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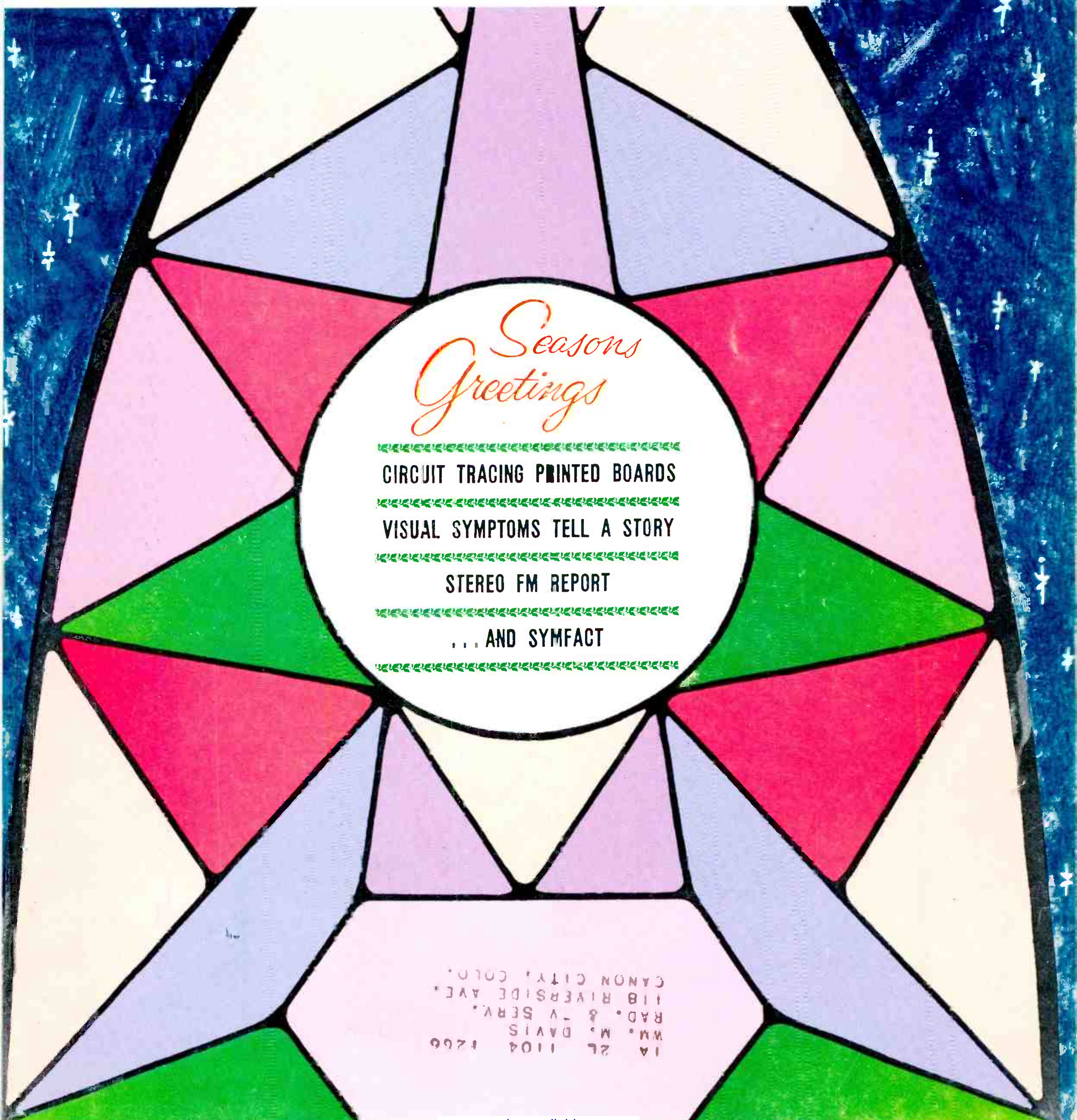

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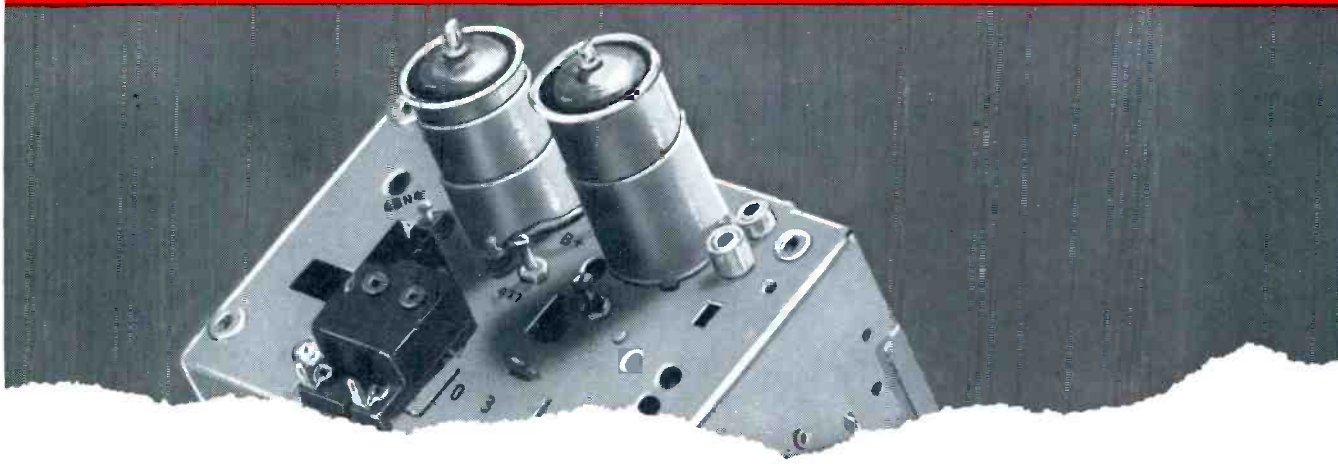

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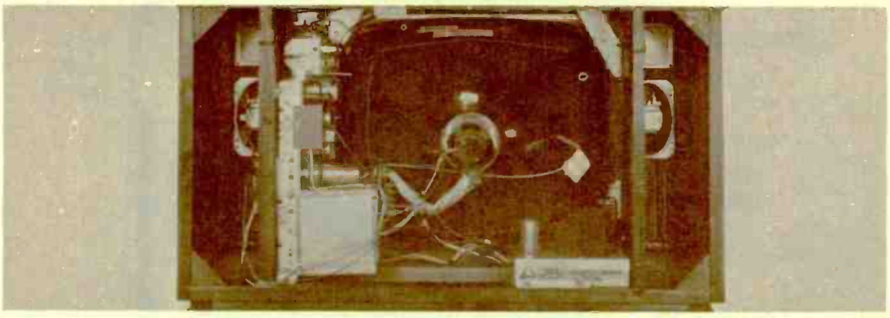

