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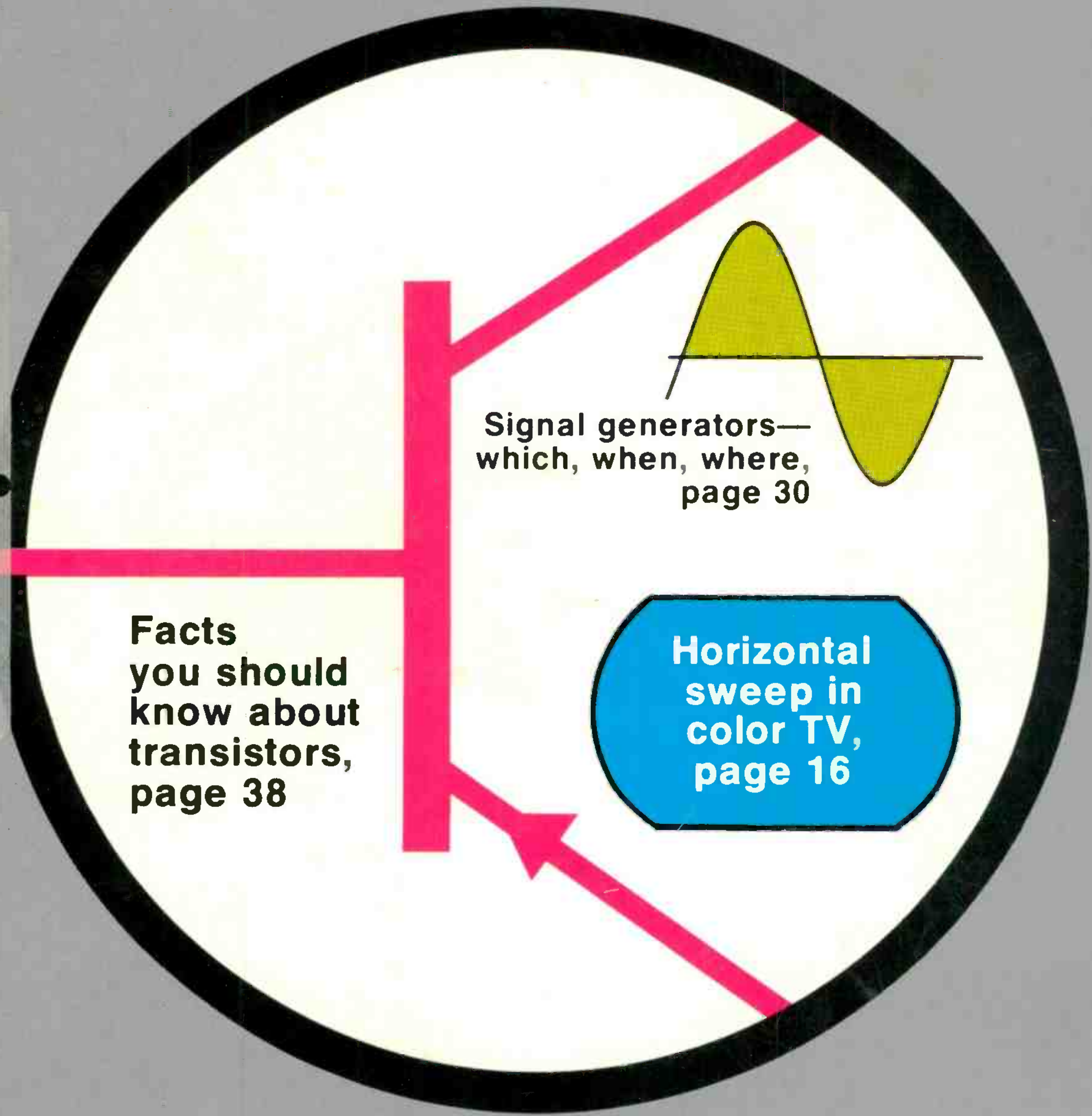
Electronic Servicing



Signal generators—
which, when, where,
page 30

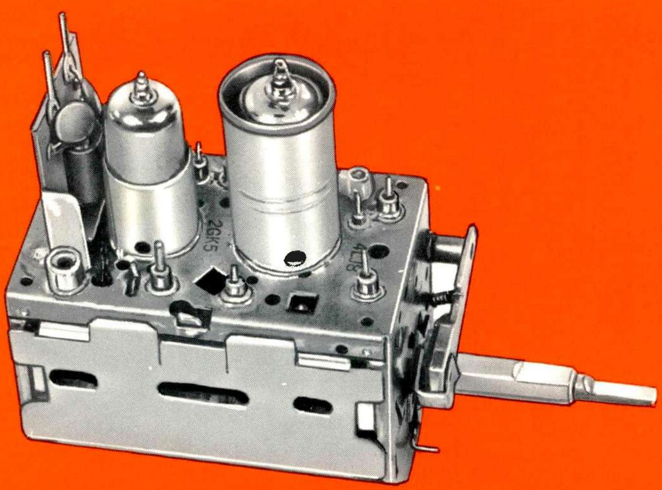
Facts
you should
know about
transistors,
page 38

Horizontal
sweep in
color TV,
page 16

Weak color, page 22

Staar system equips cassettes
for autos, page 56

New in auto radio audio, page 50



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March 1972 • Volume 22, No. 3

Electronic Servicing

DEPARTMENTS

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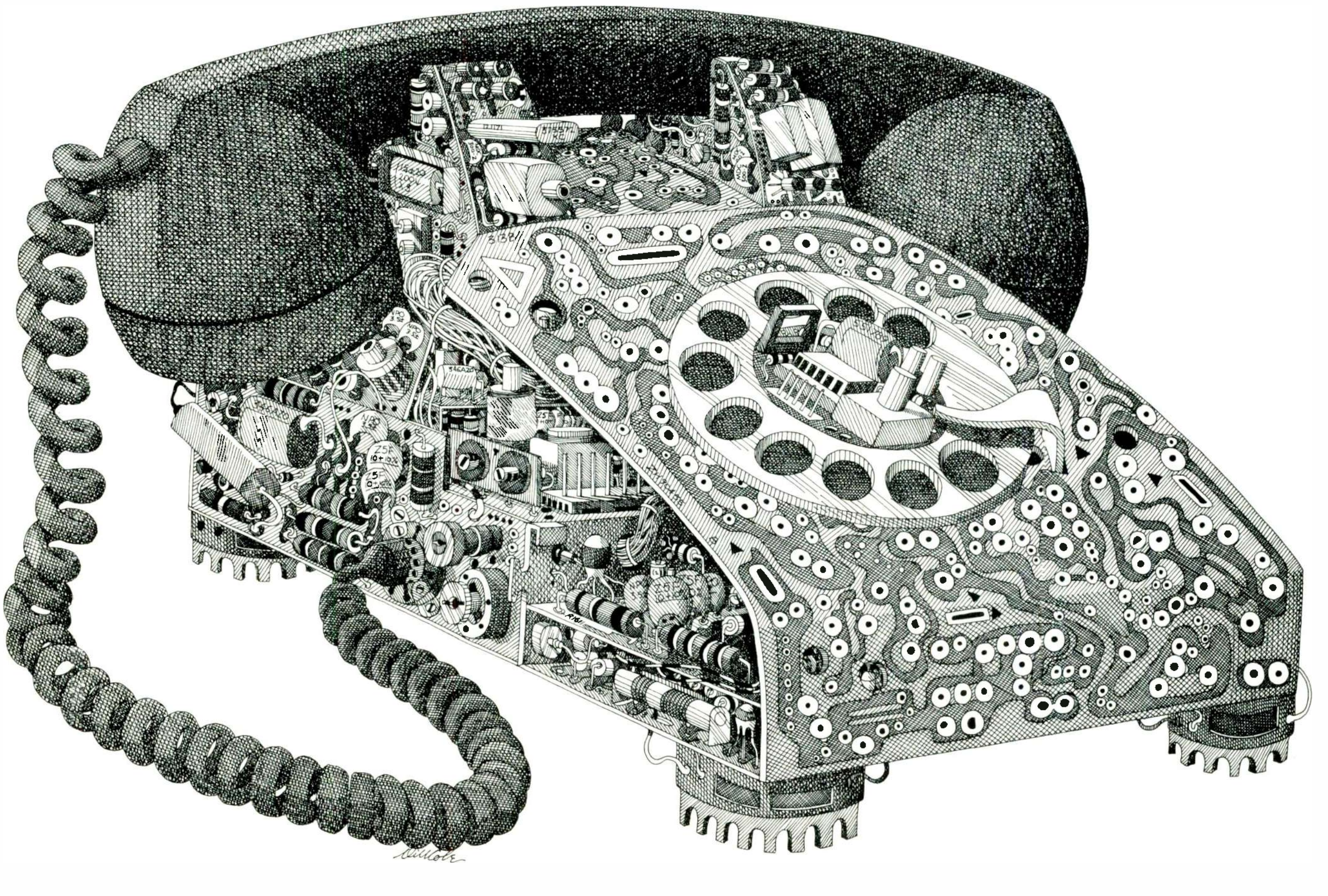

electronic scanner

news of the industry

Ampex Corp. is discontinuing operation of its consumer electronic equipment division, including the production of all tape recorders and related equipment, except for prerecorded and blank audio tapes. The reason given for the closeout is "inadequate profitability."

The warranty on all RCA Silverama black-and-white television picture tubes sold for replacement use has been increased from 12 months to 3 years, effective "with initial replacement installation made in home entertainment equipment on or after December 15, 1971, and at no additional charge to the customers."

Zenith's national parts and service department has been moved to 1500 N. Kostner Ave., Chicago, Ill.

Sony has begun construction of their color TV assembly plant in a suburb of San Diego, California. Initial production, which is expected to begin this summer, reportedly will be 5,000 Trinitron color TV sets per month, and is expected to be increased gradually to about 20,000 sets per month.

A national program to test and certify the competency of auto mechanics tentatively has been scheduled to begin this fall, according to a recent report in the **Wall Street Journal.** Automotive service groups reportedly have retained the Educational Testing Service (ETS) to develop an exam for the program. A certification agency will encourage mechanics to take the test on a voluntary basis. According to the report, an ETS researcher stated, "If certification can work in this field (auto repair) it can work in others, such as radio and TV repair." The Princeton, N.J.—based testing service reportedly in 1971 began administering standardized exams to prospective real estate salesmen in four states, and is now preparing to administer exams in six others.

Teledyne Service Company reportedly is now establishing target dates for opening servicing centers in major areas of its newly organized East-Central marketing zone, which is comprised of all of Ohio and West Virginia, the Western half of Pennsylvania, the Southwestern corner of New York state and the extreme Southeastern corner of Michigan. Major population areas in the zone include Detroit, Pittsburgh, Cleveland, Toledo, Akron, Buffalo and Rochester. Teledyne Service Company is the servicing arm of Teledyne Packard Bell, which is based in California. The company recently opened a new warehouse and distribution center in Akron, Ohio.

The Television Service Association of Ohio (TSA) will sponsor a "spring convention" in Toledo, May 18-21. Site of the convention will be the Hospitality Inn, Route 75 and Miami Street. The program reportedly includes technical and business management sessions and a trade show.

(Continued on page 6)

Philco-Ford will market this spring a line of all-solid-state modular portable TV's, according to a recent report in **Home Furnishings Daily.**

Rules covering comparable tuning of VHF and UHF channels have been issued by the Federal Communications Commission (FCC). Included in the rules are requirements that: 1) The tuner be capable of receiving each channel at the correct detent position, with a deviation from the carrier frequency of not more than 3 MHz; and 2) a numerical readout be provided for each of the 70 UHF channels if all VHF and UHF channel numbers displayed are visible all of the time on the front panel of the receiver, and a readout is provided for at least every other UHF channel, with the channels not displayed indicated by some appropriate mark. The FCC ruling reportedly is based on a new TV tuner developed by Sarkias Tarzian, an Indiana-based manufacturer of TV tuners. The new tuner reportedly is a 70-position, non-memory detent tuning type.

A complaint that Sears is trying to keep independent electronic service technicians from servicing private-label brown goods marketed by it has been filed with the Federal Trade Commission (FTC) by the Louisville Electronics Technicians' Association, according to a recent report in **Merchandising Week.** The complaint, reportedly being investigated by the FTC, was prompted by a reduction by Sears in 1970 of the trade discount on parts, from 20 per cent to 10 per cent, and a lingering fear by the technicians that Sears would eventually completely eliminate the parts discount. The independent servicers also complained that Sears stalls on parts deliveries to them, to improve its own in-home repair image by comparison. Sears reportedly responded with a statement that it has no plans to drop the 10-per cent discount to independent servicers but that it legally could, if it so desired. A spokesman for Sears also reportedly admitted that deliveries of parts to independents can take a long time but that its own servicing operation has to wait just as long, often up to a month.

A price hike of 6 per cent on receiving tubes for the replacement market has been awarded RCA by the Price Commission. This decision reinstates a comparable price increase announced by RCA last July but canceled in August because of the price freeze. The 6 per cent increase has been made already, according to an RCA spokesman. Two other electronics manufacturers, General Electric and Sylvania, also have been awarded price increases by the Price Commission. General Electric is allowed to increase prices on its domestic products and services an average of 2 per cent during 1972, the increase applied for by the company. Sylvania applied for and has been granted an increase of 2.57 per cent on its television picture tubes and receiving tubes.

An additional 20,000 TV and radio technicians will be needed by 1980, according to statistics and a forecast issued recently by the Bureau of Labor Statistics, an agency of the U.S. Department of Labor. The Bureau bases this required increase on the contention that at least 145,000 TV/radio technicians will be needed in 1980 to meet the demand for servicing of home entertainment electronic products. If correct, it means that an additional 3,000 TV/radio technicians must be trained yearly between now and 1980, to fill newly created vacated positions. □

CUT YOUR INVENTORY, BOOST PROFITS

Just 3 Zenith Chromacolor picture tubes replace 72 others

C-25BAP22, 23VATP22 replace 39 types

23VAHP22	23VBGP22	25BCP22	25CP22A
23VAJP22	23VBHP22	25BGP22	25GP22
23VALP22	25ABP22	25BJP22	25GP22A
23VANP22	25AFP22	25BMP22	25SP22
23VARP22	25ANP22	25BRP22	25VP22
23VASP22	25AP22	25BVP22	25WP22
23VATP22	25AP22A	25BXP22	25XP22
23VAUP22	25AP22A/25XP22	25BZP22	25XP22/25AP22A
23VAXP22	25AQP22	25CBP22	25ZP22
23VBEP22	25BAP22	25CP22	

23VAZP22 replaces 10 types

23VAZP22	25RP22
25AEP22	25YP22
25BP22	25YP22/25BP22A
25BP22A	
25BP22A/25YP22	
25FP22	
25FP22A	

C-25BKP22, 23VBAP22 replace 23 types

23VACP22	23VBDP22	25AXP22
23VADP22	23VBJP22	25AZP22
23VAMP22	23VBRP22	25BDP22
23VAQP22	25ADP22	25BFP22
23VAWP22	25AGP22	25BHP22
23VAYP22	25AJP22	25BSP22
23VBAP22	25ASP22	25BKP22
23VBCP22	25AWP22	

2-YEAR WARRANTY
Zenith CHROMACOLOR picture tubes sold for renewal use in standard television receivers are warranted against defects in workmanship, material and construction for 24 months after date of purchase by the consumer or user. OR if tube is supplied no charge to fulfill a warranty obligation in a Zenith color television receiver, then the warranty shall be limited to the unexpired portion of said Zenith color television receiver warranty. No other warranty is expressed or implied.

"The obligation of Zenith Radio Corporation under this warranty is limited to replacing, or at its option repairing, such defective color picture tube and does not include the cost of any labor in connection with installation of such replacement tube or repaired tube nor does it include responsibility for any transportation expense."

Available new or re-built. Zenith Cinebeam (C type) picture tubes contain used materials which, prior to reuse, are carefully inspected and selected to meet Zenith's high standards of quality.

SIMPLE INVENTORY. Stock Chromacolor and you can immediately replace almost any 23" diagonal tube.

FASTER SERVICE. No time lost waiting for replacement tubes to arrive. Less downtime means satisfied customers.

AMPLE PROFIT MARGIN. Chromacolor tubes are realistically priced. Zenith's suggested retail price is competitive, yet gives you an attractive profit margin.

BRILLIANT CHROMACOLOR PICTURE. Chromacolor . . . Zenith's patented picture tube that revolutionized color TV. First tube to fully illuminate every color dot on a jet-black background.

POWERFULLY PRE-SOLD. Special magazine ads all year long are telling your customers about the bright, sharp picture they'll see with a Chromacolor replacement tube.

ZENITH

The quality goes in before the name goes on

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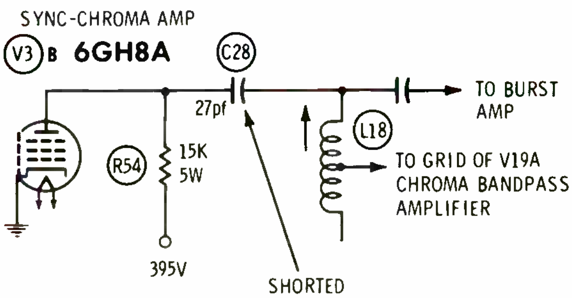
Circle 7 on literature card

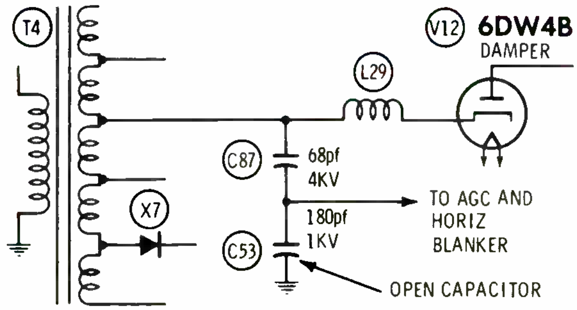
symcure Symptoms and cures compiled from field reports of recurring troubles

Chassis—RCA CTC24
PHOTOFACT—912-3



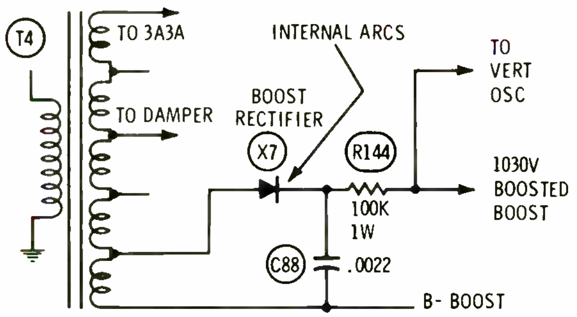
Symptom—Overload and smeared picture with weak color
Cure—Test C28 and replace, if shorted

Chassis—RCA CTC24
PHOTOFACT—912-3



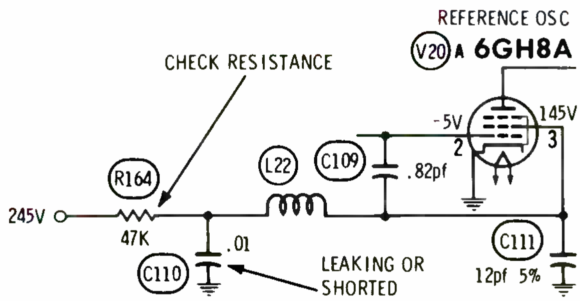
Symptom—Dark picture which exhibits a white vertical bar that moves when the horizontal-hold control is adjusted
Cure—Check C53 and replace, if open

Chassis—RCA CTC24
PHOTOFACT—912-3



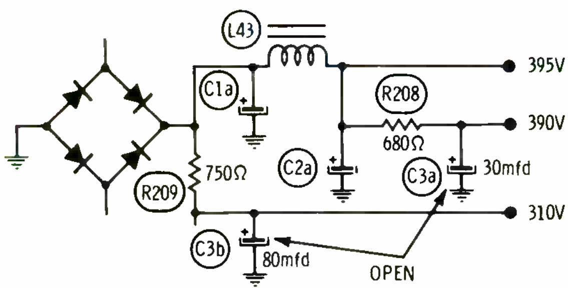
Symptom—Action of height control is erratic and extremely sensitive
Cure—Replace boost rectifier X7

Chassis—RCA CTC24
PHOTOFACT—912-3



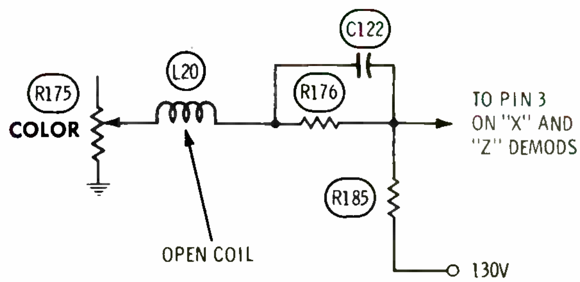
Symptom—Missing or weak color
Cure—Check for leakage in C110. Also check R164 for damage

Chassis—RCA CTC24
PHOTOFACT—912-3



Symptom—Horizontal off frequency and left side of picture dark
Cure—Check for an open filter capacitor C3

Chassis—RCA CTC24
PHOTOFACT—912-3



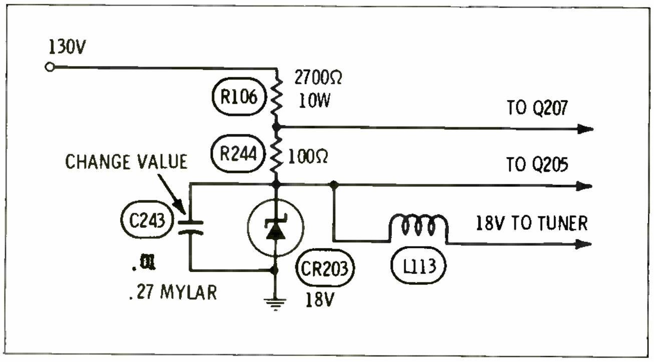
Symptom—Missing or intermittent color
Cure—Check for an open circuit in L20 □

service bulletin

a digest of info from manufacturers

Horizontal pulling caused by low line voltage
RCA CTC55 color TV chassis

Cure horizontal pulling in early-production RCA CTC55 chassis by changing C243 from the original



.01-mfd 500-volt disc ceramic capacitor to a .27-mfd, 75-volt Mylar dielectric capacitor. The RCA stock number of this new capacitor is 120057.

New tube types used in Zenith chassis
Zenith chassis, as listed

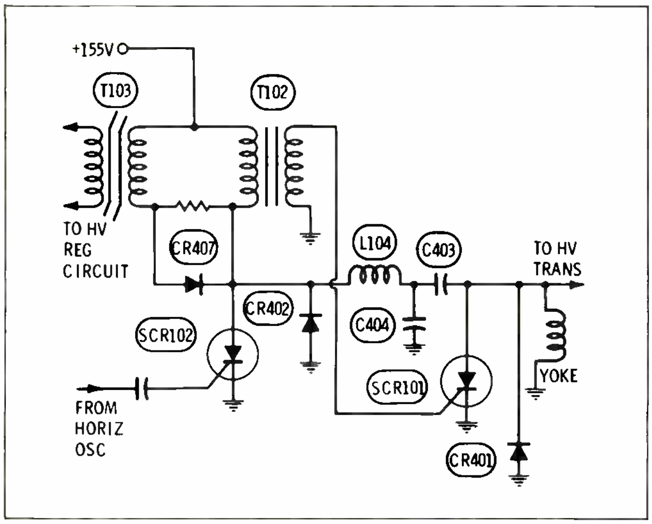
Zenith has changed several damper, high-voltage rectifier and high-voltage regulator tubes in later production chassis. The color TV chassis numbers and tube changes are:

Chassis	Change
14A10C27Z 14A10C29Z 14B9C50 12B14C52 20BC50	The 3DJ3 HV rectifier replaces the 3DB3. 6DN3 damper replaces the 6CJ3, and the 6JD5 high-voltage regulator replaces the 6HV5A. The 6DN3 and 6JD5 should always be used in pairs, as should the 6CJ3 and 6HV5A.
19CC19	The 19BQ3 damper tube replaces the 19CG3.

Don't defeat the circuit breaker
RCA CTC40, CTC44, and CTC47 color TV chassis

In any RCA color TV chassis which uses SCR's in the horizontal sweep circuit, it is very important that the circuit breaker should **not** be defeated.

For example, suppose SCR102 or CR402 in the simplified schematic shown here, shorted and the circuit breaker operated to open the B+ circuit. The symptom would be: No high voltage, breaker opens. If the breaker is defeated and the chassis operated in an effort to find the defect, a large current would flow through the 2.65-ohm primary winding of T102. The heat of such current flowing

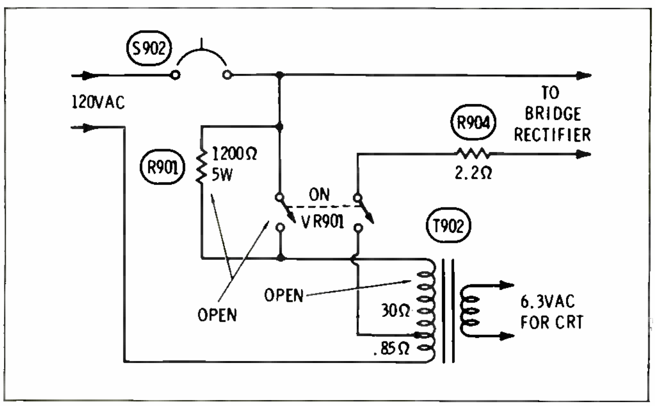


for only 4 to 8 seconds might burn some of the insulation from the wires in the winding and cause shorted turns. Then after the original short in SCR102 or CR402 was repaired, the new symptom would be: No high voltage, breaker holds. A minor defect could be changed into a larger one because of an improper servicing technique.

Also, damage to the filter choke or the power transformer is possible, if the chassis is operated with a short circuit for an extended period during which the circuit breaker has been defeated.

Excessive CRT heater voltage
Sony Models KV-1200U, KV-1210U and KV-1220U

A defect in the power supply can cause exces-



(Continued on page 12)

The last tube-tester you'll ever have to buy!

It's strange, but while tubes are on the way out—tube-testers are needed more than ever. That's because the home electronic sets today use sophisticated tubes in sophisticated circuits—and simple Shorts and Emission tests don't take into account the actual operation of the tube. Now B & K offers the Model 747 Dyna-Jet Solid State 100% *Dynamic Mutual Conductance* Tester—the last tube-tester you'll ever have to buy.

Triodes, nuvistors, tetrodes, pentodes and all other multi-element tubes can now be tested under AC operating conditions for 100% *dynamic mutual conductance.* Intermittents, low gain and other tube problems that would be obscured in an emission test, show up in this tester's dynamic mutual conductance tests.

A special Dynamic test has been designed into the B & K Model 747 to test high-voltage regulators. This test puts one signal on the regulator grid and another on the plate—actually operating the tube with the correct plate current. Too much or too little current can either destroy the tube or produce an unreliable reading.

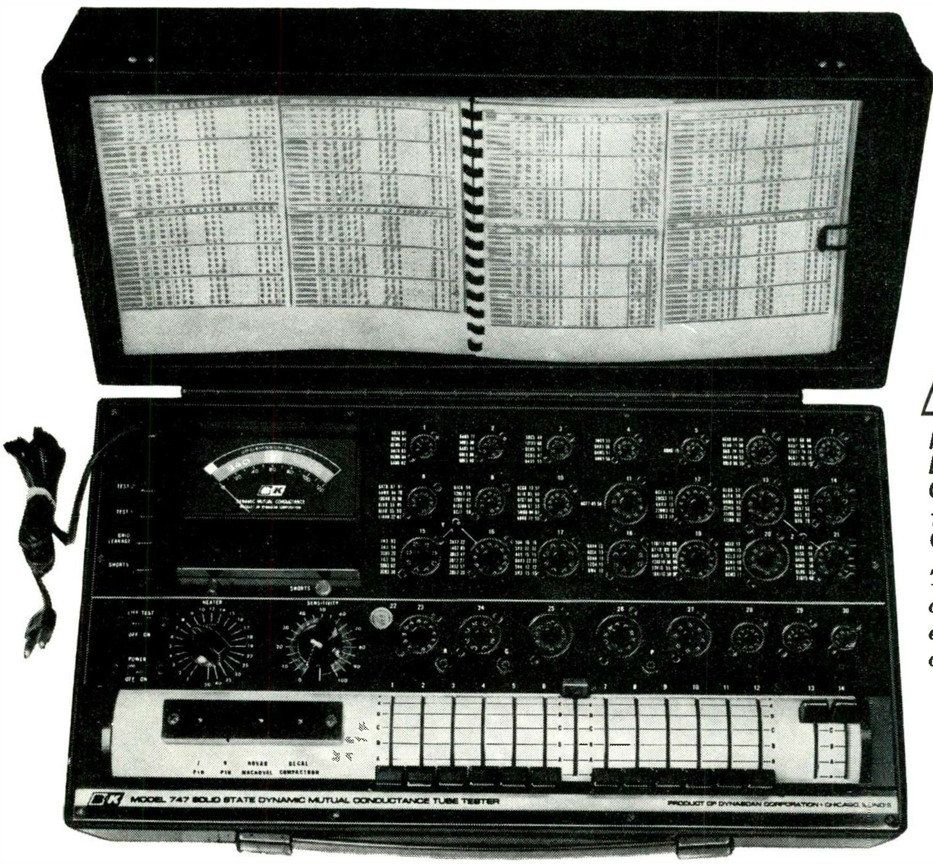
Diodes, low- and high-voltage rectifiers are tested with proper voltages and loads to determine their emission capability.

And, of course, you'll still want to test for shorts, leakage and gassy tubes. The B & K Model 747 makes this easy with a one-button "Shorts" test and a one-button grid-leakage and gas test. And it "quick tests" 82% of the tubes you'll test. And gives you functional pin-straighteners to fit any tubes you'll ever run into. And to help you predict a tube's reserve, the 747 has a built-in "Life" test. Filament voltage is reduced 10% when the "Life" test switch is set on.

All-in-all, the B & K Model 747 Dyna-Jet Tube-Tester has all the features you've wanted—all the features you'll ever need in a tube-tester. And it's small, lightweight and very good-looking.

See it at your B & K distributor, and you'll see why it's the last tube-tester you'll ever have to buy!

Model 747
100% Dynamic Mutual Conductance
Dyna-Jet Tube-Tester ....Price $249.95



B&K

Product of
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CORPORATION
1801 W. Belle Plaine
Chicago, Illinois 60613

There is a difference in test equipment — ours works!

