test must be made out of circuit since there are always resistors in shunt across these elements. Germanium transistors have a small amount of natural leakage. Silicon transistors have none, and even a leakage as low as 10-15 microamperes is enough to cause trouble. The major symptom of this would be low gain or no gain and usually a severe voltage upset. Beta often checks close to normal. However, the voltages and/or currents give a clue. For example, a vertical-output transistor may show excessive collector current and low output, and the bias controls have practically no effect on this current since the transistor itself is leaky.

Safety note: When checking any transistor in a set with an AC power supply, be sure that the set's AC power cord is out of the socket. This eliminates any chance of some kind of odd circuit forming between the set and tester chassis. Although this may be rare, making transistor tests with both the set and tester plugged into the AC line, even with the set switched off, can result in a blown transistor or even a blown tester.

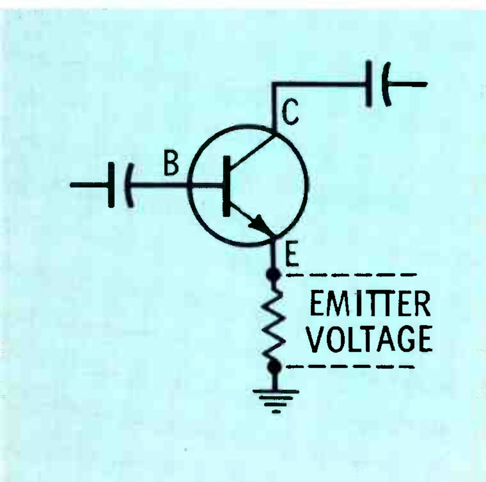

Fig. 20. Emitter voltage provides a simple test of transistor's operational status.

Hand Tools and Others

There are only a few additional tools needed. One is a good sharp pointed pick. A needle point test prod with no wire should suffice. A pair of small long-nosed and diagonals, or tweezer, and a couple of nylon sticks (alignment tools, etc, for punching and probing around in transistor circuits without the danger of a short) are needed.

A solder-sucker type of soldering iron is almost a necessity for PC board work, especially for removing parts with more than one terminal, like IC's, IF transformers, filter capacitors, etc. The soldering iron and air hose method to blow the melted solder away is often used, but this is messy.

There are other tools that are not necessary but useful. A short test lead with needle-point test prod on each end is used to bridge PC board conductors suspected of having hairline breaks, etc. If this completed the circuit, take the fine-pointed soldering iron and run a thin coat of solder all the way down this conductor. This will bridge all hairline breaks, including the ones not seen.

Needle point test prods on VOM or VTVM and ohmmeter penetrate PC boards coated with moisture-resistant varnish. Blunt test prods will not penetrate such a coating to detect resistance or voltage, and, thus, will give a false open-circuit reading. Stout alligator clips on the common leads of the voltmeters, etc., must have a strong grip to make a tight, low-resistance ground connection.

Short test leads with miniature alligator clips on each end are used for making temporary connections of parts or even transistors for testing. If all the solder joints are rounded off so the clips will not hold, tack short (¼" or so) pieces of solid wire on each. Bend a little hook on the end and the clips will hold. If need be, these can be left in place if they will not cause a short. Small scraps or wire clipped off resistors and capacitors are ideal.

A small, powerful, pen-light flashlight is used for spotting parts or solder joints on the other side of a PC board. Hold the light on the end of the resistor wanted; its solder terminal will then show up in the center of a spot of light on the underside of the board.

Voltage Measurements: Why and How

In the typical transistor stage, there will be a voltage on the collector, either from an external power supply source or developed by current flow through a resistor. Fig. 18 shows these two types of voltage source. (The only difference between the methods shown is the polarity of the voltage. The electron flow enters negative ends of the load resistor, as shown.)

If the transistor is working, collector current is flowing. If collector current is flowing, there will be a

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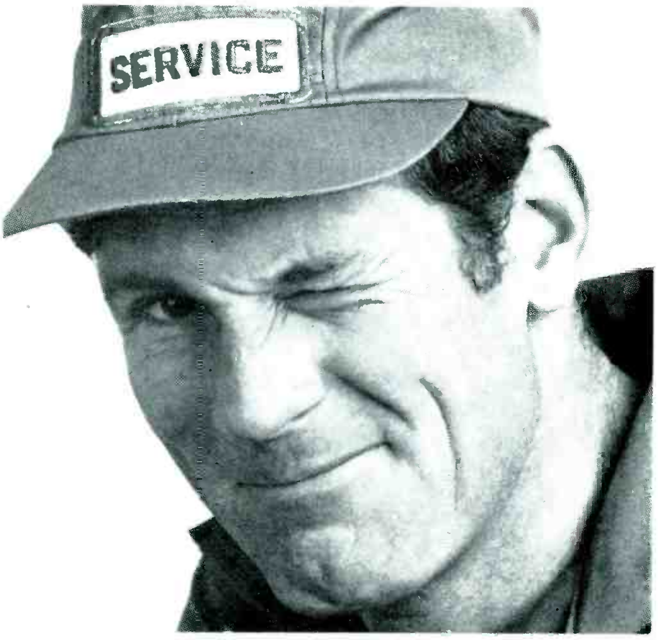

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voltage drop across the load resistor. This will be shown in the form of a positive or negative voltage to ground; read the voltage at the collector.

There is also a voltage on the base. This can come from a voltage divider, an external voltage source (AGC, etc.) or the base current flowing through a resistor to ground, as in Fig. 19. In all cases, if this voltage is different from what the schematic calls for, investigate.

Watch for test conditions also. In practically all cases the DC voltages found on the schematic are taken with no signal input to the receiver. In many stages, such as AGC, IF's sync separators and even in some audio stages, the voltages with signal present will be different from the no-signal voltages.

The emitter voltage, as shown in Fig. 20, is used by many transistor technicians as an indication that the transistor is operating — current flowing through the emitter resistor, which in this case is identical to the cathode resistor used in tube circuits. If there is no voltage drop across this resistor, no current is flowing, and the transistor is not operating. In the frequently used common emitter stages, the emitter voltage of each transistor can be checked in stages such as the video IF. When no voltage is found, the trouble has been located. The opposite reaction is useful, too. If the emitter voltage reads higher than it is rated, there is a defect in the circuit. Bias voltage is always read between the emitter and the base, which is the same as reading bias between the cathode and grid of a tube.

Following is a description of what happens when the bias changes:

PNP: Base goes more negative for higher collector current.

NPN: Base goes more positive for higher collector current. In tube circuits, if the grid becomes more positive, a higher plate current is drawn and vice versa. Due to the different types of transistors used, there can be a higher collector current for either polarity, depending on what type of transistor is in the circuit (NPN or PNP).

Another important point: a tube at zero-bias will draw a high current. If a transistor is at zero bias (zero voltage difference between base and emitter), it will cease to function. No collector current will flow, no emitter current will flow, so the voltage-drops across the respective resistors will be incorrect. As a good test, read the voltage between emitter and base on a low scale on the meter—as low as 0.2 volt, or lower. The schematic will state what the normal voltage difference should be. Subtract one from the other to get the bias, e.g., with 5.2 volts on the emitter and 5.6 volts on the base, the bias is 0.4 volts. This can be either positive or negative, depending on the type of transistor. The actual bias also depends on the type of semiconductor used. Silicon transistors will average about 0.6 volt; germanium about 0.2 volt.

Circumstances alter cases. The preceding figures are for a typical amplifier operating Class A. For instance, a transistor with zero bias should be checked to see if it is being used as a sync-separator, etc. If so, zero bias is normal since the transistor should be cut off to prevent the video signal from getting through. Only the sync-tips drive it into conduction, thus clipping the sync, which is the correct action.

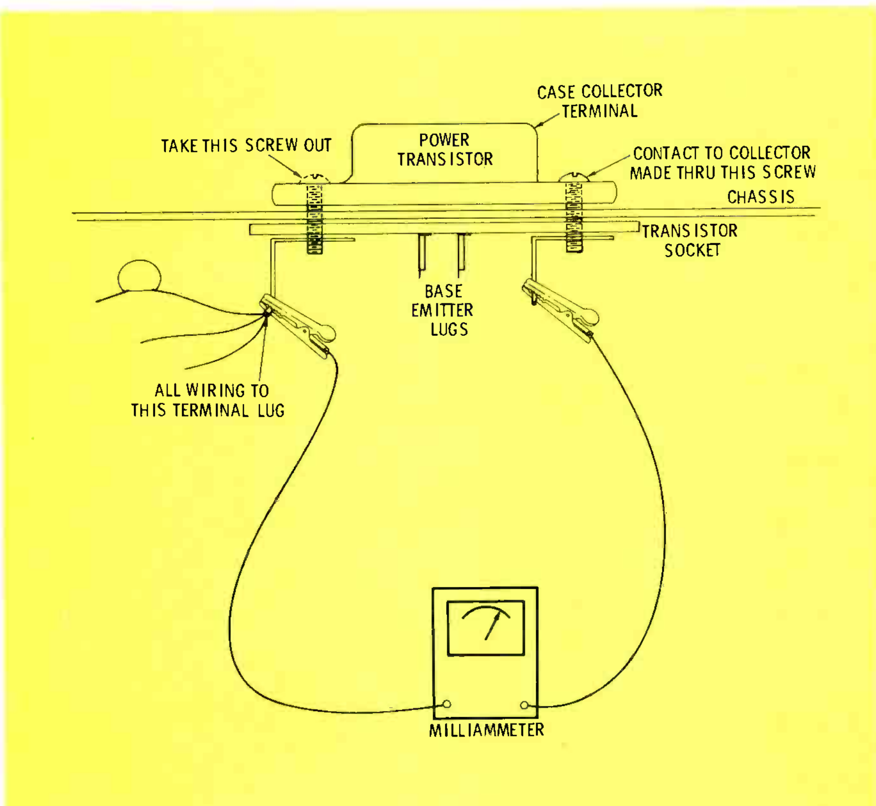

Fig. 21. Removing screw at end of socket where wiring is attached and connecting milliammeter across to other screw provides quick test of collector current.

Hints for Transistor Testing

To check collector currents in big power transistors, remove one of the two screws holding the collector (case) to the socket (Fig. 21.) Be sure that all wiring connections are made to this screw. Now that the collector circuit is broken, connect the milliammeter between the two terminal lugs as shown, and you will directly read the collector current. The remaining screw makes contact to the collector.

When removing a transistor TV from the cabinet, be sure to connect at least two jumper leads between the chassis and the CRT mounting. When such sets are turned on, the high voltage comes on instantly. There is always the chance of an arc to the chassis, and the resulting spike or transient can cause damage to the output or other transistors.

Check the settings of the vertical size, linearity and hold controls. If these have been turned far from their normal settings, they can cause the vertical-output stage to draw a high current—often enough to trip the circuit breaker. (Since there are actually no defective parts or shorts, this trouble symptom can be time

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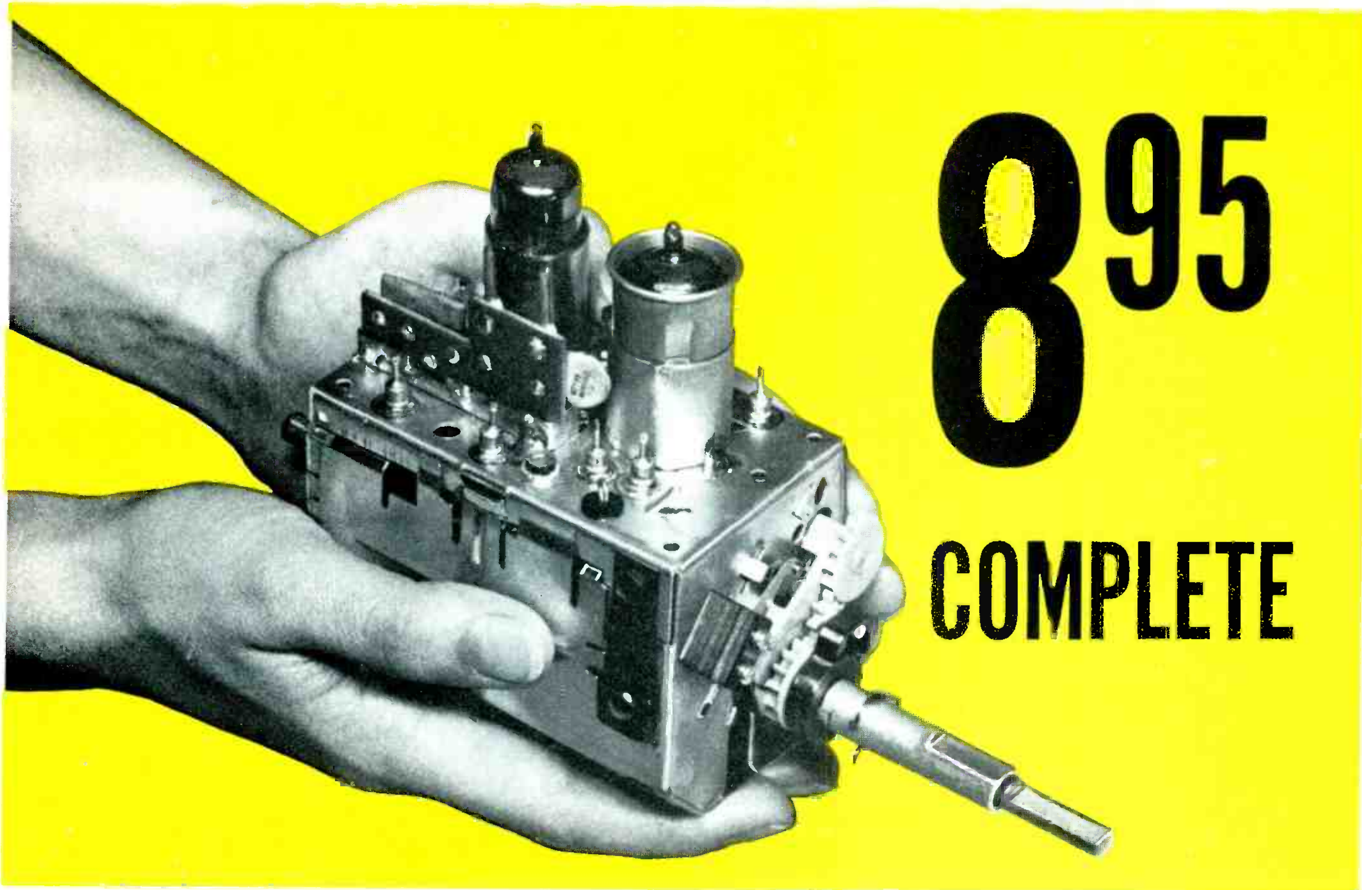

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consuming). As a quick check of the vertical oscillator: connect the scope to the vertical circuit and set the scope to AC line sweep (60 Hz). If there is only one waveform, the circuit is all right. If there is more than one cycle, or only a half-cycle, etc., the vertical oscillator is off frequency.

When testing stereo amplifiers, tie the two inputs together and feed in an audio signal. Next, go through each stage of the circuit, comparing signal levels at the input and output of each stage in the two channels. This cross-checking simplifies stereo testing. If there are no signals in either channel, there is probably a lack of power.

The IC should not be suspected until all other possibilities have been exhausted. Check signals and voltages through the whole circuit, as the trouble could be in a bad transformer, resistor, voltage supply, or something external.

The typical TV set now uses a great many diodes. Even in tube-type receivers there may be as many as 17. They can leak, short or open, just like a transistor. The transistor tester can check a great many of these in-circuit. For a definite leakage test, one end of the diode must be lifted, as with the transistor, to get away from the shunting resistance which is always present.

General Replacement Transistors

As stated in the beginning, there will be a great many cases where general replacement transistors will work well. The best test is to just try them, and if there is any meaningful loss of gain, power, etc., it will be noticed. In TV circuits any change can be seen.

When replacing unknown transistors, find out as much as possible about the circuit. A schematic will show the type, NPN or PNP. From this, or by checking the battery used, the maximum voltage is known. Then, from the application (RF, IF, audio, etc.), a similar transistor may be found in the general-replacement catalogues.

An example would be the IF transistor in a broadcast radio. RCA's catalog shows that SK-3005, 3006, 3007 and 3008 are PNP germanium types, rated 12-15 volts. General Electric's catalog shows the GE-1 (PNP) and the GE-5, GE-6 and GE-7 (NPN's), also rated at 12-15 volts. If the set uses a 9-volt battery, a substitute transistor of the proper type can be used. A test transistor can be attached temporarily to the proper connections on the bottom of the board.

Conclusion

The need now is for the really skilled technician in electronics maintenance. It is necessary to know the circuitry, its function, why and how. Learn to look for the function that isn't there—horizontal sweep, high voltage, vertical sweep, signal, etc. This should isolate the area of the trouble, and from here stage by stage tests will pinpoint the difficulty. Circuits used with transistors are no more complex than the ones used in tube sets. The only major difference is the voltage level and polarity such as −4 instead of 400.

Those who are willing to learn the circuits and apply this knowledge will have a definite advantage over those who are not. ▲

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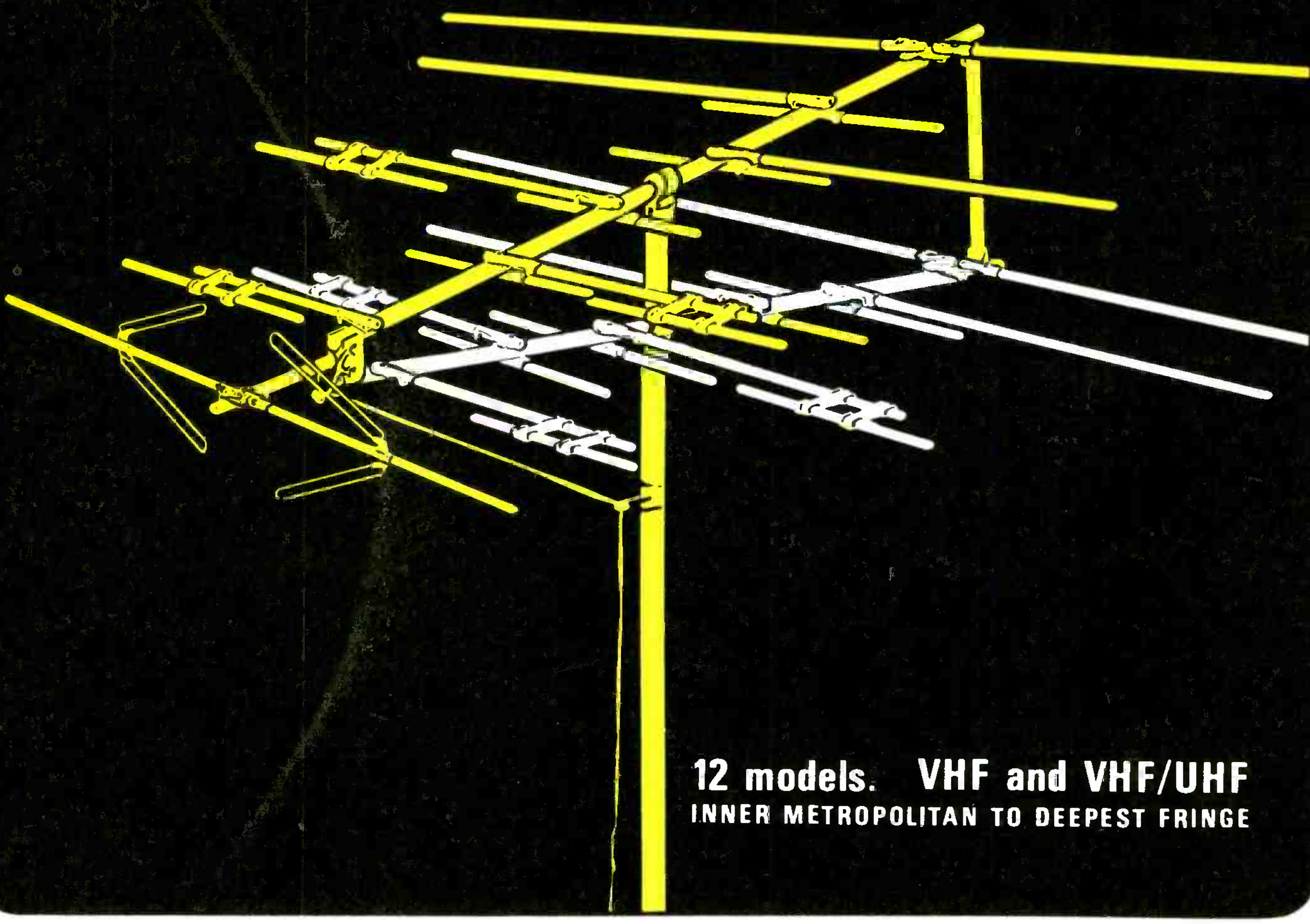

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Stage-by-stage gain testing

A method for quicker localization of trouble in transistorized circuitry

Technological advances are wonderful, but sometimes they cause a lot of new problems while they are solving old ones. Transistors and printed-circuit (PC) boards did just that for the harassed electronics technicians. They are hard to fix. I have diagnosed and repaired thousands of tube radios in less than 10 minutes; I would like to see someone do that consistently with a transistor radio.