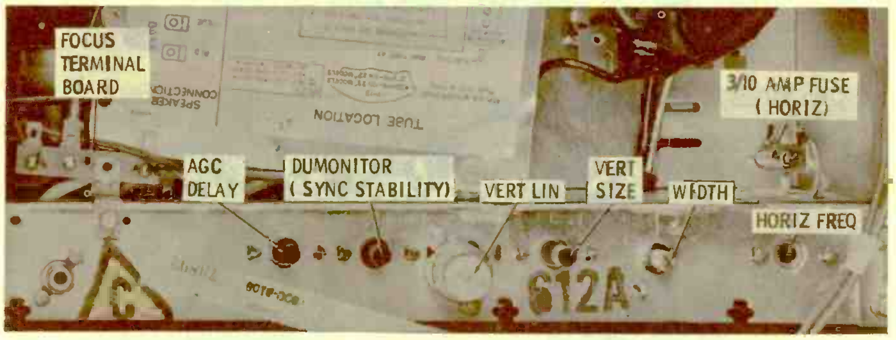

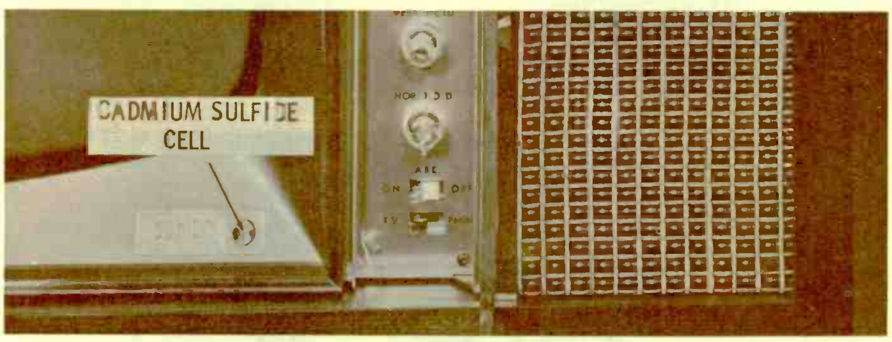

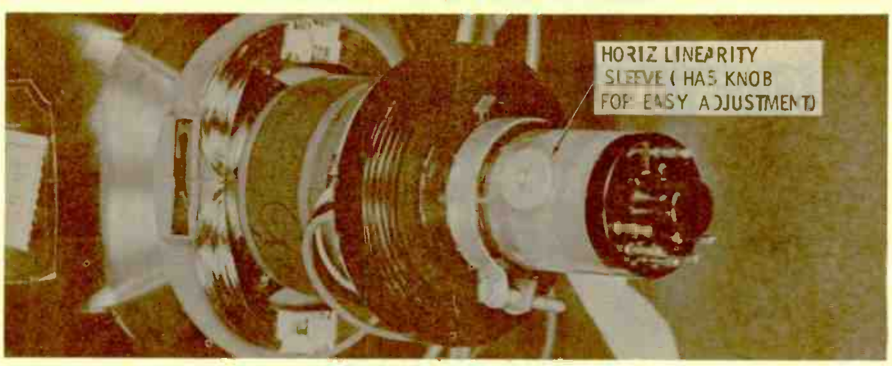

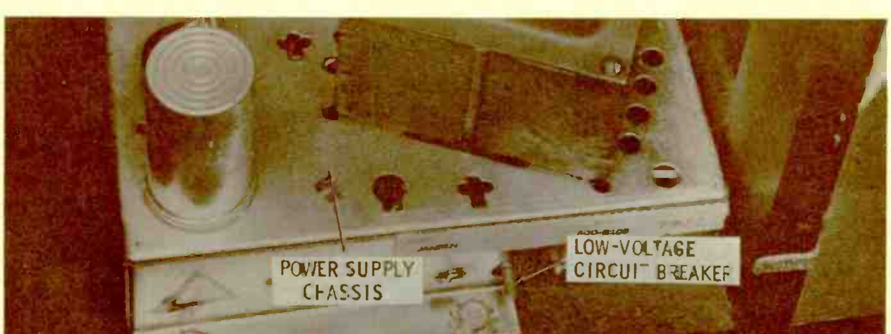

DuMont Model 800-B108

Chassis 120612-A

The 23" console TV shown here contains a bonded 92° CRT, the 23YP4. Models with a 27" picture tube (27VP4) are also available in this line. In addition, some models come equipped with a four-function remote-control unit which turns the receiver on and off, changes channels and adjusts the volume.

This receiver has a separate power chassis upon which are mounted all of the components necessary to supply B+ and filament voltages. A B+ circuit breaker and a wire-link filament fuse provide protection for these circuits. The horizontal sweep section has its own fuse, a 3/10-amp unit mounted inside the high-voltage cage.

A cadmium-sulfide cell is the nucleus of the automatic brightness-contrast control (ABC) circuits used in this set. It reacts to any change in the ambient room lighting by initiating an appropriate change in brightness and contrast on the CRT screen. A switch mounted on the front control panel enables the operator to turn the ABC circuit off or on. Don't forget to unplug the leads to the light-sensitive cell if you have reason to pull the chassis.

Another switch on the front panel is used to select TV or phono operation. When placed in the phono position, it opens the brightness circuit to kill the raster, breaks the TV audio path from the detector to the volume control, and connects the phono input socket (on the rear of the chassis) to the volume control. It's a good idea to check this switch if sound, brightness, or both are absent.

A plastic-covered metal sleeve, placed between the yoke and the neck of the CRT, is the horizontal linearity adjustment in this set. Attached to the plastic is a circular metal tab (see photo), which makes it easier to move the sleeve in or out. A width control in the horizontal-output screen circuit is used in conjunction with the linearity sleeve to obtain the proper sweep. Adjust the sleeve first (for the best horizontal linearity); then rotate the width control to obtain the correct width.

Frame-grid tubes (6EH7/EF183) are used in all three video-IF stages. The horizontal-AFC dual diode is a 6AL5 tube instead of a semiconductor.

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Magnavox Model 2MV135D

Chassis V38-04-00

Among this portable TV's features are a 19″ viewing screen, automatic brightness-contrast control (ABC), and a built-in rabbit-ear antenna. A cadmium-sulfide cell, physically located below the on-off-volume control, varies the contrast and brightness circuits whenever any change in room lighting takes place.

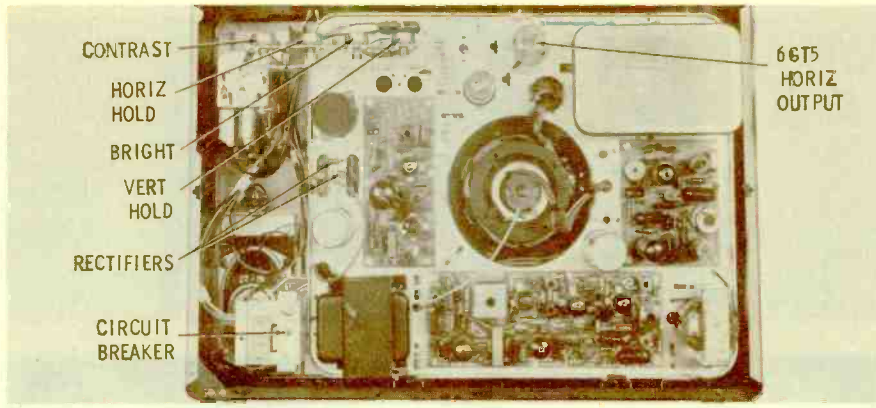
Printed wiring, adopted by Magnavox in their 35 and 36 series chassis, is used once again in this receiver. All three printed boards are clear of obstructions on both sides, a feature which makes soldering operations easy. The two silicon rectifiers, the 1N60 video-detector diode, and a dual diode in the horizontal AFC stage are all plug-in types.

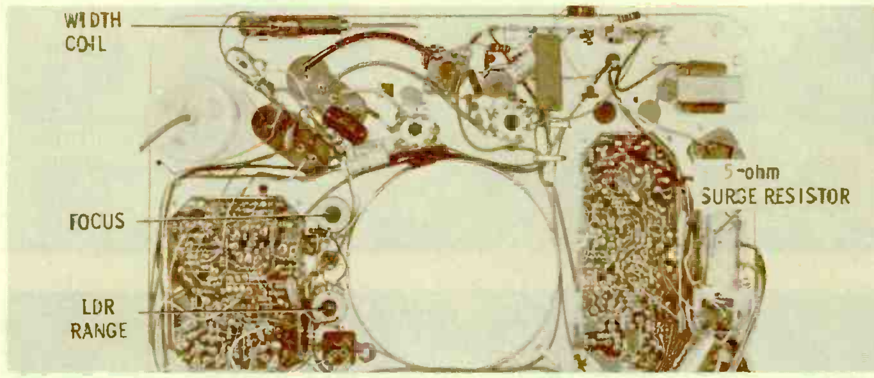
A circuit breaker and a 5-ohm, 10-watt resistor protect the B+ supply, and a wire-link fuse is used to protect the 6-volt filament supply.

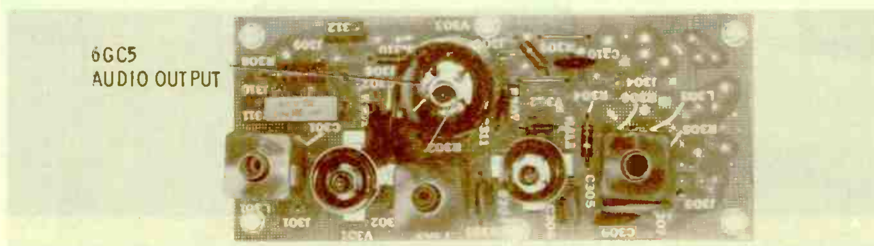
The vertical blanking circuit in this set is unusual; the blanking pulse is obtained from a separate winding on the vertical output transformer and coupled through a .0033-mfd, 2-kv capacitor to the accelerator grid (pin 3) of the 19BTP4 picture tube. This signal has a peak-to-peak voltage in the neighborhood of 550 volts; so, if you have need to check it, set your scope gain accordingly.

The tube complement of the horizontal stages is as follows: 6CG7 multivibrator, 6GT5 horizontal output (a *novar* with *no* top cap), 6DA4A damper, and 1G3GT high-voltage rectifier.