Circle 9 on literature card

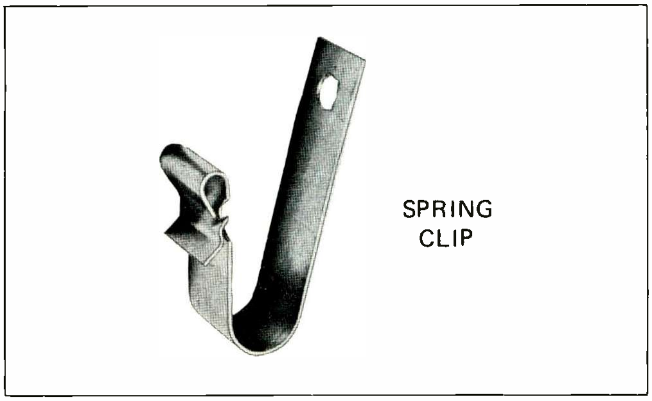
(Continued from page 10)

sive heater voltage to be applied to the color picture tube; this might reduce the lifespan of the picture tube.

An open section of the power switch which parallels R901, and open R901, or an open circuit in the primary winding of T902 can cause the heater voltage of the picture tube to increase to 9 volts from the normal 6.5 volts. Whenever the color picture tube is replaced in these models, check and replace any of these parts which might be defective.

Elimination of static from knobs and trim
Magnavox Models 7322, 7324 and 7326

In early-production Magnavox color receivers, Models 7322, 7324 and 7326, the implosion-protective metal band around the picture tube was not grounded. Consequently, static charges can build up on knobs and the decorative trim.



Magnavox has made available a spring clip (Magnavox part number 171192-1) which can be installed easily (without removing the purity shield) between the metal support rail and the band around the rim of the picture tube.

New high-voltage rectifier tube
General Electric KE-11 C2/L2 and N2 chassis

Tube type 3DS3 is a new high-voltage rectifier tube which has integral X-radiation shielding. The 3DS3 is used in the current production of GE KE-II, C2/L2 and N2 chassis.

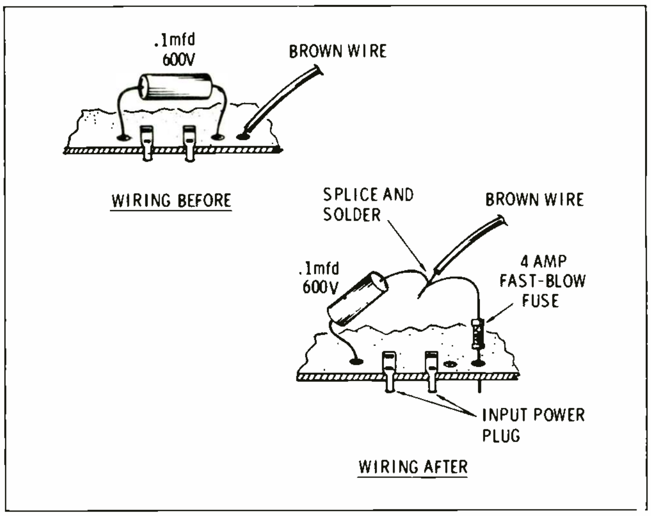
This new tube is not interchangeable with any previously-used rectifier tube. Replace a defective rectifier tube **only** with the original type which is listed on the tube-placement chart. The use of an incorrect type will cause incorrect high voltage.

Because the 3DS3 tube is heavy, a white-plastic strap is employed to hold it in the socket during shipment. Cut off the strap and discard it, if the original tube is replaced.

The manufacturer cautions against any test that causes an arc between the plate cap of the 3DS3 and the chassis. Such an arc might damage the X-radiation shield and create a fire hazard.

Addition of a fuse for lightning protection
General Electric SB and SC chassis

Additional lightning protection, which includes a .1m-fd line bypass capacitor, should be installed in each GE SB and SC chassis you service.



Add a 4-amp slow-blow fuse, as shown in the schematic. This modification requires the removal of only the cabinet back. □

With Sylvania's 3 lines of color tubes, you can meet it.

Customers' wallets come in different sizes.

Thick, thin and in-between.

With Sylvania's 3 complete families of replacement color picture tubes, you can be sure of having the right-priced tube for each one.

At the top end of the line, you've got the *color bright* 85®XR, the tube with our brightest phosphors and X-ray inhibiting glass.

And in the middle, you have the *color bright* 85® RE. This is the tube that brought color TV out of the dark ages. Its bright rare-earth phosphors still make it *the* tube to watch.

For economy, there is the *color screen* 85 family of replacement tubes. But, economy doesn't mean cheap construction. You can still give your customer features like Sylvania's Sharp-Spot electron gun and a rare-earth phosphor screen without breaking his budget.

When you sell Sylvania, you're selling from the broadest line in the industry. You'll have the tube to match the set.

And a price to match the wallet.

SYLVANIA
GENERAL TELEPHONE & ELECTRONICS

Every man has his price.

bookreview

ABC's Of Electronic Power (Catalog No. 20884)
Author: Rufus P. Turner
Publisher: Howard W. Sams & Co., Inc., Indianapolis
Size: 5½ x 8½ inches, 96 pages
Price: Softcover, $3.50.

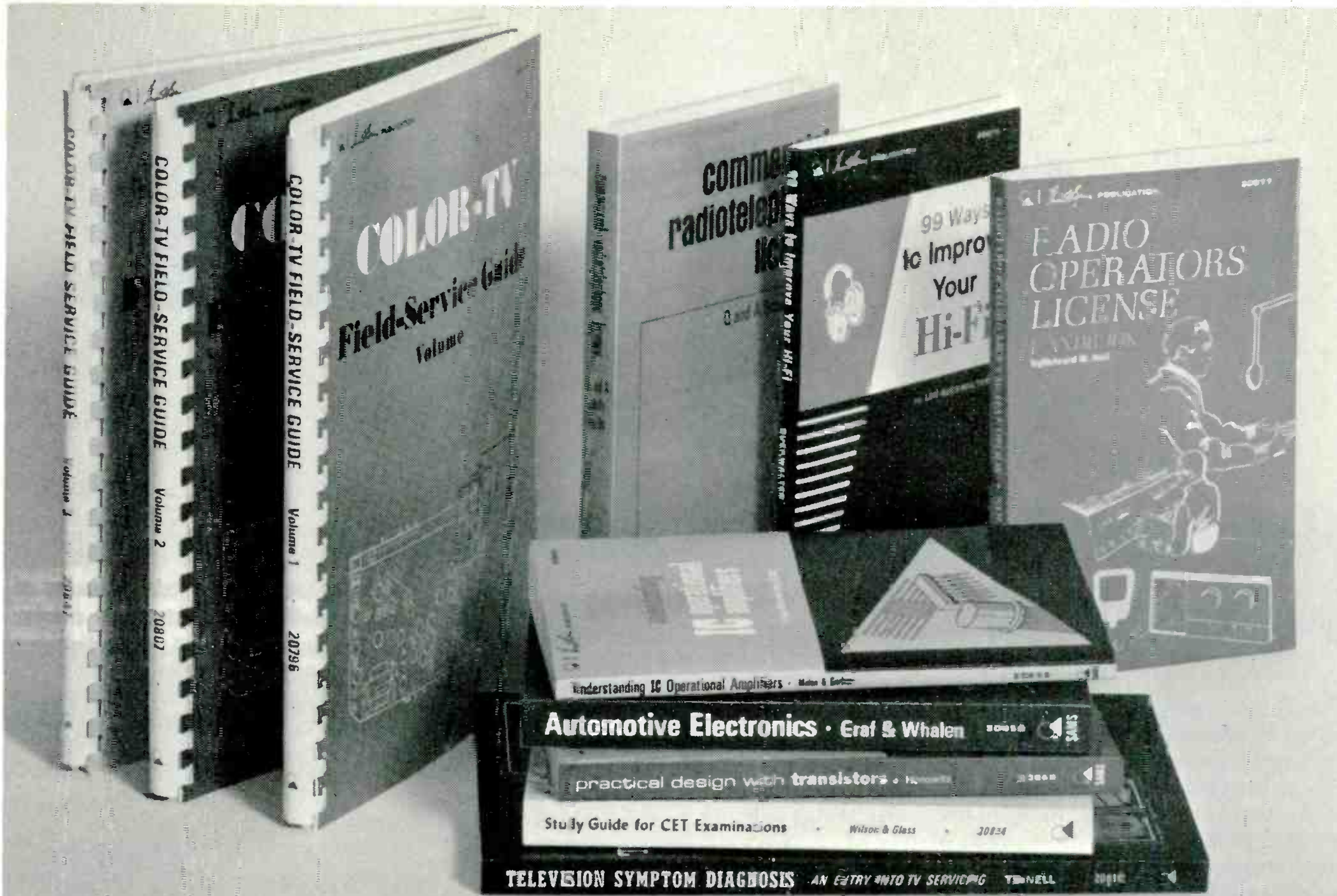
A thorough explanation of both the theoretical and the practical aspects of a subject which has gone begging for too long. Any electronics technician who reads this well-organized, comprehensive text should come away with at least a good working knowledge of what DC and AC power is and how to accurately measure it—knowledge which most professional electronic technicians will agree is essential to proficient servicing of audio and most other consumer electronic products.

Contents: Fundamentals; DC Power Measurement; AC Power Measurement; Audio Frequency Power Measurement; Radio Frequency Power Measurement.

Repairing Transistor Radios
Author: Sol Libes
Publisher: Hayden Book Company, Inc., New York
Size: 5⅜ x 8¼ inches, 176 pages
Price: Softcover, $4.65.

Updated to include recent advances of technology, and the changes in and additions to servicing procedures required by such advances, the second edition of this practical radio-servicing guide should be as useful to electronic technicians as was the first. Although many "more-practical-minded" technicians will want to skip the first chapter, which discusses the fundamentals of transistor & IC construction, theory of operation and characteristics, most should find the other chapters of this book useful both as a procedures and trouble-symptom guide and as a "review" text, to refresh their knowledge of and sharpen their techniques for servicing home and auto AM and FM radios.

Contents: The Transistor; The Superheterodyne Receiver; Audio Amplifiers; Power Amplifiers; IF and RF Amplifiers; Oscillators, Converters And Mixers; AM And FM Detector And AGC Circuits; Portable Radio Receivers; Auto Transistor Radios; Troubleshooting Techniques; Tools And Test Equipment. □



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No. 20807 (Vol. 2) $4.95
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By J. A. Wilson, CET, and Dick Glass, CET
A comprehensive review of the material covered by the CET (Certified Electronics Technician) examination. It's almost a "must" for gaining a CET designation, for passing a state or local licensing exam, or for a "brushing-up" when applying for a position in the electronics field. Includes question-and-answer sections and a 50-question test in each chapter.
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99 Ways to Improve Your Hi-Fi
By Len Buckwalter
This book covers many methods — many of them simple, little- or no-cost adjustments—for improving your hi-fi and stereo sound systems. All-inclusive coverage from the antenna to the speaker is divided into ten sections and supplemented, wherever necessary, by photos and illustrations. Basic or elementary knowledge, simple tools and equipment are all that is needed to make the most of the suggested innovations.
No. 20876 ....$3.50

Understanding IC Operational Amplifiers
By Roger Melen and Harry Garland
This book explains how IC op amps work and how they can be used in many practical circuits. Discusses in detail basic semiconductor electronics, integrated op amp circuitry, practical design considerations in circuits using IC op amps, bias current, offset voltage, frequency compensation, slew rate, and more.
No. 20855 ....$3.95

Commercial Radiotelephone License Q and A Study Guide
By Woodrow Smith and Robert Welborn
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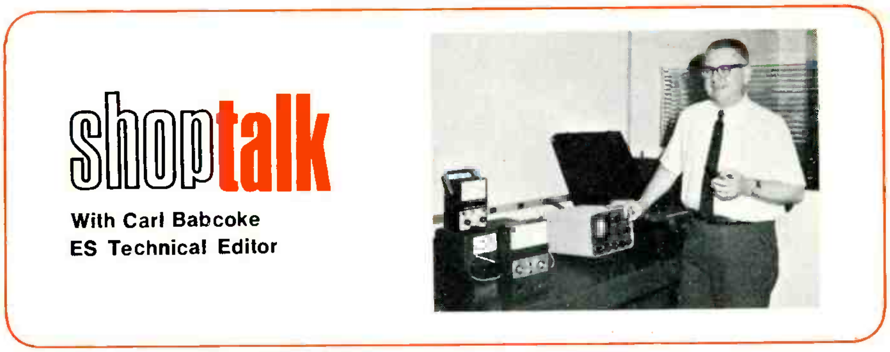


Horizontal sweep and high voltage in color TV, Part 1

A three-part analysis of circuit and individual component functions, typical defects and their causes, and proven techniques for quickly isolating them. The generation of and the important characteristics of the drive signal required at the grid of the horizontal-output tube are the topics of this first part.

Troubleshooting the horizontal sweep and high-voltage circuits in a color TV receiver is similar to troubleshooting those in a b-w receiver, except that many of the components have higher ratings, and additional functions, such as high-voltage regulation and pincushion correction, have been added.

The theory of horizontal sweep was covered in the November, 1971, issue of ELECTRONIC SERVICING, and will not be repeated because the *fundamental* principles are the same for both b-w and color receivers.

An older color chassis, (RCA CTC7AA) was selected for analysis because it is representative of many built before the introduction of rectangular picture tubes. In a future issue, a newer (and more complex) color TV chassis will be analyzed in similar fashion.

Important Characteristics Of The Horizontal Drive Signal And How Oscillator Defects Affect Them

Horizontal sweep begins with the horizontal oscillator. The oscillator and automatic frequency control (AFC) circuits are required to supply to the grid circuit of the horizontal-output tube a drive signal which has a specified amplitude, waveshape, frequency and phase. (Another important function in many receivers is that the drive signal prevents rapid destruction of the horizontal-output tube.)

Frequency

If the oscillator operates at the wrong frequency, the horizontal

Table 1

How Operating Conditions Or Component Defects Affect The Voltages And Current On Or Through The Elements Of The Horizontal-Output Tube Of The RCA CTC7AA Color TV Chasis

Condition or Defect	DC Grid Voltage	Cathode Current (milliamps)	Screen Voltage
(A) normal operation	−53	200	134
(B) normal brightness minimum	−53	200	134
(C) normal brightness maximum	−53	200	134
(D) 560K-ohm leakage in C77	−35	220	86
(E) R119 open, excessive drive	−72	165	155
(F) insufficient drive	−44	210	145
(G) R120 open	−56	175	140
(H) osc. dead	0	600+	110
(I) horiz. out of lock	−48	210	140

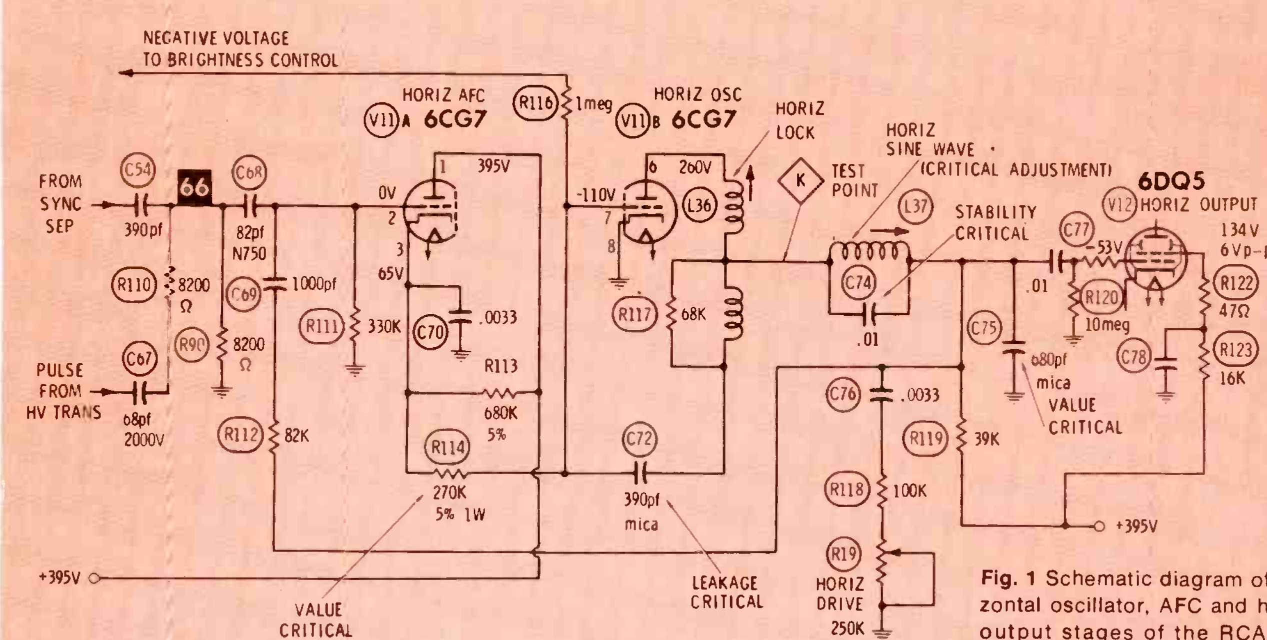


Fig. 1 Schematic diagram of the horizontal oscillator, AFC and horizontal-output stages of the RCA CTC7AA color television chassis.

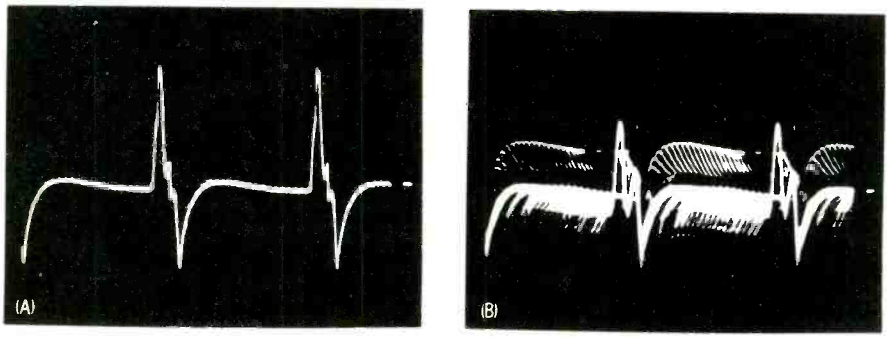


Fig. 2 Frequency of the horizontal oscillator can be checked with an oscilloscope, which will reveal when the oscillator is locked. In the CTC7AA, Circuitrace 66 is the point at which both sync and sweep signals should be compared. **(A)** The waveshape produced when the oscillator is locked. The sync and the sweep signals have the same frequency and phase. **(B)** When the oscillator is out-of-lock, the scope remains locked to the sweep waveform, and the sync portion moves rapidly across the screen of the scope.

drive signal is of little value beyond preventing failure of the output tube. (See Line "H" in Chart 1.) Correct amplitude and waveshape alone are not enough.

A large change of the frequency often eliminates the high voltage, which, in turn, eliminates the raster. Without a raster, there is no visual symptom to reveal that the frequency of the oscillator is incorrect.

Normal AC and DC voltages measured at the grid of the horizontal-output tube are not proof of correct frequency. The frequency should be measured. Several methods, including the use of a cycle counter, can be used to measure the frequency with excellent accuracy. However, such a high degree of accuracy is not essential. Any oscillator frequency between approximately 15 KHz and 19 KHz should be sufficient to produce horizontal sweep and high voltage.

My favorite method of measuring the oscillator frequency is to compare the frequency of the horizontal sync with the sweep frequency. Perhaps this sounds difficult, but it is not. The horizontal oscillator is brought into lock. A scope (instead of the picture on the CRT) is used to determine the locking.

Every AFC circuit has a point at which both the sync pulse and the pulse (or sawtooth) from the sweep can be viewed simultaneously on a scope. In many late-model receivers, this point is one of the three connections to the AFC duo-diode. However, the CTC7AA chassis does not use a duo-diode (see Fig. 1). The best viewing point in the CTC7AA is at Circuitrace 66 (Photofact 433-2), which is the junction of C54, C68, R110 and R90.

The waveforms at Circuitrace 66, both for locked and free-running operation, are shown in Fig. 2. To prove that both sync and sweep signals are present, first force the oscillator out of lock. Then, lock the scope to the stronger of the two signals (usually the sweep waveform) and the sync pulses will move rapidly across the other waveform. Next, adjust the horizontal locking so that the two waveforms merge into one. Set the sweep vernier on the scope to produce three or four waveforms, and examine them. The waveshapes should be identical.

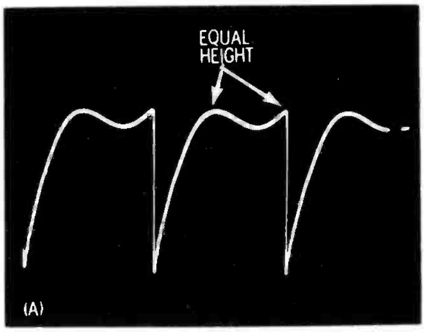
If one waveshape is a composite of sync and sweep, but the next is a sync pulse, and the third is another composite, the oscillator is operating at half the normal horizontal sweep frequency. At the other extreme, composite waveforms with a sweep waveform centered between them prove that the oscillator is operating at double the normal frequency. Other out-of-lock frequencies between these two extremes cause the sync to move in a blur across the sweep waveshape.

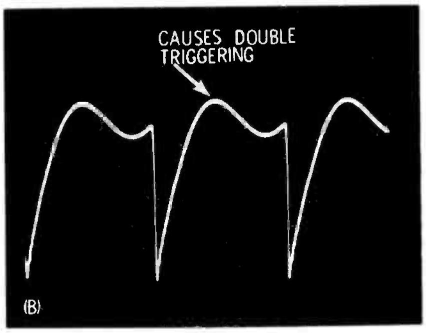
Often, one inherent problem must be solved when using the preceding method. If the horizontal-output stage is not operating, normal AGC action will be disrupted, and the sync pulses will be lost because of signal overload in the video IF's. If this is the case, clamp the AGC voltages with a bias box, or decrease the received signal by loose-coupling the antenna lead-in. The overload should be reduced by one of these methods, and the sync restored for the test.

Tips about the CTC7AA horizontal oscillator frequency

The components which mainly determine the horizontal sweep frequency in the CTC7AA are: R114, C72, L36 (the oscillator coil), L37, C74 and C75.

All locking can be lost if the value of R113 or R114 is out of tolerance. For example, if the resistance of R114 increases, and it often has, the cathode voltage of the AFC tube becomes a few volts too positive, which biases





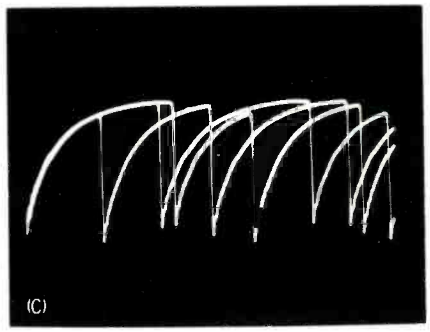
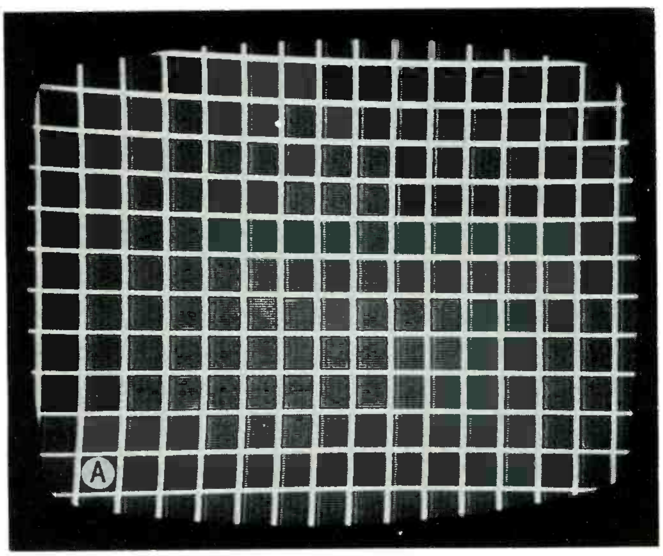


Fig. 3 Best stability of the oscillator is obtained when the sine-wave stabilizing circuit (C74 and L37) is adjusted correctly. **(A)** Equal height of the rounded and sharp tips of the waveform (when the oscillator is locked) are desired. If the sharp tip is higher, some immunity against horizontal line displacement caused by impulse noise will be lost.**(B)**When the rounded tip is higher, double triggering (Christmas Tree) is possible, especially after the chassis becomes warmer. **(C)** Unstable drive signal produced at the grid of the output tube during double-triggering.



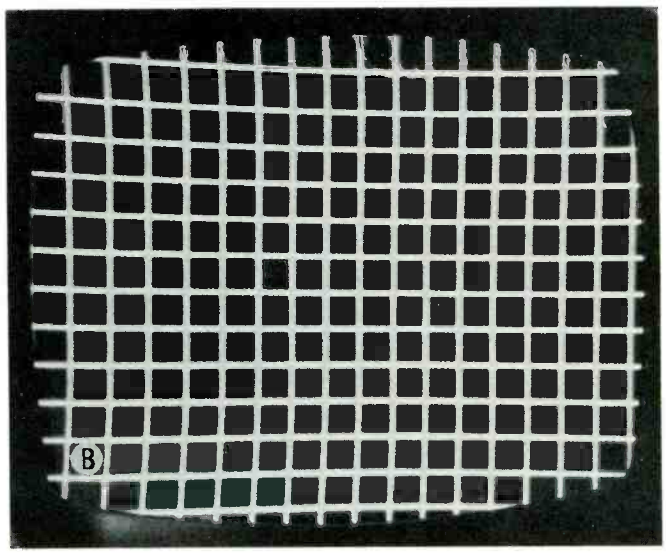


Fig. 4 Comparison of a normal crosshatch pattern to one produced with insufficient drive at the grid of the output tube. **(A)** Normal crosshatch pattern on the screen of a test tube. Some pincushion distortion is evident because the chassis was designed to operate with a round, 90-degree-deflection CRT. **(B)** Insufficient drive narrowed the picture by about 1 inch on each side, reduced the brightness and blurred the focus.

the tube into cutoff, and it cannot respond to changes in the phasing of the two signals that are applied to the grid. Because the change of value of R114 appears to be caused by heat cycling over a period of years (and thus there is no danger of it changing again soon), a permanent repair for the loss of locking can be made by paralleling R114 with a ½-watt resistor. Try 1.8M-ohm, 2.2M-ohm and 2.7M-ohm resistors, and solder in the largest value resistor which sufficiently improves the locking.

Because even a slight leakage or a gradual change of the value of C72 or C75 will cause the frequency of the horizontal oscillator to drift, silver-mica capacitors should be used for replacement of these components, when replacement is required.

If C75 opens, the frequency of the oscillator increases drastically, perhaps to about 30 KHz, and the raster fades out because the high voltage is lost. However, the AC and DC drive voltages at the grid of the output tube remain nearly normal. These symptoms could mislead you into believing the defect is in the sweep circuit.

Any large increase in the sweep frequency caused by a defect in components other than C75 will significantly reduce the amplitude of the drive signal at the grid of the output tube. (In such a case, C75 reduces the amplitude and straightens the rounded sawtooth of the drive signal.)

The sine-wave stabilizing circuit, consisting of L37 and C74, can cause gradual drifting of the frequency, or, worse yet, double-triggering (Christmas Tree-ing). C74 should be replaced with a high stability type, and sine-wave coil L37 reset.

To adjust the stabilizing circuit:

- Lock the oscillator and keep it locked during the adjustment. If the oscillator will not lock because it double-triggers, short across L37 with a short test lead, lock the oscillator, remove the test lead, and adjust L37 for locking. (This can serve as a "quick and dirty" field adjustment in emergencies.)
- Connect a low-capacitance scope probe to testpoint "K" (junction of L36 and L37).
- Adjust L37 to produce equal heights of the rounded and sharp tips of the waveform, as shown in Fig. 3A. Keep the oscillator locked; if it falls out of lock, the two tips will be of equal height but the adjustment of the circuit will be more incorrect than when you began.

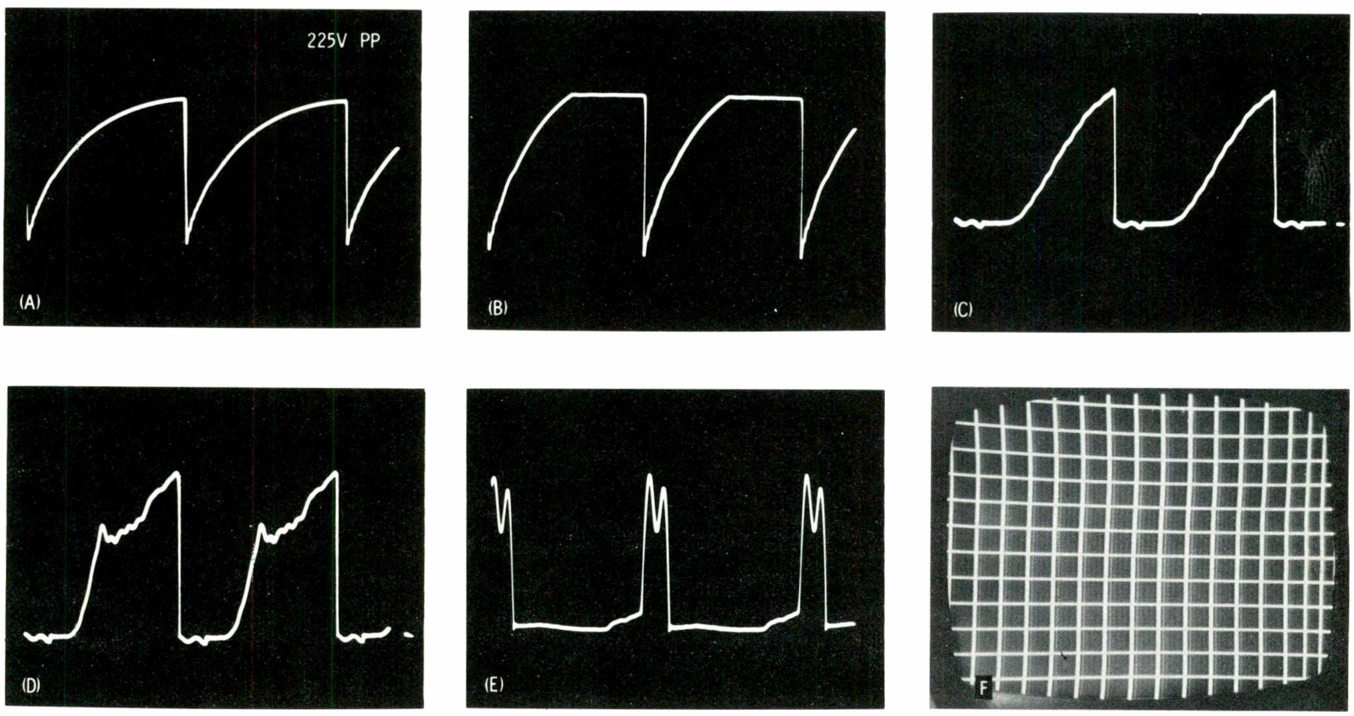


Fig. 5 Leakage of 560K-ohm across C77, the coupling capacitor between the oscillator and the grid of the output tube, produced many distorted waveforms and trouble symptoms. **(A)** Normal drive signal at the grid of the output tube. **(B)** Clipped-sawtooth drive signal that resulted from the leakage of C77. **(C)** Waveform produced by normal current through the cathode of the output tube. **(D)** Waveform of the cathode current through the output tube when C77 was leaky. It reveals that conduction occurs too soon and the maximum current is reduced. **(E)** Distortion of the yoke voltage waveform occurs just prior to the pulse. Compare this to the normal waveshape shown in Fig. 13B. **(F)** Compression of the linearity on the right edge of the CRT screen when C77 was leaky.