However, printed circuits are here and we can't lick 'em, so we must join 'em. We must work out a practical method of diagnosing and repairing trouble in this equipment if we are going to remain competitive in the service business.

Learn From The Past

History often shows us the answer to a "modern" problem. Away back in the late 1930's, we used a service method that was fast and reliable—signal tracing. This servicing technique has a fine, logical basis. Electronic equipment is inherently logical; therefore, service methods are based on logic.

Every type of electronic equipment handles a signal of some type. The signal goes in at the front and comes out at the other end, usually much larger—the signal-path is always a series circuit. When there is a fault, the signal-path is broken, we have input, but no output. In order to effectively repair, we must locate the break in the signal-path—find out where the signal stops—in the shortest possible time. Once we locate this point, we make voltage tests, component checks, etc., until we find the defective part.

In audio amplifiers, we have an AF signal. In radios, RF/IF and audio. In TV sets, RF/IF, video, sync, color, sweep, etc., but all this is just more of the same. Each circuit has its own specific signal-path. This fact can be used to lead us to the source of the trouble in the least possible time—if we use the proper test instruments.

A Two-Way Process

There are two types of test methods that use a signal. The original, called signal tracing, used a test signal applied to the input. This signal was followed through the circuits with special indicating instruments—tuned RF voltmeters, AF voltmeters, etc. The main path of such tests is from "front to back", starting at the input and working stage by stage toward the output.

(There were several special "signal-tracers" built for use on radios: the old Hickok 155 "Traceometer" with three tuned VTVM's—RF/IF, oscillator, and AF; the Meissner "Analyst": and the Rider "Chanalyst", which used magic-eye tubes, etc. A lot of this old equipment has been reclaimed and returned to service. Several test instrument manufacturers are designing new versions.)

There is another servicing technique that uses a signal; it is called "signal substitution" and is possibly a little simpler than "signal-tracing", requiring less equipment. Basically, you start at the back (output) and work toward the front. You can use the set's own "output indicator" (picture tube, speaker, etc.) or a meter or oscilloscope. All that is needed for signal substitution is the right test-signal: AF for audio stages and video stages, modulated RF for RF and IF, a color-bar pattern for color circuits, etc. The signal is fed to the input of the last stage, and the output noted. Then, the signal is moved to the input of the preceding stage, and the amount of increase in output noted. This is followed all the way back to the input, reducing the level of the test signal each time, as required.

With an identifiable test signal, this method will show you exactly where the signal stops or has a loss in gain. All you need to do is look for an increase in output each time the probe of the indicating device is moved to the output of the succeeding stage.

Stage-By-Stage Gain Figures

To use this method, we need some data. Experience will soon tell us about how much gain should be expected through a given stage. However, if the stage-by-stage gain data is given on the schematic, it will be a big help. For instance, in the video amplifier of Fig. 1., you can see that there is 0.9-volt p-p on the base of Q4, the 1st video amplifier, and 0.8-volt on the base of Q5, the video-output transistor. The output on Q5's collector is 50 volt p-p.

There appears to be little or no gain through the 1st video amplifier, in fact, a slight loss. That's right. No voltage gain, but the normal input and output signal levels, and that's all you need. The input stage and output stage are direct-coupled, and there is a current gain; however, there is no resistor to develop a voltage drop across.

The video-output stage employed in the same chassis has voltage gain in large quantities; a 0.8-volt p-p input comes out as a 50-volt p-p output—a gain of roughly 60.

You will run into the same situation in audio circuits, particularly direct-coupled stages. However, using a signal-substitution, and starting with a known signal value such as the output signal to the speaker, excellent results can be obtained. As we go along, we will give you some values that will be close to normal for most circuits.

For instance, the General Electric T-25 transistor amplifier has five transistors per channel. Fig. 2 shows one channel. The voltage values as given in the General Elec-

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in solid-state TV by Jack Darr

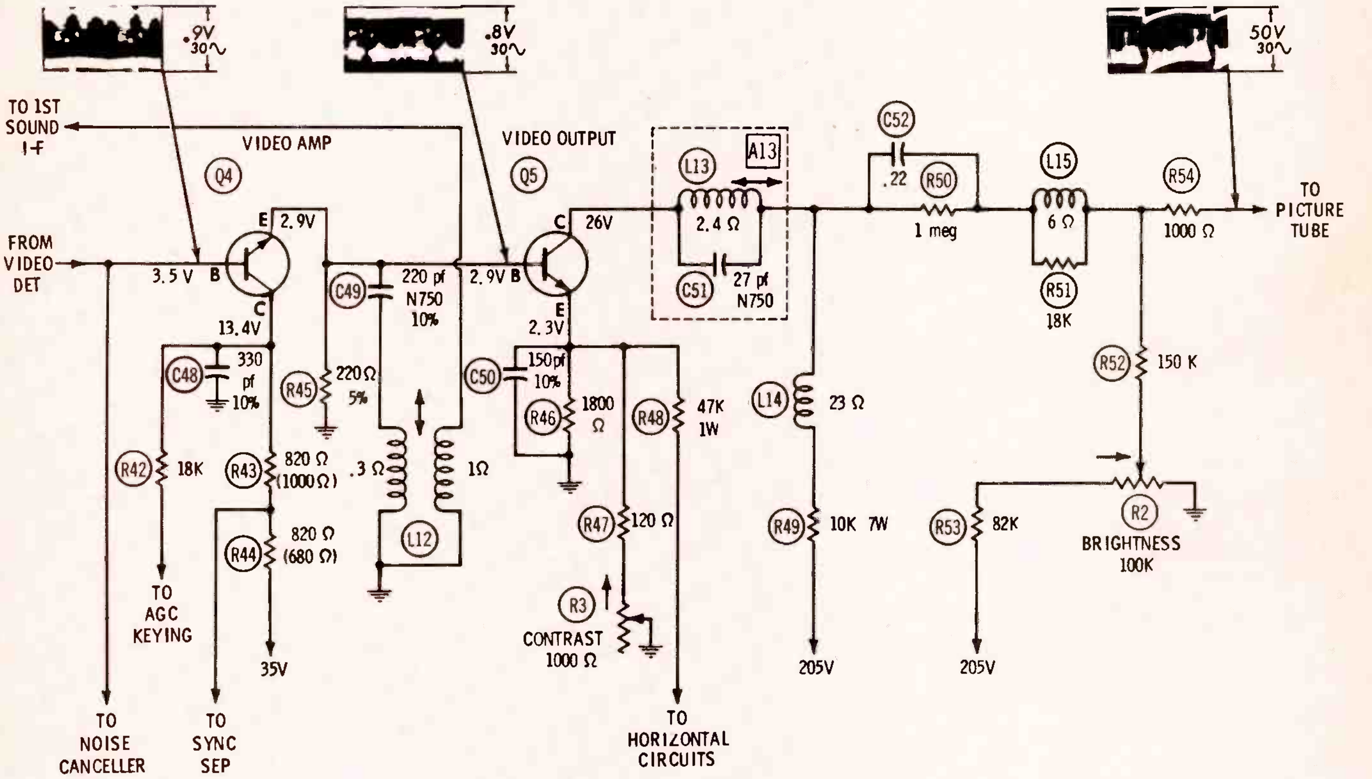

Fig. 1. First video amplifier indicates voltage loss.

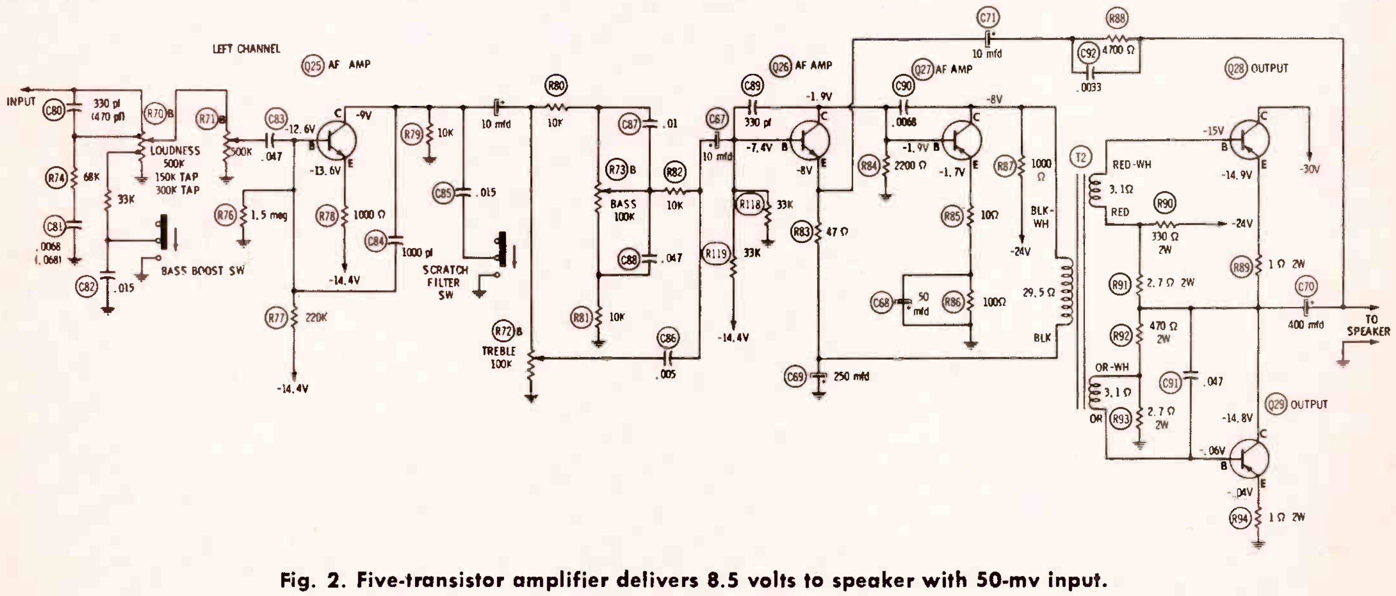

Fig. 2. Five-transistor amplifier delivers 8.5 volts to speaker with 50-mv input.

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tric service manual, are shown in Table 1:

Table 1

Across the speaker	8.5v.
Q28/Q29 bases	2.0v.
Q27 collector	6.0v.
Q27 base, Q26 collector	40 mv.
Q26 base	40 mv.
Q25 collector	250 mv.
Q25 base (input)	50 mv.

All of these voltages are rms, although it makes no difference which one you use, rms or p-p. What we are looking for in this type of test procedure is the ratio between input and output signal.

Notice that here, too, we have an apparent "no gain" situation in Q26 —40 mv on base and collector. However, this stage has unity gain or "one" and we should get the same levels at the input and the output. The collector is direct-coupled to the base of Q27, so the voltage gain is small, but the current gain is normal.

Also, note the loss as the signal proceeds through the tone-control circuits: 250 mv on the collector of Q25, and only 40 mv on the base of the following stage (Q26). This is normal in many transistorized tone-control circuits, because of the low impedances. However, the preamplifier stage, Q25, has a voltage gain of 5, with a 50-mv input and 250-mv output.

Test Voltage Levels

At this time, it would be a good idea to go over some actual test-voltage levels. There is no universally accepted standard for this, although a lot of manufacturers seem to use 50-mv input, as you can see from the figures above. However, this is pretty small, especially for accurate reading with service-type equipment.

We do not want to use a very high signal level at the input; excessive signal will cause overloading of the transistors in the output, etc. During actual tests of assorted mono and stereo cartridges, we obtained the following output signal-levels using a 1,000-Hz tone from a test record as a source: FET voltmeter —15-megohms input impedance, 0.7 volts rms; tube VTVM—11-megohm input, 0.6 volts rms; scope, direct probe—1.8 volts p-p. These readings were taken with the cartridge output disconnected from the amplifier. With the cartridge connected to a low-impedance input, the readings would have been lower.

You will be safe in using a more readable level of voltage for testing —something like 0.5 volt rms fed to the input. Use the smallest "readable deflection" possible to be on the safe side. If you prefer a 50-mv signal, you can get one quite easily. Construct a voltage divider using a 950- and 50-ohm resistor in series, and apply one volt of audio across the circuit. You will have a low-impedance source of 50-mv developed across the 50-ohm resistor (See Fig. 3). You can use any value of resistors you want, as long as you keep the 950-50 ratio.

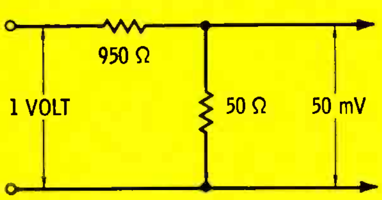

Fig. 3. Voltage divider provides 50-mv source.

No Weak Stages

There is one thing about transistor circuitry: weak stages are rare. If a transistor is defective, it usually either shorts or opens. Even with a high leakage condition (I_{ceo}, I_{CBO}), the resultant upset of the bias will usually kill the gain because the base can no longer control the collector current. Therefore, we hunt for a stage with normal input, but distorted or reduced output.

AM Radio Checking

AM radios can be signal-traced in much the same manner as that discussed previously. For example, in one such circuit (Fig. 4), we find the values shown in Table 2.

TABLE 2

Detector output (Audio, 1-kHz)	30 mv.
2nd IF transistor base	1500 μv.
(455-kHz, 30% modulated)	
1st IF transistor base	50 μv.
Converter base	6.0 μv.
Antenna input	90 μv.
(1,000-kHz, 30% modulated)	

Here again, we do not have to have an absolutely accurate RF signal. We can use the voltage-gain ratios of each stage as we check back through the IF and RF stages (we are assuming that the audio stage has been checked out as previously described). For example, the 1st IF stage has a voltage gain of 1500/50, or 30 times; from the converter base to 1st IF base, 50/6, or 8 times, etc. Even if your RF signal generator does not have a well-calibrated output attenuator, you will soon learn what amplitude of RF voltages is "normal" for each stage.

FM Radios

In a typical FM radio, we find values similar to those in Table 3.

Table 3

Limiter base	80,000 μv.
(10.7-MHz, AM)	
3rd IF base	8,000 μv.
2nd IF base	800 μv.
1st IF base	55 μv.
Mixer base	60 μv.
RF amplifier base	5 μv.
(98.0 MHz, AM)	

Very few of us have "microvolters" or an RF generator with an accurately calibrated output. So, we must find a way to do without such instruments. Actually, as we said before, all that is needed is the voltage gain ratio between the input and output of a given stage. To obtain an indication of this ratio, connect an output indicator (scope, FET-VM, VTVM, or VOM) to point A in Fig. 4, which is the schematic of the FM receiver from which were taken the gain figures in Table 3. Connect the RF signal generator to the base of the limiter (X8) through a DC-blocking capacitor. Set the signal generator to 10.7 MHz, (0% modulation) and adjust the RF output to show any readable deflection on the meter—1.0 volt, 0.5 volt, 0.1 volt or whatever is "comfortable" for you. Note the attenuator setting of the signal generator. This may not be 80,000 μv, but that is what we are going to use it for. It is our "standard."

Next, move the signal generator output back to the base of the 3rd IF stage. The meter reading should increase appreciably. In fact, if the 3rd IF stage has normal gain (80,000/8,000 = 10) you should have to turn the step attenuator of the signal generator from X100 back to X10 (divide output by 10) to get approximately the same meter reading you had originally. That is all

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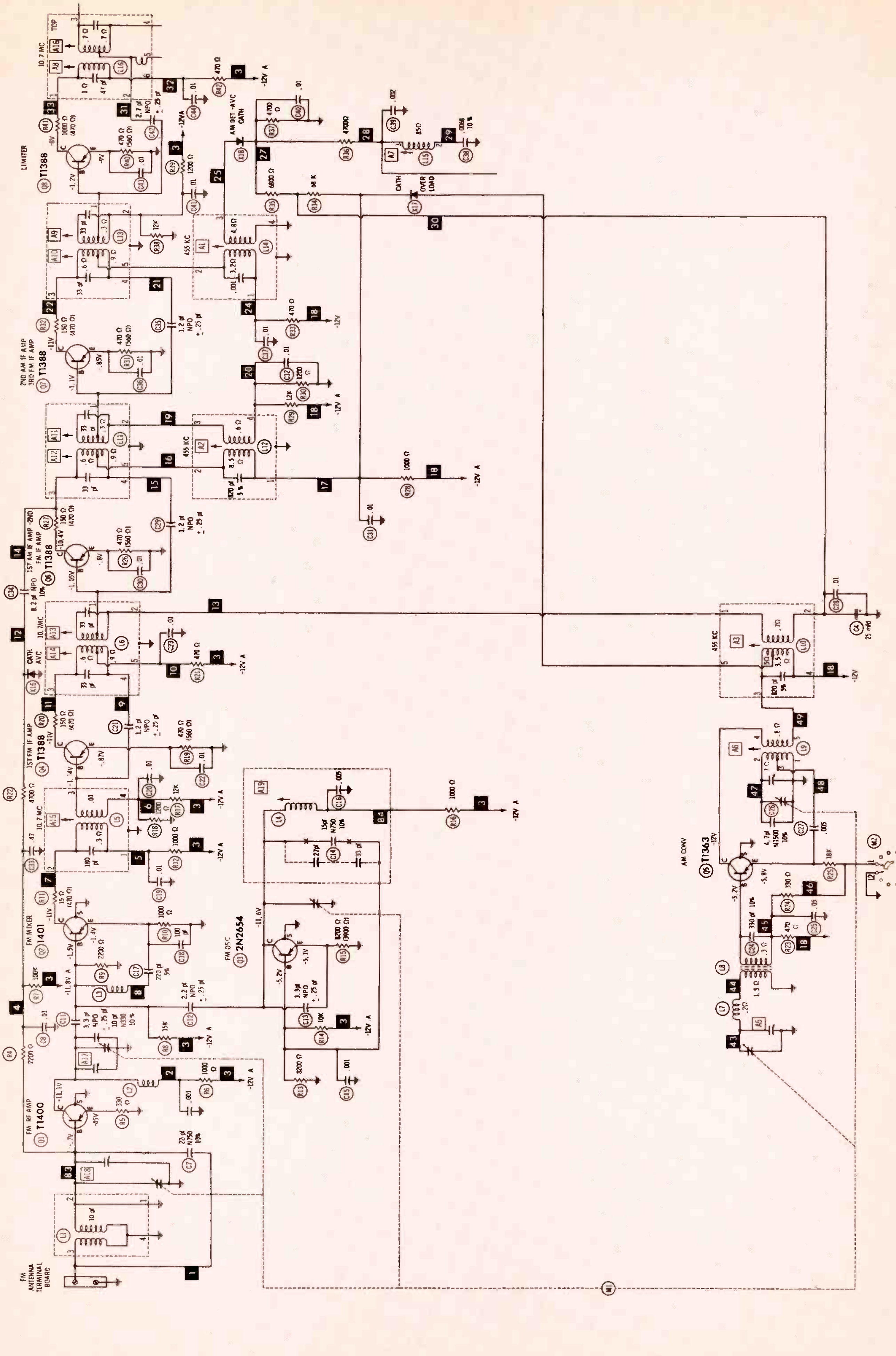

Fig. 4. Transistor radio employs the same transistors for AM or FM IF amplification.

there is to it; proceed through the rest of the stages, following the same procedure. To make the meter indication easier to read, you can adjust the signal generator output when you determine the "comfortable" output for that stage. All of the tests discussed in this article can be made "one stage at a time," so we can adjust the instruments to read the gain of only a single stage.

The average shop-type RF signal generator probably will not produce a signal level low enough to give an accurate 30- to 40-mv level; this is because of leakage around the output attenuator, stray capacitance, etc. However, if you require a weaker signal, loosen the coupling and, instead of making a direct connection to the input of a stage, clip the signal-generator output to something near (proximity coupling) the input.

This procedure is particularly helpful for checking RF stages; if you cannot direct-couple a 90-MHz RF signal to the RF transistor base, you can obtain ample signal by simply laying the end of the RF output cable on the bench near the antenna (loop). Just make sure that it is clipped to something solid (and insulated, of course) so that it cannot change position, which changes the coupling and, consequently, the level of the input signal.

Notice that in both the AM and FM RF/IF circuits we do get a voltage gain through each stage—which makes things a lot easier. Troubles in these circuits are usually caused by open IF transformers, leaking capacitors, bad resistors, or leaky transistors. Also, AGC trouble will affect the overall gain of all controlled IF stages. However, the AGC circuit can be clamped in the same manner as in TV AGC circuits. Check the normal bias voltage shown in the schematic with no signal input; this is the maximum gain condition for IF amplifier stages.