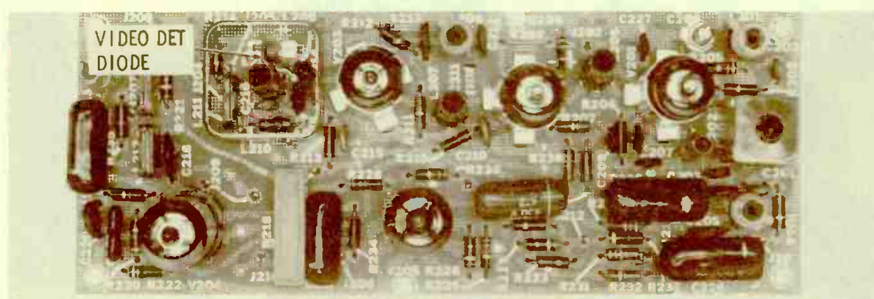
The operating controls for on-off-volume, channel selection, and fine tuning are mounted on the front control panel. Those for contrast, horizontal hold, brightness, and vertical hold are operated by thumbwheel knobs on the rear of the set. The width coil and the focus, vertical linearity, height, and LDR range potentiometers can be adjusted through holes in the rear cover. The LDR range control sets the typical operating level of the ABC circuit and should be adjusted in the following manner: With the room lighting at a normal level, turn the control fully clockwise. Place your hand over the light-sensitive cell to simulate dim room light, and manually reduce the contrast and brightness to a level suitable for viewing in semi-darkness. Then remove your hand from the cell and see if the picture returns to normal. If it appears too pale, rotate the control slightly counterclockwise. Repeat this procedure until the *ratio* of contrast to brightness remains consistent with room lighting.



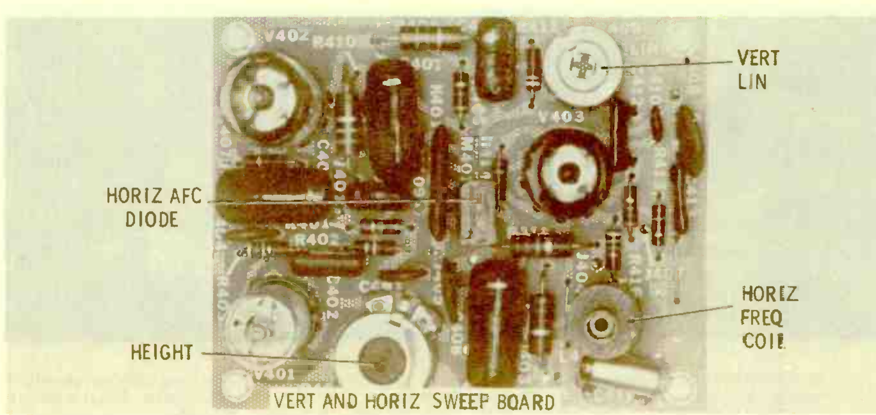




SOUND BOARD



IF, VIDEO, AGC, AND SYNC BOARD



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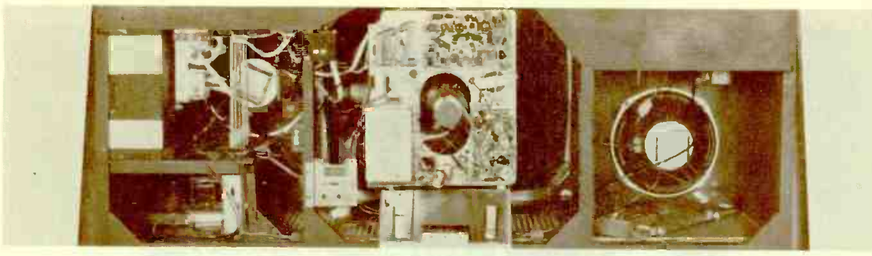
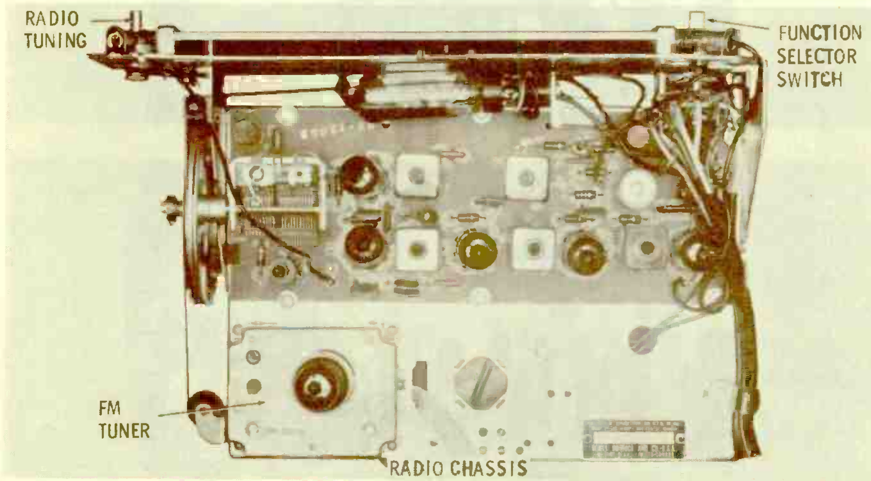
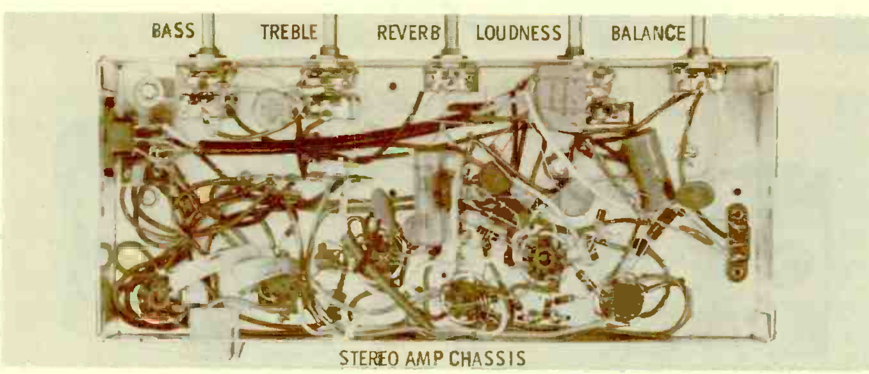
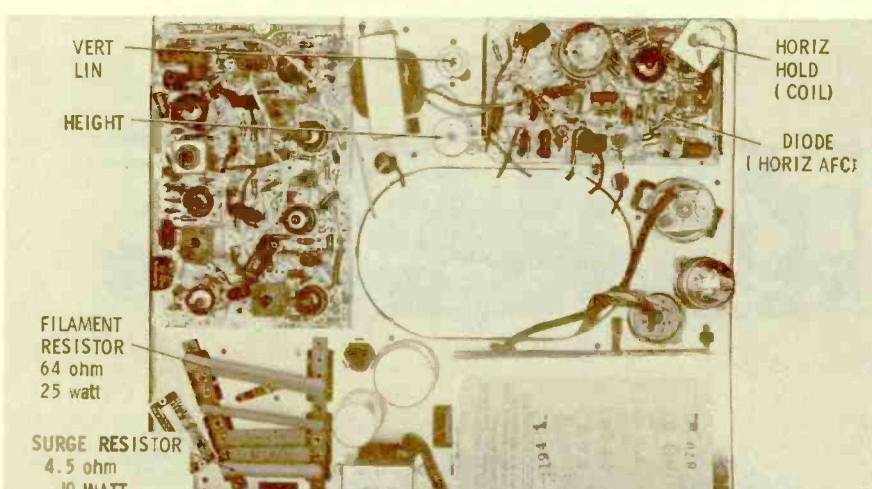








Silvertone Model 21941

TV Chassis 528.51868

Appearing here is one of the newest Silvertone combination models. In addition to a 23" TV chassis, this set contains a FM-AM tuner, a stereo amplifier (with reverberation circuits), and a four-speed phonograph. The mechanical delay unit for reverberation is contained in a separate chassis, mounted on the bottom of the cabinet.

The tubes used for TV operation are mounted on two printed circuit boards, with the exception of the 12DQ6B horizontal output tube, the 12AX4GTB damper, the 1G3GT HV rectifier, and the 90° 23BDP4 picture tube. Also, the majority of the other components are mounted on these boards, including the soldered-in dual diode used for developing horizontal AFC voltage.

A dual selenium rectifier, mounted on the underside of the chassis and wired as a voltage doubler, develops B+ in this receiver. Both a circuit breaker and a 4.5-ohm, 10-watt resistor (surge limiter) provide protection for this circuit. The resistor is soldered in, but you may be able to replace it without pulling the chassis; try clipping out the old component and attaching the new one to the remaining lead stubs.