- If the rounded tip is too high, compared to the pointed tip, as shown in Fig. 3B, the oscillator might double-trigger after the temperature of the receiver reaches the operating level. Double-triggering produced the erratic and unstable output-tube drive signal shown in Fig. 3C.

Waveshape

A rounded sawtooth, or a rounded sawtooth with a pulse at the bottom, is the approximate waveshape required at the grid of the horizontal-output tube. This important waveshape is included in each Photofact and in some other service literature.

Although high voltage and sweep can be obtained even when the drive waveform is badly distorted, the raster will be narrow or nonlinear and the high voltage reduced. The curvature and the amplitude of the right half of the sawtooth are the critical factors of the drive waveform.

The values and conditions of C75, R119 and C77 mostly affect the waveshape of the drive signal. (C75 and C77 will be discussed later.) A reduction of the value of R119 produces an increase of the amplitude of the sawtooth drive signal but it will be more rounded on the top. This can compress the linearity on the extreme right edge. An increase of the value of R119 causes just the opposite effects: The sawtooth drive signal becomes more linear and the amplitude is reduced. This can reduce the width and spread the linearity on the right edge.

The waveshaping circuits in other models sometimes add a resistor between the capacitor (C75 in this circuit) and ground. If used, the resistor adds a negative-going pulse to the bottom of the sawtooth. The larger the resistance, the larger the pulse; because of this the value of the resistance is critical.

Amplitude

Drive signals that have either excessive or insufficient amplitude reduce the width of the raster and the high voltage. (See Table 1, lines "E" and "F," and Fig. 4.) It is not true that increased drive always produces more high voltage. In each design of chassis a certain optimum amplitude of drive signal is required for maximum width and high voltage.

The amplitude of the horizontal drive signal (at the grid of the horizontal output tube) is determined mainly by C75, R119 and the oscillator tube. Other components—such as C77, C76, R118, R119 and the output tube—have less effect on the amplitude.

The actions of C75, the waveshaping capacitor, are unique, because the value and condition of this capacitor can affect all three of the important horizontal drive signal characteristics—frequency, amplitude and waveshape.

Functions Of The Individual Components Used To Couple The Drive Signal To The Grid Of The Output Tube And The Effects Produced When They Are Defective

In the ELECTRONIC SERVICING laboratory, we have investigated the functions and effects of many components and we have simulated typical parts failures and have changed the values of many components to determine the actual effects of such defects. The most significant results and findings of these tests are presented here and in subsequent parts of this series.

(During these tests, the chassis was operated on a test jig which used a 19-inch rectangular picture tube. Because the CTC7AA chassis normally is used with a round CRT which has a smaller angle of deflection, pincushioning will be noticed in pictures taken from the screen of the test-jig CRT. Also, some of the voltages will differ slightly from the ones typically measured when the chassis is operated with its own yoke and CRT.)

- **C77** (.01m-fd paper or Mylar capacitor) couples the oscillator signal to the grid of the horizontal-output tube. The value is not critical, although capacitances of less than .001 reduced the width and high voltage. Leakage of 560K ohms across the capacitor produced the voltage changes indicated on Line "D" in Table 1, and also clipped the top of the drive sawtooth and compressed the linearity at the right side of the raster, as shown in Fig. 5. A gassy horizontal-output tube might cause the same effects.
- **R120** (10M-ohm resistor) is the grid return for the output tube. The resistance is not critical. Values from 2.2M ohm to an open circuit caused only slight changes in the crosshatch pattern. Line "G" in Table 1 shows the voltages that were produced when the resistor was removed from the circuit.

Insufficient amplitude of the drive signal applied to the grid of the output tube changed the voltages as shown on line "F" in Table 1. The reduced drive also narrowed the width about 1 inch on each side of the screen and blurred the focus, as shown in Fig. 4.

Excessive drive caused by an open circuit in the HORIZ DRIVE control (R119 in Fig. 1) compressed the center of the raster. More compression would have caused a white drive line. The voltages produced by this defect are shown on Line "E" in Table 1.

In Part 2

The specific functions of the individual components which make up the horizontal-output yoke and high-voltage circuitry of the CTC7AA and the effects produced when they are defective will be analyzed in Part 2 of this series, along with related troubleshooting techniques. □

Weak color–Typical causes and how to find them

The Tuner Seldom Is The Cause

Don't blame the tuner for weak color. At least, not without some proof. It is a natural mistake to assume that the tuner is at fault when the fine tuning must be adjusted carefully to obtain *any* color.

However, color saturation is *always* stronger when the fine tuning is near the point where sound bars are produced. The action of the fine tuning control "slides" the chroma signal up or down the sound-carrier side of the video-IF response curve.

This change of color intensity which normally accompanies adjustment of the fine tuning control often is obscured by automatic chroma gain control (ACC) action, which "levels off" most of the increase or decrease. Weak color can make the ACC ineffective, and thus reveal what is a normal change of color intensity.

Severe misalignment of the antenna and RF stages in the tuner *can* cause the fine tuning to abnormally affect the quality and quantity of color. An open antenna transformer (balun) or dirty, corroded switch contacts in the antenna or RF stages might cause weak or smeared color on one channel. There is little chance such defects would affect all channels.

Despite these few exceptions, in most cases we can safely say: If the fine tuning control will produce sound bars, the defect causing weak color will not be in the tuner but in the video IF's or the chroma circuitry.

Antennas

A comparison of the color pictures produced by each of several antenna systems can reveal startling differences in the intensity and sharpness of the color signal. Even the poorest antenna, however, usually will produce a good color picture on at least one channel. Most receiver defects produce the *same* symptoms on all channels. We recommend that you use a color-bar pattern to test the receiver without the antenna connected.

Your own shop antenna system is not immune to defects. It is better to periodically check it than to waste time trying to find a receiver defect which does not exist.

Incidentally, a poor antenna system can cause symptoms that seemingly are caused by incorrect Automatic Fine Tuning (AFT) action. An AFT defect causes poor fine tuning on all channels. A defective or incorrect antenna can cause poor AFT action on just a few channels and good AFT on the others. For more details, refer to the article starting on page 32 in the September, 1969 issue of ELECTRONIC SERVICING.

Color Killers

All color killers should perform two functions: 1) They should permit the color signal to pass, with full gain, through the chroma circuit when burst is received. 2) They should kill completely the gain of the chroma channel when a b-w program (without burst) is received. No in-between action is desired.

A defective color-killer circuit can eliminate the color at the wrong time, simulating a dead chroma-bandpass stage, or it might reduce the gain and cause weak color.

A shunt-type color-killer circuit typical of many used in tube-type receivers is shown in Fig. 1. Tube V1 functions as a rectifier, the conduction of which can be stopped by a grid-cathode bias of −3 volts or more. The AC input voltage, which consists only of positive-going horizontal pulses, is coupled to the plate through the peak-reading capacitor, C3.

Grid bias voltage for the color-killer tube is obtained from two different sources. One is a "fixed" positive voltage the value of which is dependent on the setting of R3, the color-killer control, and which is fed through a large-value resistor, R2. The second is a control voltage obtained through a small-value resistor from either a phase detector or the grid circuit of the 3.58M-Hz oscillator. Regardless of the source, the control voltage varies from slightly negative during b-w reception to more negative when burst (and color) is received.

The small, positive voltage from the color-killer control is needed to cancel the small, negative voltage produced during b-w reception, so that the color-killer grid voltage is nearly zero. With such a small bias applied to the grid, the tube conducts heavily, the plate circuit rectifies, and the negative voltage thus produced biases off the chroma-bandpass-amplifier tube. This kills the color.

Test for color-killer plate rectification by grounding the grid of the color-killer tube. All color should disappear and a negative voltage of more than −12 volts

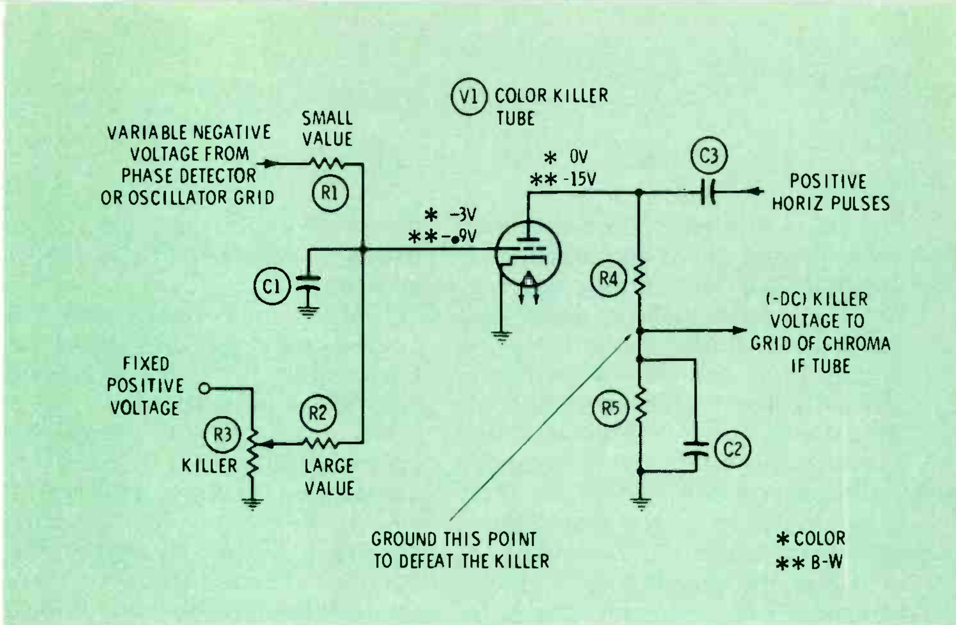


Fig. 1 Schematic of a typical color-killer circuit in a tube-equipped chassis. During b-w reception, V1 has minimum bias, which permits rectification of the horizontal pulses at the plate. Negative voltage produced by the rectification is filtered and applied as cutoff bias to the grid of the chroma-bandpass tube.

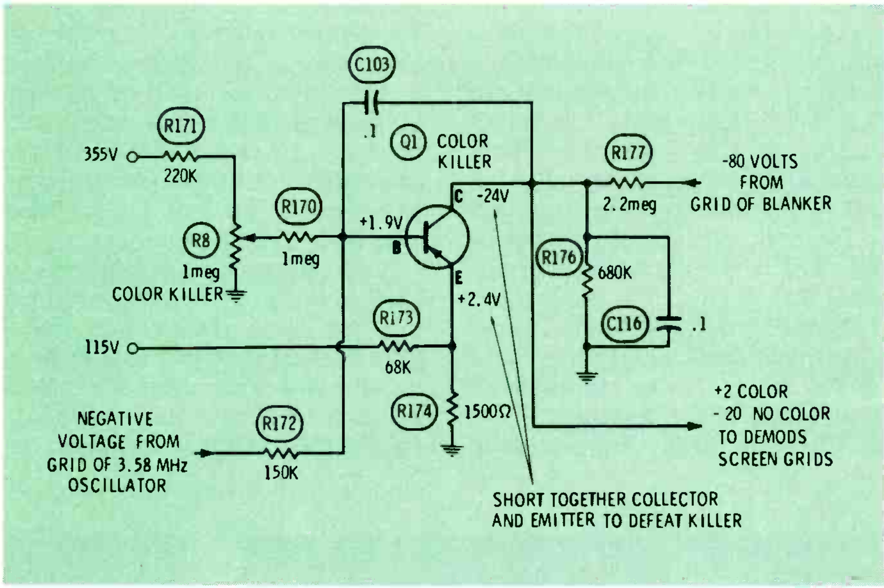


Fig. 2 Schematic of the color-killer circuit in a RCA CTC31 chassis. The killer transistor, which acts as an on/off switch, applies to the screen grids of the demodulators either a negative voltage (to kill the color) or a positive voltage (to permit color).

should be produced at the plate of the color killer.

The ratio of R1 to R2 is usually about 1-to-10 (or more) so that most of the *change* of the controlling voltage actually reaches the grid. This enables the color-killer function to respond more quickly. If the value of R1 should increase or if the change of controlling voltage between b-w and color should be decreased, undesired color-killer operation between the regular on-and-off states is possible. Weak color could be the result.

Defeat the killer

In this discussion, we are not concerned so much with specific parts failures in the color-killer circuit as we are with methods that prove whether or not the color-killer circuit is defective.

All color-killer circuits have two points which can be connected together to defeat the color-killer action and thus restore the color which was eliminated by a defective color-killer circuit. In the circuit in Fig. 1, these two points are ground and the junction of R4 and R5. Connect a test lead from this junction to the chassis; if the intensity of color increases, it is certain that a color-killer defect exists.

In many color-killer circuits, neither of the two points are at ground potential. For example, many late-model Zenith color chassis have terminals that are plainly labelled "K" and "KK". Connect them together to defeat the color-killer action.

One type of RCA color killer

Fig. 2 shows a partial schematic of the color-killer circuit in the RCA CTC31 color chassis (Photofact 928-3). The color-killer transistor, Q1, is operated as an on/off switch, to change the polarity of the DC voltage applied to the screen grids of the two demodulators. This is accomplished by connecting together, or by not connecting together, a positive voltage and a negative voltage. These voltages are supplied by separate voltage dividers.

During b-w reception, when the transistor is an open circuit because of insufficient forward bias, the collector is supplied with about −25 volts by a high-resistance voltage divider (R177 and R176) which is supplied from the −80 volts at the grid of the horizontal blanker tube.

The emitter is supplied at all times with about +2.4 volts by a low-resistance voltage divider, R173 and R174.

DC voltage from the collector

of Q1 is filtered, routed through the secondary of the bandpass transformer, and finally applied to the screen grids of both demodulator tubes. When the program is in b-w (Q1 is an open circuit), the negative voltage at the collector of the color killer reverse biases the screen grids of both demodulators, so that demodulation is prevented and the color signal is eliminated.

When the program is in color, the base of Q1 becomes less positive (more negative relative to the emitter). Because this is a strong forward bias, the collector and emitter virtually become shorted together. The voltage that is produced at the collector by this "connection" of collector and emitter is nearly the same as the voltage at the emitter, because the low-resistance supply at the emitter swamps out the high-resistance negative supply at the collector. This collector voltage of about +2.2 volts is sufficient, when applied to the screen grids of the demodulators, to permit normal demodulation.

To defeat this color killer, short together the collector and emitter leads. If you are not sure which lead of Q1 is which, short all three together. Any increase in the intensity of the color is proof of a defect in the color-killer circuit.

Test the ability to eliminate the color by connecting together the base and emitter leads of Q1. The color should disappear.

We suggest you study the color-killer circuit in each receiver you service, determine which two points must be connected together to defeat the color-killer action, and then mark this information on your Photofact, or other service data, for time-saving use in the future.

Weak Color Can Originate In The Video IF's

Incorrect alignment of the video IF stages definitely can cause weak or smeared color. This much is well known. However, serious temporary changes in alignment also can be caused by such defects as corroded tube sockets, gassy or out-of-tolerance tubes, burned resistors, or poor grounds on coils, tube shields or circuit boards.

It can be a serious mistake to realign the video IF stages before making some preliminary tests. One recommended procedure is to tune in a color-bar pattern and physically move tube shields, rock tubes in their sockets, replace tubes, or check board grounds while watching the screen of the color CRT for any changes in the color intensity or color sharpness. Often, some kind of erratic behavior will result and point directly to the source of the trouble.

Or, if you have good sweep alignment equipment, connect it to the chassis as though you were going to align the IF's. Be sure to use fixed bias voltages as substitutes for the AGC voltages. Do *not* touch the alignment adjustments until after you have first tested the resistance of the B+ and cathode resistors and also have made the physical checks listed previously while monitoring the alignment curve for intermittent changes.

Generally, weak color is produced by any video IF which has an alignment curve like that in Fig. 3A, in which the center of the curve has been elevated by an incorrect adjustment, gassy tube, poor ground, burned resistor or corroded tube sockets. The higher on the side of the curve the three color frequencies are placed, the stronger the color intensity. However, the 42.67MHz marker must not reach the corner of the curve (42.75 MHz)

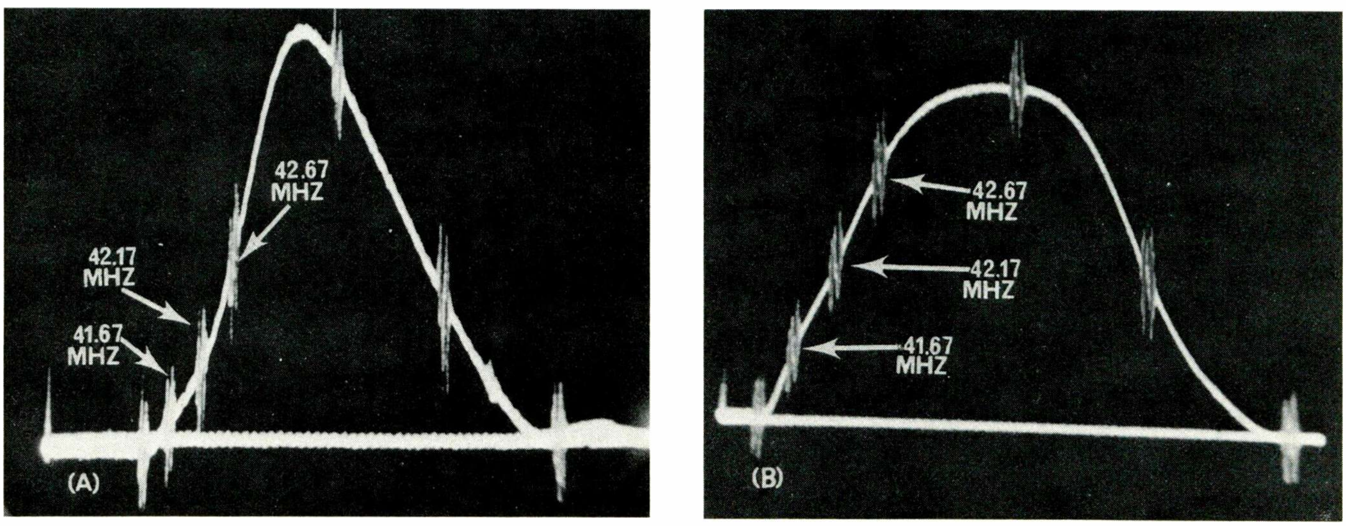


Fig. 3 Alignment curves can reveal the approximate amount of color passed by the video IF stages. **(A)** Curve that produces weak color. The color markers are too low on the curve. Curvature between the three color markers indicates poor-quality color. **(B)** Normal semi-haystack curve produces good color gain.

or the quality of the color will be degraded. Whether the curve is a normal "haystack", as shown in Fig. 3B, or a "flat-top" is not so important as the straightness of the color side of the curve and the height of the color markers above the base line.

The Chroma-Bandpass Amplifier Stages

Typical defects

Defects in the chroma-bandpass amplifier which are the most likely causes of weak color are weak tubes, leaky capacitors and burned resistors.

Cathode bias resistors are particularly susceptible to damage by overload from shorted tubes. The schematic in Fig. 4 shows that some cathode resistors are common to two separate stages and functions. This doubles the chances of a cathode resistor failure.

Physical condition of small resistors can be clue

Moderate overload of a carbon-composition resistor most often causes an *increase* in the resistance and sometimes swelling near the center of the resistor body. Heavy overloads often *decrease* the resistance and cause swelling and cracking of the resistor body. Extreme overloads might cause the resistor to disintegrate and become an open circuit. Any resistor that shows signs of heating should be suspected, and either replaced or checked carefully.

V1 and V2 in Fig. 4 have about the same probability of shorting and burning-up R3. However, the blanking amplifier, V2, is less likely to have current variations which would upset the cathode voltage. A loss of blanking would affect the brightness of the raster, and it would be the predominant symptom instead of the color saturation. Also, V1 has color-killer voltages applied to the grid return, and this causes the cathode voltage to vary from a low of about +2.7 volts when V1 is cutoff to a high of about +5 volts when the color-killer voltage is zero. Operation off channel or with a b-w program or with the color oscillator out of lock produce voltage readings between these two extremes.

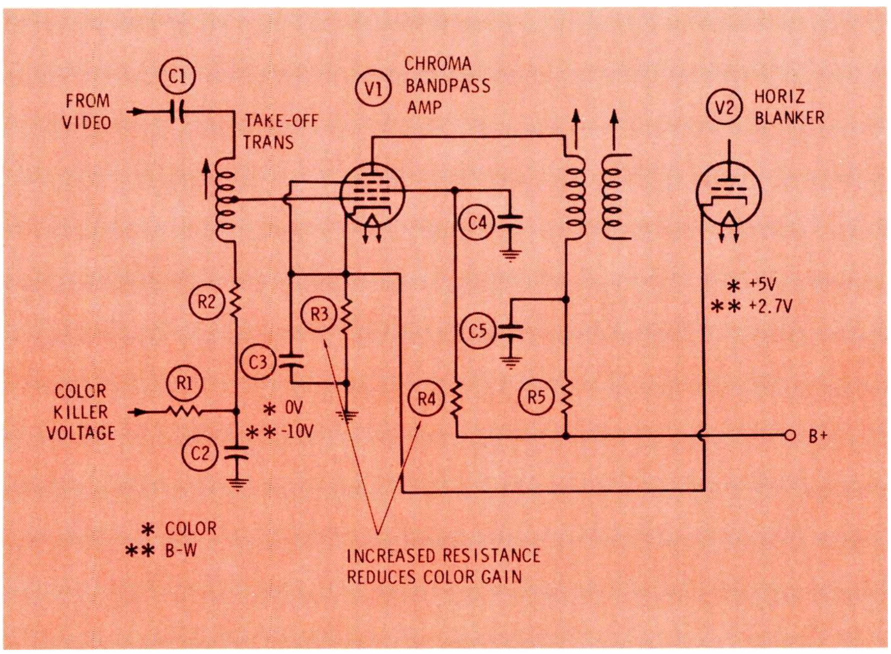


Fig. 4 Schematic of the chroma-bandpass stage in the RCA CTC31. Resistors which can change the gain after their resistance is changed by overload include R3, R4 and R5. Notice that R3 is common to both the chroma-bandpass tube and the horizontal-blanker tube. Shorts in either tube can cause R3 to burn, change value and reduce the chroma gain.

Analyze the bias voltage

Tube bias is always measured between grid and cathode, not between grid and ground. This basic point should always be kept in mind. The bandpass amplifier, V1, has grid-to-ground voltage and cathode-to-ground voltage in addition to the complication of the blanker tube cathode current.

But, first, the cathode-to-ground voltage produced by an open cathode resistor needs clarification. Contrary to some things said in print, the cathode voltage in this circuit will *never* increase enough to equal the screen voltage or the plate voltage. This is because the grids return to ground, not to the cathode. The cathode voltage will increase to the value which barely cuts off the cathode current. This value is dependent on the type of tube, and the screen and plate voltage. If the current tries to increase, the voltage increases to bias off the tube. Because two tubes share the same cathode circuit, an open resistor would cause the cathode-to-ground voltage to increase to the value of voltage needed to cutoff the tube which requires the highest bias.

During typical operation, when V1 is conducting sufficiently to produce maximum gain, the grid voltage is zero and the cathode voltage is +5 volts, or a total bias of 5 volts. When V1 is cutoff by the color-killer voltage, the grid voltage is −10 volts and the cathode voltage (to ground) is +2.7 volts, or a total bias of 12.7 volts.

To test the performance of the bandpass amplifier, ground the color-killer voltage at C2 and measure the cathode voltage. A voltage of +5 should give maximum color gain (saturation) and a voltage of +12.7 should give zero gain (no color). Voltages near, but less than, +12.7 produce weak color.

A resistor-substitution box could be used by connecting it from cathode to ground and trying the various resistances, to reduce a cathode voltage that is too high. This is a good auxiliary test, but remember that most pentode tubes have maximum gain with about 3 volts of bias applied. Consequently, do not reduce the cathode voltage below 3 volts.

Other voltages

Plate and screen voltages, especially screen grid voltages, have a large effect on the gain of tubes. These DC voltages should be checked early in the chroma tests.

A leaky screen-grid bypass capacitor, C4 in Fig. 4, reduces the screen grid voltage and the gain; a shorted one produces no color or very weak color. Although an open capacitor does not change the DC voltages, it still reduces the gain, because of degeneration. These effects are true if the value of the screen-grid dropping resistor, R4 is large, (several thousand ohms). In those circuits where the resistor is only 1000 ohms and connects to a low-voltage supply, the condition of C4 has much less effect on the performance.

Incorrect ACC Action

The normal function of the automatic color gain control (ACC) is to reduce the gain of a chroma bandpass amplifier when the color signal (usually, judged by the burst level) exceeds a certain minimum. However, a faulty ACC circuit can reduce the gain too much, which, in turn, produces weak color.

ACC circuits which change the bias of a tube are easy to defeat. If the normal range of ACC control voltage is always negative and never becomes positive, even with no signal, ground the point where the ACC voltage is injected into the grid circuit.

Some ACC circuits, like that used in the RCA CTC31 chassis, shown in Fig. 5, supply the bandpass-amplifier tube with a positive voltage during no-signal operation and a negative voltage which increases according to the level of the burst when color is received.

The CTC31 ACC circuit functions in the following manner: Two voltage dividers supply the control voltage; one supplies negative voltage, the other positive. Resistor R180 and the collector-emitter path of Q2, the ACC transistor, supply the variable positive voltage. An increase in the amplitude of burst at the grid of the 3.58M-Hz oscillator causes the grid voltage there to become more negative. Part of this voltage, through R178, is applied to the emitter of Q2. Because Q2 is an NPN transistor, the forward bias is increased. More forward bias decreases the resistance of the collector-emitter path, increases collector current, which, in turn, reduces the positive voltage at the collector. This is the variable positive voltage, which becomes less positive when the burst signal increases.

Resistors R181 and R204 are the fixed voltage divider for the negative voltage supply. Because the source of the negative voltage is about −80 volts, the maximum negative voltage possible at point "D" is −8 volts (with Q2 a virtual short circuit).

Addition of the variable positive voltage from Q2 and R180 and the fixed negative voltage from R181 and R204 produces the ACC control voltage, which is applied to the grid return of the 1st chroma bandpass amplifier tube. In practice, the ACC voltage at point "D" varies from about +5 volts (a b-w picture) to about −7 volts (strong burst, perhaps with a color-bar generator supplying the color). The typical voltage produced by a colorcast is between zero and −4 volts.

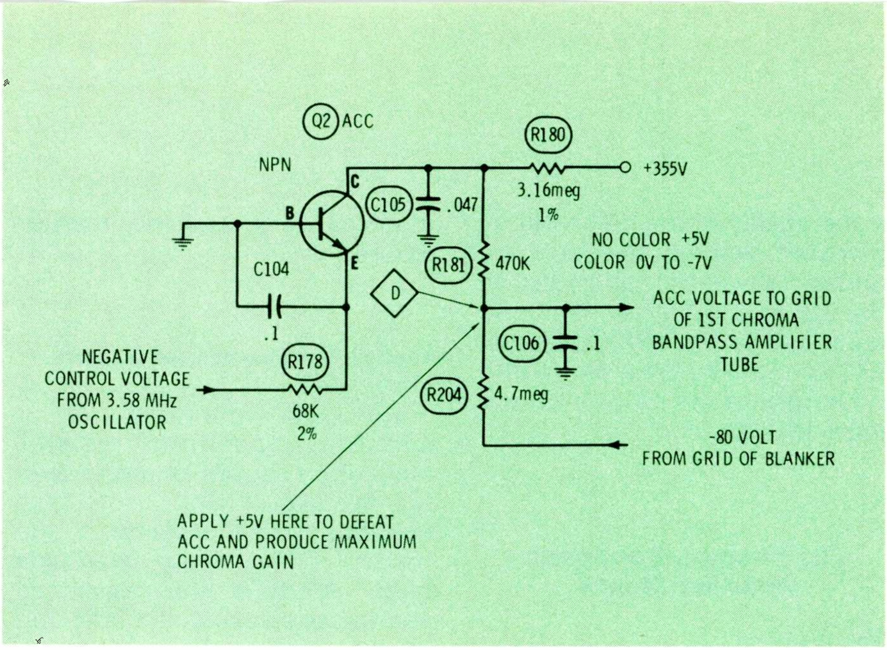


Fig. 5 Schematic of the ACC stage in the RCA CTC31. The ACC transistor, which functions as a variable resistor, changes the amount of positive voltage that appears at the collector. This positive voltage cancels out part of the −8 volts obtained from R181 and R204, to provide a grid voltage for the chroma bandpass which becomes less positive (or more negative) when the amplitude of burst increases. In this way the gain of the chroma-bandpass tube is regulated according to the level of the received color signal.

Because cutoff of the band-pass amplifier tube occurs at about −12 volts, it is easy to understand how a component failure could increase the ACC to a higher-than-normal negative voltage and cause weak color.

Full chroma gain can be obtained if an external bias box is connected to point "D" and adjusted for +5 volts. However, a more typical simulation of the voltage necessary for *normal* gain can be obtained by merely grounding point "D".

Insufficient 3.58M-Hz Carrier

Obviously, to produce vivid colors a strong chroma signal must be applied to the demodulators. Not so well known is the requirement for a definite minimum amplitude of the 3.58M-Hz carrier applied to each demodulator.

The exact amount of the carrier which is needed varies with the type of demodulator. Many schematics show a carrier waveform with a specified p-p level. If the level is not shown on the schematic, it can be determined in other ways, such as by measuring the DC cathode voltage in the older triode demodulators or by measuring the DC voltages in diode-type demodulators.

If the amplitude of the 3.58M-Hz carrier at the demodulators is decreased more than approximately 20 per cent from the normal amount, the color saturation also will be decreased a like amount. Check the amplitude of this signal whenever the color is weak.

Defects In −Y Amplifiers Can Weaken Individual Colors

The typical gain of a −Y amplifier stage is not always known. If the p-p signal voltages at the input and output are listed on the schematic, the input reading divided into the output reading gives the gain. To measure the actual gain, tune in a color-bar pattern and measure the amplitude of both the input and output signals. (The output signals from many −Y amplifiers also contain blanking pulses, which must be ignored when p-p readings are being made.)