The actual test procedure requires less time than it takes to read about it. After connecting the test equipment and locating the proper test points, you can proceed through the circuits very quickly and isolate the defective stage in a minimum amount of time. As in TV IF testing, we can shortcut the test procedure by injecting a very weak signal into the input of the IF stages and listening for a strong "beep" from the audio output. If you get nothing through the IF atall, begin the stage gain tests.

Gain Checking in Transistor TV

A transistor TV set is no more difficult to signal trace than any other type of solid-state equipment—there are more signals, not different ones. They are all "signals," no matter how you define them.

The fastest way of servicing transistor TV is by "function," which is the same method you have been using for years; you look at the defective unit and find out what is not working—picture, sound, sync, etc. Then, through the process of elimination, you go direct to the stage(s) that relates to that function.

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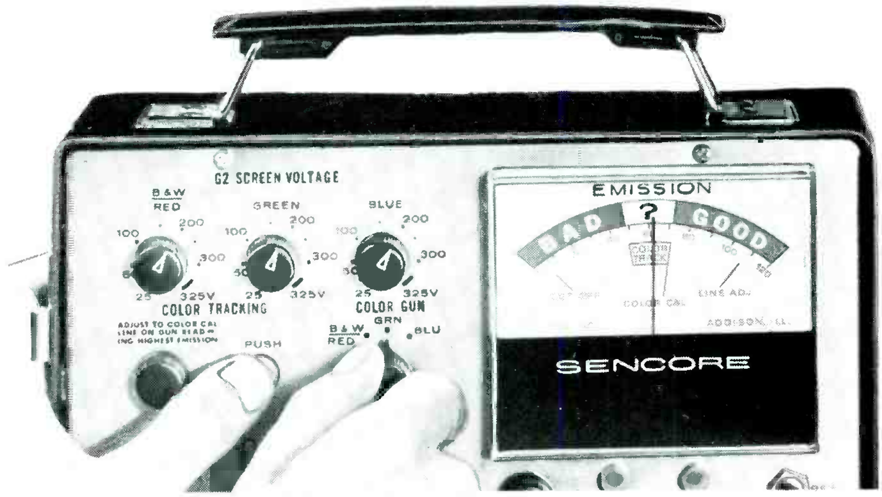

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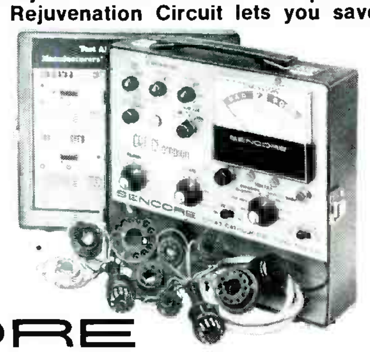

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this is the scope. Even a very accurate peak-to-peak VTVM can tell us only that we have a certain amplitude at a specific test point, it cannot tell us the shape of the waveform. It could be video, audio, or even hum. Only the scope can tell us whether we are actually measuring the correct signal.

Because the scope is basically a "comparison" instrument, you can make very rapid gain checks with it. Touch the scope probe to the input and output of a stage, and you have your information. If the input shows a 0.25" (vertical) pattern, and the output a 2.5" pattern, the stage has a gain of 10.

The scope is an ideal "output indicator"; use it as the VTVM was used in the radio tests discussed previously. Connect it to the output of the circuit—CRT cathode for example. Next, adjust the scope controls for a "usable" pattern. You can then check the preceding stage for gain by simple moving the scope probe to the input of the preceding stage, and noting the decrease in pattern height. Assume the circuit under discussion is a video amplifier with a normal voltage gain of 50, as in the example previously given. The difference between the input and the output patterns should be representative of 50 times, the output being 50 times greater than the input (approximately).

We do not have to make absolute gain measurements with the scope. (Or with any of the previously mentioned indicators, for that matter.) What we are looking for during the initial tests is a stage that has no gain at all, or one with a distorted pattern or greatly decreased gain. Connect the probe of the scope to the input and output of the stage, and look for an unusually large difference in pattern height. When testing a multi-stage circuit, you need to touch the probe to only two points per stage—signal input and output. This will tell you what you must know, or, at what point the signal disappeared.

Service Data: Location of Parts and Stages

Last, but definitely not least, is the most important thing of all—service data. For the most efficient service, you must have complete, accurate service data; not only a schematic diagram, but also a phantom-view and photographs of the actual chassis. Without this, you are greatly handicapped in the performance of any servicing technique. That is, as far as making any money is concerned. As an experiment, I tried to "cold turkey" a little import auto radio without a schematic, photo or any data at all; the results—almost 4 hours of bench time. (Approximately twice the value of the whole radio.) The same thing happened on other "experiments" with portables, etc. Out of several units, the only one that was fixed in anything like a reasonable time was a small three-transistor phono amplifier that had a shorted rectifier.

Summary

If you are going to be able to profitably s e r v i c e transistorized equipment, you must develop and *use* a practical servicing method that will permit you to find faults and repair them in the *shortest* possible time. The method described in this article is one that works for me, and I think it will work for you. ▲

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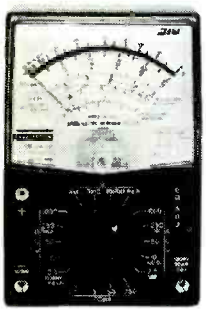

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DC current:	50μA 0.5mA 5mA 50mA 250mA
Resistance:	Range - RX1 RX10 RX100 RX1K
	Midscale - 50Ω 500Ω 5kΩ 50kΩ
	Maximum - 5kΩ 50kΩ 500kΩ 5MΩ
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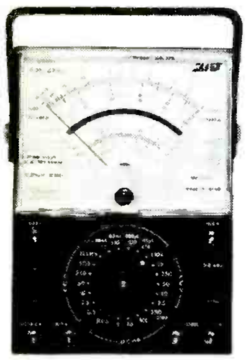

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AC voltage:	2.5V 10V 50V 250V 1kV - 4k Ω/V
DC current:	50μA 1mA 10mA 100mA 250mA 10A - 250mV
Resistance:	Range — ×1 ×10 ×100 ×1K ×10K
	Midscale — 34Ω 340Ω 3.4kΩ 34kΩ 340kΩ
	Maximum — 5kΩ 50kΩ 500kΩ 5MΩ 50MΩ
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Routine servicing of AUTO RADIO

A logical testing sequence speeds troubleshooting. by Homer L. Davidson

Quick servicing of any consumer electronic device demands a routine, logical troubleshooting procedure. Auto radio is no exception—even though it is relatively simpler to service than a b-w or color TV receiver. To diagnose and repair the greatest number of receivers within a given period and thus realize the greatest profit, the technician must employ a servicing routine that will quickly pinpoint the trouble with a minimum amount of testing. Such a routine begins with an accurate analysis of the trouble symptom(s), proceeds with a logical troubleshooting technique and concludes with correct replacement or lasting repair of the defective part or component.

The following paragraphs discuss the general servicing procedures and test equipment required for repairing auto radios. Although a logical, step-by-step analysis of the subject is intended, in some cases it has been necessary to deviate from this course in order to dwell on the more probable causes of a specific trouble symptom.

Test Equipment Requirements

Although there are some hybrid designs still in use, the majority of auto radios are of solid-state design. Thus, if you are now servicing other solid-state consumer electronic products, most of the test equipment required for auto radio servicing is probably already on your service bench. Specific equipment includes: a well-filtered variable DC power supply producing from 0 to 15 volts; a VTVM or FET-type VOM; a transistor tester, preferably an in-circuit beta tester; and an RF or noise signal generator. A pencil-type noise generator, such as the one shown in Fig. 1, is suitable.

Fig. 1. Pencil-type noise generator.

In-Auto Checks

Before removing the radio from the auto, determine exactly what trouble symptoms are displayed either from the owner or, preferably, from your own first-hand evaluation. Typically, the owners description of the trouble is "It doesn't play" or "It just went dead." Such descriptions, although basically true, don't provide any specific clues to the source of the trouble. Usually the owners description is helpful only in the cases of intermittent operation, fading sound, or distortion. Consequently, you'll probably save a lot of diagnosis time by evaluating the operation of the radio yourself.

First, turn the on-off switch on. If a thump is heard from the speaker, you can eliminate the audio output and speaker as the source of the trouble. If no thump is heard, check the speaker for continuity with an ohmmeter. The speaker should click as the ohmmeter leads are applied.

With the volume control fully advanced, slowly tune across the band, listening for even a faint signal. If none is heard, connect a spare antenna to the antenna jack on the receiver. The receiver should now pick up a local station if the original antenna or lead-in was defective. If the receiver operates normally with the spare antenna and lead-in attached, troubleshoot and repair the original antenna system, looking for broken or corroded connections or an open lead-in or antenna. If the trouble symptom was intermittent operation, thump the antenna, tighten connections, or bend the lead-in in an attempt to determine if the antenna system is the source of the trouble.

If you have not uncovered and repaired the source of the trouble at this point, you have learned all there is to learn about the trouble with the receiver in the car and must now remove it for bench checking.

Bench Checking

After connecting the receiver to the DC power source and the shop antenna and speaker, perform another quick evaluation of the trouble symptom: Turn the volume to maximum and slowly tune across the band. In some cases, the receiver will suddenly come to life, indicating that you have overlooked a bad antenna system or speaker during your in-auto check. However, it is more probable that the original trouble will still be present.

Dead Radio

Many technicians consider this symptom the easiest to solve since it involves a go/no-go situation. The best approach to finding the source of the trouble is a logical process of elimination commonly referred to as signal substitution.

First, localize the trouble to either the RF-IF or audio sections of the receiver. This is accomplished by injecting an audio or noise signal at the detector side of the volume control (point 1, Fig. 2). If the signal is not heard in the speaker, the audio section is probably the

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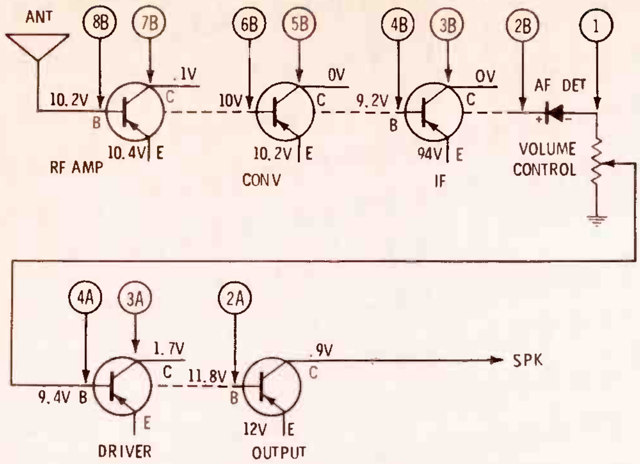

Fig. 2. Block diagram of auto radio showing signal injection points.

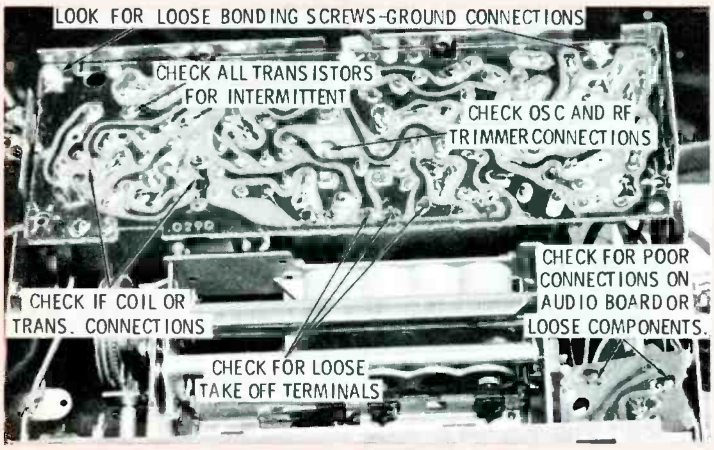

Fig. 3. Possible sources of trouble causing intermittent symptom.

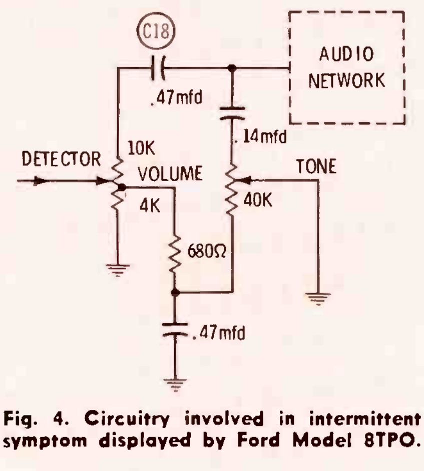

Fig. 4. Circuitry involved in intermittent symptom displayed by Ford Model 8TPO.

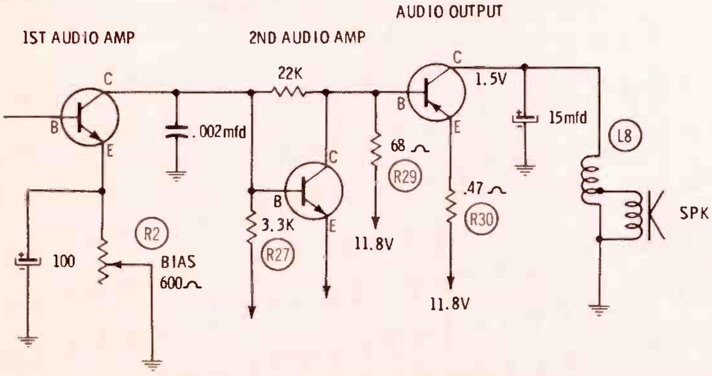

Fig. 5. Open bias control caused weak reception in Delco Model 7303311.

source of the trouble. Apply the audio or noise signal to point 2A in Fig. 2. If no sound is heard in the speakers, check the output transistor with a transistor tester. If the transistor checks good, perform voltage and resistance measurements in the output circuitry. (When making resistance checks in transistor circuits, remove the transistor for more accurate measurements. In many instances the internal resistance of the transistor can produce misleading readings.) If the power supply is the cause of the "dead radio" symptom, voltage measurements will now reveal it. Typical voltages found in an auto radio are shown in Fig. 2.

If a signal is heard in the speaker when the test signal is injected at point 2A, proceed to test points 3A and 4A, respectively, until the defective stage is located. Perform voltage and resistance checks to isolate the defective component(s) as previously described.

If the initial test at test point 1 indicates the trouble is toward the front of the receiver, proceed toward the antenna coil with tests at 2B through 8B, respectively.

When the noise signal generator is placed on the opposite end of the detector (test point 3B, Fig. 2), there is substantial loss in audio signal. Because of this, the noise generator is not effective in the convertor and RF stages. An RF signal generator is required for signal tracing in these stages.

Set the RF generator to 262 KHz to match the IF frequency of the receiver. Start at the base of the second IF stage, then move to the collector of the first IF stage as indicated in Fig. 2. Next, start at the base of the convertor stage and keep turning down the gain control of the RF signal generator. To signal trace the RF stage, set the RF signal generator frequency to 1600 KHz with the radio dial at 1600.

The FM section of an AM-FM radio is serviced in the same manner as the AM section. If the AM section is working and the FM receiver is not, check the FM-RF and convertor stages. Since the first FM-IF stage is common to the AM section, the trouble must lie ahead

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of the IF transformer. The components in the FM section are compact and should be replaced in the exact location as the originals. Follow the alignment procedure outlined by the manufacturer's service literature or PHOTOFACT Folder.

Intermittent Conditions

Intermittent trouble symptoms in an auto radio are difficult to locate and repair. Sometimes they occur only while the receiver is in the automobile. In most cases the trouble causing the intermittent will be found to be a defective transistor, a cracked PC board, a rosen joint, coupling capacitor or IF transformers as indicated in Fig. 3.

In cold weather if the radio refuses to play until the auto is warmed up, the trouble is probably an intermittent transistor. Remove the radio from the car and connect it to the bench power supply. Lower the supply voltage to 9 volts (auto radios will perform at this low supply voltage). If the radio cuts out, replace the convertor transistor. (This also applies to a radio that will not play on either end of the broadcast band.)

To locate the intermittent transistor, first try the noise signal generator. Always inject the signal to the collector terminal of the transistor. Then apply the signal to the base terminal. If the radio suddenly begins playing the transistor is probably intermittent.

Remove the suspected intermittent transistor from the PC board and connect it to the beta transistor tester. If the results of the test are good, leave the transistor connected and apply cold mist. Generally this will cause it to open. If not, leave the transistor connected to the tester

Fig. 7. Applying silicone grease to power output transistor.

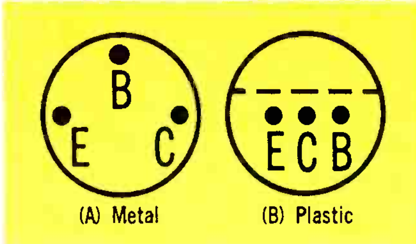

Fig. 6. Metal and plastic-cased transistors have different lead layout.

and check it every half hour. Sometimes, carefully applying heat from a soldering gun near (but not touching) the transistor will cause it to open. A quick spray of cold mist sometimes helps after heat has been applied.

It is best not to apply the in-circuit transistor tester to a suspected intermittent transistor while it is soldered to the PC board. Applying the in-circuit tester will probably cause the intermittent transistor to snap on, and you will have to wait until the radio is dead again.

Transistors with plastic cases are prime suspects for an intermittent condition. Twist the body of the transistor with long nose pliers to determine if the connecting element wires inside the case are making connection only intermittently.

Another method to make the intermittent transistor react is to spray each transistor with cold mist while the radio is playing. Start at the RF amplifier and work toward the power output stage. Spray the transistors at least three times, letting each warm up before going to the next one. Warm the transistor by holding it between your fingers. For difficult intermittent conditions, lower the supply voltage to 9 volts and then again spray each transistor with the cold mist.

Check the PC board by gently twisting and prodding around on it. Sometimes it is quicker to resolder the complete PC wiring to eliminate an intermittent board. Repair the cracked board with regular hookup wire.

Probe around on the soldered terminals of the IF transformer to reveal a suspected intermittent condition. While the radio is playing, twist the IF can. Remove the suspected IF transformer from the metal case. Check to see if each coil winding is soldered to the terminal connections. Many of these terminals have the coil wire just wrapped around and not soldered.

An example of a typical intermittent trouble involved a Ford 8TP0 model. The radio would quit operating and would only resume when the car dash was hit. At other times, if the car hit a bump in the road, the radio would cut out. When the receiver was pulled from the car, it resumed operating on the repair bench. By tapping the chassis, the music would become intermittent. With the radio in a non-playing condition, a noise generator traced the signal past the audio network. The signal was dead at the center tap on the volume control.

This meant the trouble lay between the volume control and the audio network. A look at the schematic revealed that the most probable source of the trouble would be C18, the .47-mfd coupling capacitor. With the noise signal generator probe on the top terminal of the volume control, C18 was twisted and the radio began to play. C18 was replaced and the intermittent condition disappeared.

Weak Reception

Defects causing weak reception can be uncovered using the signal substitution method described for a "dead radio symptom," except in this case the indication of a weak stage will be a drastically reduced output from the speaker instead of a signal or no-signal condition. Experience will acquaint you with the signal levels that are satisfactory for each test point in Fig. 2. However, simple voltage and resistance tests, together with a clear understanding of circuit action, will often provide an even quicker indication of the defective stage.

Following is a typical case history of a weak reception symptom. Only a whisper could be heard on all stations across the broadcast band of a Delco Model 7303311. When the on-off switch was turned on, no sound was heard from the speaker. The trouble was assumed to be in the output circuit.

The output transistor had recently been replaced, so the .47-ohm bias resistor was checked. This resistor had also recently been replaced, so both units were again checked. The emitter and base terminals indicated 12 volts. Zero voltage was indicated on the collector terminal. Both bias resistors and the audio output transformer checked normal.

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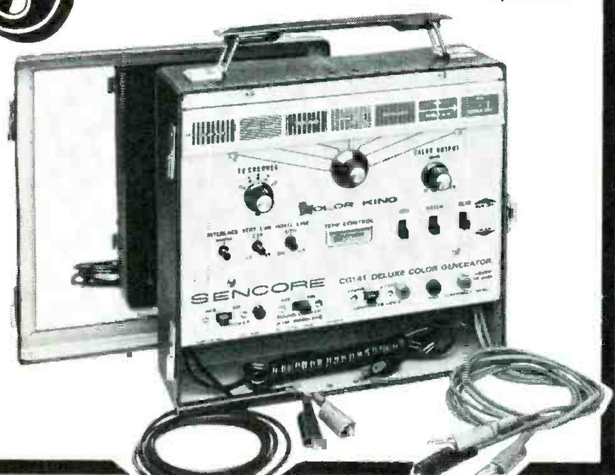

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Since the first and second audio amplifier transistors were directly coupled, each collector lead was removed and in-circuit transistor tests were made. Both transistors tested normal. Checking the schematic, we focused our attention on R2, which varies the voltage on the emitter of the first audio amplifier. The bias control was found to be open near the emitter terminal of the first audio amplifier. Replacing the bias control restored the radio to normal service.