Each chassis in this set contains its own separate operating controls, but all of the knobs used to operate them are conveniently mounted close to one another in the upper right compartment of the cabinet. Located on the radio chassis is a function selector with which you can choose one of five different modes of operation—phono, AM, FM-AFC, FM stereo multiplex, or TV. Since the amplifier is mounted in the lower section of the cabinet, the operating controls on this chassis (bass, treble, reverb, loudness, and balance) are coupled to their respective knobs via plastic extension shafts.

The width adjustment in this receiver is a metal sleeve inserted between the neck of the picture tube and the yoke. Slide the sleeve in or out to obtain the correct width. Three service controls—vertical linearity, height, and horizontal hold (frequency coil)—are adjustable from the rear of the chassis.

Two 3BZ6's and one 3CB6 are the tube types used in the IF stages. Unlike some Silvertones, this set has a crystal-diode video detector. A 3GS8 (improved version of the 'BU8) functions as the AGC keying, noise limiter, and sync separator tube. The combined vertical multivibrator-output stage uses a 10EM7.

Truetone Model 2DC3250

Chassis 1171-62

This portable TV uses a 114°, aluminized 19XP4 picture tube and comes equipped with a retractable monopole antenna. The tuner is a turret type using a 2GK5 for RF amplification and a 5CG8 for the mixer-oscillator function. VHF/UHF-equipped models are available in this chassis line, or a UHF tuner can be added later if desired. Field conversion involves installing a separate UHF tuner, and adding a UHF switch and channel strip to the existing VHF tuner.

The receiver is a *hot-chassis* type, so use appropriate servicing precautions when working on it. The series-filament dropping resistor is a 35-ohm, 15-watt unit; if it becomes defective, you'll need to pull the chassis before you can replace it.

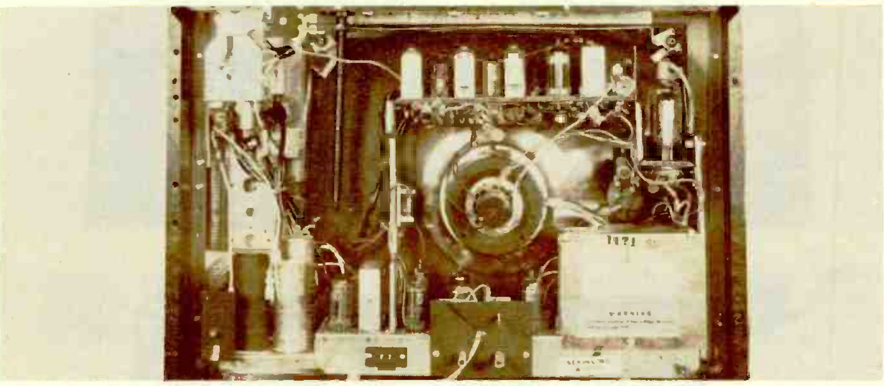
The low voltage is developed by a half-wave doubler circuit using two silicon rectifiers (marked in the photo). A circuit breaker and an 8-ohm, 20-watt resistor provide protection for this circuit. The 12CU5 audio output tube, wired in a DC voltage-dropping circuit, develops the secondary B+ source voltage. (The 270 volts from the main source is dropped to 140 volts.)

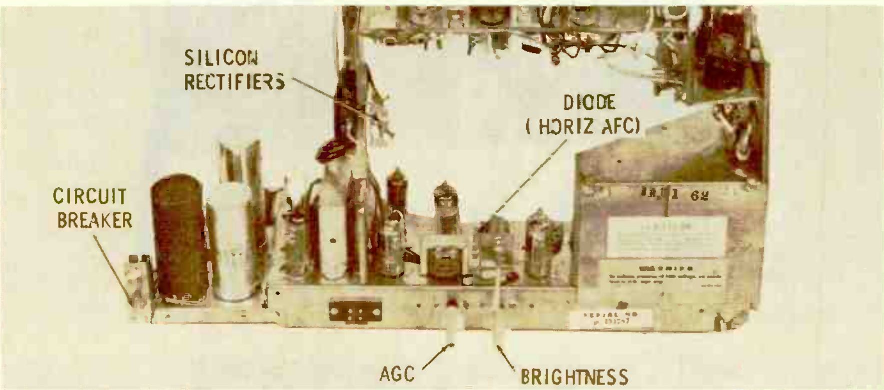
Two 3BZ6's function as the first and second IF amplifiers in this chassis, while the third IF tube is a 3CB6. A crystal-diode video detector is mounted inside the third IF can. To replace it, you must first remove the complete can, then remove the shield.

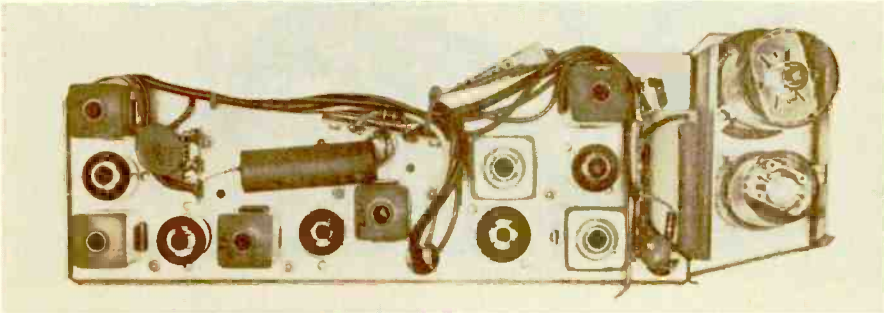
The AFC dual diode, a series type, plugs in on top of the chassis. Two input sync signals are fed to this AFC circuit from one half of a 6CG7, used as a phase inverter. The other half of this tube, operating in conjunction with a 12DT5 output tube, functions as the vertical multivibrator.

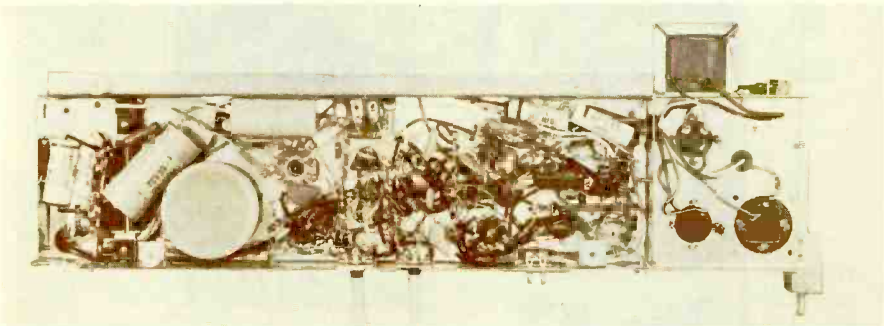
Operating controls for channel selection, fine tuning, on-off-volume, contrast, and vertical hold are mounted on the front control panel. The vertical linearity control is mounted directly behind the contrast control, and the one for height is mounted on the rear of the vertical hold control. The controls for AGC, brightness and horizontal hold (frequency coil) are adjustable from the rear of the chassis.

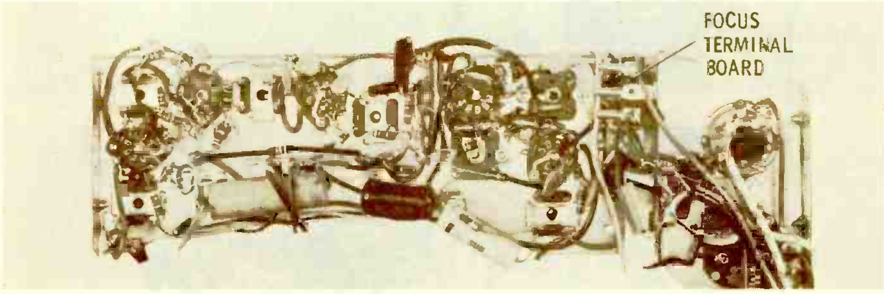
To remove the safety glass for cleaning, remove the front operating knobs, the rear cover, and 16 metal screws on the inside of the cabinet at the front; then remove the speaker leads and the front mask assembly.