Excessive input signal at the grid of a −Y amplifier tube, combined with insufficient bias, causes a decrease of gain, because of the negative grid voltage produced by grid rectification. Check for this possibility by connecting a DC meter between the plate of the −Y amplifier tube and ground, and then varying the color control from no color to maximum usable color. Any voltage change indicates grid current overload and subsequent loss of gain in the stage. □

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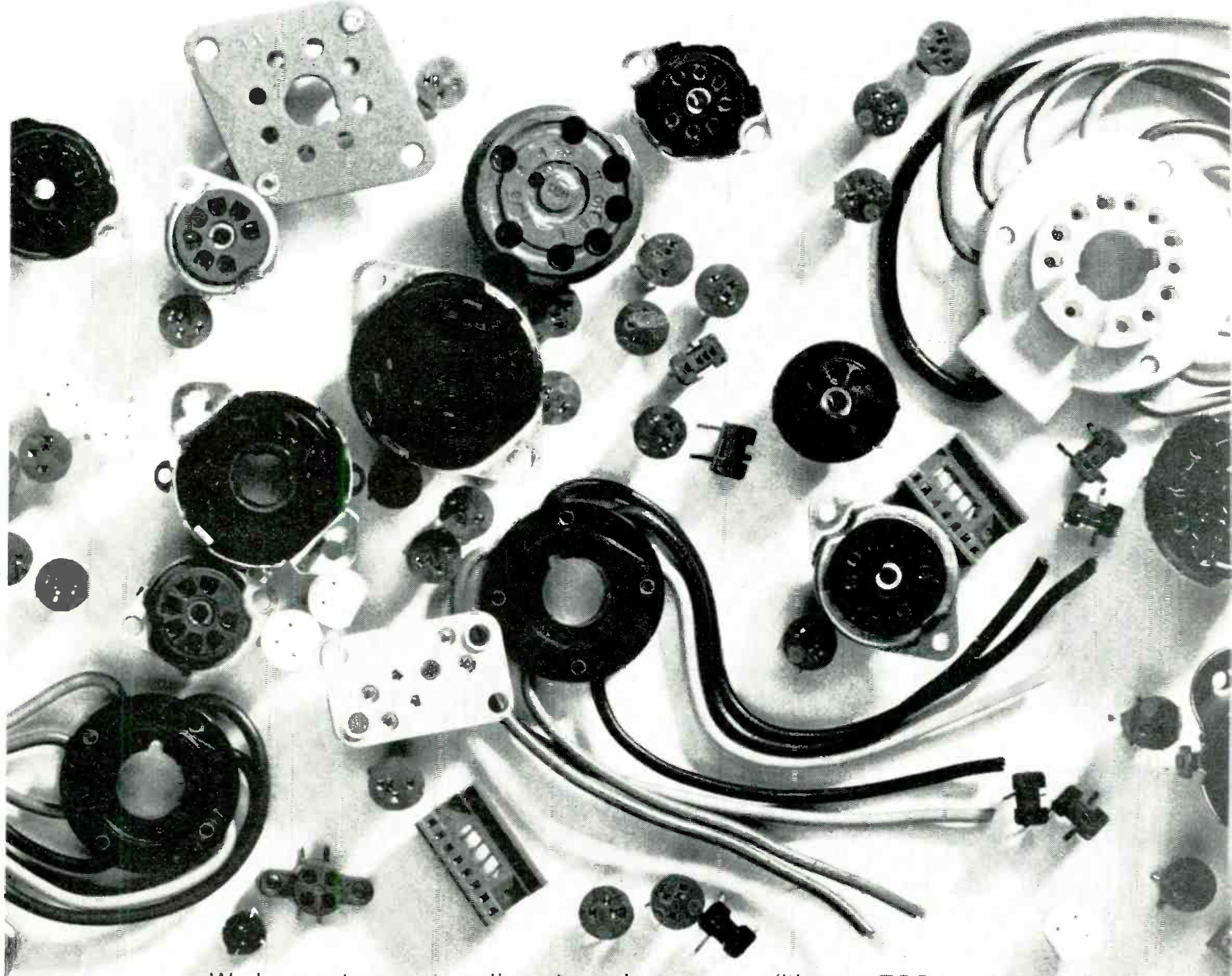

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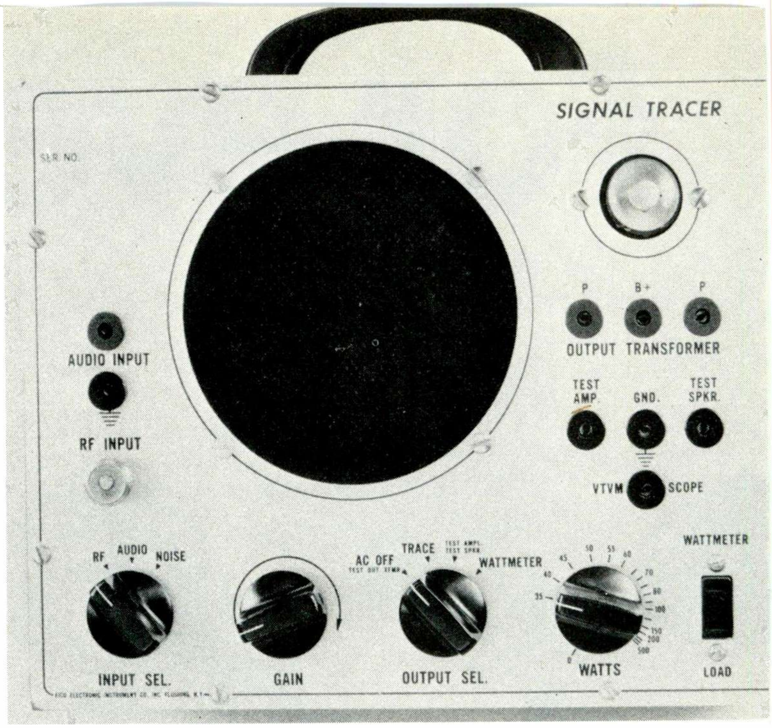
Signal Generators And Tracers: Which, When and Where

by Joseph J. Carr



In the following paragraphs, we are going to consider two primary troubleshooting techniques, signal tracing and signal injection, and determine which is the most suitable for various situations.

Basic Designs

The first step in this process is to become familiar with the various instruments presently available.

Signal tracers

There are a number of different types of signal tracers. About the simplest and cheapest, of these is probably a pair of old-fashioned, high-impedance earphones. Although not so common in radio/TV shops, they are used in many shops that service communications, amateur radio, public-address systems, etc.

While certainly the simplest, and probably the cheapest, type of signal tracer, a set of "cans" does have certain limitations that make their application somewhat less than universal. For example, the drive requirements are enormous compared to other types of signal tracers. Certain low-level signals—the output of a phono cartridge, for example—might not be audible in a set of earphones.

Another difficulty is that the usual range of impedances for earphones is one to five thousand ohms. This is high impedance to a speaker circuit but it could be a low impedance for a tube or transistor circuit.

One way to eliminate some of the limitations of the headphone signal tracer is to drive it (or a loudspeaker) with a high-gain audio amplifier which has a very high input impedance. If the amplifier is also a wide-band type it can be used as a general-purpose oscilloscope preamplifier. Most commercially available signal tracers, whether ready made or in kit form, are little more than an audio amplifier with certain mechanical adaptations. Many units offer additional features such as external access (via banana jacks) to the speaker voice coil and the output transformer primary winding.

Fig. 1 shows a block diagram of a highly satisfactory "homebrew" tracer/generator made by Frank Weisel and Don Newlon of the Auto Radio Center in Norfolk, Va. It is made from a "surplus" Philco-Ford car radio. The unit is cheap, simple, and, I can add from personal experience, highly effective.

Frank and Don's idea, however, wasn't original and unique. True, they thought of it independently, but the same basic set up was used in signal tracers made before and immediately after World War II. A similar set, which by the time I purchased it was old enough to have voted in several presidential elections, was known as the "Autolyzer." Although at least one manufacturer in the early sixties offered a similar unit for transistor radio servicing, this design has been largely forgotten by contemporary test-gear manufacturers. Basically all this system consists of is an AM radio with a probe that can be switched to or from any stage in the radio. It can be used as either a signal generator or a signal tracer, according to the technician's preference.

Signal generators

Signal generators also come in many designs. One of the simplest to use and least expensive to buy is the so-called noise generator. These devices are nothing more than a solid-state square-wave generator operating in the 1K-Hz region. Such square waves are extremely rich in higher harmonics, which will pass through any stage in an AM radio. However, their amplitude, and therefore usefullness, falls off drastically as they approach the common FM IF frequency of 10.7 MHz.

Another simple type of signal generator consists of a transistor, battery-powered oscillator using resonant quartz crystals to set the frequency. It can be designed so that the technician either plugs in the needed crystal or he can select with a switch permanently installed crystals. One such unit built by the author has crystals at 100 KHz, 262.5 KHz (common auto radio IF), 455 KHz, 460 KHz, 500 KHz, 1 MHz, 9 MHz, 10 MHz, 10.625 MHz, 10.675 MHz, 10.7 MHz, 10.725 MHz, and 10.775 MHz. The 100 KHz crystal is used as an alignment marker, while the other low-frequency crystals are for common IF frequencies. The 500K-Hz frequency also can be used to mark the 1000K and 1500K-Hz points on an AM radio dial. The 1M- and 10M-Hz crystals are zeroed against WWV, for calibration purposes. Harmonics of 9 MHz provide convenient markers in the FM band at 90, 99, and 108 MHz. The 10.7M-Hz crystal is, of course, for the most frequently found FM IF. The other four frequencies are plus and minus 25 and 75 KHz from the FM IF center frequency of 10.7 MHz. These are used to check descriminator and ratio-detector linearity.

Variable-frequency signal generators can be classified into one or both of two overlapping categories: audio and RF.

Audio generators are generally those which produce an output between 20 Hz and 20,000 Hz. Some types, notably the ones whose frequency is controlled by a set of switched decades, go down to 1 Hz. On the other hand, however, some lab-grade audio oscillators go up to 10 MHz. A little higher and they could be used for such "RF" purposes as FM IF alignment. This is what we mean by "over-lapping categories." Most of the better audio generators have an output meter calibrated in both volts (rms) and dBm. If such an instrument has both a square-wave output and a good attenuator, it also can be used in place of the noise generator mentioned earlier.

Many types and qualities of RF generators are available. In many instances, the technician can get away with using one of the lesser-quality types. Simple signal-injection troubleshooting is one of those times. For alignment purposes, however, these types have too much leakage (RF coming out somewhere besides the coax jack on the front), instability, and inaccuracy. For alignment, a lab or communications shop-grade instrument generally is preferred.

The quality of RF generators can be divided into several additional categories. First, on the

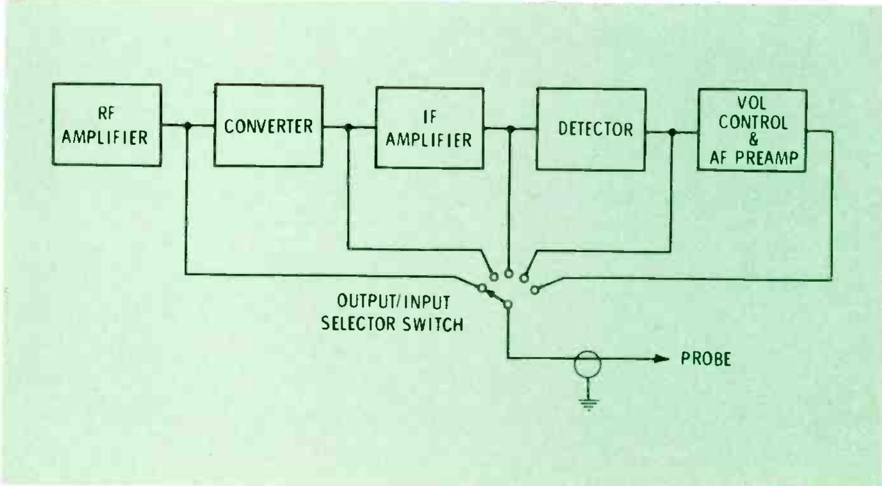


Fig. 1 Block diagram of a tracer/generator built from a discarded AM radio receiver.

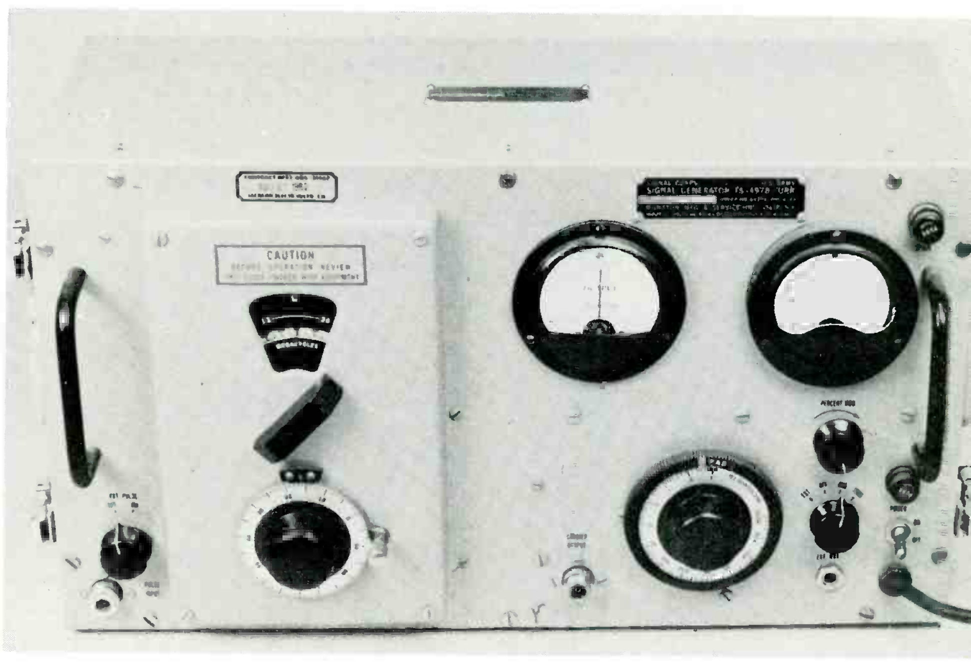


Fig. 2 A typical lab-grade signal generator. This unit offers outputs from 2-400 MHz, with 400- and 1000-HZ modulation up to 30 per cent. It also has a provision for external pulse modulation and is equipped with an attenuator (dial at lower center) accurately calibrated from .1 to 100,000 microvolt. Such generators are popular in communications shops.

low end of the price/quality spectrum are the so-called hobbiest signal generators. These usually sell for less than $100 and often less than $50.

Next are the service-grade generators. These offer better accuracy, shielding, and stability in a price range of $80 to $300 or so. These are the instruments most often found in repair shops.

No matter how you cut it, though, the parameters of even the best service-grade generator usually do not even come close to equalling those offered by the lab-grade type of RF signal generators. Such generators offer almost no leakage and are much more accurate than their lower-priced cousins. The prices of lab-type RF signal generators range for $400 up. Fig. 2 shows one such signal generator. It can be found in two-way radio shops, on production lines, and in R&D labs.

Other Types Of Signal Tracers

Scope

Before moving on to our discussion of troubleshooting methods, we must consider at least two additional types of signal tracers. One of these is the scope. Although it's read-out is visual instead of aural, the scope often will present much more information than can an audio amplifier type of tracer.

VTVM

Another signal tracer is the standard bench VTVM. Although normally thought of in other contexts, this instrument can frequently take the place of the conventional tracer. Technicians who work on VHF FM communications equipment have long used metered test sets for receiver troubleshooting. Any stage that uses grid leak bias, for example, can be checked by measuring the grid current or it's related voltage. If all of the stages

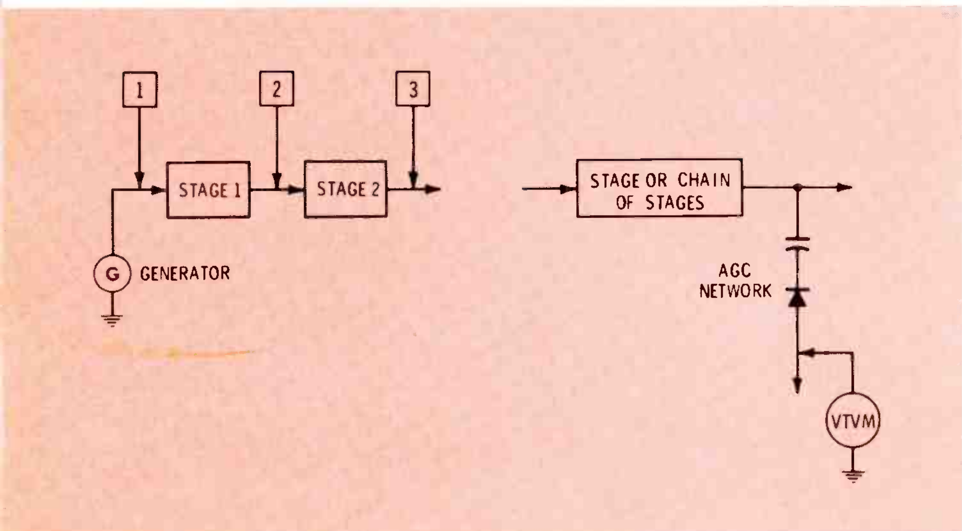


Fig. 3 Combination setup of a signal tracer at the output of a stage or section and a signal generator at the input can be used to measure both stage gain and frequency response. Stage gain is measured by comparing the signal levels at points 1, 2, and 3. Another method is to monitor point 3 while applying a signal to points 1 and 2, in succession. If the input to the AGC network is from a point like 3, it can be monitored.

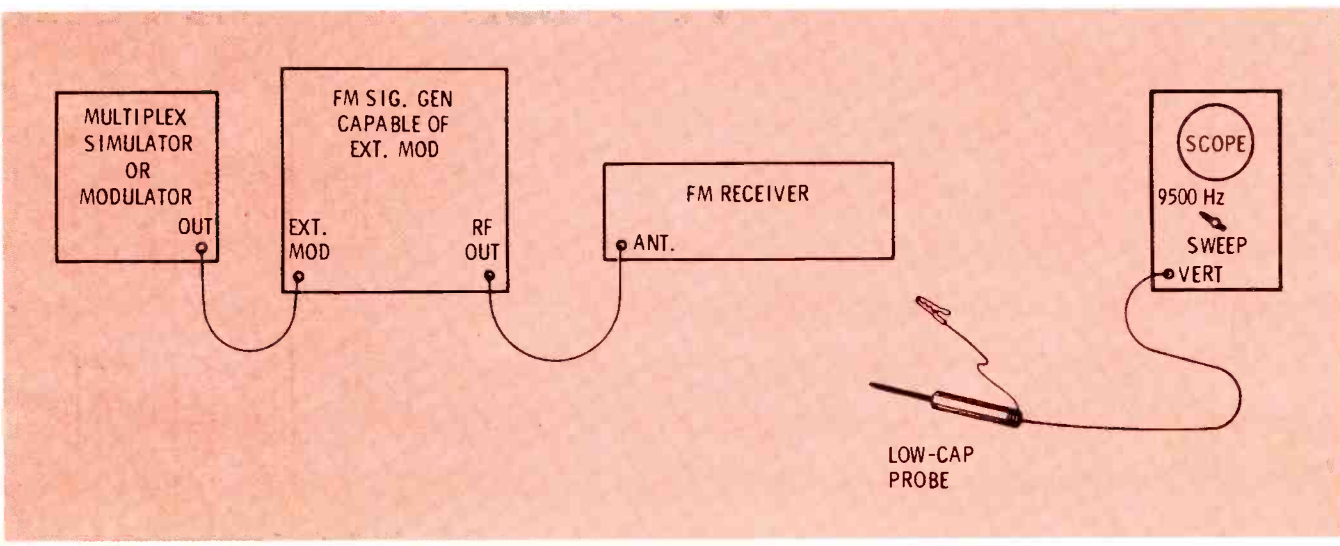


Fig. 4 Typical setup of a signal generator and tracer (scope) used to align stereo FM multiplex section.

(Continued on page 35)

(Continued from page 32)

in, say, an IF strip use grid leak bias, the entire section can be checked with a VTVM.

VTVM with demodulator probe

The signal tracing effectiveness of the VTVM can be expanded by using an RF demodulator probe in place of the normal DC/AC/Ohms probe. Using this attachment, we can measure RF voltages and trace them from one stage to another. As a matter of fact, some service manuals for Citizens'-Band transceivers specify such a probe for both alignment and troubleshooting operations. One manual, for example, calls for 2.8 volts p-p at point X with 1 microvolt of unmodulated signal applied to antenna input. Such specs immeasurably aid troubleshooting because most of our test equipment will not be so effective at higher frequencies.

Troubleshooting

Signal tracing

A signal tracer is used to sample the signal at various points in the set. Start at one end of the radio and work in logical sequence to the other end. Most texts state that signal tracing should start at the RF amplifier. Isolation of the dead stage is accomplished by noting at which point the signal no longer gets through a stage. DC analysis, or perhaps another method, is then used for pin pointing the specific defect.

Signal injection

When using the signal injection method, start at or near the output stage and substitute a signal from an external generator for the signal normally found in the set. Again, as in signal tracing, the point where the signal fails to go through indicates where, if not what, the difficulty is.

Combination

A combination method involves the use of a signal tracer at the output of a stage or a chain of stages and a signal generator at the input. Such a setup can be used, as shown in Fig. 3, to measure both stage gain and frequency response.

Which?

At first glance, these procedures appear deceptively simple and universal. An inexperienced person might ask whether or not either might be used, depending only upon the instrument at hand or the technicians preference. In many cases this could be true. Just as often, however, there can be good reason to prefer one over the other.

In some circuits, for example, the normal signal voltage levels may be too low to use a signal tracer. The input of an RF amplifier or the tap leading to the base connection on the secondary of an IF transformer are two such points. I suppose that this situation has caused a lot of 1st IF transformers to be needlessly replaced.

Another effect of low signal levels is that residual hum and noise pick-up might be sufficient to drown out even some relatively healthy signals. The high gain needed to amplify the signals to a usable level will also amplify all the hum and noise. The unshielded probe found on

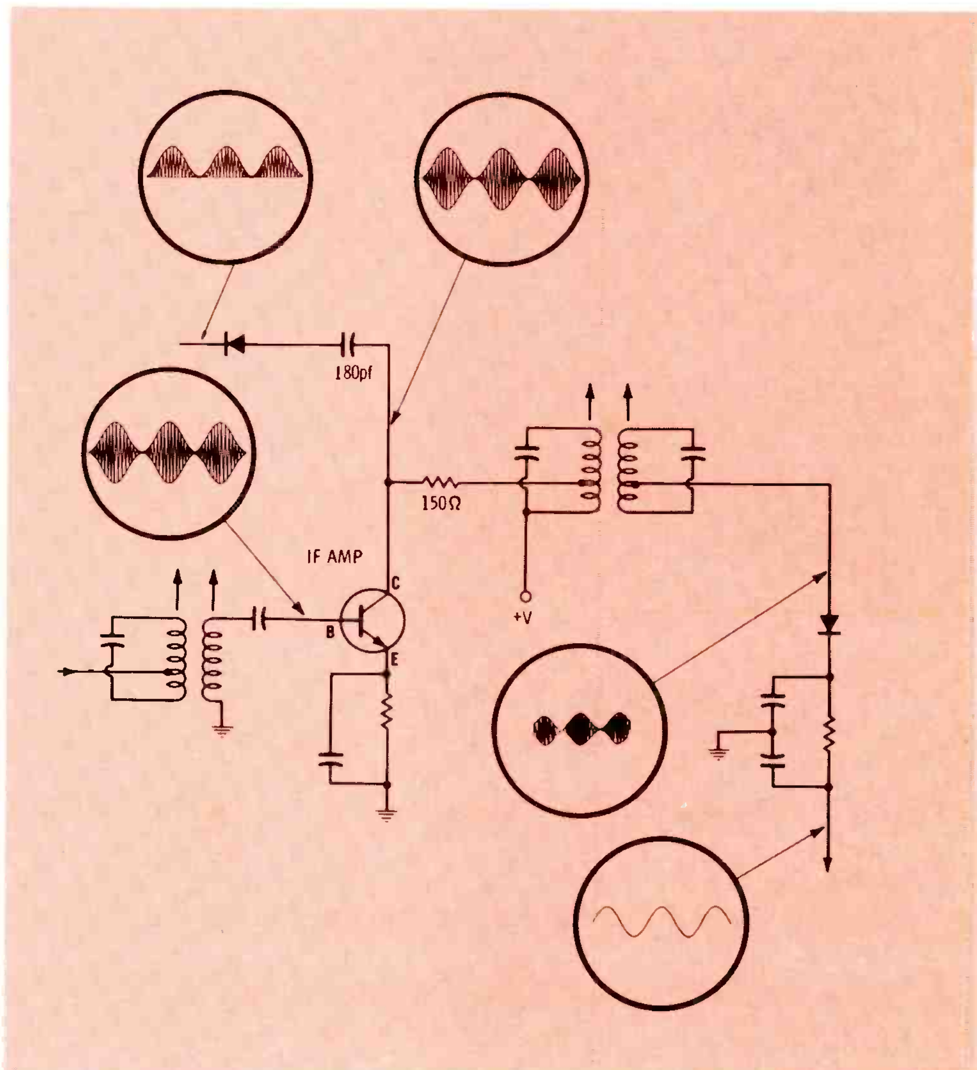


Fig. 5 Schematic diagram of IF amplifier stage of an AM radio showing typical waveforms at key test points.

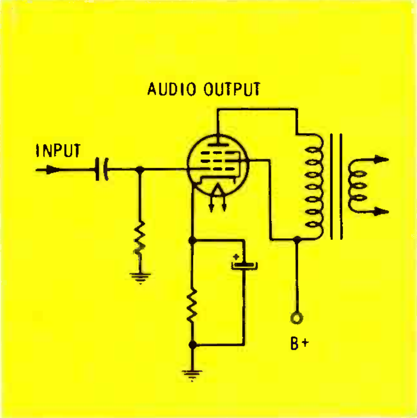


Fig. 6 An open cathode bypass capacitor can cause significant reduction of stage amplification without significantly affecting the DC voltages.

many tracers does little to alleviate the situation.

At this point one might ask whether or not it would be wise to just go ahead and use the signal generator at all points in a receiver. It would certainly make a technician's life easier if he only had one test procedure to consider. Unfortunately, though, all signal generators have a low-impedance output. They range from around 50 ohms in most RF generators to 500 or 600 ohms in audio generators. There are some circuits that simply cannot be tested with a low-impedance instrument. In certain others the test results are less valid because of the low-impedance loading of the generator. The 1 meg-ohm (or higher) input impedance of the signal tracer, on the other hand, produces significantly less circuit loading.

The main criteria, therefore, seems to involve impedance levels and signal strengths. In most cases these two parameters can be used to determine which to use.

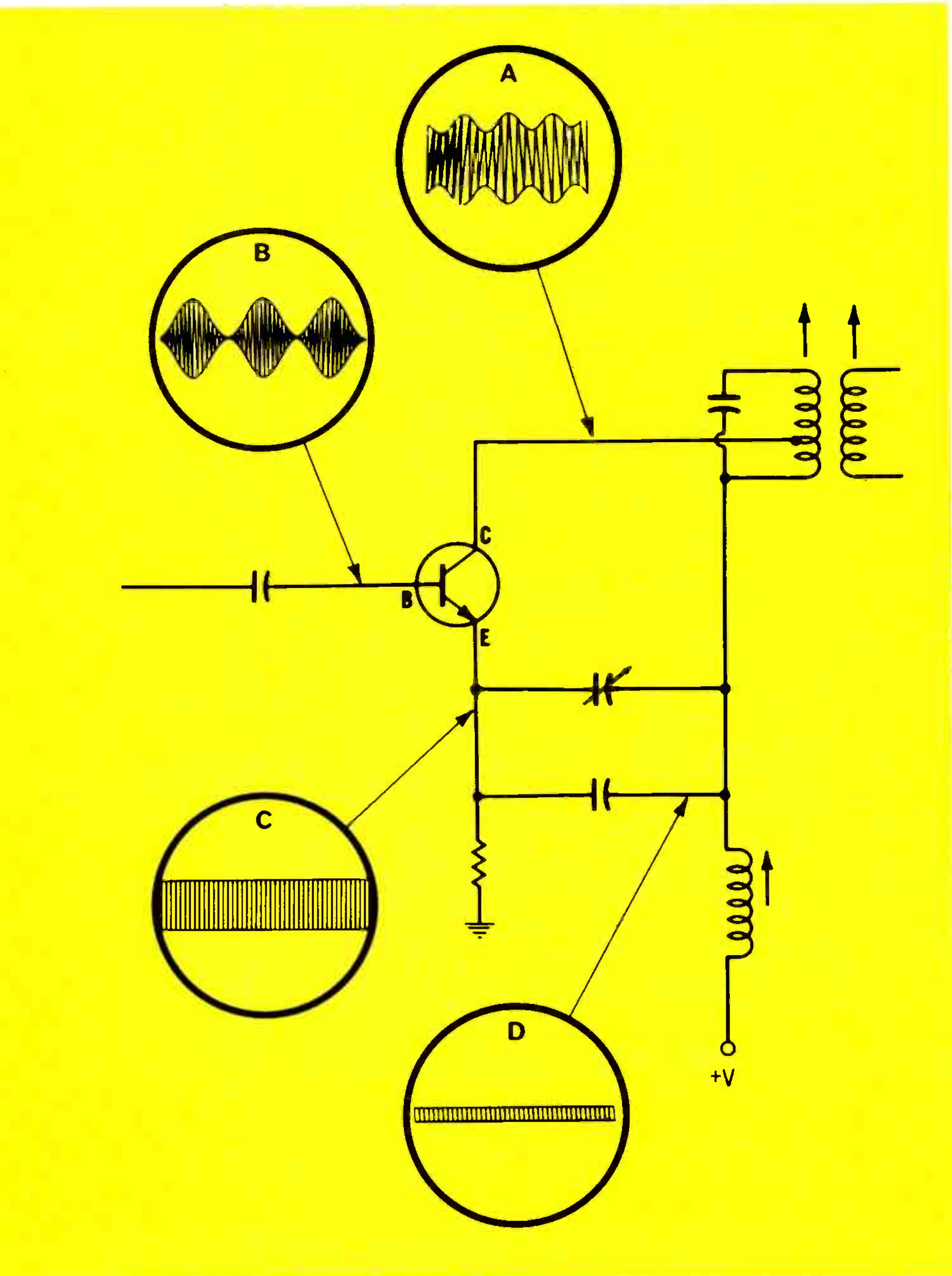


Fig. 7 Schematic diagram of the converter stage of an AM radio showing typical waveforms at key test points.

Specific Applications

Tape units

Many four- and eight-track tape systems are designed to be operated in conjunction with an external audio amplifier. Several Ford automotive tape players and numerous imported and domestic home models use this method. The signal tracer will be of great use when working on one of these sets. The usual bench practice is to connect the tape player outputs to the inputs of a low-powered stereo amplifier system installed at the bench just for such servicing. Not all shops, however, do enough audio work to justify keeping an amplifier around. In these cases, a good signal tracer is a must.

Stereo alignment

Alignment of stereo FM multiplex stages is another place where both a signal generator and a signal tracer is needed. Fig. 4 shows the setup generally used for FM multiplex alignment.