Distorted Reception

Garbled or distorted sound usually results from a defect that affects the frequency response of the audio section. Bias resistors and coupling capacitors are the most likely suspects, although a damaged speaker should be the first suspect during the in-auto check. Substitution of suspected components is usually the only positive method of isolating and curing a distortion symptom.

Removing and Installing the Transistor

To prevent further damage, exercise care when removing a suspected transistor from the PC board. Use a bulb or other type desoldering attachment to remove excess solder. Also, use the tip of a pair of long nose pliers as a heat sink.

A small, pencil soldering iron will not provide enough heat to remove a transistor element lead from a double-sided PC board. Use a large soldering gun, being careful not to "pop" any PC wiring from the insulated board.

Always check to see where the collector terminal is located. Some transistors are marked with an arrow beside the metal transistor case or on the PC board. In some instances no terminals are marked on either the PC board or transistor. Most metal transistors can be mounted directly into the PC board holes; however, this does not hold true for some plastic transistors whose leads will not correspond to the position of the holes in the PC board (Fig. 6). After the transistor is installed, do not cut the terminal leads until you are sure the replacement has cured the trouble.

To remove the defective transistor from a double-sided PC board it is easier to cut the element leads close to the PC wiring. Cut the new transistor leads close to the correct length and form a curl, or loop, on each element wire and slip it over the cut lead on the PC board. Solder the two leads together with a pencil iron.

Before the transistor is replaced, all corresponding components should be checked. Determine if associated capacitors are leaky, and check for burned base and emitter resistors. If a small transistor runs warm, replace it; but do not become alarmed if the power output transistor feels warm; this is normal. However, an output transistor that will turn moisture to steam should be replaced.

When replacing the power transistor on the heat sink, use a clean piece of insulation material. Apply silicone grease to the transistor and one side of the insulation piece as shown in Fig. 7. All power transistor base and emitter terminals are off center and should be lined up before being placed into position.

Checking Transistors

A quick method of checking the condition of a transistor is with a beta in-circuit transistor tester. Clip the small, insulated alligator clip leads to the correct transistor terminals. Double check to insure that all terminal clips are on the correct transistor elements. The transistor can be tested for open, leaky, shorted, or intermittent conditions while the transistor is still soldered to the PC board.

When a transistor is open there will be no reading on the beta scale of the tester. If the tester indicates an open transistor, check to see that all clips are firmly attached to the correct transistor terminal, and be sure the tester is set to the correct PNP or NPN position.

Generally, if the meter registers high on the beta scale the condition of the transistor is good. In auto radio circuits, the in-circuit leakage tests will usually read quite high. This does not necessarily mean the transistor is defective. However, when the in-circuit leakage test indicates a dead short, the transistor is definitely defective. To make a correct leakage test, unsolder the collector terminal from the PC board and take another reading.

Alignment

For complete RF and IF alignment of the auto radio, follow the general procedures outlined in Table 1. Although auto receivers very seldom need alignment, often a quick touch-up will improve the selectivity. Always touch up the RF-IF alignment after replacing an IF transformer or convertor transistor. When an RF or IF stage will not align properly, check for defective coils, IF transformers, and bypass capacitors.

Last Minute Adjustments

Before the covers are placed on the radio, be sure to check the condition of the pilot light. Clean all dust and dirt from the chassis and front dial assembly. Spray picture tube cleaner on the front dial and push button assemblies, brushing the solution around to get into the corners and between the push buttons; wipe dry. Adjust all push buttons to the favorite local stations. ▲

TABLE I.

Signal Generator Frequency	Signal Generator Connection	Set Radio Dial	Meter and Connection	Adjust
Connect probe through a .1-mfd capacitor to base of convertor transistor ground shield.	262KHz with 400Hz modulation	above 1600KHz	Output meter across voice coil of speaker	Top & bottom slugs of both IF transformer for maximum reading on meter.
Connect probe through 47-pf capacitor to antenna input.	1600KHz	1600KHz	same	Adjust OSC, RF trimmer capacitors for maximum reading on meter.

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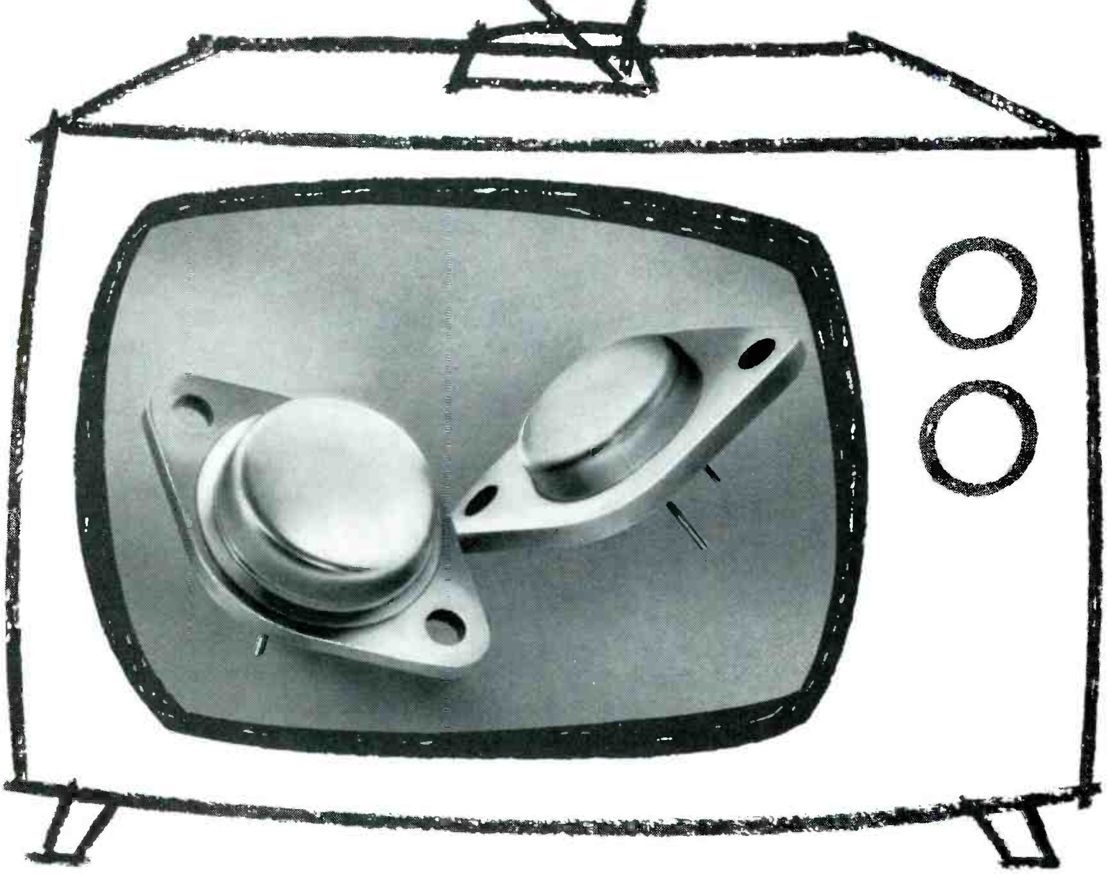
Two New SK Devices Simplify Servicing of TV Deflection Circuits



More than a dozen solid-state TV sets—RCA and others—can use these two new RCA SK-Series transistors—specifically designed for replacement use in deflection circuits.

The RCA SK3034 is for replacement use in horizontal driver and in vertical-deflection-output circuits; the SK3035 is for replacement use in horizontal-deflection-output circuits.

Both units are germanium p-n-p devices in hermetically-sealed TO-3 packages, and are for use in domestic and imported TV sets with anode voltages to 18 KV and with picture tubes having deflection angles up to 114°.

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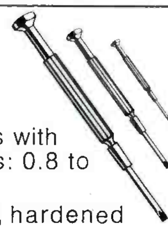

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analysis of test instruments . . . operation . . . applications

NOTES ON TEST EQUIPMENT

by ELLSWORTH LADYMAN

Solid-State Meters

Solid-state meters seem to be the answer to the service technician's prayer. These compact, small meters combine the attributes of both VTVM and VOM meters and, seemingly, have none of the inherent disadvantages of either instrument. Advantages include:

a. Lightweight
b. Compact design
c. Battery operated
d. High input impedance
e. Versatile
f. Extremely portable.

Current drain is not extreme, and with proper care battery life will be fairly long. Most solid-state meters use conventional batteries that are available anywhere, which lessens the possibility of losing the services of your meter due to a dead battery while on a service call.

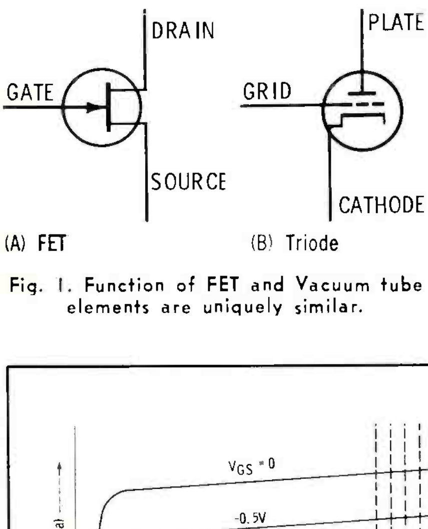


Fig. 1. Function of FET and Vacuum tube elements are uniquely similar.

FET Circuit Analysis

A brief discussion of field-effect transistor (FET) circuits, illustrating their relation to vacuum-tube operation, will help to show their adaptability to meter circuitry (see Figs. 1 and 2). A negative bias voltage is applied between the gate and the source elements of the FET. This voltage is analogous to the grid bias applied between the grid and the cathode of a vacuum tube. A positive voltage is applied between the drain and the source. This voltage compares to the plate voltage of the vacuum tube. When the gate voltage is increased (negatively) to a suffi-

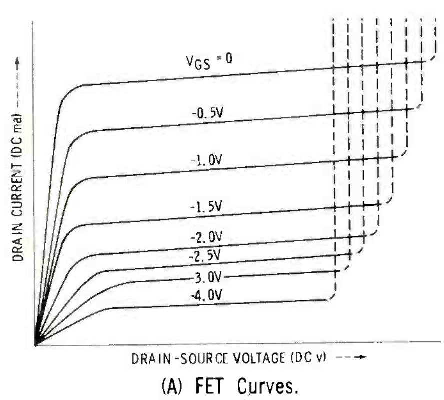
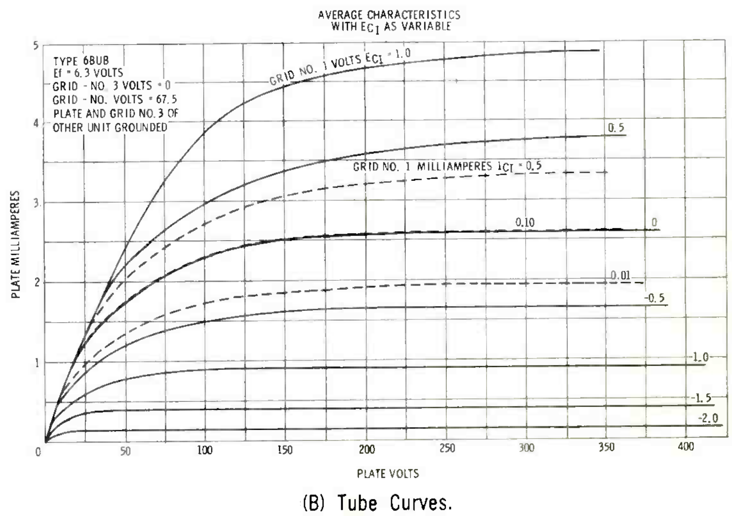


Fig. 2. Performance curves point up similarity of FET and vacuum tube.



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cient value, "pinch-off" occurs and drain current flow ceases. This is the same as bias cutoff in the vacuum tube.

When the proper values of voltages are applied to the gate, source, and drain, a decrease in gate bias effects an increase in drain current and, conversely, an increase in gate bias effects a decrease in drain current. The reverse-biasing of the gate junction causes gate current flow to be at a minimum; therefore, the high input-impedance characteristic that is desired for meter application is attained.

Solid-State Meter Circuits

DC Voltmeter (Fig. 3)

For measuring DC voltages, an amplifier employing an FET at the input provides impedance conversion and drives the meter. Precision voltage dividers extend the range from the basic 100 mv sensitivity to 1000 volts. In the AC mode, an additional amplifier furnishes the required gain to provide 10 mv sensitivity. The DC voltage at the input is applied across a voltage divider to the amplifier. Basic attenuation is in decade steps; intermediate ranges are attained through a reduction in amplifier sensitivity.

Ohmmeter (Fig. 4)

Ohmmeter action is the same as for most meters. The unknown resistance, when connected across the input circuit, is placed in series with a portion of the voltage divider network and the battery. The voltage drop across the known and unknown resistance is proportional to their value since identical current flows through each. The voltage applied across the unknown resistance is applied to the amplifier; meter deflection is calibrated in terms of resistance, or ohms.

AC Voltmeter (Fig. 5)

Input AC voltages of less than one volt amplitude are applied directly to an impedance converter circuit. The output of the impedance converter is attenuated to provide a 10-mv input to the amplifier at full scale on all ranges. A compensated attenuator reduces input voltages ranging from 1 to 1000 volts, 50 db previous to impedance conversion.

The AC amplifier circuit is conventional. DC feedback provides for bias stability. Output detection is normally accomplished through the use of an average-responding detector between the input and the meter.

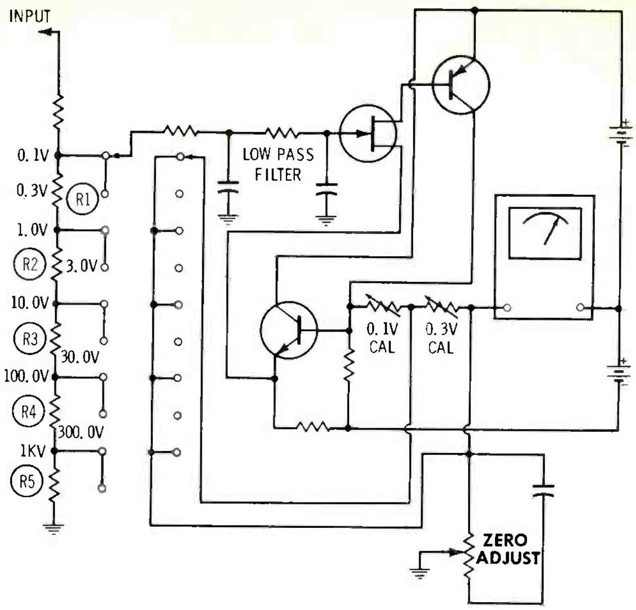

Fig. 3. Simplified schematic of FET DC voltmeter.

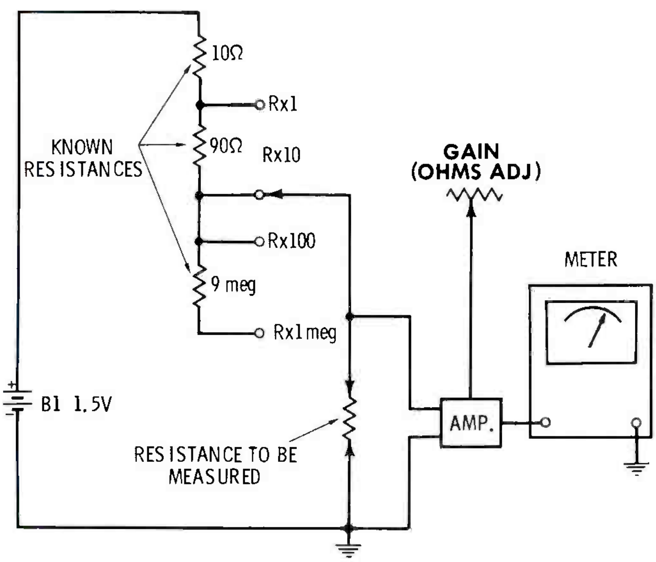

Fig. 4. FET meter ohmmeter circuit is similar to that employed in conventional VTVM.

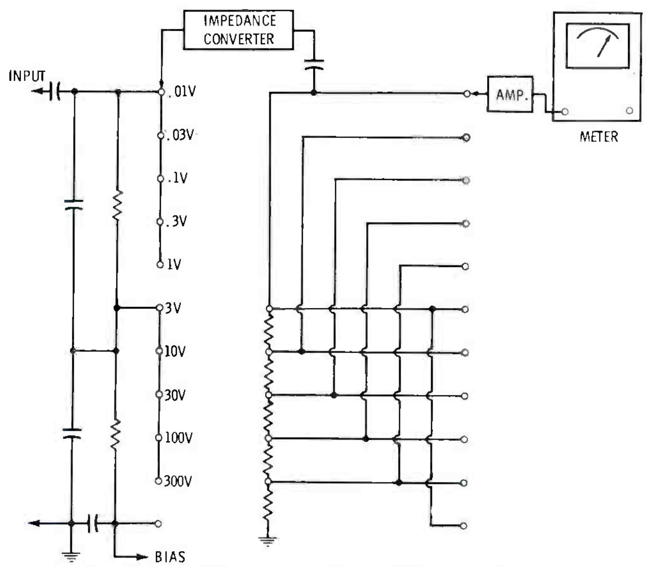

Fig. 5. Simplified schematic of FET AC voltmeter.

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Triplett Model 601 is designed to provide a means of measuring practically every variable in the home entertainment field from ohms to dB. Push-button switching allows the service technician to quickly select either DC volts (+ and —), ohms, AC volts, or power ohms.

A unique feature of Model 601 is the Low Power Ohms range. This allows the operator to make in-circuit resistance measurements of integrated circuits without damaging delicate electronic components. In-circuit resistance measurements are made without loading; 75 millivolts is applied to the device under test, with maximum applied power being 0.1 mw.

Hi-fi and stereo service technicians will like the dB scale range. The operator can make measurements in 10 dB steps from —40 to +60 dB. A single function selector provides control of all operations.

To counteract the high-sensitivity requirements for AC measurements, Model 601 utilizes a slender, shielded probe and insulated lead. The probe has a built-in slide switch with a resistor in series with the meter circuitry for DC voltage readings. This probe plus a "ground lead" comprises the probe requirements for all measurements.

The outside dimensions of the instrument are 3 3/16" x 5⅛" x 6½". The theory of operation of Model 601 was covered under the heading of "DC Voltmeter," "Ohmmeter," and "AC Voltmeter" earlier in this article.

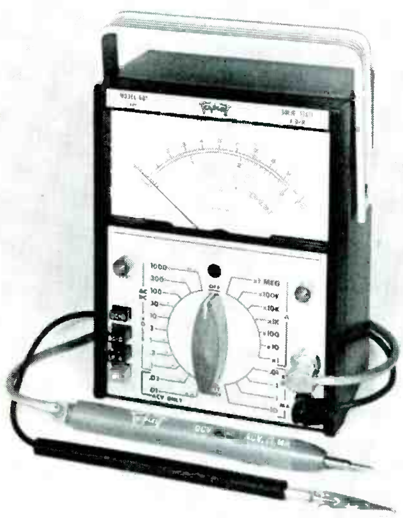

Fig. 6. Triplett Model 601 solid-state VOM.

Differential Amplifier Meter Circuit (Sencore Model FE14, Fig. 8)

Sencore uses a different approach, employing an all-FET circuit design in a differential amplifier type circuit (see Fig. 9). Circuit operation is as follows: Q1 and Q2 form the differential amplifier used for DC volts and ohms measurements. With zero volts applied to the input of Q1, the Zero Adjust control (R31) is adjusted in such a manner that voltages developed across the source resistor, R14 and R22, are equal. Therefore, no current can flow through the meter. The DC Balance control (R29) is an internal adjustment. Its function is the same as the Zero Adjust control, except

Fig. 7. Amphenol Model 870 VOM.

Triplett Model 601 (Fig. 6)
Specifications

DC Volts
Ranges:
0 to 0.1, 0.3, 1.0, 3.0, 10, 30, 100, 300, 1000 @ 11 megohms.

AC Volts
Ranges:
0 to 0.01, 0.03, 0.01, 0.3, 1.0, 3.0, 10, 30, 100, 300, 1000 @ 11 megohms.

Ohms
Ranges:
0 to 1000, 10K, 100K, 1 meg, 10 meg, 100 meg, 1000 meg (standard 1.5V, 5.5).
0 to 1000, 10K, 100K, 1 meg, 10 meg, 100 meg, 1000 meg (Low Power 0.1 mw, 75 mv).
Center Scale value 10 ohms on x1 range.