See PHOTOFACT Set 590, Folder 2

See PHOTOFACT Set 590, Folder 2

Mfr: Philco **Chassis No.** 12N51

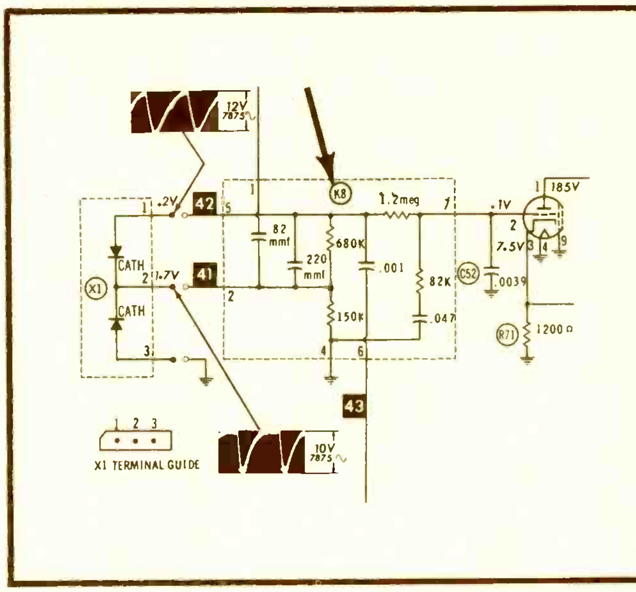
Card No: PH 12N51-1

Section Affected: Raster.

Symptoms: No raster.

Cause: Leaky feedback-coupling capacitor in horizontal AFC circuit, causing blocked grid in first triode section of multivibrator.

What To Do: Replace component-combination unit K8.



Mfr: Philco **Chassis No.** 12N51

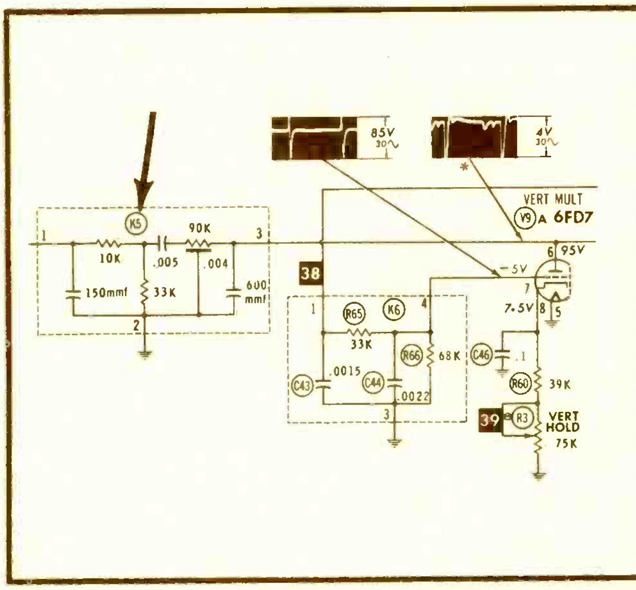
Card No: PH 12N51-2

Section Affected: Raster.

Symptoms: Lack of height; compression at bottom.

Cause: Leaky bypass capacitor in vertical integrator network.

What To Do: Replace integrator (component combination K5).



Mfr: Philco **Chassis No.** 12N51

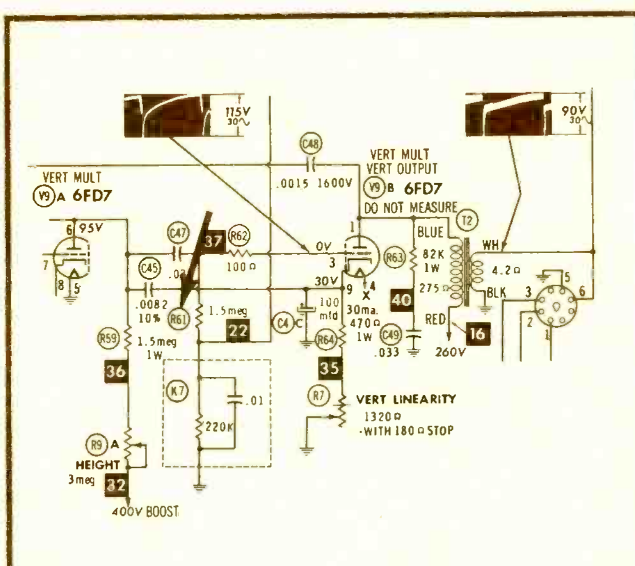
Card No: PH 12N51-3

Section Affected: Raster.

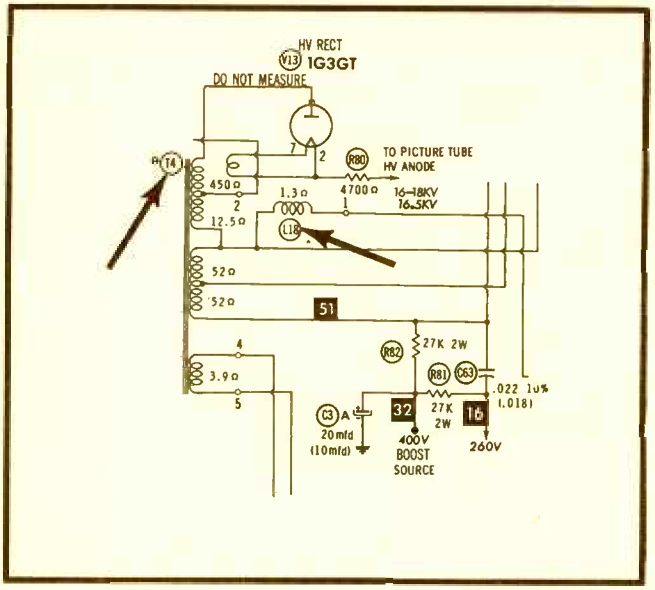
Symptoms: Too much height; controls will not reduce raster to normal vertical size. Abnormally high voltage on plate (pin 6) of V9A (6FD7).

Cause: Plate resistor in first section of vertical multivibrator has decreased in value.

What To Do: Replace R61 (1.5 meg—1W).



See PHOTOFACT Set 590, Folder 2



Mfr: Philco **Chassis No.** 12N51

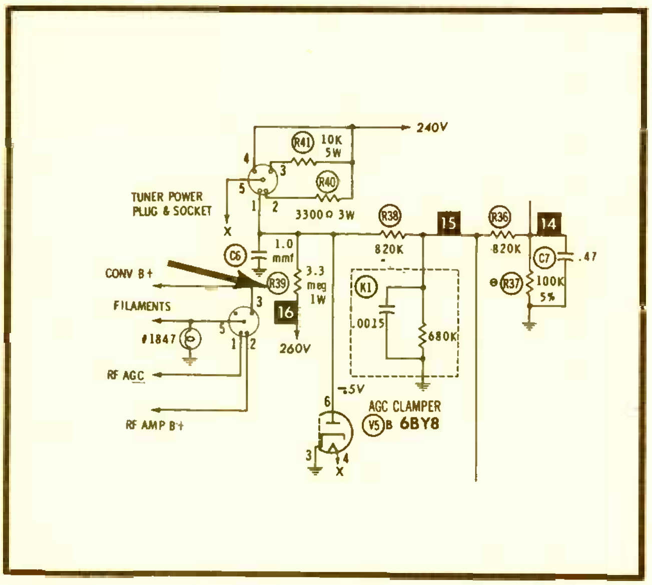
Card No: PH 12N51-4

Section Affected: Sound and pix.

Symptoms: Noise from speaker, flashing in picture, sound of arcing.

Cause: Arcing between plate lead of horizontal output tube and RF choke mounted on flyback transformer.

What To Do: Replace T4, being very careful with lead dress of new transformer.



Mfr: Philco **Chassis No.** 12N51

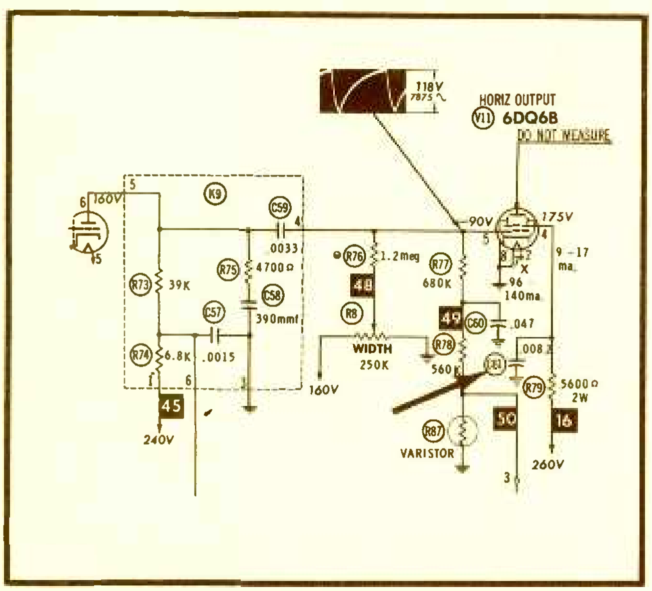
Card No: PH 12N51-5

Section Affected: Pix.

Symptoms: Snowy pictures, even when signal is fairly strong.

Cause: Open delay resistor in RF branch of AGC line.