Audio amplifiers in radios

The audio amplifier stage of most radios isn't particularly bothersome to most technicians. A good understanding of test equipment and procedures, however, can make the job speedier and, therefore, more

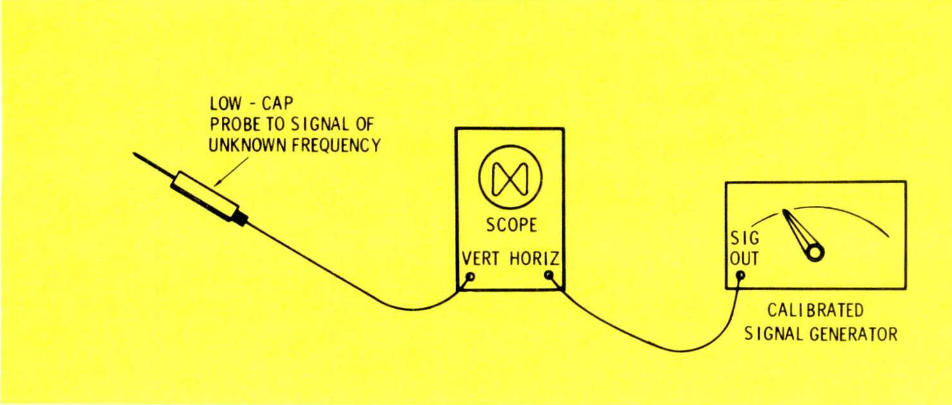


Fig. 8 Test setup here can be used to determine the approximate frequency at which the oscillator of a radio receiver is operating.Exact measurements at RF frequencies are almost impossible using such a setup.

profitable. A signal tracer, even an inexpensive instrument usually can pick up any signal that might be present at the input of the final audio amplifier. These signals, fortunately, are almost all of a high level. At the plate or collector of this stage, however, it is possible for the signal tracer to produce a false indication. Because this stage provides power amplification instead of voltage amplification, it is possible for the signal to sound strong from the tracer but weak from the loudspeaker.

If the output stage is equipped with an emitter or cathode-bypass capacitor (Fig. 5), you can use the tracer to determine whether or not it is open. An open bypass capacitor can reduce the gain of the stage without significantly upsetting any of the DC voltages. The symptoms of an open bypass are reduced signal at the plate but relatively strong signal at the cathode. This can be a little misleading. In at least one case, the same symptoms occurred with zero plate voltage. It seems that the screen grid acted as the plate and the cathode bypass was too small. As a result, there was a sufficiently strong signal voltage developed across the capacitor to sound very loud in the tracer.

Be careful when interpreting the results of signal injection in the output stage. If you depend on the audio jack of a standard RF-type generator, it might be insufficient. Many audio stages require several volts of drive before they produce a strong signal from the speaker. Because of this requirement, it might be wise to have on hand one of the audio generators which can produce upwards of 10 volts rms.

Either signal tracer or oscilloscope are a good choice for audio driver or preamplifier stages. A signal generator also can produce good results. On the output side of a preamplifier, however, it will, in effect, be driving the final amplifier. A low-level generator will, at this point, suffer from the insufficient output problems discussed previously.

IF amplifiers

There is often good reason to prefer the oscilloscope over other instruments when troubleshooting an IF amplifier stage. In many solid-state sets, for example, the voltage at the tap (base connection) of the secondary of the first IF transformer is too low to drive the standard audio amplifier/demodulator probe type of signal tracer. At the plate or collector of most IF amplifiers there is usually plenty of signal available to a tracer.

To provide plenty of sensitivity (height), a scope should have a bandwidth (3 dB point) of at least twice the IF frequency being viewed. This means 600 KHz in auto radios, 900 KHz in regular radios, and 21 MHz for FM sets. The lower IF frequencies will be displayed easily by the average service-type oscilloscope.

Another good reason to use the scope is that the AGC detector, as well as the capacitor feeding it, can be checked for proper operation. The pattern will be similar to that in Fig. 5.

A signal generator used in the IF stage must either be of the noise generator variety or it must be dialed to a specific frequency. While the accuracy of the test isn't affected by having to "dial up" the frequency, it does take a little more time than does the noise generator.

Oscillator/mixer (converter)

The oscillator/mixer stage causes more than it's share of headscratching at troubleshooting time. An audio amplifier type of tracer will show whether or not a modulated signal is passing through the stage, but that's about all it can show. A scope, on the other hand, will show a lot more. It can, for example, show whether the oscillator is running. If modulation shows up on the waveform at the output, we also know that proper mixer action is taking place. If it is properly calibrated, the scope also will tell the precise amplitude of the input, output, and oscillator signals (Fig. 7). With a signal generator connected to the scope, as shown in Fig. 8, you can determine the approximate frequency of the oscillator. Again, if the scope is properly calibrated, you can make frequency measurements without the signal generator by comparing the number of squares per cycle and the sweep frequency of the scope.

RF amplifier

The weak signal levels in the RF amplifier often will cause a standard signal tracer to be useless. For this reason, it is often necessary to resort to either a signal generator or a scope. Do not be too surprised if your signal generator actually shows a slight loss when switched from the output to the input of the RF amplifier. □

Practical Information About Transistors

by Bruce Anderson/ES Contributing Author

Facts you should know about biasing, overvoltage and overcurrent, and substitution.

Biasing

Unlike a tube, which usually will function if there is some plate voltage applied to it, a transistor requires that its base be forward biased with respect to the emitter—in addition to requiring that the collector have a supply voltage. It sometimes is convenient to think of a tube as a "normally conducting" device, and a transistor as a device which is "normally cut off." We won't insist on this concept, or even attempt to prove it; it just is a handy way to keep things straight.

Fig. 1 shows the two basic types of transistors: NPN and PNP. Two ways of connecting supply voltage to each basic type is shown. In the case of an NPN device, either positive or negative supply voltage may be used, provided the collector is positive with respect to the emitter. If the device is a PNP type, the exact opposite is true: The emitter must be positive with respect to the collector.

A transistor must be forward biased to conduct. For NPN transistors, the base must be positive with respect to the emitter; for PNP's, the base must be negative. This is important, but what is more important, the bias voltage of a *conducting* transistor is determined by the transistor itself and not by the external circuit.

Fig. 2 helps illustrate this point. It would appear that the voltage on the transistor base would be determined by the supply voltage and the resistance ratio of R1 and R2. If we were dealing with a tube, this probably would be true. However, in a transistor circuit, the relative values of R1 and R2 will determine base voltage only so long as the transistor is cut off. Once the transistor begins conduction, the base-emitter voltage will remain at whatever the characteristic voltage for the particular transistor happens to be.

Transistors today come in two basic "breeds": germanium and silicon, each of which has a characteristic base voltage. For germanium devices, the voltage drop across the emitter-base junction is about .3 volt. For silicon devices, the drop is about .7 volt. This voltage is the drop across the junction itself, and not necessarily from the base to any other point except the emitter.

The *polarity* of the emitter-base voltage drop depends on the type of transistor. For PNP transistors, the base will be negative with respect to the emitter; the polarity is opposite for the NPN type. This can be remembered easily, because the middle letter of the basic type tells the polarity of base bias required for conduction—positive for N*P*N; negative for P*N*P.

This characteristic of a transistor which causes the emitter-to-base voltage to remain relatively constant once the transistor conducts can be used, in many cases, to check transistors in the circuit. For example, in Fig. 2 the voltage from emitter to base can never exceed .7 volt (with the base positive relative to the emitter). If it is greater than this, the transistor is open. If the transistor were a germanium type, this voltage could not exceed .3 volt. By the same reasoning, the base voltage of a conducting germanium transistor should not be significantly less than .3 volt, if the transistor is conducting in its correct manner. If it is conducting appreciably and the base is significantly less than .3 volt positive with respect to the emitter, the transistor is abnormally leaky or shorted.

The "hooker" in the last statement was the word *appreciably*. In the case of low-power transistors, especially the silicon type, there will be practically no collector current if the base is cut off. There might be a small amount of normal leakage current through the collector of a power-type transistor, especially if the transistor is made of germanium. In any case, it is likely that there is trouble if the collector voltage is less than 90 percent of the supply voltage when the base/emitter junction is cut off. As a general rule, if a power transistor runs hot with no signal, the leakage is excessive.

The junctions can be checked out of the circuit with reasonable accuracy with an ohmmeter. Because neither the emitter-base junction nor the collector-base junction can conduct in the reverse direction, a simple diode check will tell if either one is open or shorted. Fig. 3 shows the equivalent diode circuit of an NPN transistor; the diodes would be reversed if a PNP device were shown. To check the device, first connect the positive ohmmeter lead to the base terminal. The resistance between the base and either the collector or the emitter should be relatively low. Then, reverse the leads; the resistance between base and either emitter or collector should be significantly higher.

To find out which is the base and also to determine whether the device is NPN or PNP, check resistances between transistor terminals until you identify the pair which always has high resistance, regardless of ohmmeter polarity. These two terminals are the collector and emitter. If no such pair can be found, the transistor is probably defective.

Having found the base by the previously described method, the device is NPN if the positive ohmmeter lead must be hooked to the base to obtain an indication of low resistance.

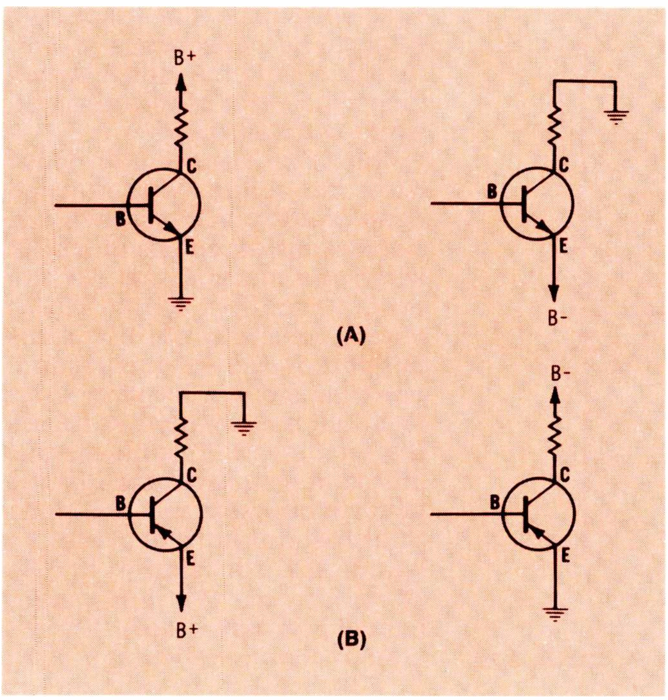
There are some transistors which have very low reverse-voltage ratings for the emitter-base junction. If you encounter one of these, the indication will be the same as a shorted emitter-base junction. These transistors are most often found in high-frequency applications, such as IF or chroma-bandpass amplifiers. They can be checked with an ohmmeter if the battery voltage is reduced to less than a volt, or a transistor checker with the lowest scale selected can be used.

Because the transistor checker has been mentioned, a comment or two about them is in order. These testers are convenient in many cases—more so than an ohmmeter—and often they may be used for in-circuit testing with either more convenience or more accuracy.

On the other hand, don't put too much faith in the Alpha or Beta measurements which you obtain from them. Because transistors do not "wear out," there is no transistor equivalent to a weak tube. With transistors, a "go/no-go" test usually tells all that is required. A transistor tester is useful to match transistors, or to select a transistor for an application where the required Beta is known; but Beta checking as a troubleshooting technique seldom is necessary.

Overvoltage and Overcurrent

It is probably safe to say that anyone who hasn't momentarily shorted the grid or cathode of a tube to B+ just hasn't done



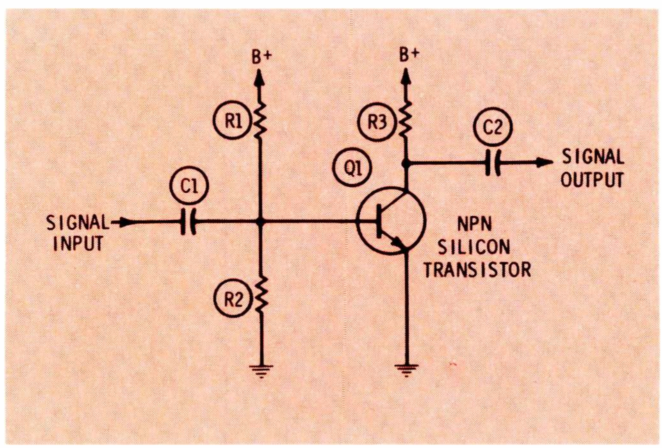


Fig. 2 Typical NPN common-emitter amplifier. Resistors R1 & R2 determine base voltage only when the transistor is cutoff. When it conducts, the base voltage will revert to the value characteristic of the particular type of transistor used—about .3 volt for germanium types, and .7 volt for silicons.

Fig. 1 Two methods of properly connecting the two basic types of transistors to sources of voltage. **(A)** NPN transistors. **(B)** PNP transistors.

much service work. Also, it is not uncommon for some circuit component to malfunction, placing an abnormal voltage on a tube element. In many cases no damage is done; the tube continues to operate just as soon as the external trouble is corrected. Transistors are much less forgiving in this respect, one shot of over-current and the device is ruined.

A look into the characteristics of a transistor will help to explain why. As we have already pointed out, the voltage drop across the base-emitter junction of a transistor is practically constant, regardless of current. Because of this, there always must be some external means of limiting the current. In Fig. 2, for example, the value of R1 always must be large enough to limit the base current to less than the maximum rating of the device.

If the base of an NPN transistor is shorted to B+, the current through the device is limited almost entirely by the impedance of the power supply. Accordingly, the base current might increase to several amperes, causing an immediate and drastic increase of junction temperature, and almost certain failure.

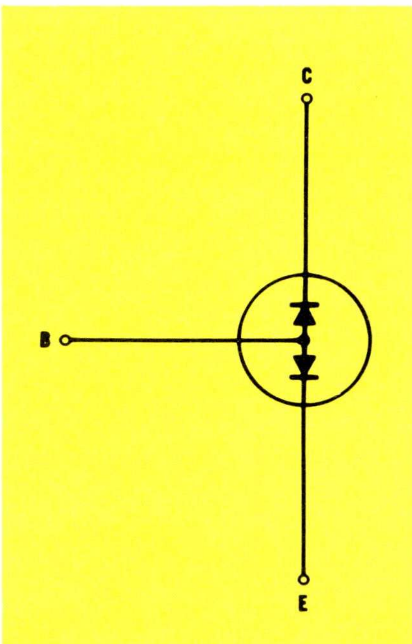


Fig. 3 Equivalent diode circuit of an NPN transistor.

In addition to the obvious method of accidentally shorting the base to a low-impedance source of voltage, there are a couple of other good ways to destroy a transistor. One of these is to use test equipment or soldering irons which have AC line leakage. Even though only a volt or two is available, if the leakage resistance is low enough, it can cause very high junction current in the transistor.

Another good way to destroy a transistor is to use a large coupling capacitor to inject or observe a signal on the base of a transistor. Suppose you inject a signal at the collector of Q1 in Fig. 4, but nothing comes out of the amplifier. Your next step would be to inject a signal at the base of Q2. However, the blocking capacitor connected to the oscillator now has a big, fat 15 volts stuffed into it, with absolutely no place to go—yet. If you connect the test lead to the base of Q2, this capacitor will discharge right through the base-emitter junction, and, even though the capacitance is only .1 mfd, it can produce an instantaneous current of several amps, which will destroy Q2.

The same results can occur when the output-meter function of an ordinary VOM is used. Fig. 5 shows the essentials of a VOM when the meter is set for the output function. Many VOM's have a sensitivity of 1000 ohms per volt on the AC scales, and, because we are looking for a small signal, we have selected the 1-volt scale. This means that the combined resistance of the meter movement and the multiplier resistor is 1000 ohms. So we check for signal at the collector of Q1 and, sure enough, we have some. We decide to check at the base of Q2 . . . That's right, 15 volts on the capacitor, discharging through the 1000 ohms of meter resistance, dumps about 15 ma through the transistor. Although some transistors will withstand such current, smart technicians use the smallest blocking capacitor that will pass the signal they are working with, and carefully discharge it after it is disconnected from any circuit.

Some technicians favor less exotic methods of getting their quotas of destroyed transistors. One type believes that a big soldering gun heats faster and so saves a lot of time. Of course, he has to work fast, before the excessive heat flows up the transistor lead to the junction. He can do it, too, maybe nine times out of ten.

Then there is the fellow who likes to make connections to transistors while the set is turned on. This saves a lot of time—excluding the time spent in changing transistors.

The same technician has a buddy down the street (they trade a lot of parts back and forth, particularly transistors) who doesn't believe in always connecting the ground lead of the test equipment first.

Other fraternity members are the fellows who collect heat sinks (to augment their tube-shield collection), and those who won't dirty their fingers by applying heat-conducting compound to power transistors before installing them.

Tolerances and Substitutions

Most everyone knows by now that the characteristics of transistors of a given type might vary over a wide range. We've heard that nobody designs transistors; the manufacturer simply makes a batch and then sorts them. We can't quite agree, in spite of some of the evidence.

Manufacturers cannot recommend a substitute device unless all units of the proposed substitute type will meet specifications of the original transistor. Nor can they be expected to recommend a substitute which will degrade performance, even if only slightly. Further, it is practically impossible to evaluate all new transistor types to determine if they will function satisfactorily in equipment manufactured at some earlier date.

On the other hand, manufacturers of replacement transistors cannot know all of the design criteria of all the circuits in which it seems that a certain transistor will function satisfactorily. Therefore, they might claim, quite innocently, that a replacement type will perform satisfactorily as a substitute for some other type, even though it actually might not in every circuit.

The transistor substitution situation is not quite as bad as it might seem. While the loose tolerances of transistors might give designers a lot of sleepless nights, it can be made to work for the service technician. Because most well-designed circuits will accept a wide range of transistor characteristics, it quite often is possible to make substitutions with transistors which might seem to be closely related to the original.

If a transistor fails and there is no recommended replacement at hand, try a transistor which performs a similar function in some other instrument and/or which has characteristics similar to those of the original. Of course, the proposed substitute must be of the same basic type (PNP or NPN).

It is usual to design a circuit using a transistor which can withstand approximately twice as much collector voltage as is available from the power supply. Therefore, a transistor used in a circuit having 30 volts B+ can be used without fear of excessive collector voltage in some circuit having an equal or lower supply voltage. There is no guarantee that the transistor will work, but at least you will be on

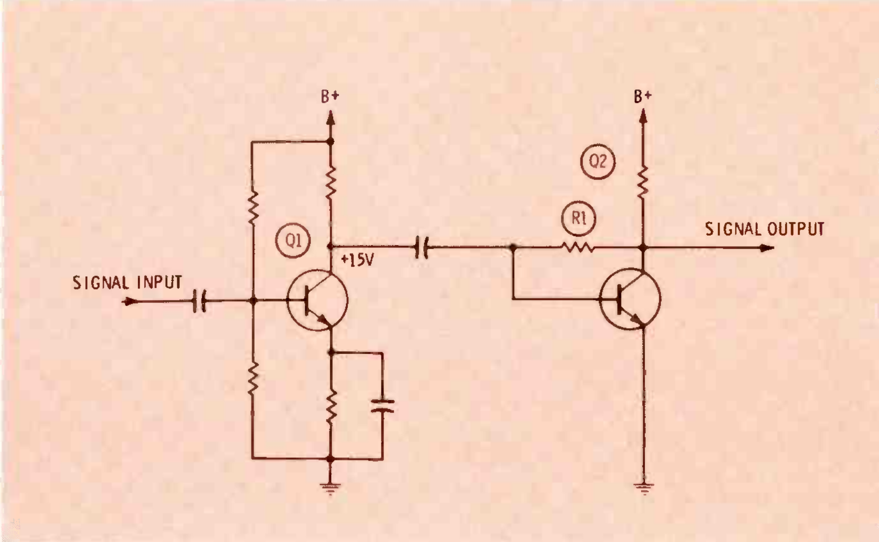


Fig. 4 Typical two-stage audio amplifier.

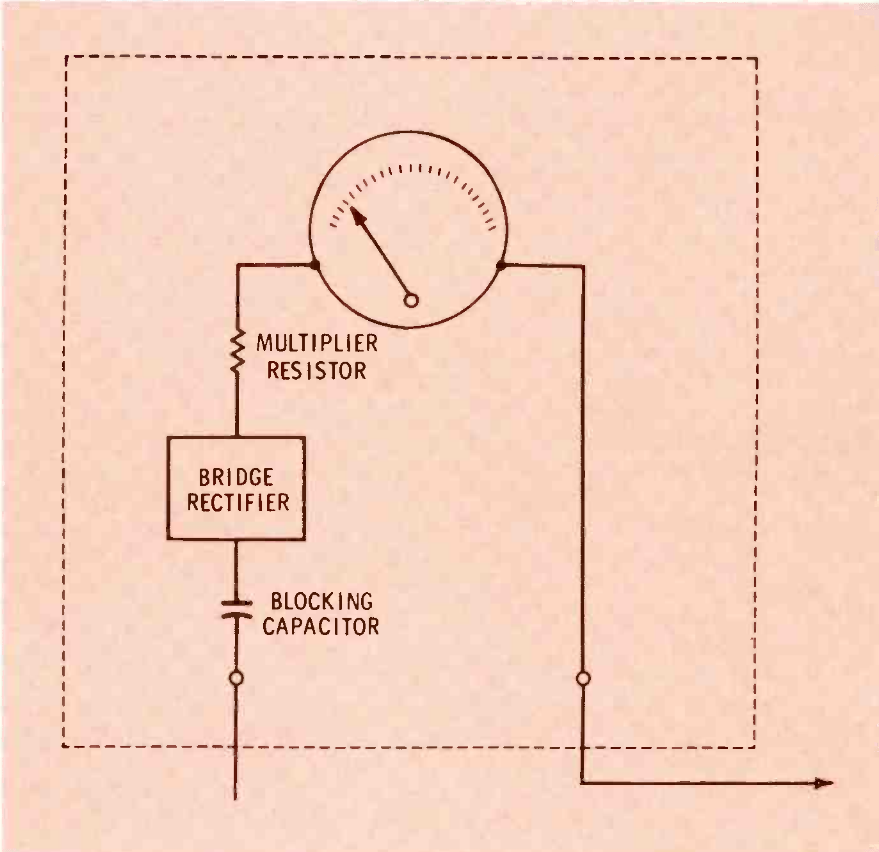


Fig. 5 Simplified diagram of the circuitry which exists when the output function of a VOM is selected.

the right track.

After the proposed substitute is installed, measure the collector voltage. Normally, this should be about one-half the supply voltage in a common-emitter or common-base circuit. In a common-collector or emitter-follower circuit, the emitter voltage probably should be about one-half of the supply voltage. If the voltage at the collector (or emitter) is indicated on the schematic, it should be considered as the normal, or reference, value.

It requires only a little careful thought to decide whether the collector current is excessive or insufficient if the voltage is abnormal, and this may be corrected by a bit of circuit modification. For example, to decrease the collector voltage of a common-emitter amplifier, it is necessary to increase the collector current. This is accomplished by slightly increasing the forward bias. Locate the resistor which provides the forward bias to the base of the transistor (R1 of either Fig. 2 or Fig. 4) and try tacking across it another resistor which is five times larger. This will give you an idea of what is required. As a precaution, if more than a 25 per cent change in biasing resistance is required, you should look for another substitute.

In direct-coupled circuits, such as Fig. 6, increasing the value of R1 is an easy way to reduce the collector current of Q2 after either Q1 or Q2 has been substituted. Many direct-coupled circuits have feedback loops which tend to stabilize the operating potentials, effectively increasing the tolerance of the devices.

When substituting a power transistor, make sure that the new device does not overheat. Check the operating temperature with your finger several times during the first few minutes of operation. If the new device gets uncomfortably warm, you have a problem; if you allow it to continue to operate, you probably will have another dead transistor.

So far, we have ignored the problem of Beta (gain). If you have enough data available to determine the characteristics of both the defective and the replacement transistors, a replacement should be chosen with approximately the same Beta, and it may be assumed that the gain will be near enough to the original gain to be satisfactory. If data is not available, about the only approach is to install the prospective substitute and see what happens.

If the gain is excessive, it is no big problem to reduce it. Removing a bypass capacitor from across the emitter resistor of a common-emitter amplifier will reduce its gain. The gain might be reduced too much; if so, divide the total emitter resistance between two resistors and

Circle 22 on literature card

Circle 23 on literature card

Circle 24 on literature card

bypass only one of them, as shown in Fig. 7. The unbypassed emitter resistor will provide degenerative feedback, which reduces gain but also increases the input impedance of the transistor; however, this increased impedance probably will not cause any problems.

If the amplifier does not have enough gain after the transistor has been changed, it sometimes is possible to get a moderate increase by increasing the value of the collector resistor. Or, if there is unbypassed resistance in the emitter circuit, bypassing a portion of this resistance will increase the gain.

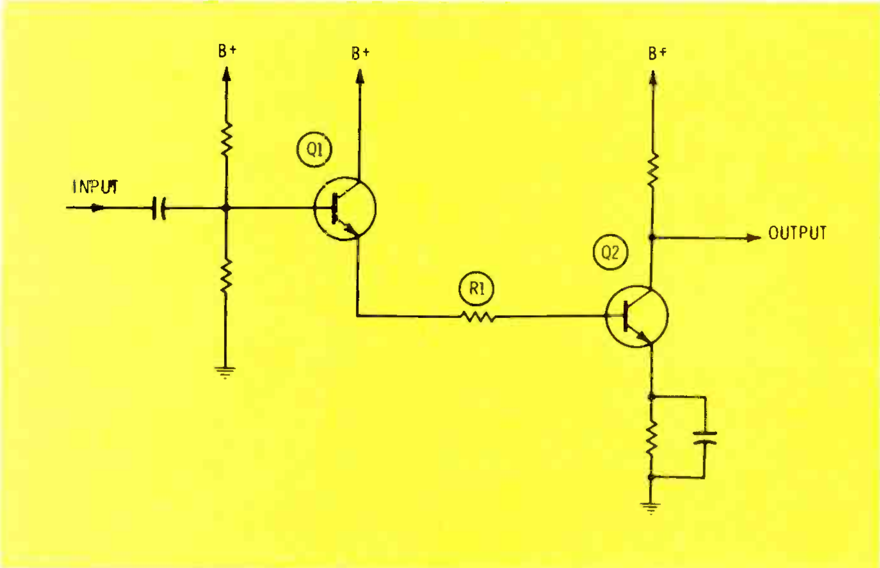


Fig. 6 Direct-coupled solid-state amplifier. Increasing the value of R1 reduces the collector current of Q2.

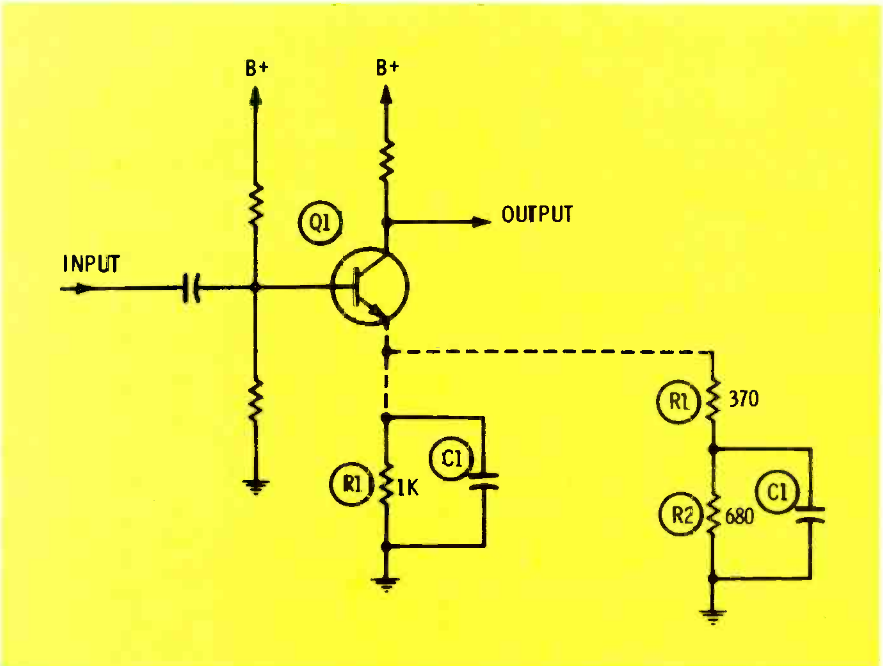


Fig. 7 Bypassing only a portion of the total emitter resistance instead of all is one method of reducing the Beta, or gain, of the amplifier.

Many amplifiers are biased in the manner shown in Fig. 8. R2 provides the bias current for the base. (R3 often is not used.) Because degenerative feedback also is provided by R2, increasing the value of it will increase gain, and vice versa. Changing the value of R2 also will change the bias current, and consequently, the collector voltage. An easy way to change the amount of feedback, and therefore the gain, without affecting the bias current is to "split" R2 and then bypass the feedback signal to ground, or around part of the biasing resistance, as required. This is shown in Fig. 8.

When attempting to substitute a transistor which operates in the video or intermediate-frequency spectrum, the internal capacitances of the device often are important. Consequently, a proposed replacement transistor which has similar ratings in other respects might not function satisfactorily. This sometimes can be improved by alignment, but the effort is seldom justified.

Another problem stems from the fact that some television IF amplifiers use forward AGC biasing; for example, more collector current reduces the gain. The gain-versus-bias characteristic of transistors used in these circuits usually is critical. However, a substitute from a similar circuit in another receiver might work.

Summary

Three of the inherent characteristics of the transistor are: 1) Its requirement for forward bias to turn it on; 2) its susceptibility to damage from over-current; and 3) the wide range of tolerances encountered within a type. While these characteristics generally are considered sources of problems, it is possible, in some cases, to turn them to advantage, or, at least, to develop techniques which eliminate or reduce the problems.

By making use of the voltage drop across the base-emitter junction, it is possible to test most transistors with nothing more complex than a VOM. By removing the forward bias while a transistor is in its circuit, it is possible to check most devices for shorts and leakage. If the transistor is out of the circuit, its base and basic type can be identified and it can be determined whether it is good or defective by measuring junction resistances.

Some of the better methods of damaging good transistors were discussed in this article. These ranged from test-equipment hookups to simple tricks like using a 200-watt soldering iron and connecting the "high" sides of test equipment before attaching ground connections.