DC Current
Ranges:
0 to 10, 100, 1000, 10,000 microampere at 100 mv.

AC Current
Ranges:
0 to 10, 100, 1000, 10,000 microampere at 100 mv.

dB
Ranges:
—40 dB to +60 dB in 10 dB steps.

Meter Size and Type:
4½" suspension meter movement

Sensitivity:
10 mv on AC

Accuracy:
± 2% of full scale on DC
± 3% of full scale on AC

Input Impedance:
11 megohms on all ranges.

Frequency Response:
50 Hz to 50 KHz

Batteries:
Ten 1½-volt "AA" cells, NEDA #15.

Amphenol Model 870 (Fig. 7)
Specifications

DC Volts
Ranges:
0 to 0.1, 0.3, 1.0, 3.0, 10, 30, 100, 300, 1000

AC Volts
Ranges:
0 to 0.01, 0.03, 0.1, 0.3, 1.0, 3.0, 10, 30, 100, 300

dB
Ranges:
—40, —30, —20, —10, 0, +10, +20, +30, +40, +50 (—12 to +2 Scale)

Accuracy:
± 3% of full scale on all ranges from 50 Hz to 50 KHz.

Input Impedance:
10 mv to 1V, 10 megohm shunted by 31 pf.
3V to 300V, 10 megohm shunted by 20 pf.

Weight:
5 lbs. (includes batteries)
4.5 lbs. (less batteries)
8.5 lbs. (shipping weight)

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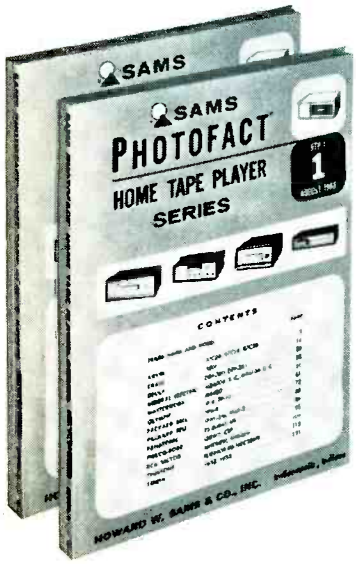

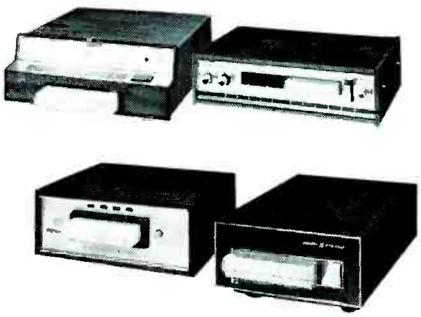

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that it provides only a **coarse** zero adjustment, functioning to compensate for component aging and tolerances in manufacture. When a DC voltage is applied to the input of Q1, the balance existing between Q1 and Q2 is upset. The meter will indicate in proportion the amplitude of the applied voltage. Seven DC and AC ranges are supplied by the input voltage dividers, R1 through R8. Capacitors C2 through C8 provide compensation for the dividers for measuring AC voltages. The DC Calibrate control (R15) is, as the name implies, used to calibrate the meter on the DC scale. A known DC voltage is applied to the meter; the DC Calibrate control is then adjusted to read accordingly. When a voltage whose amplitude exceeds the setting of the range switch is applied to the gate of Q1, a neon bulb (NE2) conducts (fires), holding the applied voltage to a safe level and, thus, preventing damage to the FET.

Resistance

Resistance readings are accomplished by applying the battery voltage across a voltage divider consisting of the unknown resistance and a resistor of a known value (R9 the known resistance for Xl range, R10 the known resistance for X10 range, etc.), then reading the voltage developed across the known resistance. Originally, with the unknown resistance having a value of zero (leads shorted together), the Ohms Adjust control (R23) is adjusted so the meter reads full scale (the total battery voltage supplied by B1 is applied across Q1). When an external, unknown resistance is placed between the leads, the meter will read proportionately lower, depending on the value of resistance. This is due to the voltage drop across the divider network. The voltage applied (battery voltage) divides across the known and unknown resistors according to the value of the unknown resistance.

AC Measurements

The input AC voltage is applied to Q1 through a voltage divider network consisting of R2 through R8, as was also true for operating in the DC volts mode. The output of Q1 is coupled to a peak-to-peak detector consisting of capacitors C10, C11, and diodes X1 and X2. The DC output of the peak-to-peak detector circuit is applied to Q2 through a coupling network composed of R25, R26, R27 and X6. The meter movement is connected to the source circuit of Q2; therefore, the meter indication is proportional to the peak-to-peak AC voltage applied to Q1. Diodes X5 and X6 function to compensate for temperature changes, keeping the meter indication accurate over a temperature range from 32° to 122° F. Diodes protect the meter movement from excessive overloads of several amperes. Resistor R24 functions to protect diodes X3 and X4 and will open when the maximum current ratings of the diodes are exceeded.

Fig. 8. Sencore Model FE14 FET meter.

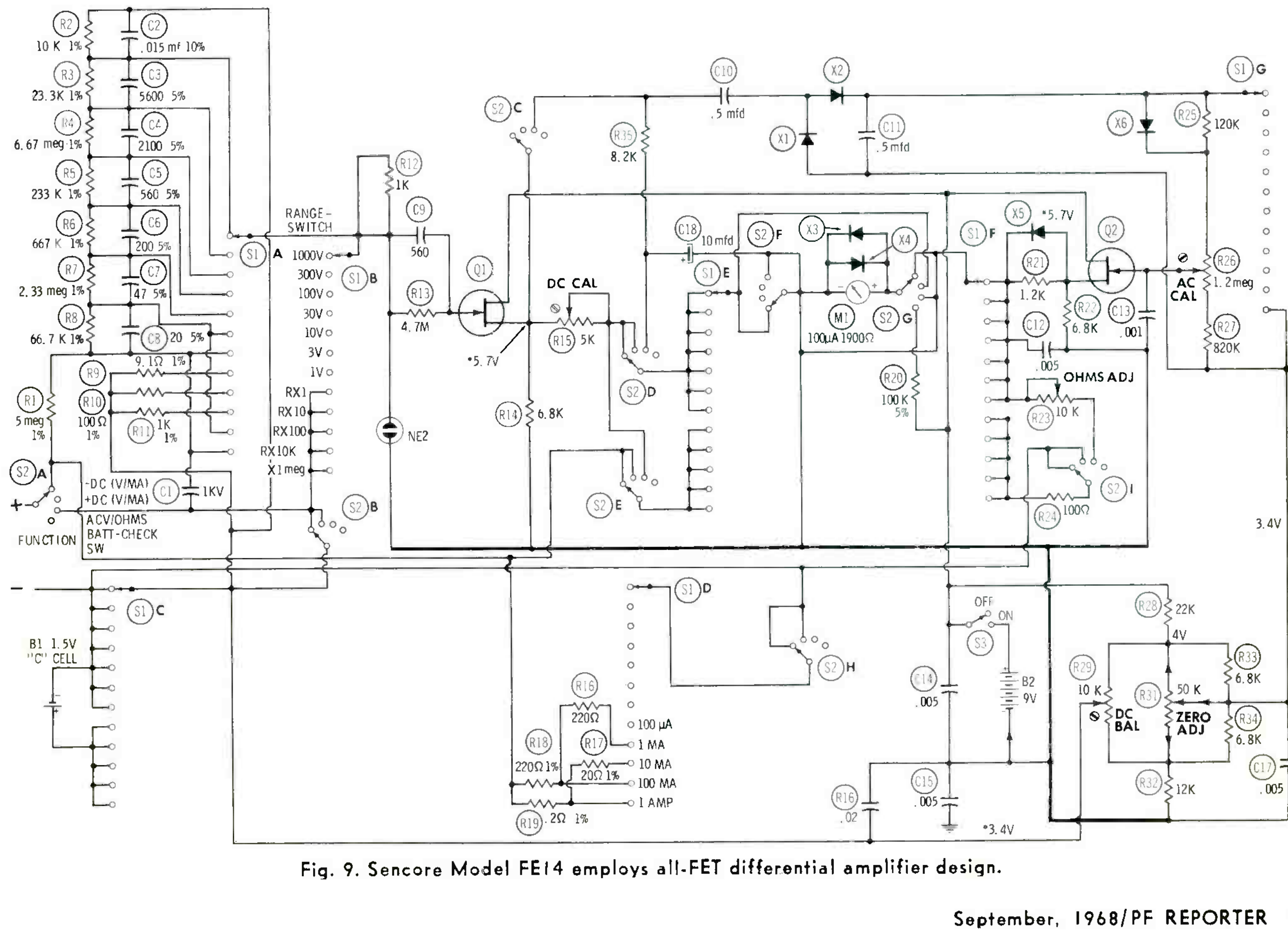

Fig. 9. Sencore Model FE14 employs all-FET differential amplifier design.

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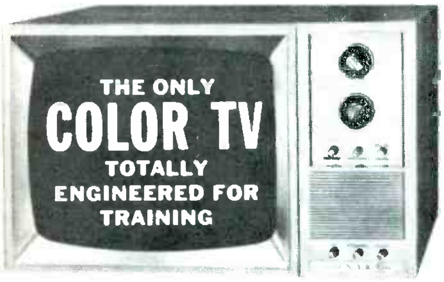

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Sencore Model FE16 (Fig. 10)

Sencore is shortly going to make available Model FE16, identical in size and specification to Model FE14 but with closer tolerances and geared for industrial electronic functions. Accuracy of the FE16 will be 1.5 percent on DC ranges and 3 percent for AC ranges.

Fig. 10. Sencore Model FE16 FET meter.

Sencore Model FE149 Senior (Fig. 11)

Another new model proposed by Sencore is a bench-type FET meter, Model FE149. It will feature pushbutton range and function selection, with a 15-megohm input impedance on both AC and DC ranges. Included in the specifications of this model are: true peak-to-peak on AC volts, AC and DC current ranges, calibrated zero center and a 6-ohm center-scale ohms range that will measure up to 6,000 megohms. Model FE149 also features a unique three-way power system. It can be operated either from an AC line, from a rechargeable battery system or while the batteries are recharging. A simple probe is used on all functions of Model FE149.

Sencore Model FE14 Specifications

DC Volts

Ranges:
0 to 1, 3, 10, 30, 100, 300 and 1000, full scale —.5 to .5, —1.5 to 1.5, —5 to 5, —15 to 15, —50 to 50, —150 to 150 and —500 to 500, zero center scale ranges.

Input resistance:
15 megohms shunted by 14 pf.

Accuracy:
+3% full scale from 32° F. to 122° F.

AC rejection:
30 to 300 times (30 to 50 dB).

AC Volts

Ranges (Rms):
0 to 1, 3, 30, 100, 300 and 1000 full scale, frequency compensated.

Ranges (peak-to-peak):
0 to 2.8, 8.4, 28, 84, 280, 840 and 2800, full scale, frequency compensated.

Input resistance:
10 megohms shunted by 29 pf.

Frequency response:
Flat from 25 Hz to 1 MHz.

Accuracy:
±5% full scale from 32° F. to 122° F.

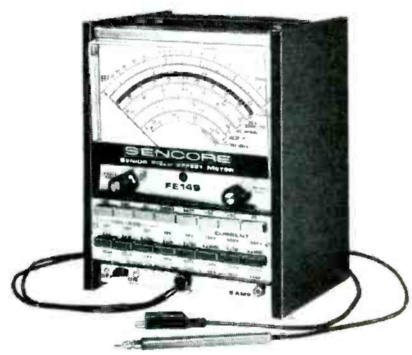

Fig. 11. Sencore Model FE149 FET meter.

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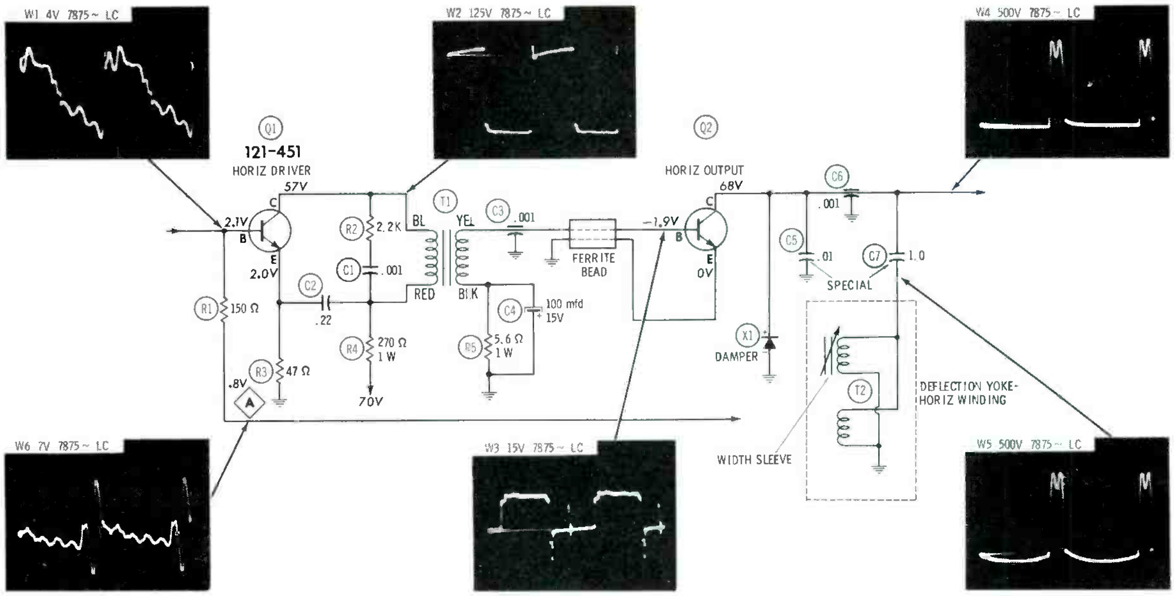

DC VOLTAGES taken with VTVM—no color signal input. *Indicates voltage taken with color-bar input—see "Operating Variations."

WAVEFORMS taken with wide-band scope; TV controls set to produce normal color-bar pattern. LC (low-cap) probe used to obtain all waveforms.

Normal Operation

Circuit shown (Zenith Ch. 1Y21B55) is typical horizontal driver/output stage used in both small- and large-screen, all-transistor TV receivers. Configurations may vary, but action is similar. Driver stage receives pulses at horizontal rate, shapes signal into square wave, and powers the output transistor. Both driver and output transistors operate as switches; driver conducts only on positive pulses from oscillator. Output transistor is cut off during negative portion of waveform present at base, but conducts heavily during positive-going portion. Zenith Ch. 1Y21B55 uses sine wave horizontal oscillations at collector (sine-wave pulse occuring at horizontal rate). Emitter is direct-coupled to base of Q1 (driver); oscillator collector pulses are shaped into a square wave (W1). Q1 (NPN) conducts on positive portion; collector output is square wave with positive portion starting simultaneously with occurrence of horizontal sync pulse. W2 is transformer-coupled (matches impedance of Q1 collector to Q2 base) to output stage. With transformer inversion of signal, first portion of W3 (negative going) drives Q2 into cutoff, second half cycle (positive going) saturates Q2. Output transistor (Q2) circuit action: During Q2 cutoff capacitor C7 discharges through yoke winding, deflecting CRT electron beam linearly. At center of trace Q2 becomes saturated by positive portion of W3 and conducts heavily, supplying power to yoke, sustaining remainder of trace. Combined action—Q2 cutoff/saturated—results in linear trace across CRT (W4, W5). At end of trace W3 drives Q2 into cutoff, causing overshoot pulse in flyback transformer. This pulse reverses yoke current, producing retrace. Capacitor C7 charges during Q2 conduction time.

Operating Variations

Q1 Very slight DC variation with changing signal strength; drops approximately 0.1 volt only because B+ source drops approximately 0.1 volt. Adjustment of horizontal hold control to point where picture is out of sync effects a slight change in contour of wave shape; however, basic peaks remain the same.

Q1E, Q1C Little or no variation at these points in either voltage or waveshape. Neither signal strength nor adjustment of control produces a change in waveshape or amplitude.

Q2B,C Very slight change with signal variation, voltage difference caused by slight change in B+ source voltage. Contour and magnitude of waveforms remain fairly constant.

Yoke-Input Contour and magnitude of waveform remains fairly constant under change of signal strength. Slight variation in voltage although contour of waveshape does not change when brightness control is varied.

Boost Signal voltage composed of rectified output of Q2. This signal then filtered and used for focus action. Magnitude of signal voltage remains fairly constant under different signal strengths and control adjustments.

High Voltage High voltage varies 1.5K from minimum to maximum brightness control settings; 20KV at normal brightness, 19KV at maximum brightness and 20.5KV at minimum.

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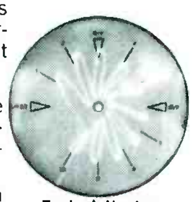

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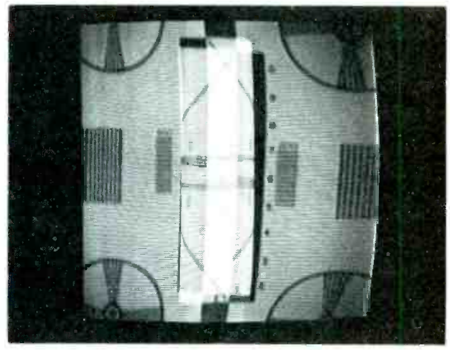
SYMPTOM 1

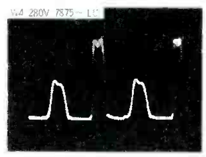
Horizontal Foldover

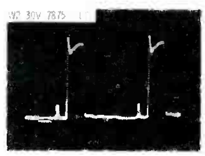
Narrow Picture
R4 Increased in Value
(Q1 Collector—270 ohms, 1 watt)

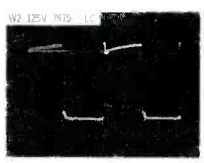
Symptom Analysis



Raster shows 2″ to 3″ foldover in center of screen. Width is insufficient regardless of adjustment of width sleeve. Picture is dim and slightly out of focus. High-voltage measures 10KV but blooms slightly more than normal. Vertical sweep excessive; however, controls work normally.



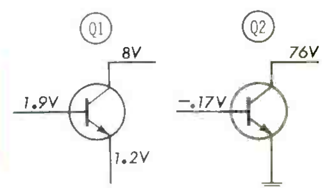




Waveform Analysis

W4 is key: large pulse decreased to 280 volts p-p with an unaccountable trailing pulse. W1 is decreased (3 volts p-p, normally 4 volts p-p), but sufficient basic content provides proper square-wave output at collector of Q1. W2, at Q1 output, indicates timing is off (Q1 not on long enough during each cycle). W2 is reduced (30 volts p-p. normally 125 volts). W3 supports findings of W2 (5 volts p-p, normally 15 volts). W6 could also be key: only 3 volts p-p compared to normal 7 volts.

Voltage and Component Analysis



B+ on collector of Q2 measures higher than normal, indicating horizontal output stage not conducting. B+ source voltage is high (77 volts). Reading at Q2 base (—0.17V) indicates reduction in drive. Q1 collector measures only 8 volts—condition affects B+ and bias circuits. Symptom usually originates as compression in center of screen, critical horizontal sync or "Christmas tree" when brightness control advanced. Reduced amplitude of W2 is relevant, but important clue is change in "on-off" cycle of square wave. Shorter duration of "on" cycle, coupled with voltage inversion in T1, reduces cutoff time of Q2, distorting W4 and W5.

Best Bet: Scope, then VTVM.

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SYMPTOM 2

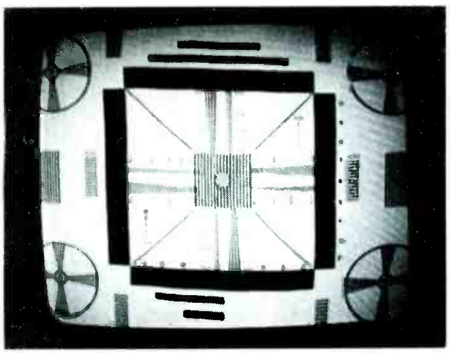
Narrow Raster

Dim Picture

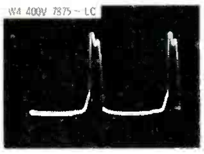
Q1 Leaky

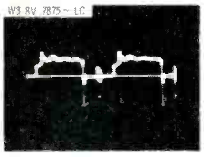
(Horizontal Driver—NPN)

Symptom Analysis



Right side of raster lost. Raster can be expanded by centering and adjusting width sleeve. Right side compressed, left side expanded. Raster blooms when brightness control is advanced; focus poor; second anode voltage low (10 to 12KV, normally about 20KV with normal brightness adjustment).