What To Do: Replace R39 (3.3 meg—1W).



Mfr: Philco **Chassis No.** 12N51

Card No: PH 12N51-6

Section Affected: Raster.

Symptoms: Insufficient width.

Cause: Leaky screen-bypass capacitor in horizontal output stage.

What To Do: Replace C61 (.0082 mfd).

See PHOTOFACT Set 558, Folder 2

Mfr: Westinghouse **Chassis No.** V-2414-1

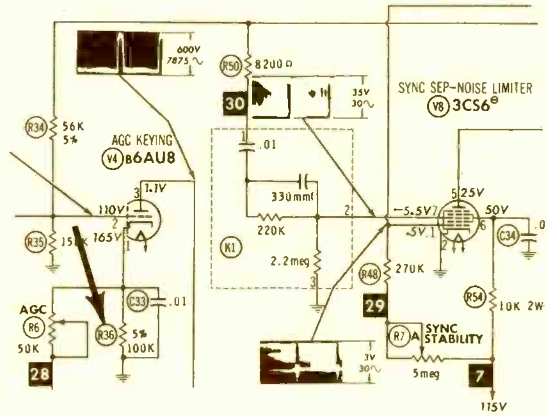
Card No: WE V-2414-1-1

Section Affected: Pix.

Symptoms: Video overload; voltage at cathode (pin 1)) of V4B (6AU8) is too high.

Cause: Cathode resistor in AGC keying circuit has increased in value.

What To Do: Replace R36 (100K).



Mfr: Westinghouse **Chassis No.** V-2414-1

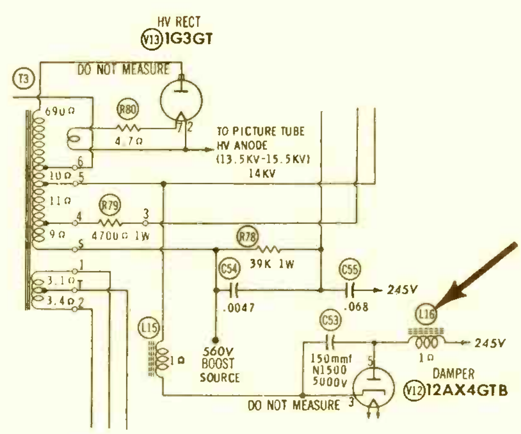
Card No: WE V-2414-1-2

Section Affected: Raster.

Symptoms: No raster; no high voltage.

Cause: Open choke in plate circuit of damper.

What To Do: Replace L16 (14 uh).



Mfr: Westinghouse **Chassis No.** V-2414-1

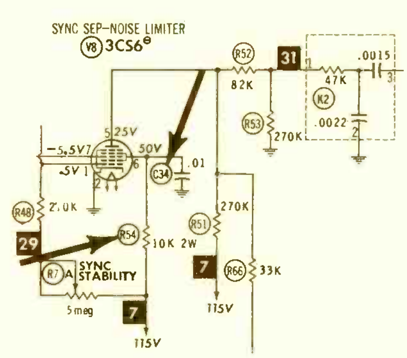
Card No: WE V-2414-1-3

Section Affected: Sync.

Symptoms: No horizontal or vertical hold; zero voltage at screen grid (pin 6) of V8 (3CS6).

Cause: Screen-bypass capacitor shorted; screen resistor burned open.

What To Do: Replace C34 (.01 mfd) and R45 (10K—2W).



See PHOTOFACT Set 558, Folder 2

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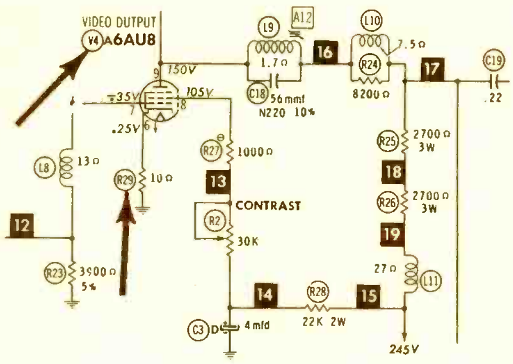


Mfr: Westinghouse **Chassis No.** V-2414-1

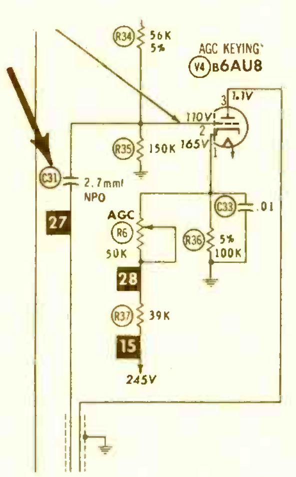
Card No: WE V-2414-1-4

Section Affected: Pix.

Symptoms: Picture flashes off and on; finally disappears altogether.

Cause: Cathode resistor in video output stage overheats and opens.

What To Do: Replace R29 (10 ohms) and check V4A (6AU8) for shorts.



Mfr: Westinghouse **Chassis No.** V-2414-1

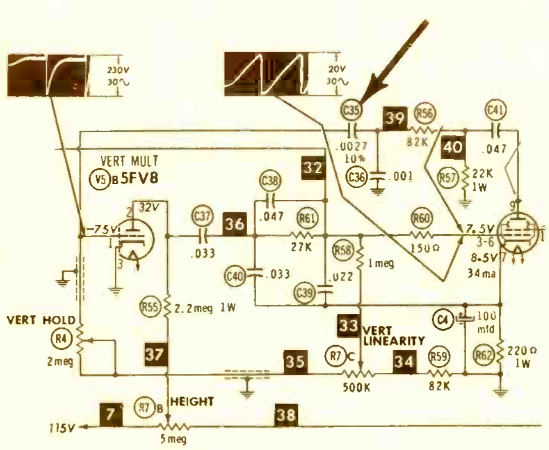
Card No: WE V-2414-1-5

Section Affected: Pix.

Symptoms: Video overload.

Cause: Shorted pulse-coupling capacitor in grid circuit of AGC keying stage.

What To Do: Replace C31 (2.7 mmf, NPO).



Mfr: Westinghouse **Chassis No.** V-2414-1

Card No: WE V-2414-1-6

Section Affected: Sync.

Symptoms: Vertical-multivibrator frequency drifts out of hold-control range.

Cause: Leaky feedback capacitor.

What To Do: Replace C35 (.0027 mfd).

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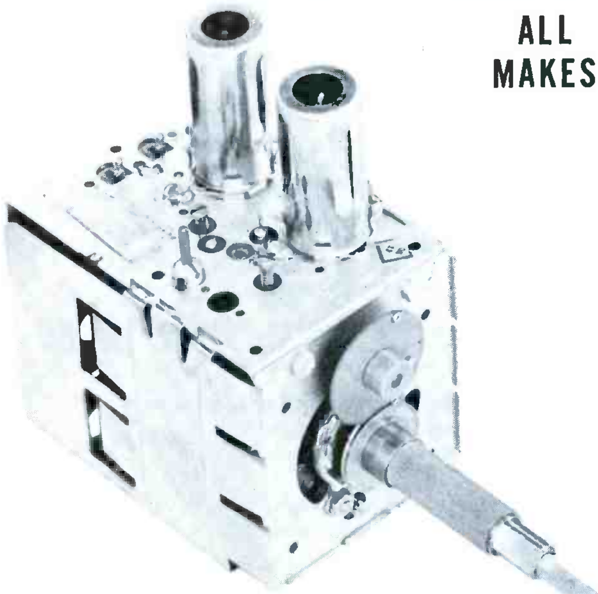

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including **Electronic Servicing**

VOLUME 12, No. 12 — DECEMBER, 1962

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ABOUT THE COVER

Even in a magazine that "lives and breathes" electronics, the time has come again to turn our thoughts away from everyday activities and revive the timeless Christmas message, "Peace on earth, good will toward men." We take this opportunity to wish each of you a Merry Christmas and a Happy New Year.

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Indexed in Lectrodex.
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New Heavy Duty RFI Suppression Kit For Mobile Radio

RADIO HAMS, fleet owners, and CB operators can now enjoy clearer, more readable, less tiring mobile communications at longer effective ranges.

Sprague's new Type SK-1 SUPPRESSIKIT provides effective R-F Interference suppression—at moderate cost—up through 400 megacycles. Designed for easy installation on automobile, truck, or boat engines with either 6-volt or 12-volt generators, the Suppressikit makes possible high frequency interference control by means of Sprague's new, extended range, Thru-pass® capacitors.

The components in the SK-1 Suppressikit are neatly marked and packaged, complete with easy-to-follow installation instructions. All capacitors are especially designed for quick, simple installation.