Finally, some of the ins and outs of transistor substituting were mentioned. Substitution guides are always a help, as are the data supplied by vendors of all-purpose transistors; but to a large degree, "it's every man for himself." Some of the tricks of making a similar transistor work in place of the original were discussed; there are many more. Admittedly, the time spent in cooking up a substitution job might better be spent doing something else—unless the "something else" is explaining to an irate customer why her instrument isn't fixed after two weeks. And, while the tricks may look good on paper, there are some sad surprises in store for those who expect the best every time. But, pulling a substitution trick out of the hat can make a fellow look awfully good on occasions. □

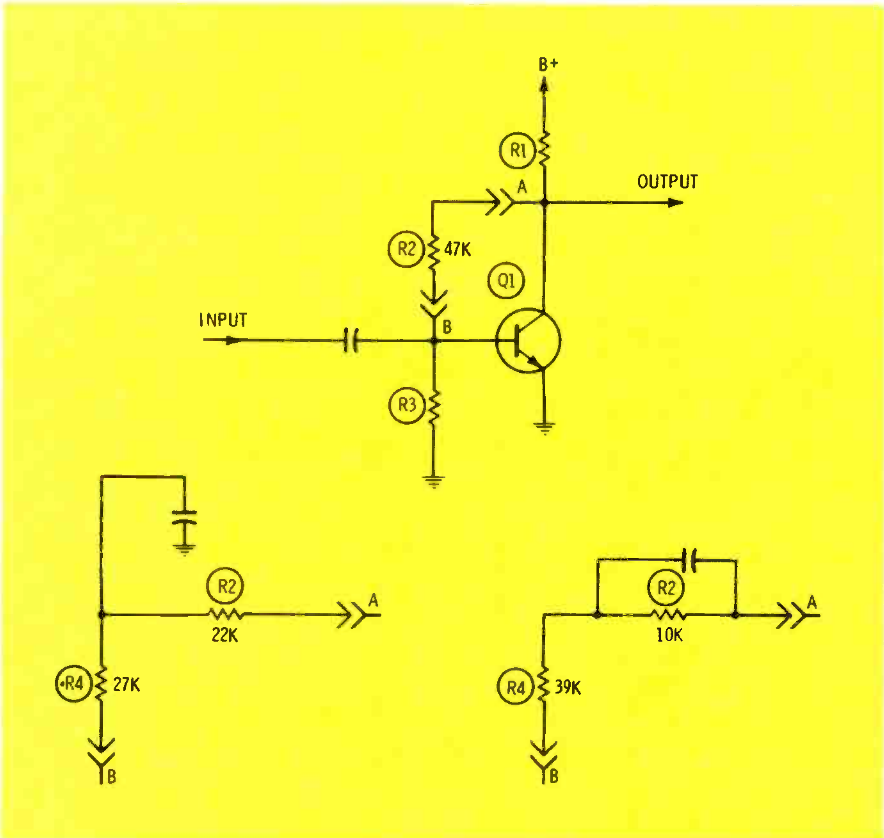


Fig. 8 Shown here is a method of changing the collector-base feedback to vary the gain. See text for details.

servicetraining

SCHEDULE

Manufacturers, distributors, electronic technical schools and service associations are invited to use this column to announce their electronic training activities which are open to all electronic technicians. Information about the training session(s) or seminar(s) should be mailed to the following address at least 60 days in advance of the first scheduled date: Service Training Schedule, ELECTRONIC SERVICING, 1014 Wyandotte St., Kansas City, Mo. 64105. Include: a brief description of the course; the duration of each session; the location, time and date; the cost, if any; and any other pertinent information.

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Mar. 7 Mar. 8	203	203	203	203	203	203	203
Mar. 9	202	202	202	202	202	202	202
Mar. 13 Mar. 14	130	130	130	----	130	130	130
Mar. 15 Mar. 16	302	302	302	----	302	302	302
Mar. 20 Mar. 21	140	140	140	140	140	140	140
Mar. 22 Mar. 23	160	160	160	160	160	160	160
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Apr. 4 Apr. 5	511	511	511	511	511	511	511

Circle 26 on literature card

test equipment report

Features and/or specifications listed are obtained from manufacturers' reports. For more information about any product listed, circle the associated number on the reader service card in this issue.

Digital Multimeter

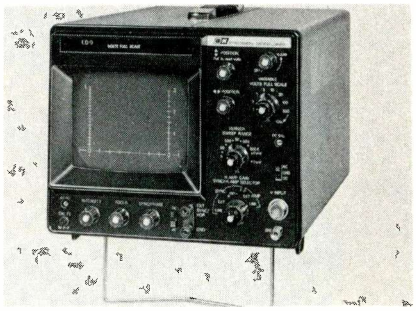
Product: Model 3301 digital multimeter
Manufacturer: Hickok
Function and/or Application: Measures AC and DC voltages, resistances, and current
Features: An optional internal rechargeable battery pack provides 20 hours of continuous battery operation.
Specifications: 5 AC voltage ranges—from 100 millivolts to 1 kilovolt; maximum resolution is 100 microvolts; accuracy is 0.5 per cent of reading ±1 digit. **5 DC voltage ranges**—from 100 millivolts to 1 kilovolt; maximum resolution is 100 microvolts; accuracy is 0.1 per cent of reading ±1 digit. **5 AC current ranges**—from 100 microamperes to 1 ampere; maximum resolution is 100 nanoamperes; accuracy is 0.2 per cent of reading ±1 digit. **5 DC current ranges**—from 100 microamperes to 1 ampere; maximum resolution is 100 nanoamperes; accuracy is 0.2 per cent of reading ±1 digit. **7 resistance ranges**—from 100 ohms to 100

megohms; maximum resolution is 100 milliohms; accuracy is 0.3 per cent of range ±1 digit. Overload is: 100 volts rms for AC voltage; 1500 volts peak for DC voltage; 10 times range for current; 250 volts rms for resistance ranges. Common mode rejection is 120 dB at 60 Hz; normal mode rejection is 60 dB at 60 Hz. DC input impedance is 11 megohms; AC, 1000 megohms shunted by 75 pf. The 3301 measures 3 1/2 inches X 8 3/8 inches X 13 inches and weighs 8 3/4 pounds.
Price: Model 3301 sells for $385.00; battery option is $75.00 additional.

Circle 50 on literature card

Cali-Brain Oscilloscope

Product: 5-inch DC to 10 MHz recurrent sweep oscilloscope
Manufacturer: B&K
Function and/or Application: Peak-to-peak voltage readings on complex waveforms

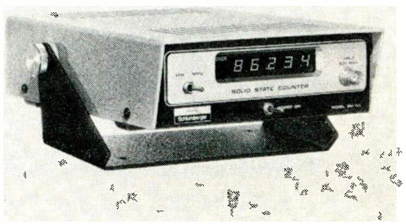


Features: Eight vertical scales ranging from .1 V to 300 V give accurate readings. Sync-separator circuits in TV-H and TV-V positions and a DC amplifier for AC and DC component measurements are included, plus a combination 10-to-1 and direct probe.
Specifications: The 1440 operates on 117 VAC, 50 or 60 H, also for 117-234 VAC, or 50 or 60 H. The "low profile" case design measures 9 inches X 10 inches X 17 inches and weighs 27 lbs.
Price: Model 1440 sells for $299.95.

Circle 51 on literature card

80M-Hz Frequency Counter

Product: Model SM-105A and SM-104A frequency counters
Manufacturer: Heath/Schlumberger Scientific Instruments



Function: Solid-state counter for measuring frequency

Features: The KHz/MHz time-base switch and overrange indicator enables 8-digit measurements down to the last Hz in seconds. Light-emitting diodes are used for 5-digit readouts and overrange indications. 100-year-use life; elimination of 170-volt power supply; low mechanical shock; elimination of parallax and reading error; G-10 glass

epoxy double-sided; plated-thru board; gimbal mounting bracket; two-switch operation; 120 to 240 VAC operation are among the features.
Specifications: The SM-104A has built-in TCXO which provides 1M-Hz ±0.1 Hz time base and +1 ppm/year stability. The SM-105A uses a 1M-Hz crystal accurate to ±2 Hz, with overall time base accuracy of ±10 ppm. Both counters trigger up to 50M-Hz with input levels at 100 millivolts; up to 80M-Hz with 250 mV input.
Price: The SM-105A sells for $350.00, the SM-104A sells for $500.00.

Circle 52 on literature card

Tube Tester

Product: Solid-state Mighty Mite VII tube tester
Manufacturer: Sencore, Inc.
Function and/or Application: The TC162 permits testing of a large variety of tubes.
Features: The 10-pin elimination switches facilitate new, as well as previous tube types which have internal connections between elements or have the same element connected to several base pins. With the switches, up to 10 pins can be isolated from test. The tester is housed in a brushed steel and vinyl-clad case with setup book.
Specifications: The TC162 re-

tains full load cathode emission tests, 100 megohm grid leakage tests and stethoscope shorts tests.
Price: The Mighty Mite VII TC162 tube tester sells for $99.50.

Circle 53 on literature card

Digital Multimeter

Product: TR-6354 mini-auto digital multimeter
Manufacturer: Marubeni-Iida (America), Inc.
Function and/or Application: Measures voltages resistances and current
Features: Non-blinking 3 1/2 digit numerical display, all solid-state design, 1 second response time is included. The TR-6354 is of lightweight die cast aluminum construction with a dual-purpose handle.

Specifications: Automatic ranging: 27 ranges including DC voltages, AC voltages, resistance and current; automatic polarity indicators; range hold/display hold control; and is accurate to .1 per cent on DC and .5 per cent on AC.
Price: The TR-6354 sells for $350.00. □

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For more information about above products use reader service card

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carr electronics

by Joseph J. Carr/ES Auto Electronics Editor

New in auto radio audio

This month we are going to take a look at some of the more recent designs of car radio audio stages. The more conventional designs were covered in an article in ES some time ago.

The more recent types are: integrated circuits (IC), packaged electronic components (P.E.C.) and later versions of the all-silicon direct-coupled complementary symmetry output stages.

There Is A Difference Between IC And P.E.C.

Of these three types, there is some confusion regarding the first two, IC and P.E.C. Some of this confusion is perpetuated by at least one car radio manufacturer who prefers to call his P.E.C. audio amplifier an "IC" design.

An IC is basically a group or series of circuit functions (i.e.: resistors, transistors) constructed on a continuous silicon substrate. A P.E.C., however, is a ceramic or epoxy-fiberglass module made up from discrete components. In most cases, the P.E.C. will be substantially larger in physical size than any IC. In the future, look for hybrid modules that have some characteristics of both P.E.C. and IC construction. At least one major semiconductor manufacturer already markets such an audio stage.

The audio circuits of immediate interest are the P.E.C. networks by Philco and Delco and the integrated circuit used by Motorola.

Motorola's IC

Fig. 1 shows the Motorola circuit using the MFC4050 IC, which is described in the data sheets as a "class A audio driver." In some versions this IC will have six leads. In most, however, the IC will be one of the four-lead versions shown in the inset in Fig. 1.

The MFC4050 is about as simple as an IC can be; it has only four terminals: input, output, power (positive voltage) and common.

The output transistor used in the circuit in Fig. 1 is the standard PNP germanium-type 2N176, which has been in continuous use almost since the inception of Motorola's solid-state car radio designs.

Functions of the MFC4050

The schematic of the internal circuitry of the MFC4050 is shown in Fig. 2. Pin No. 1 serves as common for both DC and signal currents. Power is supplied to the IC via pin No. 3. In series with this pin is an internal resistor voltage divider network and three Zener diodes (D1, D2, & D3), used for voltage regulation. Two other diodes, D4 and D5, are used to stabilize the bias on the preamplifier transistor, Q1. These diodes are connected in series between the emitter of Q1 and common. Transistor Q2 serves as another preamplifier stage.

The driver transistors are Q3 and Q4. These last two transistors are Darlington connected, for increased gain and a higher impedance. The output signal is fed to pin No. 4 while the input signal comes into the system via pin No. 2.

Because there are only four basic functions performed by the MFC4050, it seems logical for Motorola to design this "chip" with only four leads. Some IC amplifiers have "roll-off" and other frequency response shaping circuitry which require other pins. Although such chips are versatile, they are also somewhat more complex. Motorola prefers to accomplish tone shaping with the reliable, although perhaps old-fashioned, negative feedback method. The audio stage shown in Fig. 1 uses a bridged-Tee type of network in the negative feedback loop.

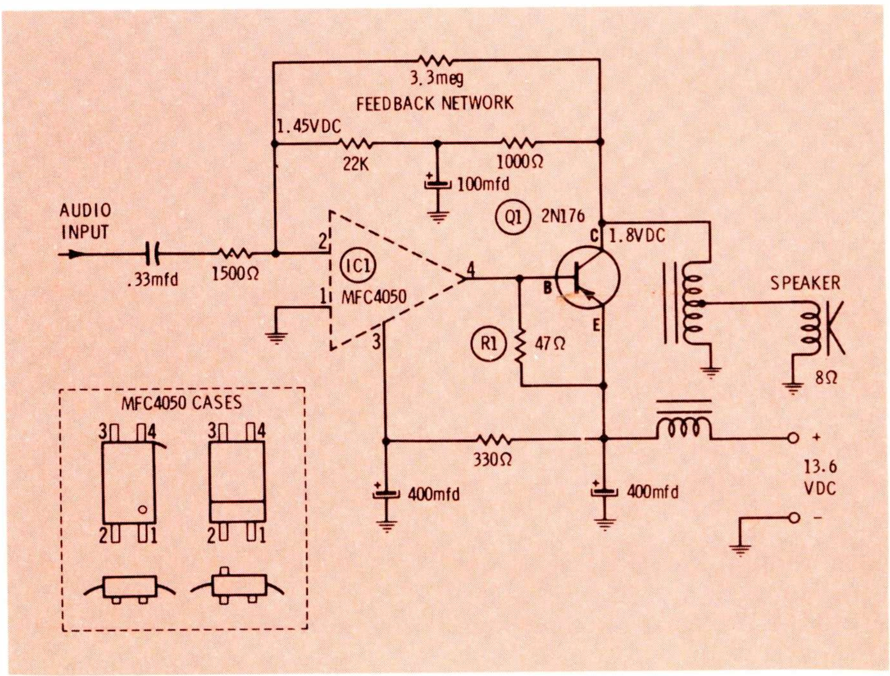


Fig. 1 Motorola audio circuit equipped with the MFC4050 IC.

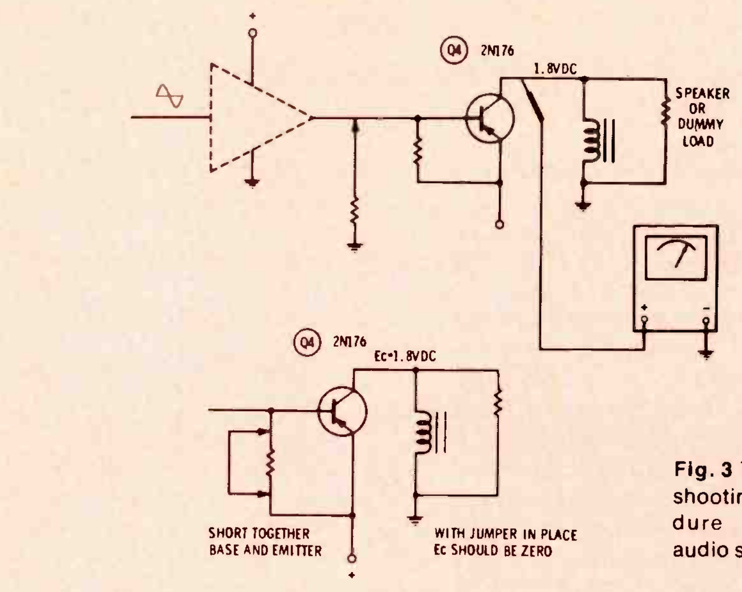


Fig. 3 Troubleshooting procedure for IC audio stage.

Radios employing the MFC4050

The radios which first used the MFC4050 or one of its closely related cousins was the O.E.M. Volkswagen models sold by VW dealers under the "Sapphire" trade name. Later production sets using this IC are used in many different types of automobiles, both foreign and domestic. This widespread use indicates that you can expect to be seeing these ICs more often as warranties begin to expire.

Troubleshooting

The general operation of the MFC4050 is not unlike the operation of conventional audio stages made from discrete components. It seems, however, that troubleshooting is somewhat simpler than in conventional designs.

There seems to be only two types of symptoms generally associated with the MFC4050 audio stage: the output transistor will either be cut off or it will be saturated. Although this might seem like a generalization applicable to any solid-state audio stage, we so far have not seen any weird distortion problems like those which were common when the PNP germanium-NPN silicon preamplifiers were king.

Fig. 3 illustrates two common approaches to troubleshooting this type of stage. In either case, the idea is to determine whether the base of the output transistor is capable of controlling the flow of collector current. In cases where the output transistor is cut off (assuming there is voltage present at both the base and emitter and zero voltage at the collector), connect a resistor or resistor-substitution box between the base of the output transistor and ground. A value of less than 500 ohms will be needed. Monitor either the collector voltage (preferred) or the power-supply drain current so that you can tell what effect, if any, the test has on the operation of the circuit. If shunting a resistor between the output transistor base and ground causes collector current to flow, it is relatively safe to assume that the IC is open and requires replacement. If, on the other hand, the transistor still fails to draw collector current, there is only a slight chance that the IC is defective. Look for either a bad output transistor or an open circuit in either the emitter or collector loops. A high voltage on the collector with zero collector current, for example, means that the collector circuit is open.

In many cases where the output transistor is saturated, there will be several volts between the collector and ground and a high collector current (approximately 2 amperes). A good test in this situation is to short together the output transistor base and emitter terminals. This will cut off an operating

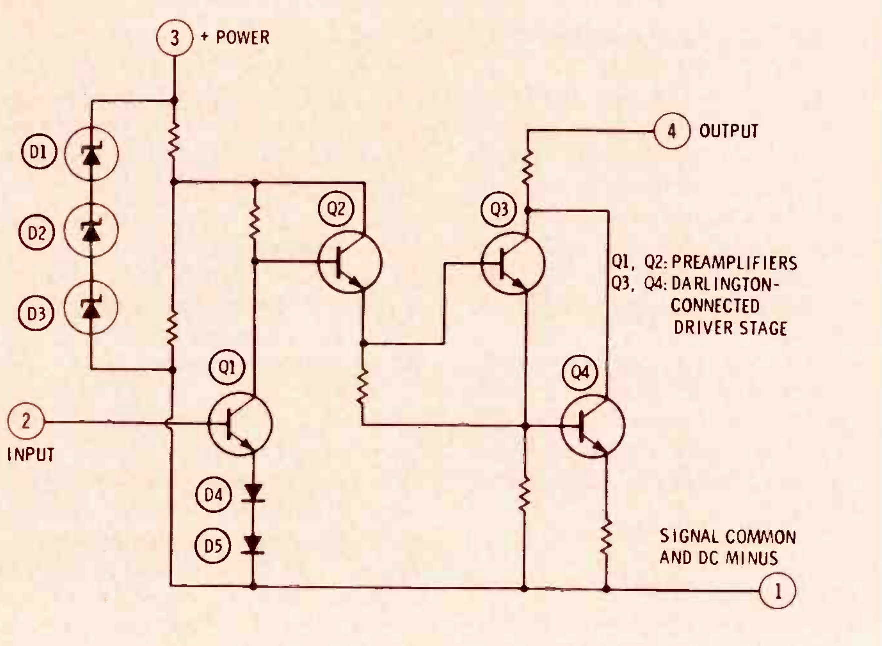


Fig. 2 Internal circuitry of the Motorola MFC4050 IC.

transistor. If the circuit continues to draw a high current when the base and emitter are tied together, the output transistor probably is shorted. Do not overlook, however, the possibility that there might be a shorted filter capacitor or other such component. Try turning the radio on with the output transistor removed. The "A" line ammeter will tell you immediately whether anything else is shorted. (In most Motorola receivers the transistor mounting screws complete the collector circuit; removing them is all that is required.)

In all cases where the output transistor is shorted, especially on radios that use the IC driver stage, be sure to check the output choke and the speaker for shorted turns before reapplying power. The radio will sound weak and distorted, even after it is presumedly repaired, should either of these parts be defective. This is a case where so-called secondary damage can cause the original symptoms to reappear. The time element for such reappearance is relatively short. These conditions generally last only a short period of time before the newly installed parts also are damaged.

If there is no readily apparent damage, try monitoring the output transistor collector voltage. If it is either abnormally high or abnormally low, immediately remove power until the defect can be found. The most likely cause of low collector voltage is a shorted output choke. In Motorola sets, these chokes are both accessible and are of a color which readily reveals burning.

P.E.C. Designs

Several car radio manufacturers have chosen the P.E.C. for their audio stages. A P.E.C. is simply a small package of discrete electronic components designed to perform either a specific job or a narrow range of jobs.

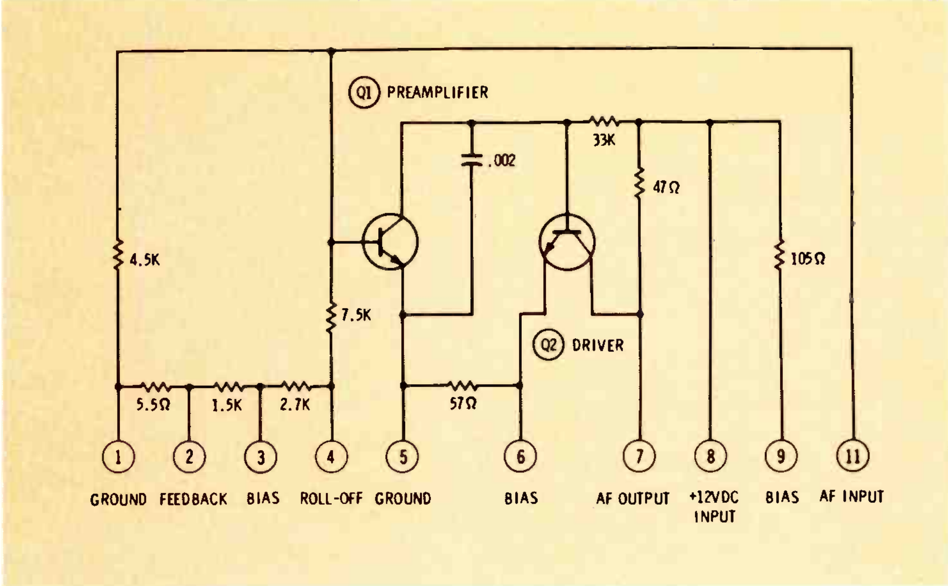


Fig. 4 Internal circuit of the Delco DM-8 P.E.C. audio stage.

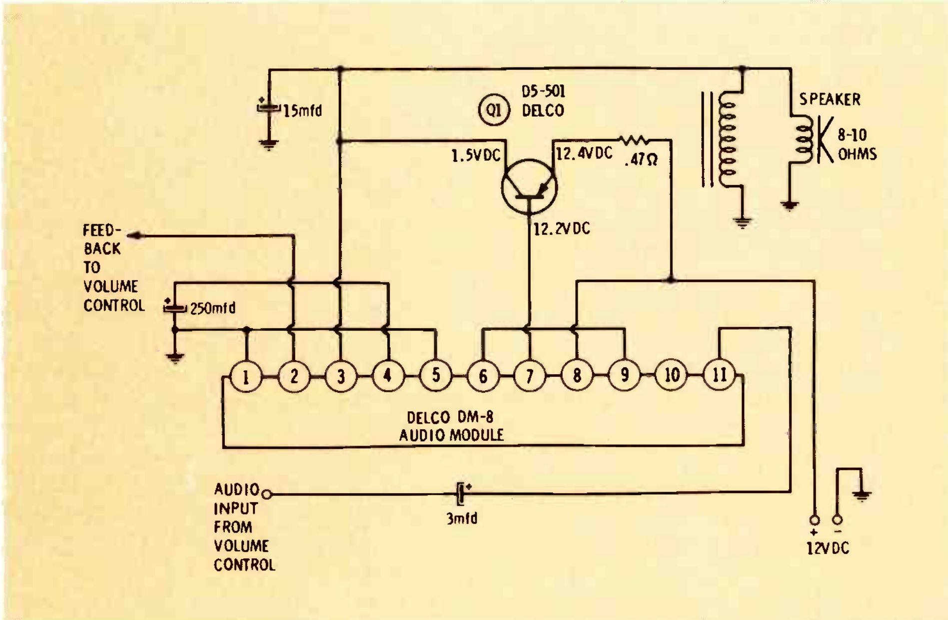


Fig. 5 Delco audio stage equipped with the DM-8 P.E.C.

In some receivers, such as Philco's, these P.E.C. modules are constructed similar to the couplates often used in television sets. (These were ceramic modules that housed RC coupling networks, AM "tweet" filters, various waveshaping networks, etc.)

Delco, on the other hand, prefers to use their own rectangular package made from plastic and potted with an epoxy-like material. These are types DM-8 and DM-28.

The Delco DM-8

The schematic of the internal circuitry of the Delco DM-8 is shown in Fig. 4. This is not an integrated circuit, although the schematic of the couplete stage, shown in Fig. 5, might lead you to believe that it is. With a few modifications, the circuit inside the DM-8 could easily become the early Delco audio stage made from discrete components. However, as revealed by Fig. 5, the stage design is simpler.

As with the Motorola IC, the troubleshooting procedure for the DM-8 appears easier than it was when all of the audio components had to be considered separately. The DM-8 stage shown in Fig. 5 can be serviced in a manner similar to the Motorola MFC4050 stage. Again, the idea is to determine whether or not

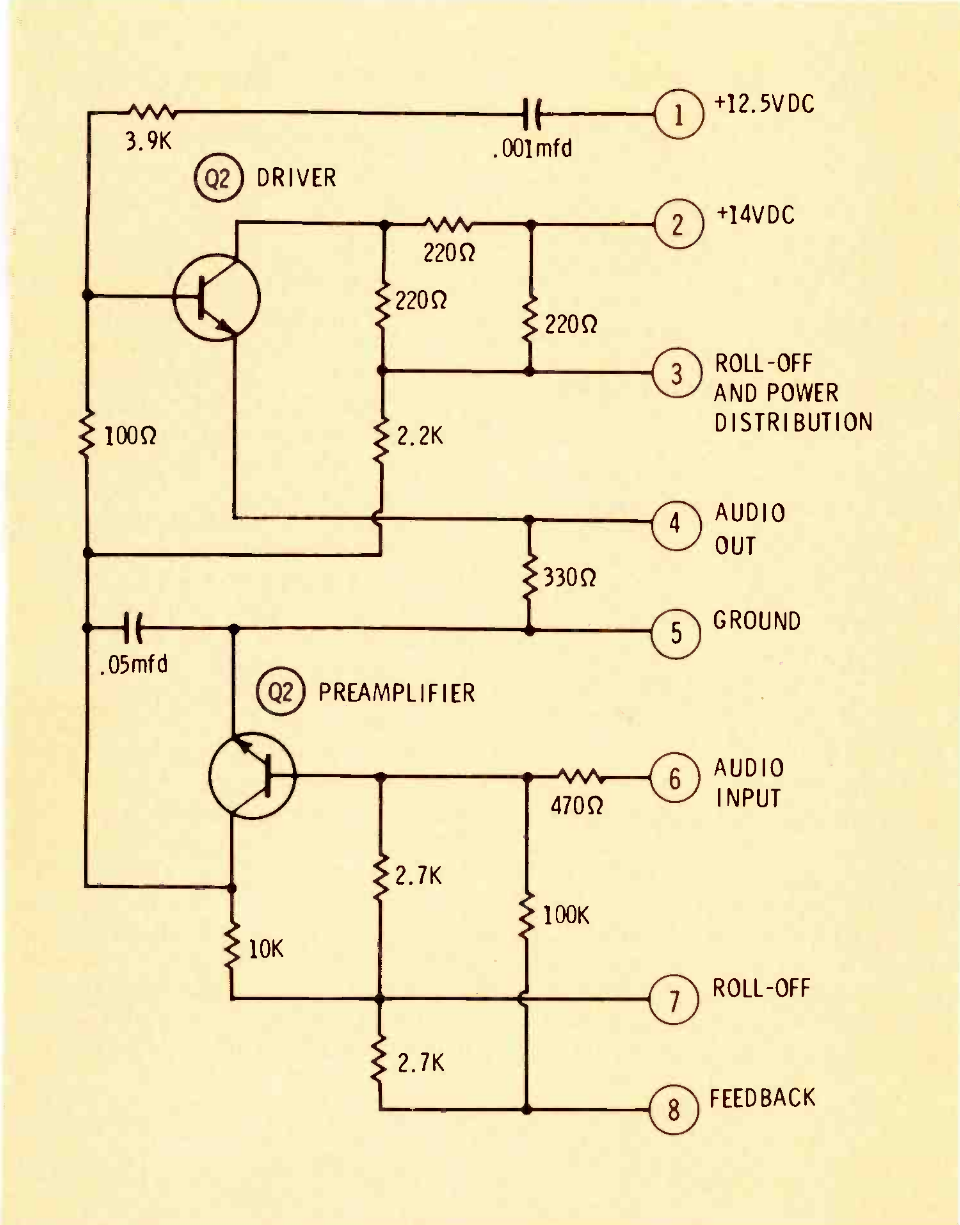


Fig. 6 Internal circuit of the Philco audio P.E.C.

the output transistor will pass current from collector to emitter in response to commands from the base. In cases where the output transistor, Q1, is saturated, short together the base and emitter terminals. If the output transistor is in good condition, the collector current will drop almost to zero.

The Philco P.E.C.

The Philco P.E.C. audio stage, shown in Fig. 6, is designed to drive an NPN output transistor. These P.E.C. modules are used with one of several different types of transistors. In older radios, Philco used an NPN transistor in a TO-3 diamond case. More recent Philco models, however, use one of the plastic-eqoxy transistors in the P-66 package. In still others, you will find a small diamond (TO-66) transistor. Most of the radios which use the P-66 epoxy transistor are also drilled to accept the TO-66 case. The proper holes are found on the front escutcheon, immediately to the right of the dial scale and bezel. It might be wise, from a reliability point of view, to replace the P-66 transistors with TO-66 types. Suitable moderate power, silicon NPN transistors in the TO-66 configuration are available in the various universal replacement lines. Another alternative is to use the TO-66 offered by Bendix under part No. 4080838-0001. These are used in later model O.E.M. Chrysler radios.

The external audio circuitry used with the Philco P.E.C. stage is shown in Fig. 7. As with all NPN negative-ground stages, in this circuit it is necessary to avoid accidentally grounding the collector, the point where the positive voltage is applied.

To be forward biased, an NPN transistor requires a base voltage more positive than the emitter. This bias voltage is supplied from pin No. 4 of the P.E.C. Fig. 6 shows how this voltage is generated. Transistor Q2 is the driver stage. Pin No. 4 of the P.E.C. supplies the emitter voltage, developed by conduction of this transistor, to the base of the output transistor. As the audio signal causes the conduction of the two P.E.C. transistors to vary, the voltage on pin No. 4 also varies. This voltage, fluctuating in step with the applied signal, is passed on to be amplified further by the output transistor.

The power amplifier transistor (Fig. 7) is transformer-coupled to the loudspeaker. These NPN stages use a transformer instead of the simple choke or autoformer common in PNP power amplifiers because it is necessary to isolate the high DC collector voltage from both ground and the speaker circuit.

Complementary Symmetry Output

Fig. 8 shows the complementary symmetry output stage used by Motorola in the AM/FM/stereo FM radios they recently made for Volkswagon. This is something of a departure for them; they have used the same type 2N176 PNP germanium transistor as the output stage in most of their radios for the past several years.