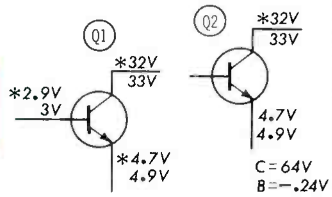




Waveform Analysis

W4 and W5 appear near normal in content but reduced in amplitude (W4 at 400 volts p-p, W5 at 420 volts p-p, normal is 500 volts). W3, only about 50% of normal amplitude, also shows distortion—not a linear square wave—positive-going portion (used to switch Q2 "on") of shorter duration than negative portion. W2 weak in amplitude and distorted (positive-going portion much longer in duration than negative portion). W1 slightly increased in amplitude—proper polarity, but distortion is evident.

Voltage and Component Analysis



The clue is reduced Q1 collector voltage (32 volts, normally 57 volts). Q1 emitter voltage is above normal and Q1 is potentially cut off, producing change in switching time. Further increase in Q1 leakage will completely cut off Q1 and raster will disappear. VTVM readings indicate 470 ohms between collector and emitter of Q1. Right side of raster is affected since second half of trace and retrace is produced by conduction of Q2. Leakage of Q2 reduces drive signal at Q2 base, therefore limiting conduction of Q2. In this instance, Q2 conduction allows nearly normal high-voltage production and flyback action.

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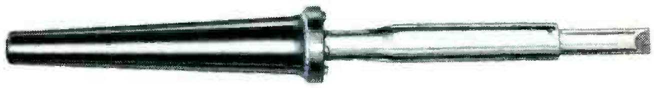

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SYMPTOM 3

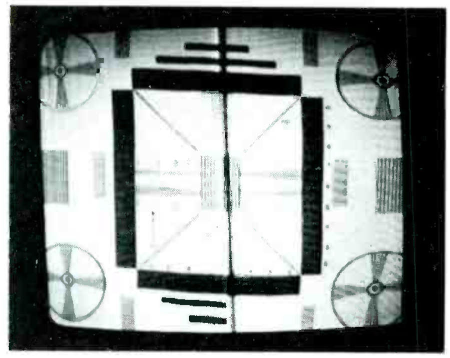
Center Drive Line

Christmas Tree Effect

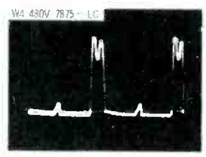
R5 Increased in Value

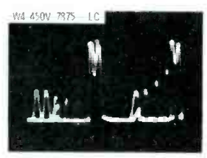
(5.6 ohms, 1 watt)

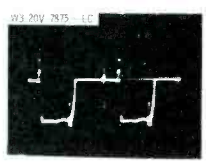
Symptom Analysis



Drive line in exact center of screen. Raster narrow; can be adjusted with width sleeve. Raster has Christmas tree effect at higher brightness control settings. High-voltage decreased slightly (18KV) at normal brightness; drops to approximately 15KV at maximum.



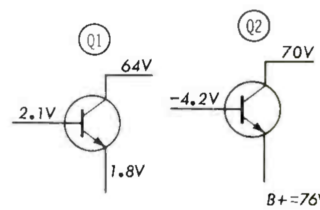




Waveform Analysis

First W4 amplitude near normal; however, spike halfway through trace causes compression of raster (drive line). Second W4, taken with brightness control advanced, contains series of spikes associated with Christmas tree effect which places increased load on output transformer. Amplitude of W3 increased 30 to 35% and slightly distorted (negative portion longer). W2 amplitude also increased (200 volts p-p, normally 125 volts), and distorted interval of negative-going portion should be shorter. W2 indicates defect probably in drive control circuit.

Voltage and Component Analysis



Relatively high bias voltage at base of Q2 is best clue (—4.2 volts, normally —1.9). Negative bias on NPN type transistor misleading, but bias set so that Q2 conducts only on positive-going portion of square wave, cut off on negative going portion. In this instance, incorrect bias upsets Q2 switch-action timing. Trouble compounded by interaction of stages. Example: horizontal oscillator emitter bias is through R1 to bottom of output secondary winding and a 100-ohm resistor to B—; thus, erroneous output signal is fed back to oscillator through driver output stage.

Best Bet: VTVM for voltage and resistance.

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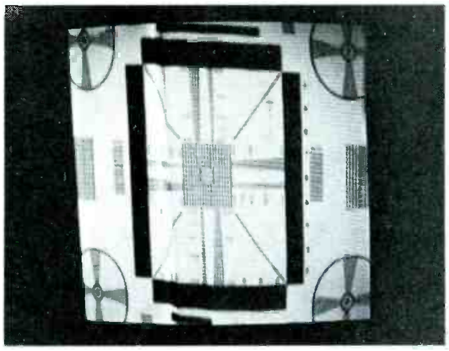
SYMPTOM 4

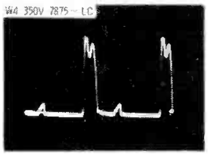
Narrow Raster

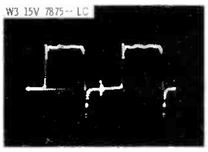
Raster Compressed At Left Center
X1 Leaky
(Damper Diode)

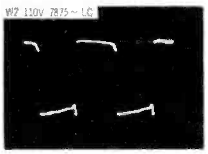
Symptom Analysis



Raster quite narrow, drawn in from both sides with distinct horizontal drive line (compressed area) at the left center portion of the screen. Raster blooms when brightness control is advanced. Picture and sound information normal.



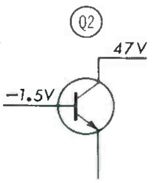




Waveform Analysis

Waveform at Q2 collector (W4) is low in amplitude (350 volts p-p, compared to a normal of 500 volts). Content distorted showing a positive going spike (same direction as retrace) about halfway through trace, thus indicating the compressed area of raster. Waveform W3 at base of Q2 is near normal in content and amplitude, a symmetrical square wave with negative going spikes, the first spike initiates Q2 cutoff, the second has no effect as Q2 is cut off at this time. W2 also near normal in content and amplitude. Waveform analysis isolates trouble to Q2 or Q2 output circuitry.

Voltage and Component Analysis



Q2 collector voltage decreased to 47 volts, 13 volts below B+. Collector supply circuit is through 10-ohm varistor and primary of output transformer, should be little drop in voltage. Horizontal output circuit is major portion of total load on B+ supply. Short causes severe B+ loading. Leaky capacitors C5, C6 or C7 could cause similar symptom, as could Q2. Damper diode serves same purpose as tube type, but if diode (damper) opens only linearity is affected since Q2 acts as damper. High voltage not lost as boost, not supported from damper circuit.

Best Bet: Scope, then VTVM.

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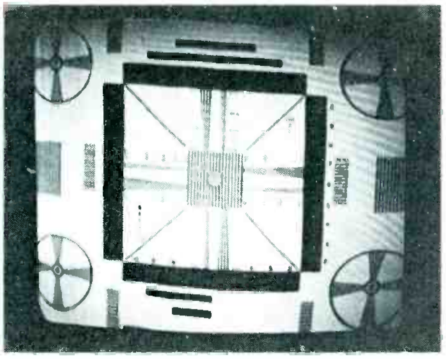
SYMPTOM 5

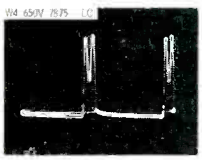
Narrow Raster

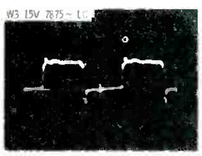
Linearity Near Normal
C5 Decreased in Value
(Flyback Tuning Capacitor)

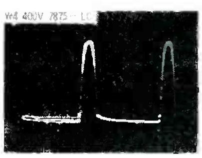
Symptom Analysis



Raster narrow. Vertical sweep near normal; width sleeve adjustment helps, but corner shadows appear before attaining proper width. Horizontal linearity slightly off—compression at left, expansion at right. Brightness excessive. Second anode voltage 22KV at normal brightness (should be 20KV).



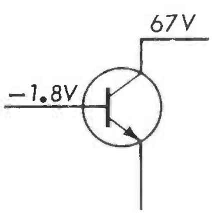




Waveform Analysis

W4 has relatively linear baseline portion (nearly straight line), retrace portion is distorted—instead of one pulse with dip at peak, it is now two separate spikes, and amplitude is excessive (650 volts p-p, normally 500 volts). Increased amplitude of W4 results in incorrect control of CRT electron beam—trace completed before entire screen scanned. W3 near normal in content and amplitude, isolating defect to output stage. W5 shows results of change in capacitance of C5.

Voltage and Component Analysis



DC voltages measure well within tolerance and offer no clues to the source of trouble. Primary function of capacitor C5 (in conjunction with other components in circuit) is to resonate with flyback and yoke inductances at a frequency of 50KHz. C5 value is extremely critical and should be replaced only with capacitor having exact same specifications. A small change in either direction results in a noticeable change in raster width and the amplitude of high voltage.

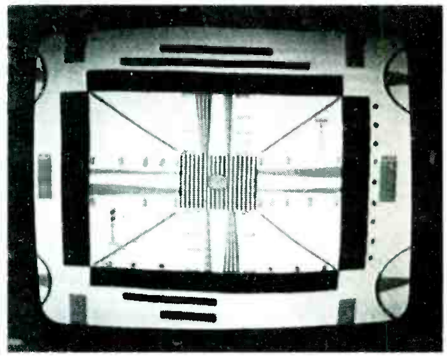
Best Bet. Careful scope work; component substitution.

SYMPTOM 6

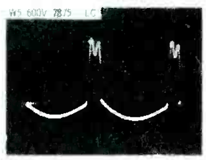
Excessive Width

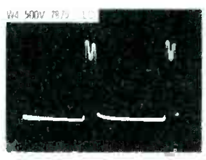
Vertical Sweep Normal
C7 Decreased in Value
(Yoke Coupling—1 mfd)

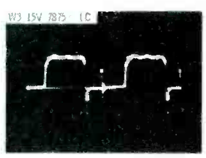
Symptom Analysis



Raster far too wide. Vertical sweep appears near normal. Much of picture is lost at edges. Width sleeve adjustment narrows picture but in process causes nonlinearity, compressed edges, and expanded center. High voltage is normal, but some blooming at maximum brightness.



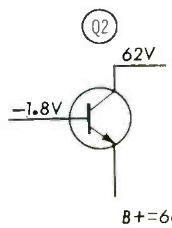




Waveform Analysis

Waveform W5, at input to horizontal deflection coil, distorted, excessive in amplitude (600 volts p-p versus normal 500 volts), dropping to an exaggerated low in base line portion. Waveform W4 is normal in both content and amplitude. Waveform W3, at input of Q2, is also normal in content and amplitude. Due to the interaction of components in the output stage, waveform analysis is far more useful in isolating a defective stage than in attempting to isolate the specific defective component.

Voltage and Component Analysis



Q2 collector voltage lower than normal, but within tolerance. C7 is close-tolerance capacitor and should be replaced only by exact type. Functions of C7: block DC from deflection yoke, couple and shape yoke drive signal. C7 charged during Q2 conduction cycle. Q2 ceases conducting at end of trace, flyback ringing starts, large pulses reverse yoke current (retrace). X1 damps ringing pulses as C7 discharges through yoke, producing linear trace through first half of sweep.

Best Bet: Scope; component substitution.

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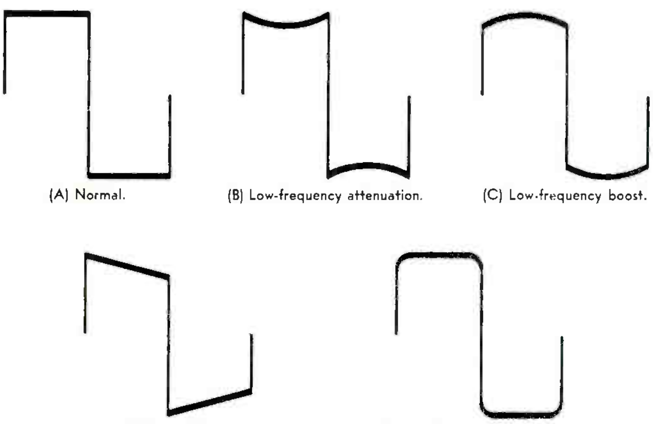
THE TROUBLESHOOTER

Smear

There is a trouble symptom that has plagued me on several occasions. This symptom has not been covered, to my knowledge, in any of your books or in PF REPORTER. It is a symptom where the brightest reproductions of white cause a smear in the direction of the scanning. This is especially true if the white object parallels the scanning lines. In extreme cases the white smear extends horizontally across the entire picture. Small portions of the picture, or the lettering is surrounded by a small, round arc.

NORBERT SHRINEK

Hutchinson, Minn.



(A) Normal. (B) Low-frequency attenuation. (C) Low-frequency boost. (D) Phase shift. (E) High-frequency attenuation.

The symptoms are interesting but due to their infrequency we have not made them the subject of an article. Our plans for the next few issues do not include this subject; however, we will keep it in mind.

The causes of this symptom seem to fall into three categories: video amplifier malfunction, vertical deflection breakdown, or a defective CRT. The smear that follows the brightest reproductions of white on the CRT can be caused by a number of component failures in the video amplifier stage. A leaky coupling capacitor, an open cathode or screen bypass capacitor, change of value in resistors, or a defective peaking coil can give this indication.

A good method of isolating this trouble is through the use of a square-wave generator and scope to check the square-wave response at 30 Hz (for low-frequency response) and then at 200 KHz (for high-frequency

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response). A 200 KHz signal contains harmonics up to several megahertz. By observing the waveshape of the video output circuit you can determine the quality of reproduction and amplification of the video output stage.

Some of the basic distortions found in video amplifiers are shown here. Most video amplifiers will have some overshoot on the leading edge of the square wave. This is done to provide for extremely fast rise time. However, this overshoot should be less than 10 per cent to prevent undue distortion.

The compression or folding of the raster during vertical scan is sometimes caused by insufficient filtering in the power supply or in the vertical output stage. Leakage and/or loss of capacitance can allow spurious signals to feed into the vertical circuits. Bridging of the capacitors does not always correct this. The best method for isolating this defect is to use the scope to visually inspect the power supply output and the voltage on the control grid of the vertical output stage. A small spike on the linear portion of the sawtooth waveform is a classic indication of an unwanted signal feeding into the vertical section.

Multiple Symptoms

I have in for repair a Catalina Model 122-772B. The original complaint was a blurry picture. Operation then degenerated, producing the following symptoms: a decrease in vertical sweep, double image (at times) and an increase in brightness resulting in an increase in vertical sweep with blooming and loss of focus. All components related to the vertical section have been replaced. The high-voltage rectifier, horizontal output, and horizontal oscillator have also been replaced. Are these symptoms related?

PAT N. KILLDORD

Taylor, Texas.

The trouble causing the symptoms you describe is not necessarily located in the vertical section. You made no mention of the boost voltage. I suggest you check that and the current through the horizontal output tube (V9). Also, check and adjust the high voltage applied to the anode of the CRT.

Intermittent Boost

I am working on an RCA CTC19D color chassis. The symptom is no picture; sound normal. Boost voltage is reduced by 50 percent. All source voltages are within tolerance. In checking the horizontal AFC, oscillator, and output stages I found the abnormal readings shown in Table 1.

Table 1

V10					
Pins	*1*	*2*	*3*	*6*	*7*
Voltage	*15V*	*—0.5V*	*0.3V*	*235V*	*0.15V*
V11					
Pins	*1 and 7*		*2 and 6*	*8*	
Voltage	*15V*		*4.5V*	*50V*	

I have checked all tubes including the CRT and they are okay. All resistance measurements (using the

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Got a Troubleshooting Tip?

If you've recently run across an unusual trouble symptom and have determined what caused it, why not pass the information on to the other readers of PF Reporter? You'll not only be saving other service technicians valuable troubleshooting time, you'll also be making a little extra change yourself. Send a thorough description of the trouble symptom and the solution along with a brief discussion of your troubleshooting technique to:

Troubleshooting Tip
PF REPORTER
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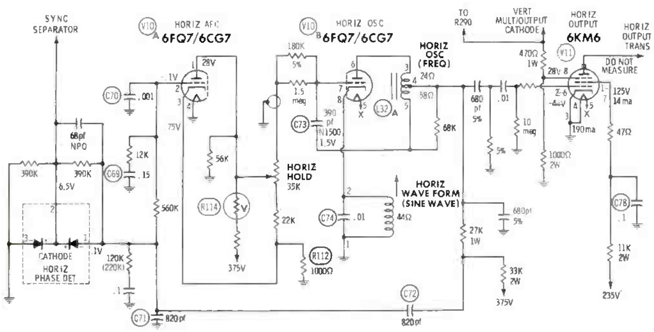
voltages indicated in Photofact *Folder 909-2 as a standard) are within tolerance with the exception of V202. Pin 3 reads 10K ohms instead of 70K ohms and Pins 6 and 9 read 8K ohms instead of 71K ohms and 80K ohms, respectively.*

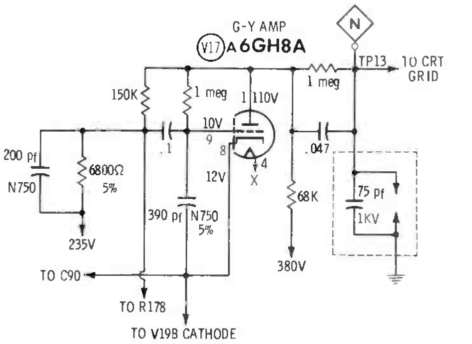
I feel the trouble is located somewhere in the horizontal circuits. I have checked practically every component in these circuits, including a resistance check of T4. While I could find nothing defective, I did replace the boost rectifier (X5).

In making some further checks, using my oscilloscope, I allowed the probe to slip from Pin 2 of V11. Immediately the screen was illuminated. I made some necessary adjustments and got a picture on the CRT. However the picture is pulled in from each side and the horizontal hold control has no effect. When setting the service switch to "service" nothing appears on the CRT. In the "raster" position I get a green tinted screen.

Edward Barnes

Mineola, New York





You are experiencing multiple difficulties. The voltages you measured while troubleshooting indicate that the horizontal oscillator stage was inoperative. When your oscilloscope probe slipped during waveform measurements the oscillator was shocked or excited into operation. Check the voltage dependent resistor (VDR) R114 on Pin 1 of V10. This could be the cause of your intermittent horizontal oscillator.

The second problem (green tinted raster) could be caused by either of two defects. Very likely it is V17A, the G-Y amplifier. When this stage becomes inoperative, the voltage on Pin 7 of the CRT will increase. This voltage increase results in a decrease of the bias applied to the green gun of the CRT, effectively increasing its conduction, producing the green raster.

Another item to check is the chroma reference oscillator. A bad crystal also can cause the green tint you describe.

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PRODUCT REPORT

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

Power Adapter
(55)

An AC adapter for use with 12- and 14-volt mobile transceivers has been developed by the **Amphenol Corporation.**

The new universal power supply is the first AC adapter ever designed to provide instant DC power for almost all transistorized in-car shortwave radio transceivers. Known as the Amphenol Model 790 "Power Pedestal," the AC to DC adapter requires no special connectors, mounting straps, terminal lugs or alignment pins. Two magnetically impregnated rubber mounting strips hold the transceiver in place. Electrically isolated from the supply circuit, they permit use with any mobile transceiver that has a flat metal base surface. Chassis isolation enables instant termination to both positive and negative ground communications sets. Electrical connections are made to two binding posts, clearly marked for polarity, at the rear of the power supply chassis.

A transistor capacitor/multiplier configuration serves to increase apparent circuit filtering capacity automatically as the load is varied. The unit exhibits five percent output regulation with only 0.05 percent ripple (low current ripple: 0.4

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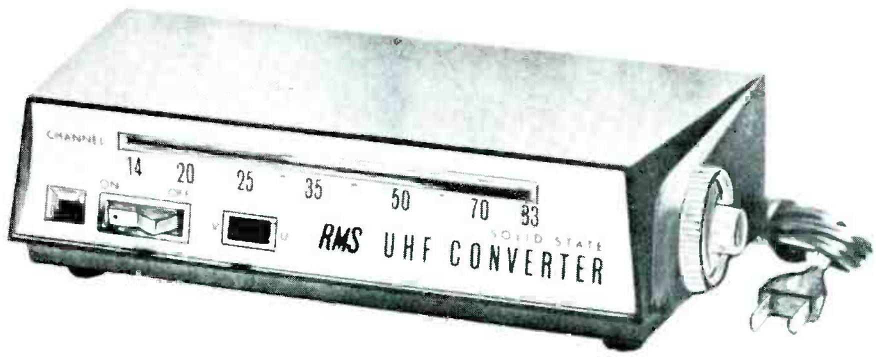

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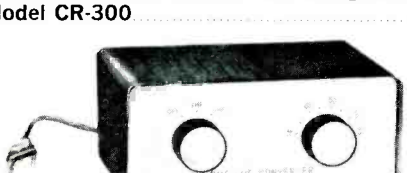

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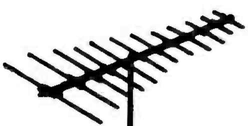

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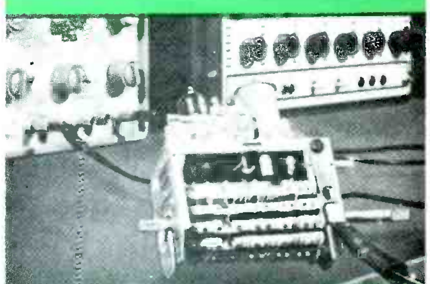

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Model 790 is solid-state throughout, featuring dual rectifier diodes, 2N544 transistor capacitor/multiplier and ZA-14 zener diode voltage regulator.