The generator capacitor is a heavy-duty unit rated at 60 amperes, and will operate at temperatures to 125°C (257°F). This means you'll have no trouble with an SK-1 installation in the terrific temperatures found "under the hood" on a hot summer's day. There's no chance of generator failures from capacitor "short outs," as with general purpose capacitors. The Thru-pass capacitors for use on voltage regulators are also rated at a full 60 amperes.

The Deluxe Suppressikit is furnished complete with an 8-foot shielded lead on the generator capacitor which can be trimmed to necessary length for any car or small truck, preventing R-F radiation from armature and field leads.

Containing only 5 easy-to-install capacitors, the Deluxe Suppressikit is a well-engineered kit. The net price is a little higher than that of many thrown-together kits, but it saves you so much time and aggravation it's well worth the slight extra cost.

For additional information on the Type SK-1 Suppressikit, see your Sprague Electronic Parts Distributor.

65-341 R3

The Moose and The Mice

(A fable for Service Technicians)

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

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

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

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

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

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

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

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

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

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

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

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

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

In today's complex electronics industry, a company must be big! For only bigness—in research, production, and distribution—can bring you the technical services you need. But bigness hasn't gone to our heads. We haven't lost the personal touch that helped us grow. Close attention to your needs is still primary with us.

SPRAGUE®

THE MARK OF RELIABILITY

WORLD'S LARGEST MANUFACTURER OF CAPACITORS

6S-320

LETTERS TO THE EDITOR

Dear Editor:

I'd like to see an article on how to add a transistorized ignition system to my car. Are you planning anything on this subject for the near future?

MICHAEL M. KEIM
Wauwatosa, Wis.

We seldom publish construction articles in PF REPORTER. *Instead, we concentrate on publishing authoritative, practical data on electronic troubleshooting . . . for professionals. In keeping with this, when transistorized ignition systems reach the mass market, we will certainly provide complete, accurate information on how they work and how to service them.—Ed.*

Dear Editor:

To give you an illustration of how badly some customers fear the serviceman's bill, I'll tell you of a recent personal experience. A new customer of mine asked me to fix a portable which he had bought (used) when his console model went bad. After paying a good fee to get the portable repaired, he decided to let me look at the console. A new 1B3, a 5U4, and a CRT brightener made his old set play like new. He could have been enjoying the large set for the several months it had been sitting in the closet — and saved the cost of the portable — if he had only trusted his serviceman and not jumped to his own conclusions.

CHUCK CHRISTENSEN
Jacksonville, Fla.

It just goes to show you!—Ed.

Dear Editor:

I always work the challenging puzzles included in PF REPORTER from time to time. Is there some reason why a puzzle is not shown in every issue?

G. BOSTANY
Colonial TV Service
Brooklyn, N. Y.

Really good, original puzzles are hard to come by. The puzzle for this issue is —know where we can find more of them?—Ed.

Dear Editor:

If Mr. Clyde Wilson Ray hasn't cured the "pops" in his sound system (September, 1962 Troubleshooter—page 80), I may have the answer to his trouble. I cured a similar case by the simple expedient of inserting a 10K-ohm, ½-watt resistor in series with the input lead of the amplifier.

KENNETH B. COBLE
Yucaipa, Calif.

Let's hope Mr. Ray reads this suggestion; in case he still has "pops" trouble, maybe this will help him get it out of his system!—Ed.

Dear Editor:

Here is another HURRAH! for your exceptional insight into the serviceman's needs. I hope PF REPORTER and our other many helpers (PHOTOFACT, Sams books, etc.) continue indefinitely. This note of praise has been prompted by your new approach to service information—*Symfact*. Keep up the good work!

F. R. UPPER
Citrus Heights, Calif.

We're indeed pleased with the continuing enthusiastic reaction to Symfact. *It's right in line with our primary aim of offering our readers help with the everyday, down-to-earth job of servicing electronic equipment.—Ed.*

Dear Editor:

When transporting a television picture tube in my car, I fasten the extra seat belt around the tube. This keeps the tube from sliding off and breaking when I apply my brakes.

NATHAN NUTKOWITZ
Philadelphia, Pa.

Sounds okay, except that CRT's are sometimes pretty slick. Why not leave it in the carton, fasten the belt around that, and be safer yet?—Ed.

Moving to a New Location?

If so, notify us by the 15th of the month to assure uninterrupted delivery of PF REPORTER.

Please be sure to give us both your old and new address, including your postal zone number. (Or better yet, enclose a current mailing label with your new address.)

Send to:
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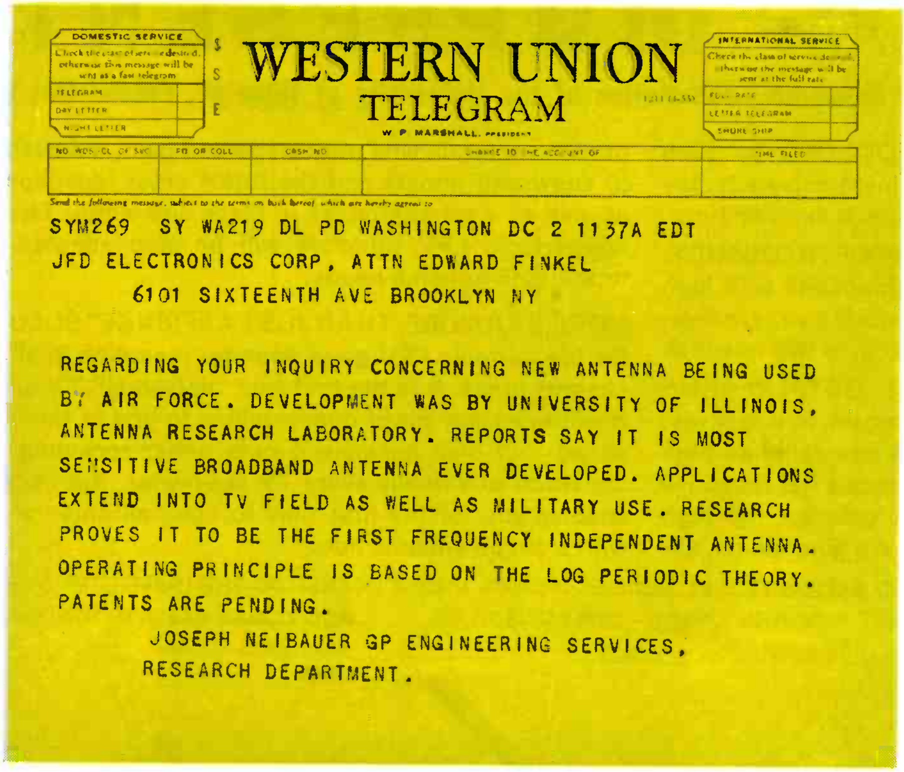
Indianapolis 6, Ind.



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JFD ELECTRONICS CORP, ATTN EDWARD FINKEL

6101 SIXTEENTH AVE BROOKLYN NY

REGARDING YOUR INQUIRY CONCERNING NEW ANTENNA BEING USED BY AIR FORCE. DEVELOPMENT WAS BY UNIVERSITY OF ILLINOIS, ANTENNA RESEARCH LABORATORY. REPORTS SAY IT IS MOST SENSITIVE BROADBAND ANTENNA EVER DEVELOPED. APPLICATIONS EXTEND INTO TV FIELD AS WELL AS MILITARY USE. RESEARCH PROVES IT TO BE THE FIRST FREQUENCY INDEPENDENT ANTENNA. OPERATING PRINCIPLE IS BASED ON THE LOG PERIODIC THEORY. PATENTS ARE PENDING.

JOSEPH NEIBAUER GP ENGINEERING SERVICES, RESEARCH DEPARTMENT.

FROM THIS BEGINNING... A NEW ULTIMATE IN TV ANTENNA DESIGN

It was in 1954 that word came out of Urbana, Illinois—the Antenna Research Laboratory of the University of Illinois had "broken through" the bandwidth problem with the log-periodic principle.

Professor Mayes and JFD's Ed Finkel discuss the LPV

The implications were profound: an antenna that would be essentially frequency-independent, that would set new standards in gain, in bandpass, in front-to-back ratio, that would have an "unidirectional pattern with a directivity comparable to a Yagi array" over bandwidths in excess of 20 to 1.

The Air Force began to apply this new concept to its critical outerspace telemetering needs—and, in 1961, JFD Electronics and the University began discussing home-television applications.

When JFD was granted the exclusive rights to develop, produce and market the TV antennas based on this principle, the resources of the world's largest antenna manufacturer were galvanized into action. A special force of engineers and researchers went to work. A succession of working models began to appear atop the 135-foot tower of the JFD Antenna Research and Development Center. Exhaustive tests were undertaken, modifications and refinements made, construction details explored.