The new complementary output transistors, types A6C and P2T, are packaged in Motorola semiconductor's version of the plastic case. The Motorola style case is the one which has the mounting hole in the middle of the transistor's plastic body.

As with all plastic power transistors, care must be exercised when they are handled. This is especially true when forming the leads or inserting them into the proper holes in the printed-circuit board. If you bend the leads the wrong way or handle the transistor too roughly, you might destroy the replacement even before it is installed in the set.

Also, be extra careful when tightening the mounting screw. If too much torque is applied during this operation, the plastic case will crumble or crack. Some radios are equipped with nylon mounting screws for these transistors. These screws can shear off easily when an attempt is made to tighten or loosen them.

On the other hand, if the mounting screw is not tight enough, the transistor will fail to properly dissipate heat. To transfer enough heat to keep the transistor operating within the maker's limits, it is necessary to use a generous dab of silicone grease and to tighten the screw sufficiently. As you can see, it is possible to be too careful as well as too sloppy.

The circuitry shown in Fig. 8 is not too unusual as complementary stages go. The two output transistors are connected in the usual emitter-follower configuration. The bases of these transistors are fed in parallel. Because the polarities of the two transistors are opposite (but otherwise they are electrically equal), the phase inversion needed for push-pull is accomplished automatically.

A diode is used in the base circuit to provide a stable decrease of the forward bias applied to the base of one output transistor. This is needed to reduce the "crossover distortion" so common in early solid-state, push-pull amplifiers. (crossover distortion, by the way, was the major factor which caused the so-called "transistor sound" associated with solid-state high-fidelity equipment.) The forward biased diode helps reduce that distortion. The next obvious question is, of course, why doesn't that diode cause its own distortion (harmonic) by clipping the input signal? The answer is

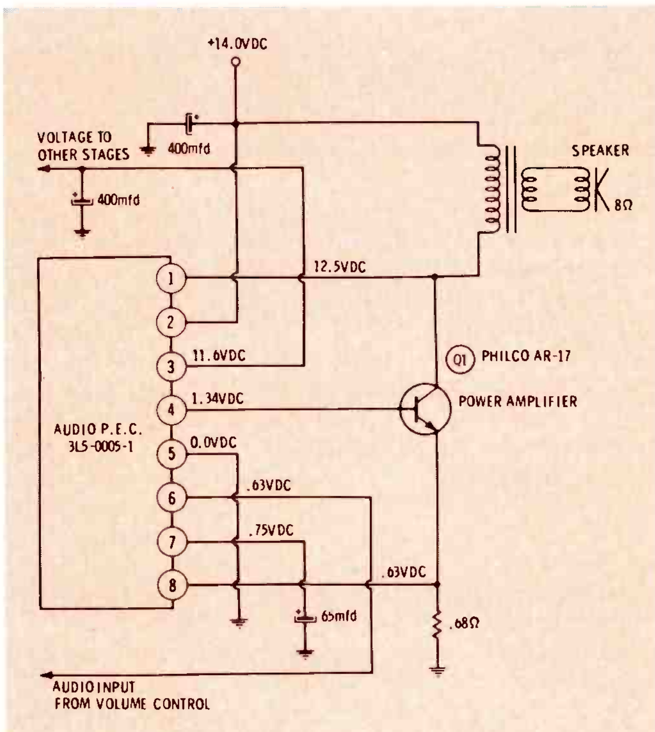


Fig. 7 Philco audio circuit equipped with the P.E.C.

simple. When a diode is heavily forward biased a small AC signal can pass, in both directions, riding on the DC component. This phenomena is the basis for diode switching used in some tuners and in "relayless" Citizen's-Band equipment.

Transistor Q3 in Fig. 8 is the driver. It is a tab-mounted PNP silicon type. However, it is not similar to the tab-mounted transistors used by Bendix and Philco or the body-mounted plastic transistors used as the outputs in the same set. When replacing any of these plastic-epoxy types with any of the universal types, be sure to "eyeball" the proposed replacement before ordering. Several manufacturers list replacement types which fit electrically but are different enough mechanically to cause mounting problems. Some of these optimistic replacements will cost an arm and a leg in labor time if an attempt is made to mount them where they simply can't fit. Added to that is the possible callback that might be created. When in doubt, order the original manufacturer's replacement.

The predriver stages in the circuit in Fig. 8 are typical NPN small-signal silicon units. These "54-series" transistors have been used by Motorola for some time. For simplification, the bias networks have been eliminated.

One thing that makes this Motorola audio stage interesting, if somewhat difficult to troubleshoot, is the small size. When you first encounter one of the stereo FM VW radios in which they are used you probably will be amazed. Later VWs (post-1968) have precious little room for the radio. Into that narrow space Motorola has managed to package a complete AM/FM/stereo FM car radio. It's a full-blown radio too ... not a skimped design. The audio printed-circuit board houses all of the circuitry for both channels, including the power transistors, in an area less than 2 x 3 inches. The entire assembly is less than one inch thick. This radio is one where trouble-shooting savvy pays off ... you know, the kind that can't be taught, but learned only by actually doing. □

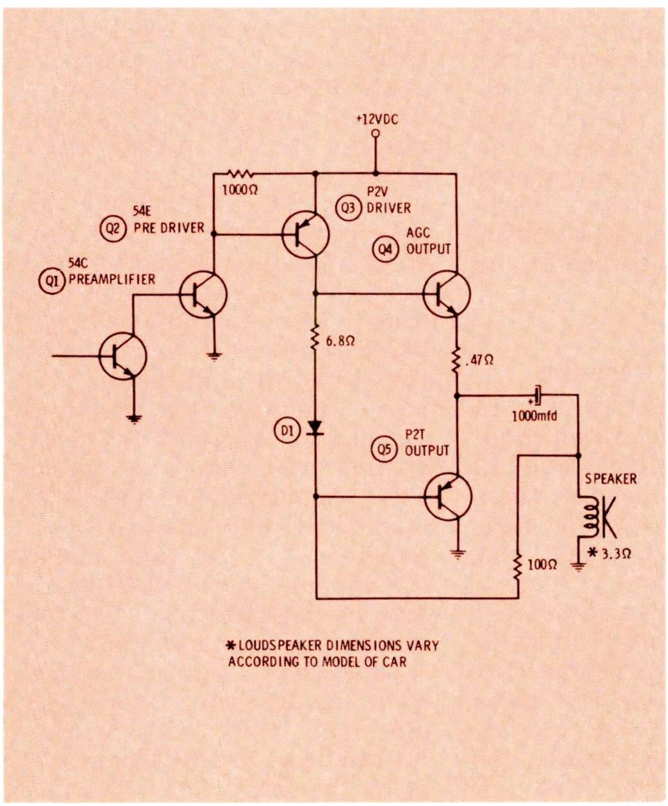


Fig. 8 Complementary output stage used in the AM/FM stereo FM Volkswagen radio designed and manufactured by Motorola.

Dale's service bench

by Allan Dale

The Staar System: Cassettes For Autos

Theory of operation plus tips about servicing.

This spring a number of companies will begin marketing cassette players and player/recorders for automobiles. Previously, the configuration of cassettes kept them out of cars because loading the cartridge was too awkward while driving a car.

The two sprocketed tape reels inside a cassette must fit down over the spindles of two hubs. The capstan (tape-drive) shaft has to fit up through an access hole in the cassette. You load a cassette into most machines only from the top (Fig. 1A). To remove it, you punch a lever that raises the cassette up off the hubs and capstan.

But that drawback was eliminated more than a year ago. Theo Staar, an audio expert in Brussels, Belgium, patented a mechanism that permits cassettes to be slot-loaded, as shown in Fig. 1B. It's called the Staar system.

The cassette is inserted into a slot. Teflon tracks guide it in straight. As it nears the back, each corner of the cassette case encounters a post. As you press harder, you push the two posts backward, and that motion lifts the hubs and capstan up into position. They are on a movable platform.

A pressure roller pinches the tape against the drive capstan, and together they drive the tape. In that respect, operation is like any other tape system. The supply and takeup hubs of the machine engage the sprocketed centers of the tape reels inside the cassette. The tape moves smoothly from one reel to the other.

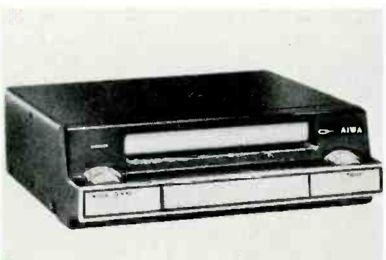
Inserting the Cassette

You can get some notion of how the Staar mechanism functions from the photo closeups in Fig. 2. Fig. 2A shows the operating components on the movable platform. Reel hubs and capstan drive shaft (from a motor/flywheel drive assembly beneath the platform) normally rest below the level of the two Teflon guide tracks. The pressure roller and the record/playback and erase heads are not on the platform. They are stationary, on the upper deck. Other parts are labeled in the photo.

Fig. 2B shows a cassette inserted halfway into the slot. The two posts temporarily obstruct further movement of the cartridge case. Notice where the posts are in their little slots. At this juncture, the platform still has not left its resting (down) position.

In Fig. 2C, the cassette has been pushed on back. The backward movement of the two slide posts lifts the mechanism platform into operating position. A latch (not shown here) catches the platform and holds it in place. The hubs have been lifted up into the sprocket holes and engage the reels. The capstan shaft fits into its hole behind the tape, and the fixed pressure roller pushes the tape against the capstan. A pressure pad inside the cassette holds the tape against the playback head.

Meanwhile, below the platform, the drive mechanism operates. The motor pulley turns a rubber drive belt which, in turn, spins the large, heavy flywheel.



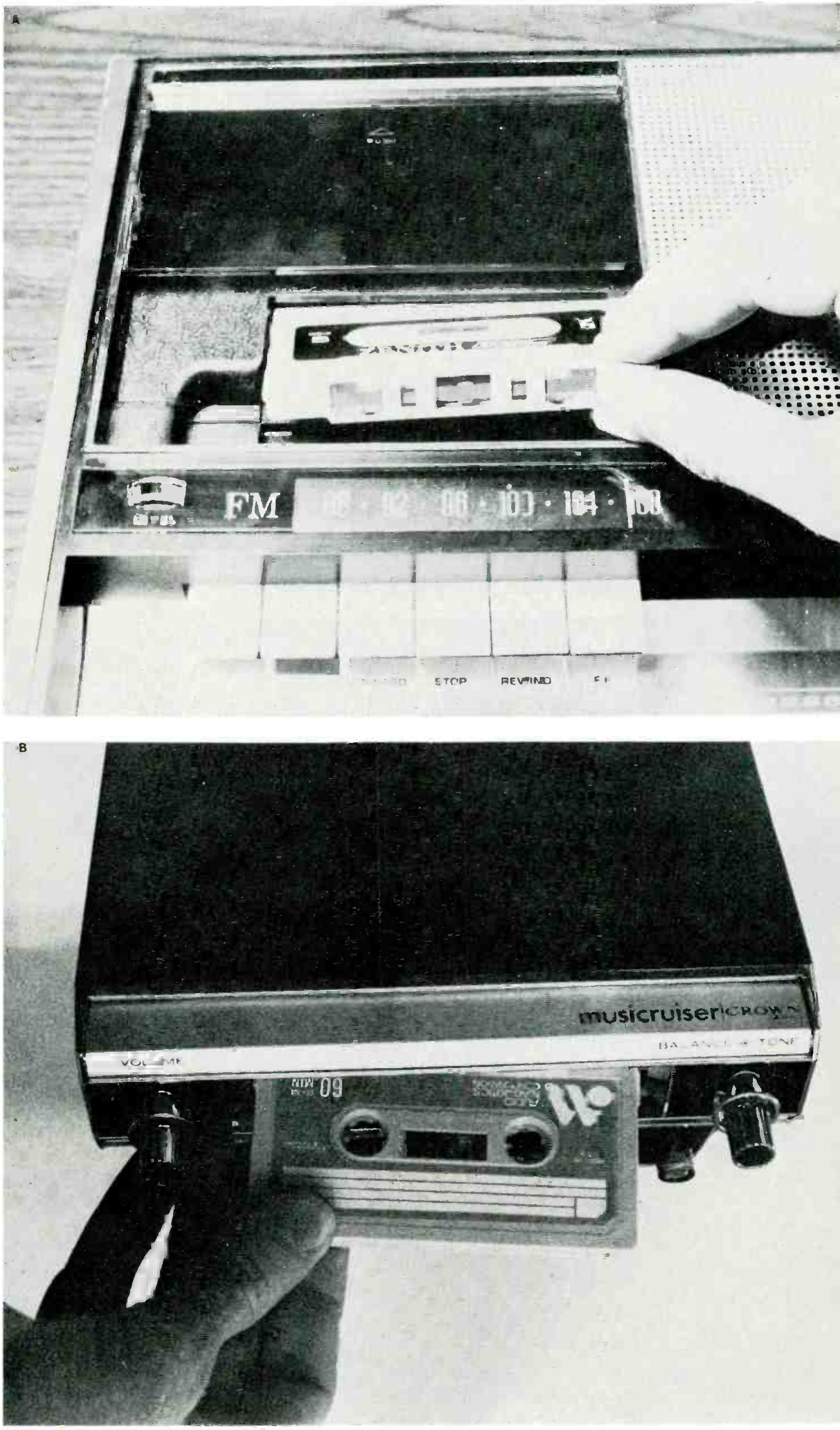
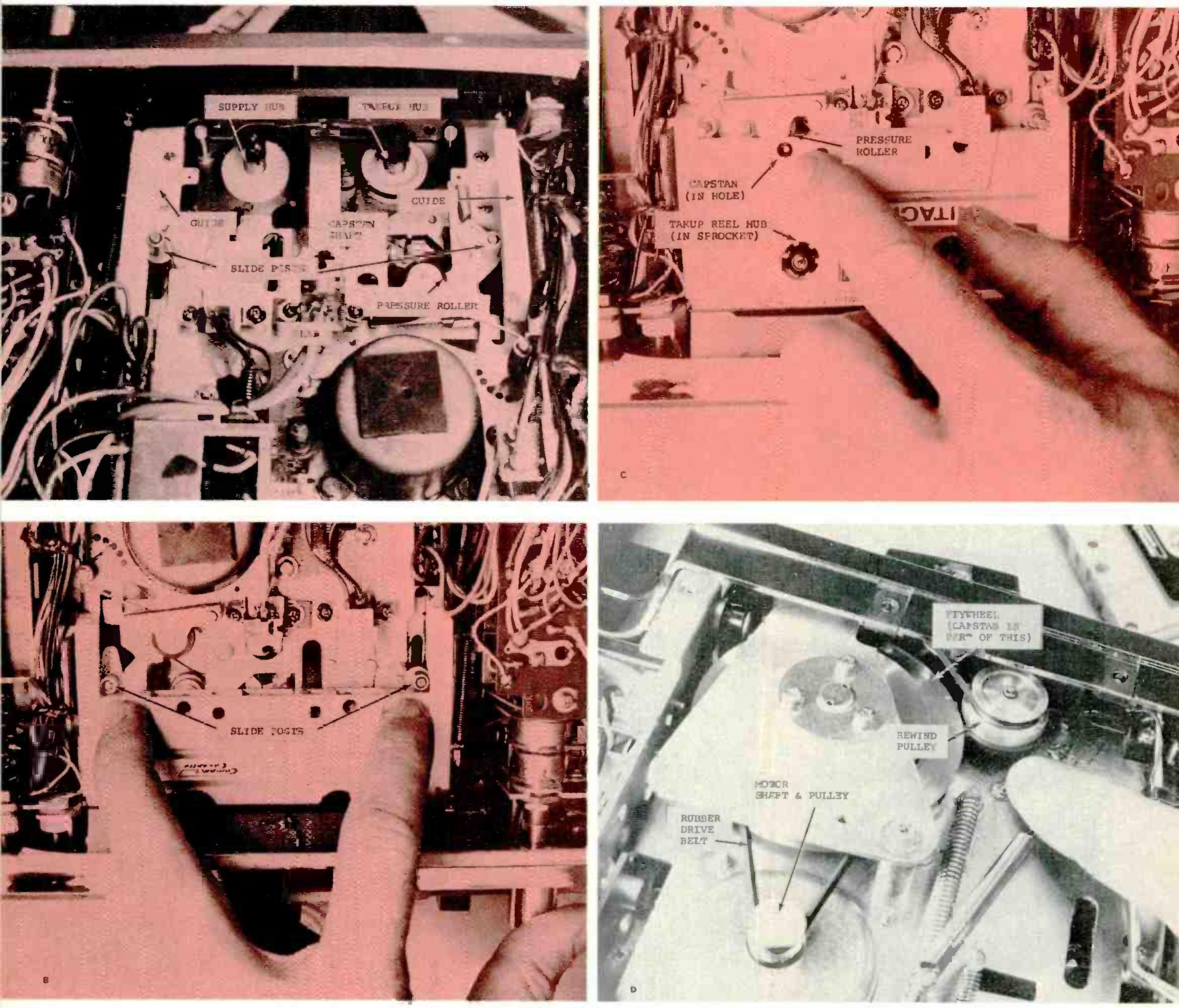


Fig. 1 Ordinarily, cassette loads **(A)** from top. Staar system **(B)** permits slot loading; makes auto cassette machine feasible.

Fig. 2 Staar-licensed cassette mechanism **(A)** has platform that can be raised and lowered; contains reel hubs and drive capstan. Cassette being pushed in **(B)** encounters slide posts. Pushed further in **(C)**, posts raise reel hubs and capstan to engage cassette; tape is caught between pressure roller and capstan. Rubber belt below deck **(D)** drives flywheel, which also turns rewind pulley.



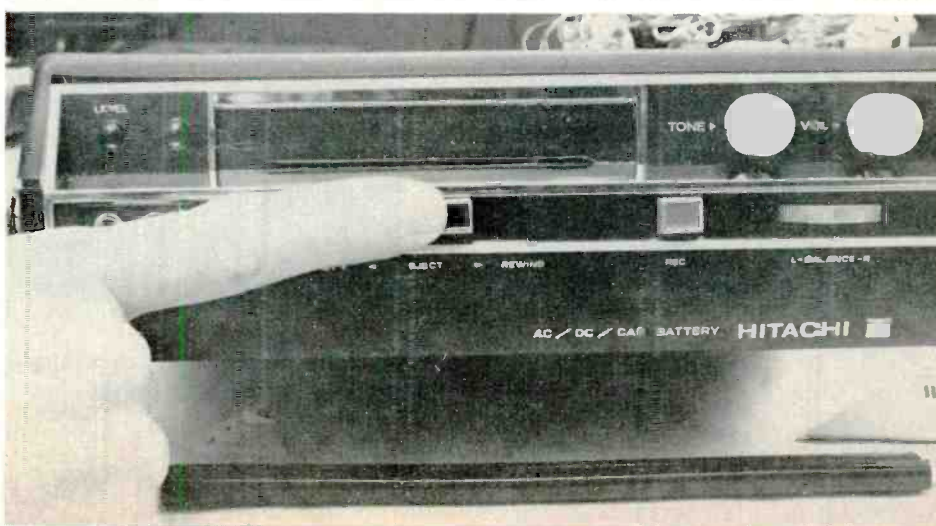


Fig. 3 Pressure on EJECT button, in center of front panel, ejects cassette. Pulling to right engages rewind pulley; to left, the fast-forward drive is engaged.

(All this is shown in Fig. 2D.) The large flywheel contains the capstan, which is part of its centershaft. As the motor and drive turn the flywheel, the spinning capstan above deck pulls the tape.

The fast-rewind pulley is also visible in Fig. 2D. A rubber rim around its bottom contacts the flywheel whenever the rewind button is punched. The speed stepup comes of course from the difference in diameters. The motion of the rewind pulley is transferred through the reel hubs to the tape reels, and the tape is pulled backward at high speed.

For fast-forward, a small pulley, almost out of sight in the center of Fig. 2D, is pulled down against the flywheel. The flywheel spins the pulley at high speed, and its rotation is transferred to the rewind pulley. But the motion turns the rewind pulley in the direction opposite that required for rewind, so the tape is pulled forward at high speed instead of backward.

The Manual Eject Function

Theo Staar's slot-loading mechanism lets you start cassettes playing with one hand and minimum distraction. That's why it's suitable for automobile cassette players. Kicking the cas-

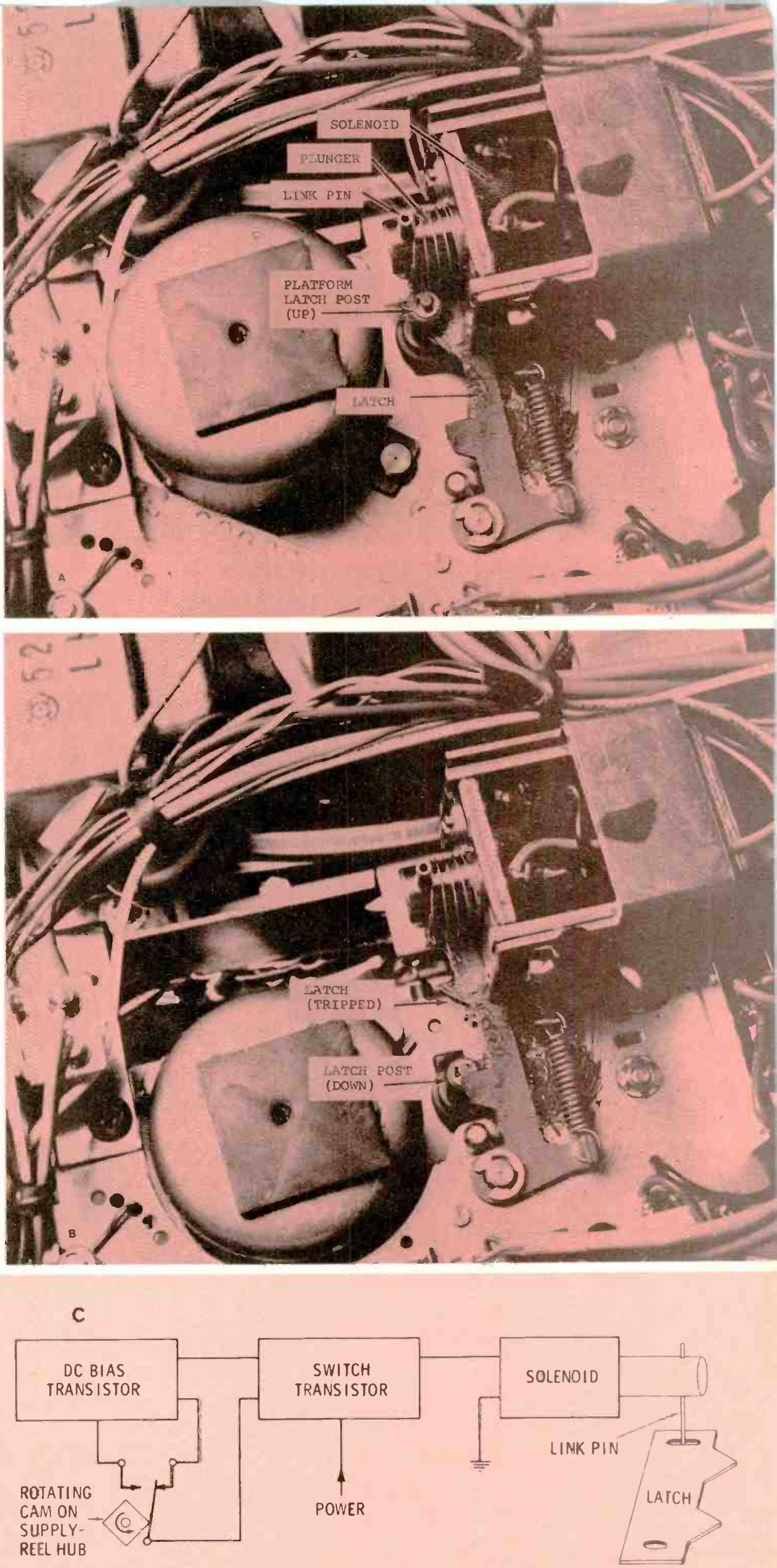


Fig. 4 Electronic/electromechanical system ejects cassette when end of tape is reached. Latch **(A)** holds platform up in playing position. Solenoid plunger and link pin trips latch **(B)** when the tape hubs stop turning. Cam and switch **(C)** sense the motion.

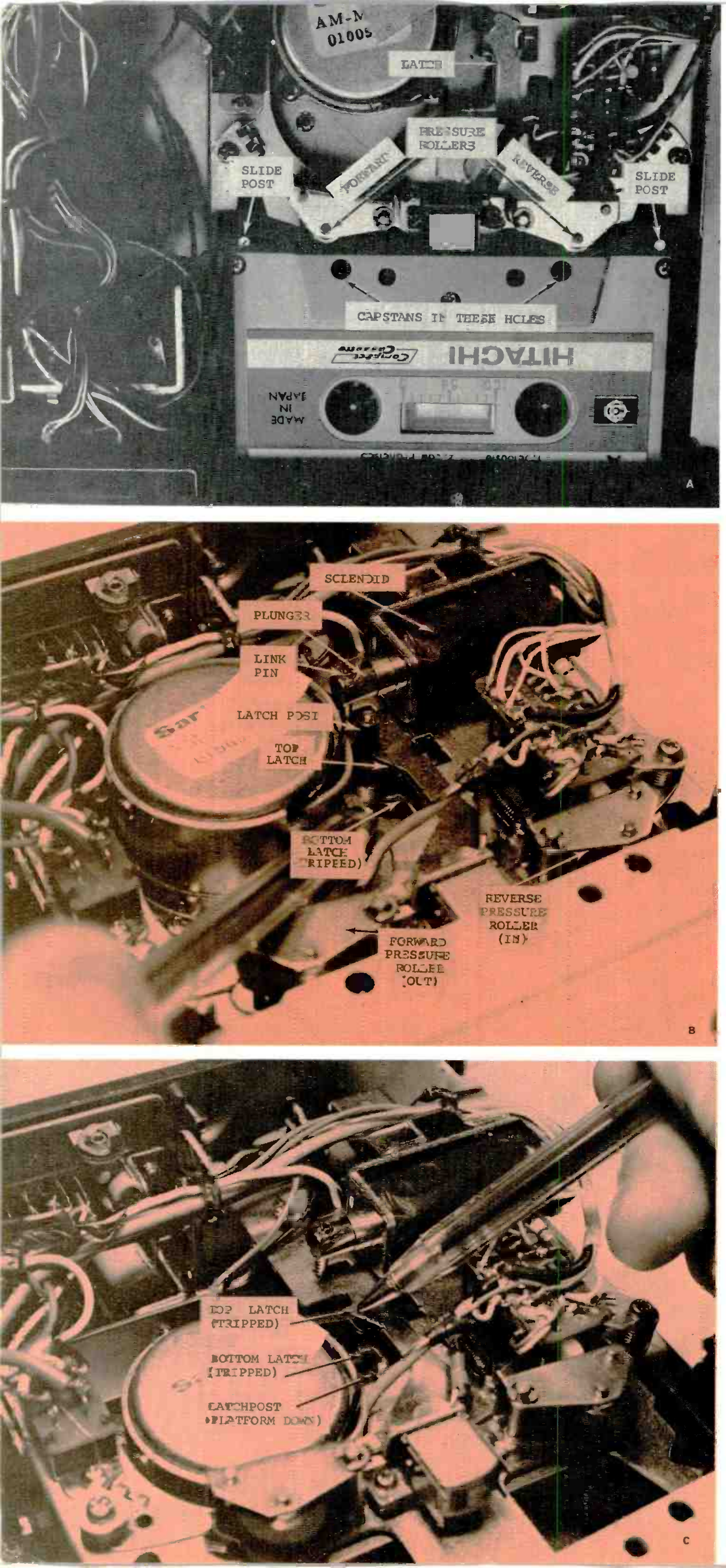


Fig. 5 Cassette in automatic-reversing machine **(A)** is driven by one of two capstans; which one depends on which pressure roller contacts tape. Two latches **(B)** catch platform latchpost; one for reversing, one for shutoff/eject. When both latches have tripped **(C)**, platform drops into its "at-rest" position.

sette back out should take just as little effort.

Pressing a button on the front panel (Fig. 3) ejects the cassette. The EJECT button releases the spring-loaded latch which holds the mechanism platform, and the platform drops down to its "off" position. This action disengages the reel hubs and capstan from the cassette, and the slide posts move back toward the front, flipping out the cassette about halfway.

Automatic Eject

When a cassette comes to the end of its tape, the Staar system unit automatically ejects it.

The latch that holds the platform in playing position can be tripped by two means. One is by mechanical linkage to the EJECT button on the front panel, as illustrated in Fig. 3 and described previously. The other is by a solenoid. Fig. 4A shows the arrangement, with the latch holding the platform in playing (or recording) position. The small, pressed link pin which extends through the end of the solenoid plunger engages a slot in the latch bar. When pushed sideways by this linkage, or by the linkage from the EJECT button, the latch no longer holds the platform latchpost, and the platform falls to its "off" position (Fig. 4B).

An electromechanical sensing circuit operates the solenoid. The circuit contains two transistors, some small parts, and a leaf-type switch. Fig. 4C illustrates the setup in simplified form.

A square cam on the supply-reel hub clicks the switch leaf back and forth. As long as the cam turns, the DC bias transistor and its associated time-constant circuits keep the switch transistor biased completely off. While the tape runs, the solenoid remains inactive.

When the tape in the cassette reaches the end, the reels can't turn any more. The DC transistor stage begins building a forward bias voltage for the switch transistor. After 1 or 2 seconds, the bias is sufficient to turn on the switch transistor. The sudden current through the solenoid pulls in the plunger, and the link pin trips the latch. The platform drops, the cassette ejects, and the machine shuts off.

Keeping the Music On

An eight-track cartridge contains a continuous loop of tape. Prerecorded music programs keep playing over and over till you eject the cartridge.

A music program on cassette stops when all of the tape has wound up on the takeup reel. To play the second program, you ordinarily have to flip the cassette over. The takeup reel for side A becomes the supply reel for side B.

Theo Staar also devised a system to keep you from having to pull the cassette out and turn it over. This version of his mechanism reverses the direction of tape travel at the end of side A and reconnects the playback head to play side B. At the end of side B, the machine ejects the cassette and shuts off, as described previously.

The makers of this year's car cassette machines generally have confined automatic reverse to play-only models. The reversing-type mechanism differs from single-play machines only in certain respects, which are illustrated in Fig. 5. The motor drives two flywheels instead of one; this provides two capstan shafts. They fit into their respective capstan holes in the cassette, as Fig. 5A shows. Each capstan has its own pressure roller, on a sort of rocker-type bar.

As you insert the cassette, it slides along Teflon guides and comes up against the slide posts, as usual. Pushing the cassette on in lifts the platform into position. In the automatic-reverse player, two latches (instead of one) catch the platform latchpost. They are highlighted in Fig. 5B.