Housed in an inclined silver and blue case, the unit weighs 4 lbs., measures 3″ x 6″ x 8″, and is priced at $29.95.

Tape Case
(56)

The **Winegard Company** has announced the availability of the Tape-Case. The portable cabinet for home and auto has been designed to file and protect both 4- and 8-track tape cartridges. The case measures 11⅝″ x 6″ x 5¾″ and holds as many as nine cartridges.

The cabinet is molded of high impact polystyrene and rollback doors are polypropylene in off-white to coordinate with the walnut grain vinyl top and bottom.

The versatile case sits on side, end or bottom and is lightweight. Price is $5.95.

Compressor-Preamplifier
(57)

Caringella Electronics announces the new solid-state Model ACP-1 Compressor-Preamp. The unit is available as a kit or completely wired and tested.

The Compressor-Preamp can be used with any tape recorder for automatic control of recording level,

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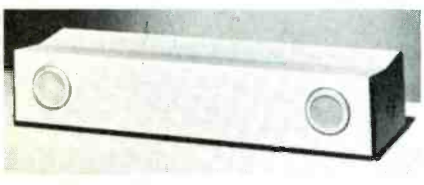
and with any P.A. system for maintaining a constant output level and eliminating annoying feedback. The unit is also a useful accessory for amateur radio and CB transmitters, providing added modulation "punch" and protection against overmodulation.

A low-noise, high-impedance FET input stage is utilized in the five-transistor one-diode circuit. The compression range is 30 dB. Frequency response extends from 20 to 20,000 Hz. Input and output signal levels are completely adjustable. The unit installs in the microphone line of any tape recorder, PA system, amateur radio or CB transmitter. Printed-circuit layout and easy-to-read instructions are included with the kit. Months of power are provided by an internal 9-volt battery. The unit is housed in a 2½" x 3" x 4¼" metal cabinet. Kit price is $18.50. Wired and tested units are $26.50.

Ultrasonic Annunciator
(58)

The **Euphonics Corporation** has developed the first ultrasonic annunciator for use in offices, homes and stores. The Model AN-1 will cover an area rather than just a specific entrance. In addition, the unit can double as a short-range intrusion alarm when the premises are not occupied and the annunciator function is not needed.

Use of the ultrasonic principle eliminates the need for photocells, light sources, and installation wir-



ing. The AN-1 plugs into any standard 110-volt AC outlet and is aimed at the general area to be covered. A standard AC receptacle at the rear accepts a line cord from a chime, a bell, buzzer, lamp, or any combination that does not exceed 5 amps. Small motors also may be connected to this outlet if desired.

Upon detection of motion produced by a person coming into the protected area, or by a door opening, etc., the AN-1 triggers the device connected into its outlet, announcing their presence. After 15 seconds, the unit resets itself, and is ready for the next visitor.

A timer control switch is provided with two positions. In the "short" position, the device controlled will ring on sound for an instant, as an annunciator signal. In the "long" position, the device controlled will go on for 45 seconds. The latter position is used to control a loud bell when it is desired to use the AN-1 as an intrusion alarm.

The range of the unit is adjustable from 4′ to 15′. Power consumption is 3 watts. Universal mounting brackets are supplied, but a special swivel mount model, ANS-1, also is available at slightly higher cost.

The case is gray aluminum with black end panels. The size is 2" x 11" x 2½". The circuitry is all solid state. Price is $64.95.

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- **Grid Leakage Test with ultra-high sensitivity of 100 megohms**
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- **Mighty Mite accurately checks over 3,000 tubes, including foreign**

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TC142

Now, Sencore's new Mighty Mite V gives you the same reliability and accuracy, plus new features that make the "V" the most up-to-date tester of all.

NEW—Magnoval socket so you check many more tubes.
NEW—Horizontal in-line switch layout saves setup time.
NEW—Rugged vinyl-clad steel case stays new longer.
NEW—Brushed chrome panel; detachable cover.

The new TC142 is truly Sencore's mightiest Mighty Mite and it's only $79.50

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WORKMAN *believes* that they make the best circuit breakers in the industry and are willing to send you one FREE to prove it.

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CIRCUIT BREAKERS

Model Numbers FA1.5 to FA7

When Red Button is depressed, contacts remain open, circuit is refused ONLY after Red Button is released.

RECOGNIZED UNDER THE COMPONENT PROGRAM OF

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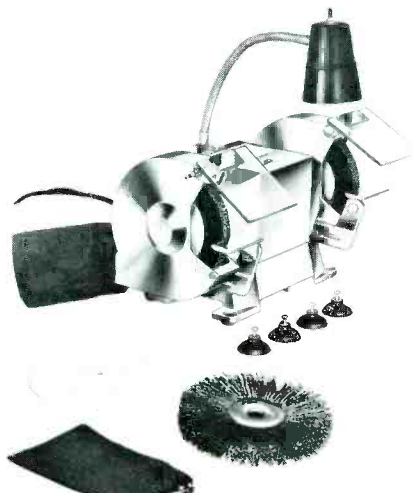
Circle 35 on literature card

Bench Grinder
(59)

A new, multi-feature electric bench grinder has been introduced by **Wen Products, Inc.** It features dynamically balanced 6″ grinding wheels ventilated for smooth, quiet, cool running using heavy duty precision ball-bearings and a 1/3 horsepower, 8.5-amp shaded pole motor delivering 3450 RPM, plus calibrated and adjustable tilting tool rests.

Also provided are two dynamically balanced Carborundum grinding wheels that are 3/4″ thick with 1/2″ arbor and have 36 grit coarse and 60 grit fine finishes.



Other features include: adjustable see-through eye shields and spark arrestors; a sharpening groove in one of the tool rests to hold drill bits for proper sharpening angle; rear dust exhaust ports designed for dust collector bag attachment; combination rubber feet and mounting grommets that are predrilled for easy work-table mounting and quiet operation; enclosed steel wheel end-guards; and a heavy cast aluminum housing with a life-time Ball-Brite finish.

Model 1030 weighs approximately 16 lbs. Its overall dimensions are 9½″ x 5¾″ x 15″. The unit sells for $49.95. An accessory kit, Model 1030-K9, consisting of two dust collector bags, one flexible auxiliary lamp assembly, a 6″ wire scratch brush wheel, a 6″ buffing wheel and four rubber feet with screw attachments for vacuum mounting is also available for $11.34. The combined grinder and kit, Kit 1030-2, is priced at $50.95.

NEW!

- TUBE TESTER
- GRID CIRCUIT TESTER

✓ CHECKS B & W PICTURE TUBES
✓ CHECKS COLOR PICTURE TUBES

MODEL 88A IN NEW MOLDED ROYALITE CASE

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MODEL 88A Complete with Adapters $89.50 NET

Model 88A Less Adapters $84.50 NET

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1003 2nd St. So., Hopkins, Minn. 55343

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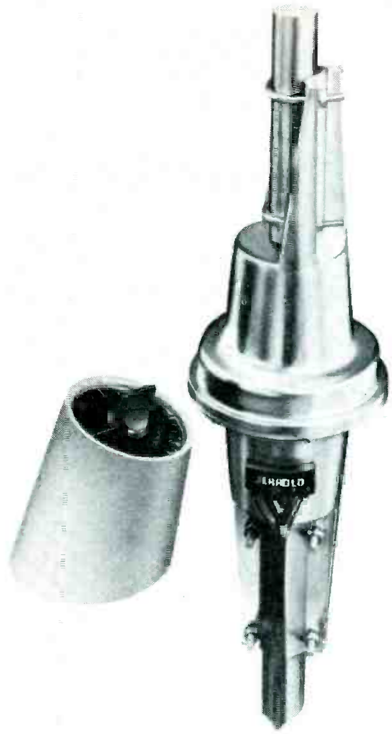
Rotator

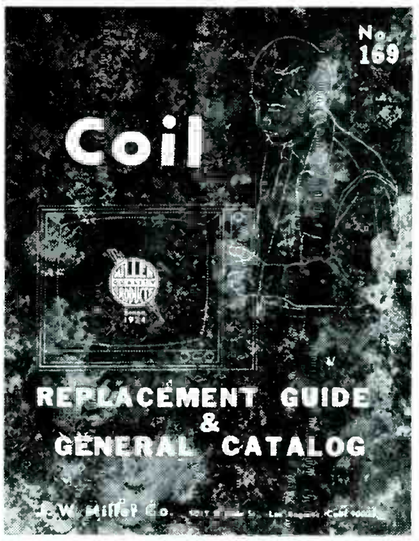
(60)



A new type of rotator for home television antennas has been introduced by **Jerrold Electronics Corporation.** The Dyna-Rotor combines an all solid-state control unit with a light home TV antenna rotor. Powered by a dynamic spline drive, with fewer parts and improved reliability the unit develops high starting torque to overcome inertia, wind and ice loading. According to the manufacturer, the Dyna-Rotor is capable of aiming and holding the antenna precisely in the directions of selected transmitters and has no need for auxiliary or mechanical braking devices. The mast-mounted unit is permanently synchronized with the control unit at the TV set and automatically locks into any selected position.

Housed in a sturdy cast aluminum case, the rotor assembly is 5″ high and 4⅜″ in diameter at its base and weighs five lbs. The Dyna-Rotor rotates the largest antennas 360° in less than 40 seconds. To operate the unit, a viewer turns the control knob to a marked position. There is no need to hold the knob in position. Price is $54.95.

New Coil Catalog and Replacement Directory



Catalog 169 gives prices, specifications and installation diagrams for the industry's most complete line of RF and IF coils. Replacement directory cross references exact replacement coils for all known color and black & white TV sets, home radios and car radios.

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SEE YOUR LOCAL DISTRIBUTOR FOR THE FULL LINE OF RF AND IF COILS, CHOKES, FILTERS AND TRANSFORMERS

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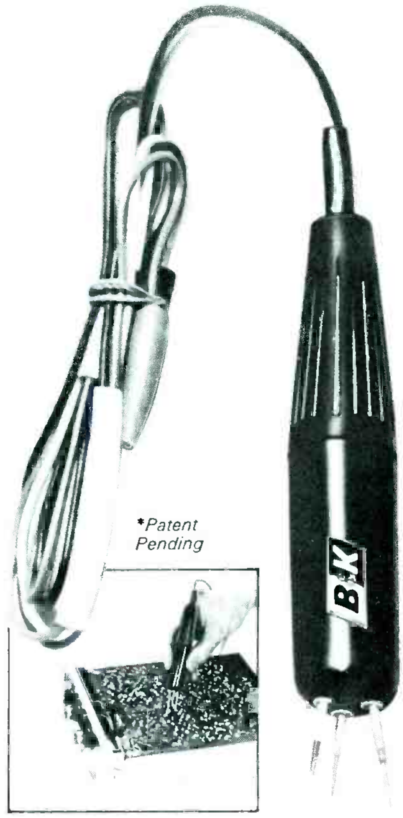
Dyna-flex*

the only practical probe for testing transistors in circuits.



*Patent Pending

Throw away your alligator clips! Dyna-flex, the world's first and only 3-point probe, makes instant test connections to transistors in printed boards. Easy to use, the Dyna-flex probes are spring-mounted on ball joints. Allow you to adjust to any spacing 1/32″ to 5/8″, using only one hand. Dyna-flex eliminates costly unsoldering; can be used to make temporary component substitutions on printed wiring boards. Each point is color-coded for fast, easy identification. Dyna-flex—another engineering breakthrough from B&K.

Model FP-3, **$12.95** user net

B&K

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Where Electronic Innovation Is A Way Of Life

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RATCHET-TYPE CHIMNEY MOUNT

With Stainless Steel Strapping

Catalog No. 8008
Suggested Net $4.28
(12′ lengths)

Catalog No. 8008-L
Suggested Net $5.10
(18′ lengths)

New in design . . . tops in materials . . . first in service life. Here is the quality-constructed two-bracket chimney mount designed to give maximum service in high wind, seasonal storms, adverse weather conditions. Available with 12 or 18-foot lengths of stainless steel strapping to fit any chimney, a locking "U" bolt that accepts antenna masts up to 1½" in diameter. This mount installs in minutes, requires only a single wrench to secure to chimney. Buy with confidence from the world's largest basic manufacturer of television hardware . . . you'll make your job easier, faster, and more profitable . . . more satisfying to your customer.

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you'll get more for your money, everytime!

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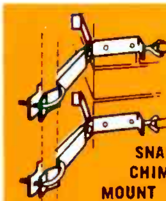
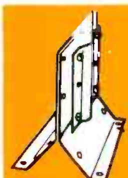
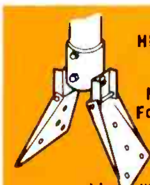


SNAP-IN CHIMNEY MOUNT with stainless steel strapping. For masts up to 1¾" in diameter. Catalog No. 8930 Suggested Net $3.16



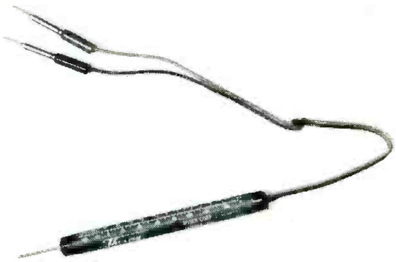
ALL-PURPOSE ANTENNA MOUNT For flat or angle roofs, and corners. Rust-resistant, heavy-gauge steel. For masts up to 1¾" in diameter. Suggested Net $2.01



HINGED-TYPE RIDGE MOUNT For peak or flat roofs, and side walls. Rust-resistant, heavy-duty steel. For masts up to 2" in diameter. Catalog No. 9022 Suggested Net $2.01

Electronic Thermostester
(61)

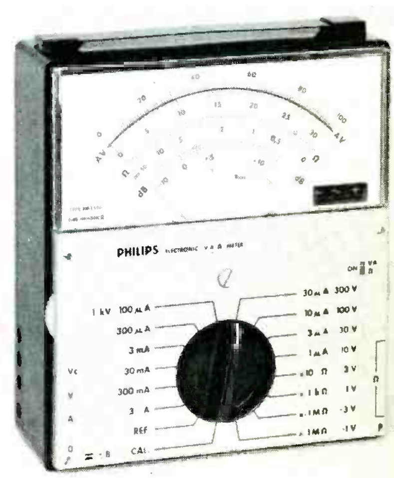
The **Mura Corporation** introduces Thermy, a patented device that electronically measures the temperature of any component from —60° to 400°F. (or from —50° to 200°C.). A sensitive thermal unit at the probe tip reacts instantly upon physical contact and reads



electronically when used in conjunction with a multitester or ohmmeter. A simple conversion scale is provided to translate values from ohms to degrees. Packaged in an attractive, protective case, it comes equipped with banana pins and phone tip adapters. Price is $12.50.

Multimeter
(62)

Phillips Electronic Instruments, Division of PEPI, has introduced the solid state PM-2400 multimeter. This unit can sense, through the use of logic circuits, DC (either polarity) or AC inputs without the need for switching and always reads up-scale. It operates 1000 hours on one set of batteries, is self-calibrating and provides 42 direct reading ranges with long, high-resolution scales. The PM-2400 automatically measures current, AC and DC, from 1 full scale to 3 amps full scale; voltage, AC and DC, from 100 mv full scale to 1KV full scale and resis-



tance from 0.5 ohms to 50 megohms. The unit has all the advantages of an electronic multitester without being power-time-bound. It floats as effectively as any passive VOM. Price is $130.

Screwdriver
(63)

A screwdriver for those working with electrical systems is the Moody #50 Insulated Reversible Pocket Screwdriver manufactured by **Moody Machine Products Co., Inc.**

The hollow handle is made of nylon which insulates against shock. The handle also securely stores the blades, and the hex head provides a strong grip as well as preventing the screwdriver from rolling away from the work area. Price is $1.50.

Scope Dolly
(64)

A new model scope dolly for laboratory and shop applications has been introduced by **Metal Dynamics Corporation.** The design of Model 61056 includes a 20° viewing angle which will accommodate

15 CRYSTAL MARKERS
3 SWEEP RANGES
ONLY $135

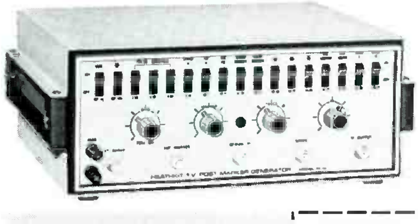
New Heathkit IG-57 Solid-State Color TV Marker/Sweep Generator

The IG-57 combines the features of both a post marker and a sweep generator for less than you'd expect to pay for just one of these functions.

• Three linear sweep ranges for TV tuned circuits in sound IF, color bandpass, video IF circuits and proper overall RF/IF response • External attenuator provides 1, 3, 6, 10 and 20 dB steps up to 70 dB maximum • Can also be used with external sweep or marker • 15 crystal-controlled markers provided for color bandpass alignment; picture and sound carrier frequencies for channels 4 and 10; FM tuner, FM IF and discriminator alignment; TV sound IF adjustments • All crystals included • Completely isolated 1-15 VDC variable voltage supply for positive or negative bias • Built-in 400 Hz modulation for trap adjustment and checking and adjusting FM tuners • Phase Control and Trace Reverse Switch so markers will appear from left to right as in set manufacturer's instructions, regardless of 'scope used • Blanking Switch eliminates return sweep and provides base line • Circuit Board Construction — three circuit boards, 27 transistors, 3 silicon diodes, 2 crystal diodes and 2 Zener diodes combine to make assembly faster with less chance of error • Bias and Scope Horiz. leads, Attenuator, Demod In, Scope Vert., RF and Demodulator cables included in kit.

Kit IG-57, 14 lbs., **$135.00; Assembled IGW-57** **$199.00**

IG-57 SPECIFICATIONS — **Marker frequencies:** 100 kHz; 3.08, 3.58, 40.8, 4.50 MHz, ±.01%. 10.7, 39.75, 41.25, 42.17 42.50, 42.75, 45.00, 67.25, 193.25 MHz ±.005%. **Modulation frequency:** 400 Hz. **Input impedances:** External Marker, External Sweep, & Attenuator — 75 ohm. Demod In — 220 k ohm. **Output impedances:** Marker Out, Sweep Output & Attenuator — 75 ohm. Scope Vert — 22 k ohm. **Bias voltage:** Positive or negative 15 volts DC at 10 milliamperes. **Type of marker:** Birdie. **Controls:** Bias control with pull-on/push-off switch; Marker/Trace — dual concentric; Sweep Width/Sweep Center — dual concentric; Marker Out — concentric with Sweep Range switch; Phase. **Switches:** Rocker type — separate switch for each of the above listed frequencies; Blanking, On/Off; Trace Reverse; Modulation On/Off. **Transistor — Diode Complement:** (19)-2N3692 transistor. (7)-2N3393 transistors. (1)-2N3416 transistor. (3)-silicon diode rectifiers. (2)-crystal diodes. (1)-13.6 volt zener diode. (1)-20 volt zener diode. **Sweep frequency ranges and output voltage:** LO Band — 2.5 to 5.5 MHz ±1 dB at 0.5 volts RMS fundamentals, and 10.7 MHz on harmonics. IF Band — 38 to 45 MHz ±1 dB, at 0.5 volts RMS, fundamentals. RF Band — 64 to 72 MHz ±1 dB at 0.5 volts RMS fundamentals, and 192 to 198 MHz on harmonics. **Attenuator:** Total of 70 dB of attenuation in seven steps — 1, 3, 6, 10, 10, 20 and 20 db. **Power requirements:** 120 volts, 60 Hz AC at 20 watts. **Dimensions:** 13⅜" W. x 5½" H. x 12½" D.



DON'T NEED THE SWEEP?
The IG-14 has the same features and specifications — without the sweep.

Kit IG-14
12 lbs. shpg. wt.
$99.95

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Describes these and over 300 other kits for test, stereo/hi-fi, color TV, SWL, Amateur Radio, CB, Marine, Educational, home and hobby. Save up to 50% the easy and enjoyable Heathkit way. Just mail coupon or write: Heath Company, Benton Harbor, Michigan 49022.