The top latch holds the platform in playing position, just as in automatic-shutoff recorders. The bottom one is held by the latchpost, rather than it holding the latchpost. (The bottom latch is already tripped in Fig. 5B, so you can see it.) This bottom latch puts the forward-drive (side A) pressure roller against the forward capstan, with the tape pinched between. The machine thus plays side A as the turning capstan pulls the cassette tape forward.

A square-cam-and-leaf-switch senses the end of the tape, when the reels stop turning, as described previously. The transistor switch, after a second or two, operates the solenoid plunger. The movement of the plunger is short, and it trips only the bottom latch—the one being held by the post. Forward movement of this latch shifts the rocker bar holding the two pressure rollers. The forward-drive pressure roller rocks back, freeing the tape at that end of the cassette. The reverse-drive (side B) pressure roller moves in to hold the tape against the capstan at that end. The machine plays side B as the reverse capstan pulls the tape backward (also slowly rewinding it).

When side B is completed, the lack of motion at the sensor cam again activates the solenoid. This time, the remaining latch, the top one, trips. The platform, released, drops down and ejects the cassette. The machine stops. Fig. 5C shows the position of the latches and latchpost after shutoff.

Servicing The Staar System

Repairs and troubleshooting in the Staar-type cassette machines are little different from those in other cassette players, once you understand the Staar workings. There are only a couple of special things you should remember:

A "sticky" cassette reel, all too common in today's cassettes, can cause the machine to reverse or to shut off before it should. When you encounter that kind of complaint—repeated premature reversing or shutting off—suspect the cassette instead of the machine. Try a cartridge you know is good. If you are playing back, you should be able to tell, by listening, whether the trouble is caused by the cassette or the machine; if the cassette is the source of the trouble, the music (or voice) usually will grind to a halt a couple of seconds before ejection.

In the recording mode, however, this kind of complaint can be baffling because the "audio" clues will not be present.

Premature ejecting also can sometimes be traced to a power difficulty in the set. The bias and switch transistors are arranged so that, if power is removed (even from the set), a charged capacitor pulls the solenoid in and the cassette cartridge pops out. Consequently, a supply-line interruption of any duration, whether inside the machine or outside, can cause ejection and shutoff. The cause of an intermittent like this can be difficult to track down unless you remember that the cause can be either inside or out, and even if inside it might not be in the automatic-ejection system.

Next In'Service Bench

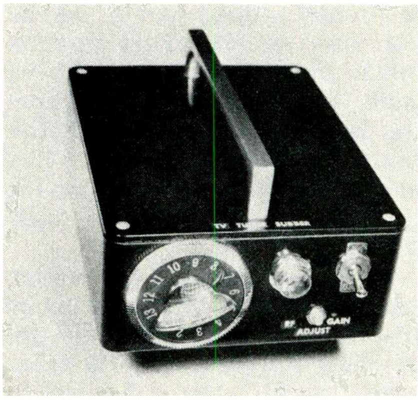
Next month, I'll be getting back to television. The subject is high-voltage regulation in color TV sets. □

product report

Features and/or specifications listed are obtained from manufacturers' reports. For more information about any product listed, circle the associated number on the reader service card in this issue.

TV Tuner Subber

Product: Transistor TV VHF tuner
Manufacturer: Castle TV Tuner
Function and/or Application: Substitutes VHF tuner in a defective TV receiver to prove if the original tuner is good or bad.
Features: Analyzes IF and AGC system defects and tests the UHF tuner in the receiver. Two connections, antenna and IF cables, can be made in most cases without removing the tuner or chassis from the cabinet. Extension cables for IF connection is



furnished. The tuner is solid-state and operates from self-contained batteries; two 9-volt transistor batteries are used and allow battery life of 4 to 5 hours or a total of more than 6 hours when used intermittently. A transistor VHF tuner with external gain control affords a gain reduction of 40 dB independent of receiver AGC. The tuner subber is portable.
Specifications: N/A
Price: Kit form sells for $22.95; assembled form is $29.95.

Circle 60 on literature card

TV Tuner Cleaner/Lubricant

Product: Silicon spray for TV tuners.
Manufacturer: General Electric
Function and/or Application: Accessibility to tuner contacts of silicon spray
Features: General Electric devel-

oped this new spray for professional technicians. It is a compound of methyl alkyl silicons for polishing and lubricating tuner contacts that provide cleaning for both color and black and white TV tuners. Available in 8 oz. aerosol can with an extension spray nozzle for easy accessibility.
Specifications: The silicon spray is safe for plastics, is driftless, nonflammable, will not evaporate or run, resists temperature extremes and is paintable and solderable after normal clean up.
Price: The GE silicon spray sells for $2.39.

Circle 61 on literature card

Dual-Heat Soldering Iron

Product: Duo-Heat pencil soldering iron
Manufacturer: Wall Mfg.
Function and/or Application: Soldering contacts
Features: A button switch on the handle permits operation at low heat for light-duty soldering or during standby time, or at maximum heat when required. The low-heat operation permits rapid return to readiness, and prolongs the life of the tip and element.
Specifications: Model DH-1 has a 15-watt and a 47-watt element which develops a 520-degree low temperature, or a 920-degree high temperature. Model DH-2 has 20- and 53-watt elements for 630-degree and 975-degree operation.
Price: The DH series sells for $8.95. ☐

Circle 62 on literature card

advertisers' index

The MARKETPLACE

This classified section is available to electronic technicians and owners or managers of service shops who have for sale surplus supplies and equipment or who are seeking employment or recruiting employees.

Advertising Rates in the Classified Section are:

- 25 cents per word (minimum $3.00)
- "Blind" ads $2.00 additional
- All letters capitalized—35 cents per word

Each ad insertion must be accompanied by a check for the full cost of the ad.

Deadline for acceptance is 30 days prior to the date of the issue in which the ad is to be published.

This classified section is not open to the regular paid product advertising of manufacturers.

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Gernsbach Library and TAB Books for sale at half the original price. Write for complete list and prices. Duncan Eadie, 3884 Ewings Rd., Lockport, N.Y., 14094.

LABELS

Mr. Serviceman—put your custom printed label on the items you repair. You get repeat business. Send for samples & prices. Carlton Tape & Label, P.O. Box 12005 Dept. ES1, Houston, Texas, 77017.

WANTED

Wanted—Experienced TV Serviceman or will sell entire shop—send for listing. M.E. Novak, Tyndall, So. Dak.

catalogs literature

ANTENNAS

100. *Jerrold Electronics Corp.*—Catalog S, titled "Systems and Products for TV Distribution," lists specifications of this manufacturer's complete line of antenna distribution products, including antennas and accessories, head-end equipment, distribution equipment and components, and installation aids.

AUDIO

101. *Arista Enterprises, Inc.*—announces their 58-page needle and cartridge catalog. The needle cross reference reportedly has up-to-date cross references of all major needle marketers, in addition to cross reference sections of phonograph manufacturers' needle and cartridge numbers.

102. *GC Electronics* – announces catalog No. FR-135-W, containing an updated line of rubber drives and belts, phono and recorder drive wheels and pulleys, pinch rollers, round rubber belts, etc. The catalog also contains a cross-reference section, with replacement part numbers for equipment made by 194 manufacturers.

103. *Jensen Manufacturing Div.*—has issued an 8-page catalog, No. 1090-E, which describes applications of 167 individual speaker models. Special automotive, communications, intercom and weathermaster speakers, plus a complete line of electronic musical instrument loudspeakers are featured.

1‹›4. *Shure Brothers*—has published a new catalog describing their line of mi-›phone and circuitry ›ucts for broadcasting, recording, motion pictures, and professional sound reinforcement. Included are illustrations and technical specifications.

AUTO ELECTRONICS

105. *Littelfuse, Inc.*—has released a new 32-page, 1971 automotive replacement fuse guide for passenger autos, sports cars, trucks, and taxi cabs. Fuse descriptions and circuits they protect are included.

106. *Nortronics Co., Inc.*—announces a revised brochure describing the Model 5800 replacement head for a reported 90 per cent of all 8-track auto and home stereo players. A listing of players is offered by more than 70 different manufacturers in terms of model number or head part number.

CABLE

107. *Columbia Electronic Cables*—has published a 92-page wire, cable, and cordset catalog No. CEC-MC-571 which includes technical data concerning comparison charts of different types of insulating materials, copper wire specifications, estimating charts, and ampere ratings.

CAPACITORS

108. *Cornell-Dubilier Electronics*—has issued an 80-page cross-reference, 1972 catalog for location of single, dual, triple, and quadruple section replacement electrolytics.

109. *Loral Distributor Products*—has made available a 24-page electrolytic capacitor replacement guide. The catalog features replacement products by the original manufacturers part number.

110. *Sprague Products Co.* — has announced a 40-page manual which lists original part numbers for each manufacturer, followed by ratings, recommended Sprague capacitor replacements, and list prices. More than 2,500 electrolytic capacitors are included.

COMPONENTS

111. *Bulow International* — announces a new parts list for spare-parts and replacement parts for several major European radio and electronics manufacturers. Components, transistors, diodes and mechanical parts are included.

112. *P. R. Mallory & Co., Inc.*—introduces a 64-page general catalog containing approximately 10,000 items. Included in the catalog are batteries, capacitors, controls, resistors, semiconductors, switchers, and timers plus security systems, cassette recorders and cassette recording tapes.

113. *Precision Tuner Service*—announces a new tuner parts catalog, including a cross reference list of antenna coils and shafts for all makes of tuners.

114. *Workman Electronic Products, Inc.*—has released a 68-page 1972 catalog of replacement components for radio and television. Included are resistors, fusing devices, circuit breakers, sockets, convergence controls, electronic chemicals, audio cables, adapters for hi-fi and cassette type recorders battery holders and prototype kit components.

KITS

115. *Heath Co.* — announces their 1972 Heathkit catalog, reportedly featuring over 350 kit projects. Projects for the home, the car, and workshop are included.

SEMICONDUCTORS

116. *GTE Sylvania, Inc.*—announces a revised semiconductor guide which reportedly gives replacement information for more than

41,000 solid-state devices. The 73-page catalog, ECG 212D, provides characteristics and outline drawings of the 124 components in the Sylvania ECG semiconductor line.

117. *Motorola*—announces release of the HEP HMA-07 semiconductor cross-reference guide and catalog. Replacements are reportedly listed for over 30,000 semiconductor device numbers. A product catalog plus 168 new hobby, dealer and industrial M.R.O. devices are also included.

118. *RCA Distributor Products*—introduces a 72-page "SK Series Top-Of-The-Line Replacement Guide" (SPG-202L) which cross-references over 20,000 semiconductor device numbers. In addition a Solid State Quick Selection Replacement Chart (1L1367) listing 79 entertainment SK-Series devices is included.

119. *Semitronics Corp.*—has a new, revised "Transistor Rectifier, and Diode Interchangeability Guide" containing a list of over 100 basic types of semiconductors that can be used as substitues for over 12,000 types.

120. *Sylvania Electric Products, Inc.*—a 73-page guide which provides replacement considerations, specifications and drawings of Sylvania semiconductor devices plus a listing of over 35,000 JEDEC types and manufacturers' part numbers.

SERVICE AIDS

121. *Chemtronics*—announces a new 12-page, 1971-1972 catalog of products, including: tuner sprays, circuit coolers, insulating sprays, contact and control sprays, lubricants, tape head and record cleaners / accessories, cartridge tape head cleaners and conditioners, electronic glues and cements, solder, and spray paints.

122. *Kester Solder*—has released an 8-page brochure presenting the company's full line of soldering products. Presented are: "44" resin core solder, acid-core solder, solid-wire, bar solder, TV-radio solder, and Metal Mender.

SOLID STATE

123. *International Rectifier*—64-page volume, JD-451, has been revised and lists information on diodes, zeners, capacitors, rectifiers and SCR's. There are a reported 4000 new transistor listings. Specifications, characteristics, tables and wall charts are also included.

TECHNICAL PUBLICATIONS

124. *Howard W. Sams & Co., Inc.*—announces publication of a new 96-page 1972 Technical and Scientific Book Catalog. Described are over 800 hardbound and softbound books which cover "do-it-yourself" titles from the Audel Division, amateur radio publications, audio visual materials, instructor's guides and student workbooks. Titles range from "ABC's of Air Conditioning" to "Writer's and Editor's Technical Stylebook".

125. *Sencore, Inc.* — Speed Aligner Workshop Manual, Form No. 576P, provides 20 pages of detailed, step-by-step procedures for operation and application of Sencore Model SM158 Speed Aligner sweep-marker generator.

126. *Sylvania Electric Products, Inc., Sylvania Electronic Components Div.* — has published the 14th edition of their technical manual, which includes mechanical and electrical ratings for receiving tubes, television picture tubes and solid-state devices.

127. *Tab Books*—has released their Spring 1972 catalog describing over 170 current and forthcoming books. The 20-page catalog covers: schematic/servicing manuals, broadcasting; basic technology; CATV; electric motors; electronic engineering; computer technology; reference; television, radio and electronics servicing; audio and hi-fi stereo; hobby and experiment; amateur radio; test instruments; appliance repair, and transistor technology.

TEST EQUIPMENT

128. *Dynascan Corp.* — announces a new 24-page 2-color catalog of B&K Precision Test Equipment. A total of 21 instruments are reportedly presented; from a Mutual Conductance Tube Tester to a new DC to 10 MHz Triggered Sweep Oscilloscope.

129. *Eico*—has released a 32-page, 1972 catalog which features 12 new products in their test equipment line, plus a 7-page listing of authorized Eico dealers.

130. *Hickok*—has published a 4-page brochure, "Hickok Oscilloscopes," which contains descriptions, specifications and prices for Models 5000A and 5002A oscilloscopes.

131. *Information Terminals*—has introduced a new brochure featuring the M-100 Tension Monitor, the M-200 Torque Tester and the M-300 Head and Guide Gage.

132. *Leader Instruments Corp.*—announces the 1972 Catalog of Leader Test Equipment. Test equipment included is the LBO-301 portable triggered-sweep oscilloscope, LSW-300 new solid-state post injection sweep/marker generator, and the LCG-384 mini-portable, solid-state battery operated color-bar generator.

133. *Lectrotech, Inc.* — announces the 1972 catalog, "Precision Test Instruments for the Professional Technician". It contains

specifications and prices on sweep marker generators, oscilloscopes, vectorscopes, color bar generators and other test equipment.

134. *Mercury Electronics Corp.*—14-page catalog provides technical specifications and prices of this manufacturers' line of Mercury and Jackson test equipment, self-service tube testers, testers, test equipment kits and indoor TV antennas.

135. *Tektronix, Inc.*—has announced a 4-page brochure describing the 54 Series oscilloscope manufactured by Tektronix English subsidiary, Telequipment.

136. *Triplett Corp.*—announces a 6-page, two-color brochure featuring four new portable, battery-operated, FET Volt-Ohm-Milliameters and accessories.

137. *Triplett Corp.*—announces a 2-page, 2-color data sheet for Model 6028, a 2¾ digit VOM. Data sheet gives DC volts, AC volts, ohms AC and DC current ranges plus construction information, price and accessories.

TOOLS

138. *Chapman Manufacturing Co.*—offers a pamphlet containing their line of tools and tool kits. Kit No. 6320, the Midget Ratchet is featured along with other available tool kits.

139. *Ideal Industries*—introduces a 2-page, 4-color brochure announcing their new Heat Gun. Performance characteristics applications, operating features, specifications and ordering information reportedly are included.

140. *Janel, Inc.*—announces a three-color catalog on precision hand tools used primarily in miniature and microminiature electronic assembly and production applications.

141. *Jensen Tools and Alloys*—has announced a new catalog No. 470, "Tools for Electronic Assembly and Precision Mechanics." The 72-page handbook-size catalog contains over 1,700 individually available items.

142. *Xcelite, Inc.*—Bulletin N770 describes this company's three new socket wrench and ratchet screwdriver sets.

TRANSFORMERS/COILS

143. *J. W. Miller Co.*—announces a new 92-page radio and TV replacement coil cross reference guide for known domestic and foreign color and black and white TV sets, home and car radios. Over 22,000 replacement coils for 327 manufacturers names reportedly are listed.

144. *Stancor Products*—pocket-size, 108-page "Stancor Color and Monochrome Television Parts Replacement Guide" provides the TV technician with transformer and deflection component part-to-part cross reference replacement data for over 14,000 original parts.

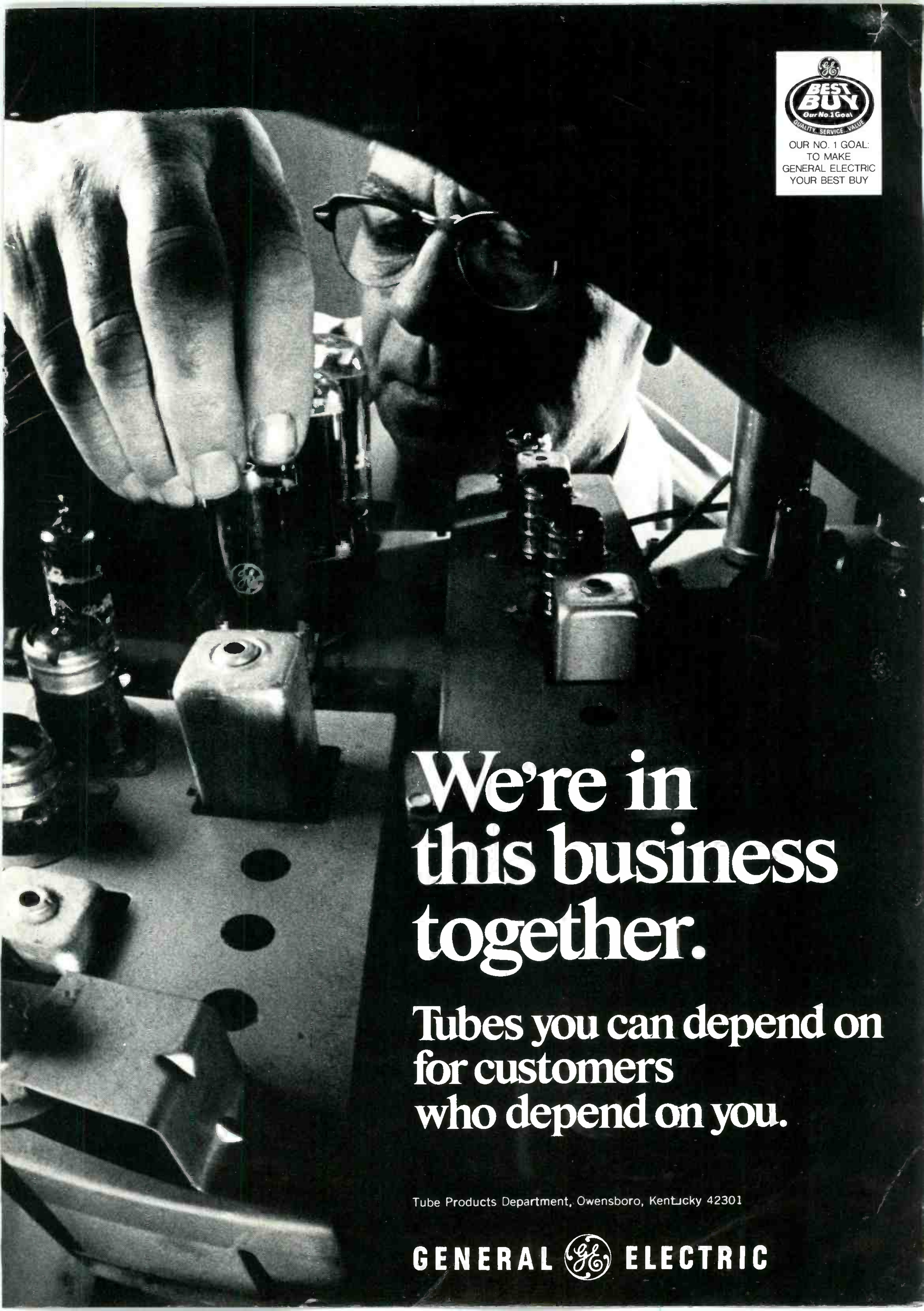
TV ACCESSORIES

145. *Telematic*—introduces a 14-page catalog featuring CRT brighteners and reference charts, a complete line of test jig accessories and a cross reference of color set manufacturers to Telematic Adapters and convergence loads.

TV PICTURE TUBES

146. *GTE Sylvania*—50-page brochure which describes characteristics of over 900 television picture tubes, plus data on interchangeability information and tips on installation and handling of TV picture tubes.

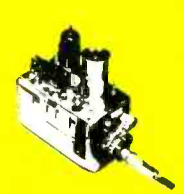
147. *GTE Sylvania, Inc.* — has published an interchangeability guide listing 191 commonly used color TV picture tubes which can be replaced with 19 GTE Sylvania Color Bright 85® types. □



BEST BUY
Our No. 1 Goal
QUALITY...SERVICE...VALUE
OUR NO. 1 GOAL:
TO MAKE
GENERAL ELECTRIC
YOUR BEST BUY
We're in this business together.
Tubes you can depend on for customers who depend on you.
Tube Products Department, Owensboro, Kentucky 42301
GENERAL ELECTRIC

WHY REPAIR TV TUNERS?
CASTLE REPLACEMENTS
***start at* 8.95**

Select by part number below. Write, phone or wire order.
No mailing ... no waiting ... no nonsense!

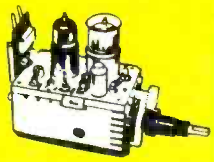


UNIVERSAL REPLACEMENTS
Prefer to do it yourself?

These Castle replacement tuners are all equipped with memory fine tuning and UHF position with plug input for UHF tuner. They come complete with hardware and component kit to adapt for use in thousands of popular TV receivers.

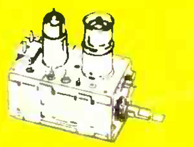
*Supplied with max. length selector shaft (measured from tuner front apron to tip) . . . you cut to suit.

STOCK No.	HEATERS	SHAFT Min.*	SHAFT Max.*	I.F. OUTPUT Snd.	I.F. OUTPUT Pic.	PRICE
CR6P	Parallel 6.3v	1¾″	3″	41.25	45.75	8.95
CR7S	Series 600mA	1¾″	3″	41.25	45.75	9.50
CR9S	Series 450mA	1¾″	3″	41.25	45.75	9.50
CR6XL	Parallel 6.3v	2½″	12″	41.25	45.75	10.45
CR7XL	Series 600mA	2½″	12″	41.25	45.75	11.00
CR9XL	Series 450mA	2½″	12″	41.25	45.75	11.00



EXACT REPLACEMENTS
Purchase outright . . . no exchange needed. **$15.95 ea.**

Castle replacements made to fit exactly in place of original tuner. Available in the following popular numbers.



ADMIRAL
94E210-1, 94E210-3, 94E227-2, 94E228-1, 94E229-4, 94E229-8, 94D257-1, 94D257-7, 94D257-49, 94E260-8H, 94E260-11, 94E261-1B, 94E261-1C, 94E261-1D, 94D261-4, 94C273-2, 94C273-4, 94C273-7, 94C273-8, 94C273-9, 94C273-10, 94C273-13, 94C273-15, 94C281-1K, 94C286-1D, 94C286-1J, 94C286-1L, 94C286-4J, 94C286-5, 94C286-12, 94C286-16, 94C289-1

CURTIS MATHES
7A11, 7A17, 7A38, 7A48, 7A050, 7A53-001, 7A056-001, 7A59-001

EMERSON
471351, 471512, 471515, 471678, 471682, 471700, 340042-1, 340052-1, 340053-1, 340066-1, 340067-1, 340069-1, 340078-1, 340078-2, 340095-2, 340130-1

G E
ET86X188, ET86X208, ET86X212, ET86X213, ET86X214, ET86X215, ET86X221, ET86X224, ET86X227, ET86X230, ET86X231, ET86X232, ET86X236, ET86X242, ET86X244, ET86X255, ET86X256, ET86X265, ET86X277, ET86X281

HEATHKIT
110-17, 110-24, 110-25, 110-33, 110-38

MAGNAVOX
340009-1, 340010-1, 340017-1, 340038-1, 340040-1

MOTOROLA
OPTT123C, OPTT123D, TT133A, TT133YA, LTT307A, RTT322A, CPTT332A, CPTT338B, DCPTT338B, CMTT340A, CMTT340B, TT348B, MTT348A, VTT348B, VTT349B, CPTT350B, CPTT356YA, TT361Y, OPTT361YB, CPTT366Y, CPTT366YD, OPTT366YD, NCPTT376YA, CPTT378YA, NCPTT378YA, OPTT385Y, OPTT385YA, OPTT386YA, OPTT388YA, CPTT390YA, OPTT390YB, OPTT394, SCPTT394, AOPTT399, LOPTT399Y, LOPTT399YA, OPTT399YA, OPTT402, LOPTT402, CPTT403, OPTT404, OPTT404A, CPTT405, OPTT414A

MUNTZ
PR0352-1, PR0364, PR0376, PR9021, PR9044, PR9045, PR9050, PR9058

OLYMPIC
CL4692-1, CL5220-1, CL28874-1, CL29554, CL29566, CL29650, CL33579, CL33858, CL34190, CL34835, K24013USA-1C, K50013USAH-3

PHILCO
76-12405-4, 76-13579-5, 76-13579-7, 76-13579-8, 76-13579-9, 76-13851-2, 76-13871-1, 76-13945-1, 76-13955-1, 76-13955-2, 76-13955-5

R C A
KRK103A, KRK103C, KRK103F, KRK103L, KRK104A, KRK104C, KRK104F, KRK104L, KRK107A*, KRK107B*, KRK107C*, KRK107D*, KRK107E*, KRK107F*, KRK108A*, KRK108B*, KRK108C*, KRK108D*, KRK108E*, KRK108F*, KRK113B, KRK116B, KRK118A*, KRK118C*, KRK118D*, KRK123D, KRK124AA, KRK124U, KRK127AA, KRK127AB, KRK127B, KRK127BA, KRK127E, KRK127L, KRK127T, KRK127U, KRK127W, KRK128AB, KRK128U, KRK133BC, KRK133D, KRK133U

SEARS
95-75, 95-141-0D, 95-358-0, 95-437-0A, 95-480-3D, 95-500-0A, 95-500-1A, 95-500-1B

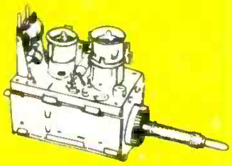
SYLVANIA
54-11644-3, 54-11702-1, 54-17234-1, 54-17436-2, 54-17436-3, 54-17436-4, 54-17436-5, 54-17778-1, 54-23853-3, 54-23857-2, 54-78093-1, 54-88847-3B, 54-89093-1, 54-89720-1A, 54-89720-3, 54-89840-2A, 54-94689-3, 54-97948-6, 54-97948-7

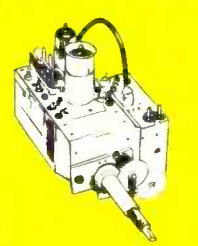
WESTINGHOUSE
470V007H03, 470V019H05, 470V019M01, 470V030H01, 470V049H01, 470V149H01, 470V151H01, 470V158D03, 470V161D03, 470V188D01, 470V188D02, 470V190D01, 470V191D01, 470V191D02, 470V191D03

ZENITH
175-167, 175-168, 175-170, 175-201, 175-202, 175-202A, 175-203A, 175-204, 175-204A, 175-206, 175-212, 175-213, 175-214, 175-216, 175-220, 175-222, 175-228, 175-230, 175-232, 175-254, 175-256, 175-262, 175-264, 175-266, 175-268, 175-272, 175-402, 175-405, 175-406, 175-412, 175-416, 175-418, 175-420, 175-424, 175-426, 175-431, 175-454, 175-601, 175-602, 175-604, 175-621, 175-622, 175-640, 175-641, 175-642, 175-643, 175-644, 175-645, 175-646, 175-647, 175-660, 175-661, 175-662, 175-663, 175-666, 175-667, 175-668, 175-669, 175-671, 175-680, 175-681, 175-682, 175-683, 175-684, 175-685, 175-686, 175-687, 175-688, 175-689, 175-690, 175-708, 175-711, 175-712, 175-713, 175-715, 175-716, 175-717, 175-718, 175-719, 175-720, 175-721, 175-722, 175-731, 175-732, 175-733, 175-734, 175-735, 175-736, 175-737, 175-738, 175-739, 175-740, 175-741, 175-742, 175-743, 175-744, 175-745, 175-746, 175-747, 175-748, 175-750, 175-751, 175-752, 175-753, 175-754, 175-755, 175-756, 175-757, 175-758, 175-759, 175-760, 175-761, 175-762, 175-763, 175-764, 175-1101, 175-1102, 175-1103, 175-1104, 175-1105, 175-1106, 175-1108, 175-1118, 175-1119, 175-1120, 175-1121, 175-1122, 175-1131, 175-1132, 175-1133, 175-1134, 175-1135, 175-1136, 175-1137, 175-1138, 175-1139, 175-1140, 175-1141, 175-1142, 175-1143, 175-1144, 175-1145, 175-1146, 175-1147, 175-1148, 175-1150, 175-1151, 175-1152, 175-1153, 175-1154, 175-1155, 175-1156, 175-1157, 175-1160, 175-1161, 175-1162, 175-1163, 175-1164, 175-1165, 175-1168, 175-1172, 175-1175, 175-1176, 175-1177

MISC INCLUDING PRIVATE LABELS
TA82, TA124, TA129, TA131, TA133, TA136, TA138, TA147, TA150, TA157, 25A1241-002B, 25A1241-004B, 25A1241-005B, 25A1241-006B, 25A1245-005D, 25A1245-006D, 25A1245-009, 25A1245-011, 25A1246-001, 25A1246-003, 25A1246-004, 25A1246-005A, 25A1247-002, 25A1249-001A, 25A1249-001E, 25A1253-001, 25A1253-001B, 25A1253-001D, 25A1256-001C, 25A1258-001A, 25A1258-001C, 25A1263-001, 25A1264-001B, 25A1265-001B, 25A1268-001, 25A1270-001, 006-014700, 006-015000, 006-015700, 006-016500, 006-017300, 006-017700, 006-018600, 006-020100, 006-020900, 006-021000

**Supplied with new channel indicator skirt knob, original illuminated dial is not used.*





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VHF or UHF tuner (1960 or later)	$9.95
TRANSISTOR tuner	$9.95
COLOR tuner	$9.95

Overhaul includes parts, except tubes and transistors.

Dismantle tandem UHF and VHF tuners and send in defective unit only.

Remove all accessories . . . or dismantling charge may apply.

Your tuner will be expertly overhauled, aligned to original standards and warranted for 90 days.

CUSTOM EXCHANGE REPLACEMENTS
When our inspection reveals that original tuner is unfit for overhaul, we offer an exact replacement.

If exact replacement is not available in our stock we custom rebuild the original at the exchange price. (Replacements are new or rebuilt.)

PROFESSIONAL "CONTACT OVERHAUL" KIT
Do your own minor tuner overhauling by using this professional kit of chemicals. Dealer Net $5.50

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