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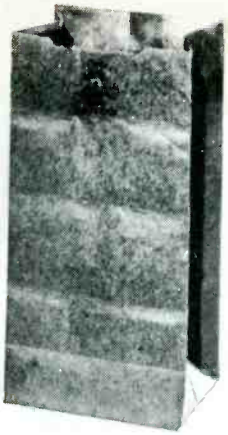

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Pick up this handful of best-selling needles from your Electro-Voice distributor, and you get a handsome display carton free.

And if you want more, ask about our permanent phono needle/cartridge merchandiser, wall banners, literature, and the best cross-reference catalog in the industry.

We don't just make the most complete line of needles and cartridges, we also help you sell ... help you profit. Insist on Electro-Voice. From the parts distributor with more than parts to offer!

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A SUBSIDIARY OF GULTON INDUSTRIES, INC.

Circle 41 on literature card

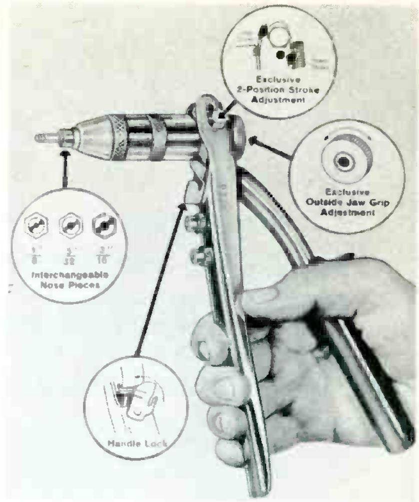
any popular type laboratory scope and a protective rubber gasket that prevents damage to the scope while installing or removing.

The unit features three convenient power outlets and one input; a storage area for spare preamplifiers, plus a storage pan for accessories, i.e., power cord, tools, manuals. Casters are 5″ diameter, ball bearing, swivel-type with semi-hard rubber wheels. It is equipped with adjustable brackets that range from 6″ to 12¾″ wide, from 16½″ to 22½″ long. The unit is constructed of cold rolled steel with a gray, textured, baked, enamel finish. Price is $59.95.

Riveter
(65)

A professional-style riveting tool called the Vaco Pow'Riveter No. 175002 has been introduced by **Vaco Products Company.** Besides being designed to reach into confined places and deep openings, it has other features.

The tool has a two-position stroke adjustment that makes it easy to adapt to a single long stroke performance or an easy-pulling power stroke. It also has an outside jaw grip adjustment that is accom-



plished by turning a knob until the jaws grip the rivet mandrel.

The tool comes equipped with three interchangeable nose pieces to accommodate ⅛″, 5/32″ and 3/16″ rivet mandrels. These pieces are stored on the handle of the tool which has a swivel keylock, and can be removed and attached to the Pow'Riveter by using a box wrench which is included for changing the stroke adjustment bolt.

Pow'Riveter No. 175002 is available in a heavy duty storage pouch, including a supply of Pow'Rivets and sells for $22.95. Also available

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THE MOST COMPLETE LINE IN THE INDUSTRY

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ROOF TOWERS

- Pre-assembled, individually boxed, opens like an umbrella.
- Gold baked enamel or Hot-Dip galvanized 1¼″ OD steel tubing.
- Exclusive adjustable slide permits tower feet to fasten directly to non-standard spaced rafters, on peaked or flat roofs.
- For masts up to 1½″ OD.
- Roof sealing pitch patches, all hardware, 2″ lag screws supplied.

AVAILABLE IN:

2 ft.	5 ft.
2½ ft.	7½ ft.*
3 ft.	10 ft.*

*Exclusive swing-lock feature permits mast to be placed in sockets from side of tower

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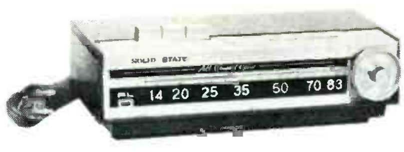
is an unbreakable, compartmented plastic box that measures 10″ x 7½″ x 1¾″ and holds the tool plus a 55-unit assortment of four sizes of Vaco Pow'Rivets. The kit is priced at $26.50.

UHF Converter and Amplifier
(66)

A UHF Converter, Model CR-880, is the latest development of **RMS Electronics, Inc.** The solid-state converter features 3 transistors, 2 diodes, and a high-gain amplifier. Another unique feature is a Local/Distant Switch that enables the user to switch from local to long distance, thereby switching on the amplifier and boosting signal gain to a full 30 dB. The manufacturer claims the CR-880 also boosts signal strength and improves reception on all channels.

The unit updates any standard TV set to receive any of the 83 UHF and VHF channels. Screw terminals at the rear of the converter provide easy hook-up of antenna and set lead-ins. The TV set plugs directly into the AC receptacle at the rear of the converter.



There are three push button controls for switching on the converter and to select either UHF or VHF signals. A pilot light is illuminated when the converter is in UHF operation. Selection of UHF channels is made by a single tuning control and accurately calibrated dial panel.

The converter features a charcoal gray, high-impact plastic housing with a silver-matte front panel and tuning control. Rubber bumpers at the base of the converter provide safe placement on any fine furniture. Price is $49.95.

UHF Antenna Add-On Kits
(67)

Gavin Instruments, Inc. has introduced three UHF antenna Add-On Kits. According to the manufacturer they can be added on to any existing VHF installation. Each

check the "Silencer"...

QUIETROLE


Check **QUIETROLE** . . . the "Silencer" for noisy radio, TV, (black and white, color too) and instrument controls, that protects your reputation, guards your profits.


QUIETROLE, the quality lubricant-cleaner for over 20 years, is harmless to plastics and metals, is non-conductive, non-corrosive, nonflammable.... with zero effect on capacity and resistance.

For best results, specify **QUIETROLE . . . Mark II for tuners Spray Pack for controls and switches Silitron for general use**

Available in Aerosol Can or Dropper Bottle

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Spartanburg, South Carolina

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Meet the Pro's Pro!

CONTINENTAL II

MU150

World's Finest Tube Analyzer

Sophisticated Circuitry Plus Advanced Mechanical Design For The Ultimate In Performance

This is the MU150 Continental II—Sencore's new combination emission and mutual conductance tube tester. So precisely accurate you'll never have to guess again whether a tube is good or bad. See why we say it's the professional's professional tester.

NEW
Replaceable tube socket chassis
Simplified setup book
Sectioned and reinforced panel and case
Portable high-style attache case

- **Checks over 3000 tubes**—foreign and domestic.
- **Mutual conductance test** with 5000 Hz square wave truly analyzes the tube.
- **Emission tests** at near full rated cathode current on power tubes. Not available on other mutual conductance testers.
- **100 megohm grid leakage sensitivity check.** A must to catch troublesome tubes with grid leakage or gas.
- **180K short sensitivity check.** Compares each element in the tube against all others for possible shorts.
- **Regulated** for complete accuracy and assurance on marginal tubes.

If you want to go first class—go with the MU150 Continental II. ....Only $219.50

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NO. 1 MANUFACTURER OF ELECTRONIC MAINTENANCE EQUIPMENT

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Circle 44 on literature card

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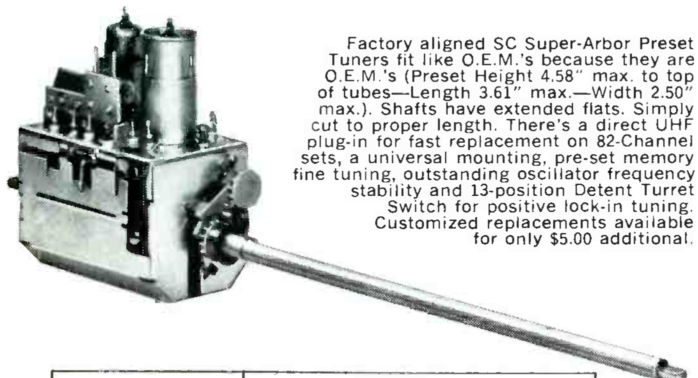
It costs you less to repair a tuner than to buy a new one. Right?

Wrong!

Figure it out. Repairing costs about $9.75. New tubes cost around $3.00. Now add your time and cost for packing and shipping to say nothing of the money you're out while waiting for it to be returned. (And who pays for your call back if another part of the tuner fails.) A brand new SC Super Arbor Preset Tuner with mounting brackets and tubes costs $12.95. And you can pick it up in whatever time it takes you to get to the distributor—5, 10, 15 minutes. You get a new tuner warranty—1 year from date of purchase. The new tuner costs you less in time and money. Your customer gets a brand new tuner instead of a used one. Everybody's happy. Right? Right. Available at your parts distributors.



Factory aligned SC Super-Arbor Preset Tuners fit like O.E.M.'s because they are O.E.M.'s (Preset Height 4.58" max. to top of tubes—Length 3.61" max.—Width 2.50" max.). Shafts have extended flats. Simply cut to proper length. There's a direct UHF plug-in for fast replacement on 82-Channel sets, a universal mounting, pre-set memory fine tuning, outstanding oscillator frequency stability and 13-position Detent Turret Switch for positive lock-in tuning. Customized replacements available for only $5.00 additional.

	MODEL		
13 Position Switch	SBR-250	SBRS-252	SBR4S-251
Antenna Input	300 ohms balanced to ground		
Intermediate Frequency	41.25 mc sound 45.75 mc video		
RF Amplifier Tube	6HQ5	2HQ5	3HQ5
Oscillator-Mixer Tube	6GJ7	5HB7	5GJ7
Heater	6.3 volts	600 ma	450 ma
B Plus	125-145 volts dc		

sk *Standard Components*

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2085 North Hawthorne Ave. • Melrose Park, Illinois 60160

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kit contains the following: a UHF antenna; a UHF/VHF antenna coupler to combine the two antennas into one existing downlead; two lengths of twinlead, cut to correct length with connectors attached; two snap-on, stand-off insulators; an indoor UHF/VHF/FM adaptor to provide separate twinleads for the UHF and VHF terminals of the TV set; and complete instructions.

Model CR-5AK uses a 13-element corner reflector antenna and sells for $15.95; Model J-1AK uses a 7-element UHF Yagi and sells for $15.50 and Model J-3AK uses a 20-element UHF Yagi and is priced at $21.50. ▲

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Book Review

Measuring Methods and Devices in Electronics: A. C. J. Beerens, Hayden Book Co., Inc., New York, New York, 1968, 182 pages, 8¼" x 5⅜", soft cover, $4.25; clothbound, $6.25.

Intended as a convenient reference to the methods and devices used in electronic measurements, this text covers the general testing procedures required by both the engineer and the technician.

Part 1 describes the operation and properties of the various types of measuring instruments — VTVM's, scopes, signal generators, impedance measuring bridges, frequency meters, regulated power supplies, etc.

Part 2 covers methods of measuring electronic quantities such as current voltage, power, frequency, resistance, capacitance, and inductance. Also included are techniques for making measurements on passive and active networks, and on tubes and transistors.

Part 3 provides guidance for determining the limits of accuracy of electronic measurements.

new Sams books

Transistor TV Training Course

by Robert G. Middleton. Provides a complete understanding of modern transistor television circuitry. Progresses functionally through a typical receiver from signal-input or tuner stages, through video and audio i-f and detector stages, picture and sound amplifier stages, vertical and horizontal deflection and synchronizing systems; concludes with analysis of power supply circuits. Includes review questions. 128 pages.
Order **20619**, *only* **$3.95**

Know Your Tube and Transistor Testers

by Robert G. Middleton. Explains principles and circuits used in tube and transistor testers. Includes schematics, specifications, and analysis of typical service and lab-type instruments. Packed with troubleshooting and repair data for various instruments. 144 pages.
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North American Radio-TV Station Guide

by Vane A. Jones. NEW 5th EDITION. Completely updated, listing frequencies, call letters, locations, etc., for all a-m, f-m, and tv stations in the U.S. and possessions, Canada, Cuba, Mexico, and the West Indies. Includes over 5,000 a-m stations, over 2,200 f-m stations, and nearly 1,100 vhf and uhf tv stations. 144 pages.
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FET Principles, Experiments & Projects

by Edward M. Noll. Explains in detail the theory and use of field-effect transistors. Black-box equivalent circuits are developed for the various modes of operation. Experiments involving the measurement of parameters and projects using FET's in practical circuits are included. 288 pages.
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Advertisers' Index

September, 1968

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FREE CATALOG & LITERATURE SERVICE

ANTENNAS

100. *Antenna Specialists*—Professional and CB radio antenna catalogs, sectionalized and indexed. Professional catalog is loose leaf with plastic slip-on binder.
101. *Belden*—4-page catalog describes basic specifications and accessory information of company's Teflon-insulated products.
102. *JFD*—New 40-page dealer catalog of TV-FM antennas and accessories.

AUDIO

103. *Bogen*—Sound systems catalog #208 describes 23 amplifiers, 5 preamplifiers, 5 booster amplifiers, microphones, loudspeakers and accessories along with technical specifications.
104. *Craig*—4-page illustrated brochure describes videotape recording systems.
105. *Jensen*—Form PK features 5 decor-styled furniture Hi-Fi systems.
106. *Robins Industries*—35-page catalog describes its line of magnetic recording tape and accessories.
107. *Switchcraft*—Bulletin 171 describes 2 new audio connector adapters. Bulletin 175 features 3 new audio adapters. Bulletin 176 lists new multi-pin adapters and cable assemblies.

COMMUNICATIONS

108. *Hallicrafters*—4-page illustrated brochure describes line of monitor receivers. Also literature on 2-way radio equipment, folder for short wave receivers, catalog on line of "Ranger" and "Sea-Air" portable radios with direction finders.
109. *Mark*—Brochure about the "Mark Invader 23" AM CB transceiver.

COMPONENTS

110. *Bussmann*—Small TV fuse leaflet designed to fit pocket or tool kit, shows list prices of fuses most commonly used in TV sets. Ask for BUSS leaflet TVLP.*

SERVICE AIDS

111. *Alpha Wire*—A new guide provides basic wire and cable specification data that includes charts, diagrams and illustrations.
112. *Bay Products*—40-page catalog of shop and laboratory furniture and storage equipment.
113. *Blonder-Tongue*—New publication, "SOLUTION 1," contains information for servicemen about reception problems.
114. *Dazor*—Catalog No. 6300 is indexed and lists floating lighting fixtures.
115. *GC Electronics*—Catalog FR69, a 304-page listing for all product divisions.*
116. *Mid-State Tuner Service*—Flyer describes 24-hour tuner service.
117. *Precision Tuner Service*—Free mailing kit and tuner replacement list.

TECHNICAL PUBLICATIONS

118. *Hayden and Rider*—92-page catalog of up-to-date, illustrated guides and reference books dealing with electricity and electronics, audio and high fidelity, computers, radio operation, test equipment, etc.
119. *Sams, Howard W.*—Literature describing popular and informative publications on radio and TV servicing, communication, audio, hi-fi and industrial electronics, including special new 1968 catalog of technical books on every phase of electronics.*

TEST EQUIPMENT

120. *Motorola*—4-page brochure No. TIC-3316, describes wide-band, triggered, laboratory-quality oscilloscope.
121. *Triplett*—literature on new 3490-A transistor analyzer with complete specifications, descriptions and data.

TOOLS

122. *Diamond Tool and Horseshoe*—16-page, pocket-sized booklet W-68 about Diamond, Diamolloy and Copaloy wrenches, pliers, snips and electronic tools.
123. *Vaco*—Catalogs No. SD-66X and SD-66 list new special imprint tools.

***Check "Index to Advertisers" for additional information.**

"and not only that, but they took his **INJECTORALL SUPER 100 TUNER CLEANER** as well."

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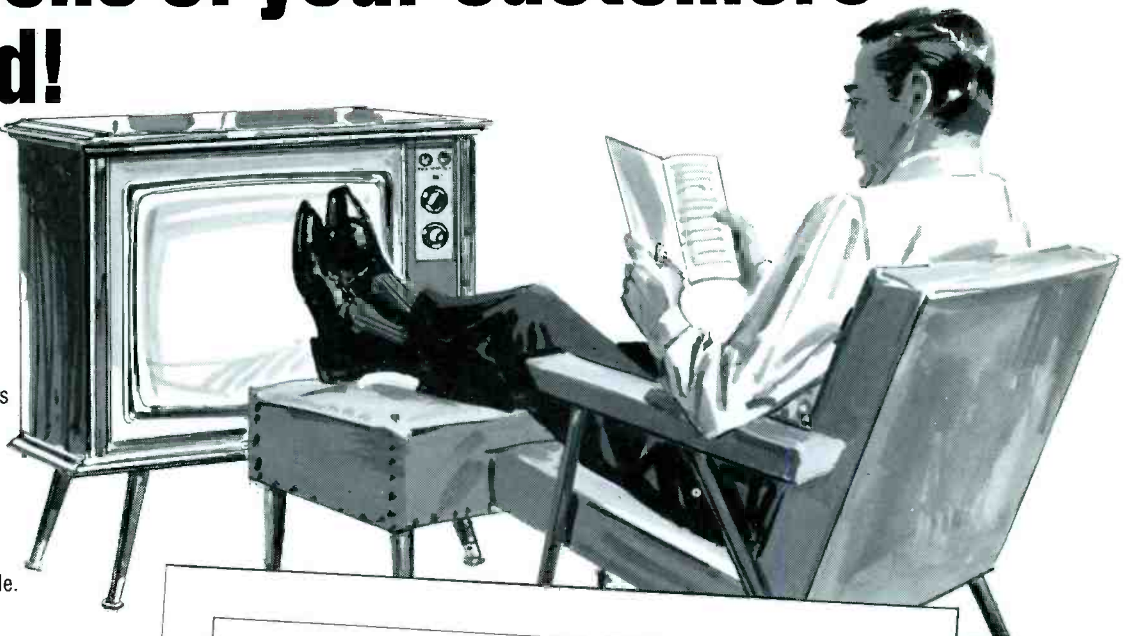
Here's something you'll want every one of your customers to read!



This important message on TV service, which originally appeared in TV GUIDE, is being made available in reprint form by RCA for your use. This message tells of the training, skills, and investment that enable the nation's TV technicians to perform a real service for their customers. It's really your story. So read it carefully and then get copies of it into the hands of your customers as far and wide as possible. They're available from your Authorized RCA Tube Distributor.
RCA Electronic Components, Harrison, N. J.

RCA

The TV Serviceman Talks Back

He details his reasons for feeling maligned, overworked and underpaid

By David Lachenbruch

Complaints about television service have received increasing publicity in recent months. But the man who fixes your set has a few complaints of his own. He feels he's misunderstood, maligned, distrusted, unappreciated, overworked and underpaid.

These complaints would appear to indicate a basic feeling of insecurity, except for the absence of one classic symptom. He doesn't feel the least bit unneeded. He *knows* he's needed. Everybody needs him, and they all need him yesterday.

This serviceman syndrome may be more a case for a public-relations man than a headshrinker. TV-repair technicians feel that they've taken more than their share of lumps lately, as the result of a wave of "exposés" which, they feel, make them look like a bunch of thieves — incompetent thieves, at that.

This malaise in the service industry comes at a trying time. It's accelerating the exit of many top-notch technicians into higher-paying, better-appreciated jobs—just when tens of thousands of new super-competent service dealers are urgently needed to doctor the ever-increasing number of complex color TV sets now moving into the Nation's homes.

TV-set manufacturers consider the technician shortage so serious that they've united in a five-year "Service Technician Development Program," whose total budget could run well above a million dollars, to attract and train young servicemen.

Richard Tinnell, a former Oklahoma State University electronics professor who coordinates this development program, rebuts the suggestion of widespread incompetence with circumstantial evidence: "There are 515 million electronic instruments in the hands of the American public—including TV sets, radios, phonographs and tape recorders—and 75 million are being added each year. All 515 million are in working order. If 65 percent of the service technicians were unethical or incompetent, this situation just couldn't exist."

He was referring to the kind of publicity which irks servicemen the most—the doctored-set caper. Two of these were summarized last fall in TV GUIDE ("Set Repair Frauds," Nov. 11), one in New York, one in Chicago. In the New York test, 20 service dealers were asked to repair sets in which one bad tube had been purposely inserted but which were otherwise in good shape. The test's sponsors esti-

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TV GUIDE

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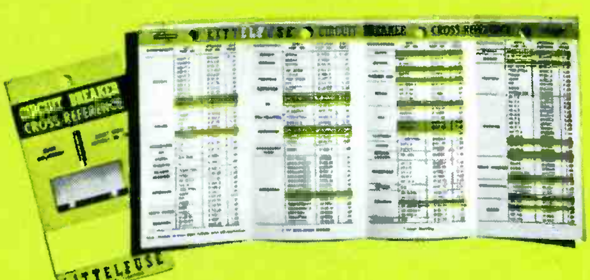
Available individually packaged one breaker per display card; or 5 breakers of same rating per unit pack or as complete, versatile assortments for shop use or replacements in the field.



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Pocket size cross reference on color and black/white TV circuit breaker applications.
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