Now, as a climax to some eight years of study and development, the first of the log-periodic V antennas is here—fulfilling every promise and presaging a revolution in TV antenna design and performance.

Professor Mayes at antenna research laboratory

University of Illinois Develops Space Age Antenna

The theoretical formulation and extensive research which led to the final development of the LPV antenna was a cooperative effort by several outstanding antenna scientists at the Antenna Research Laboratory of the University of Illinois.

Early recognition of the high caliber and originality of these scientists came from the Air Force which awarded several R & D contracts to the University.

Dr. V. H. Rumsey, who headed the Antenna Research Laboratory from 1954 to 1957, directed a large portion of its efforts towards the quest for frequency independence. Professor Rumsey suggested that a logarithmic spiral of infinite length might have characteristics independent of the frequency of operation. Further research by Professors R. H. DuHamel John D. Dyson, and D. E. Isbell established this theory and also led to the development of a series of finite size antennas which exhibited constant pattern and impedance characteristics independent of frequency over a wide range of frequencies.

The importance of this work soon became obvious with the massive effort devoted by the government to space communications and telemetry. The satellite "Transit" used a modified logarithmic spiral to communicate with our tracking stations from 50 to 400 mc.

In 1957 Professor DuHamel built the first planar Log-Periodic antenna. This was followed in 1959 by Isbell's uniplanar Log-Periodic dipole array. For the next two years, exhaustive tests at the Antenna Research Laboratory were aimed at establishing the properties of the Log-Periodic. It was during this period that Doctors Paul Mayes and R. L. Carrel made their many contributions to the understanding of these antennas and jointly hit upon the V configuration of the dipoles. Tests indicated that this extended the antenna's high directivity from the lowest frequencies covered to the highest.

Professor Mayes subsequently made some modifications in the LPV design so as to make it more suitable for UHF and VHF television coverage.

Revolution in the Air: JFD PRESENTS

Initially Developed by the Antenna Research Laboratories of the University of Illinois*, Proved-Out in Air

IT COULD ONLY HAVE BEEN PRODUCED by such massed resources as those of a prominent university, the military, and the country's leading antenna manufacturer.

BECAUSE ITS GAIN IS INDEPENDENT OF FREQUENCY, the backward-wave log-periodic LPV functions with high efficiency across the entire band. This end-fire array is comparable on any channel to a tuned Yagi cut to that channel.

ON VIRTUALLY EVERY COUNT, IT OUTPERFORMS PREVIOUS WIDE-BAND ARRAYS: in gain, in directivity, in bandwidth, in front-to-back ratio. It has gains as high as 14 db. in the 17-element model. It shows flat response across both TV bands—with greater gain on the high band, where it's needed most. Result: An all-channel, all-purpose antenna with unprecedented gain, a decisive end to snow and ghosts and the truest color reception yet—as well as vivid sharpness in black and white. The basic log-periodic LPV principle will be also adapted to all future UHF antenna needs.

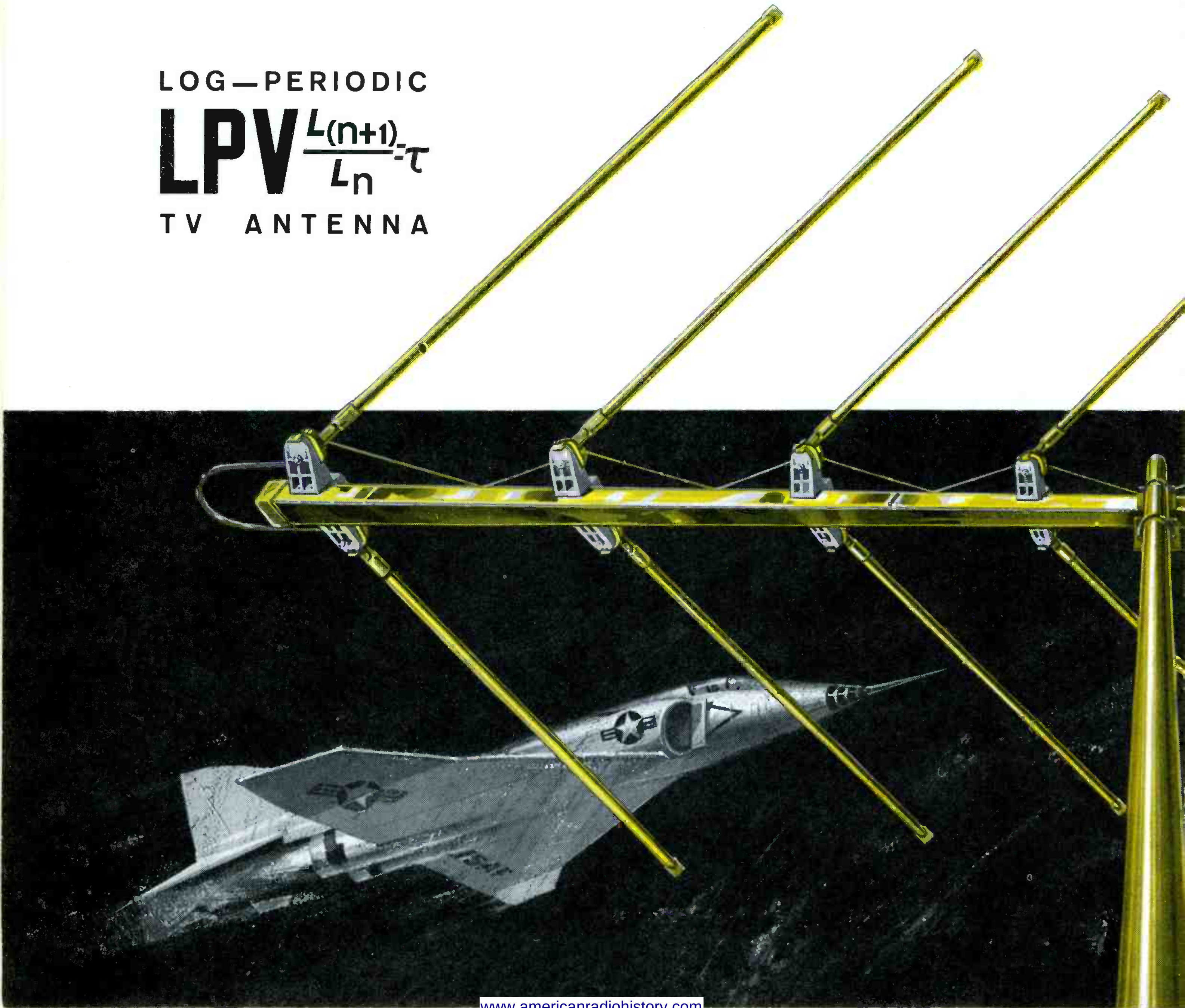
MORE, FAR MORE, THAN JUST A "FRINGE" SOLUTION, the log-periodic LPV gives superior reception in all multi-channel areas. It is the first true "universal" TV antenna. It will open key profit opportunities to you in the months ahead—not only because it puts better reception within the reach of virtually every TV set-owner, but because it enables you for the first time to meet all antenna needs with a single antenna line.

*PRODUCED EXCLUSIVELY BY JFD ELECTRONICS UNDER LICENSE TO THE UNIVERSITY OF ILLINOIS
U.S. PATENT NUMBERS 2,958,081—2,985,879—3,011,168 ADDITIONAL PATENTS PENDING

LOG—PERIODIC

LPV $\frac{L_{(n+1)}}{L_n} = \tau$

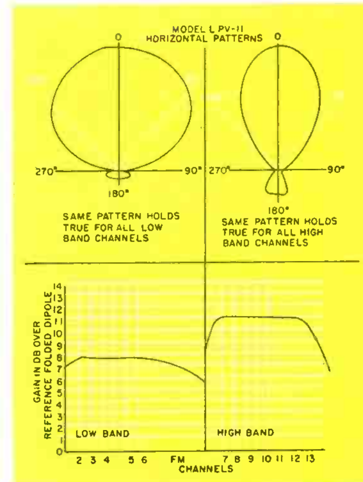
TV ANTENNA



THE LOG-PERIODIC LPV

Force Satellite Telemetry, Adapted to TV by JFD—Ending the "Era of Compromise" in TV Antenna Design

NOT A "CATCH-ALL COMPROMISE"—the log-periodic LPV signals a halt to the endless piling-on of narrow-band elements and parasitics. It is essentially frequency-independent since it is derived from an antenna geometry that repeats the electrical properties of the basic element, or cell, periodically; the periodicity being proportional to the logarithm of the frequency. (Actually, the basic log-periodic design is capable of flat response over a frequency range as broad as 20 to 1.)



BASED ON PRINCIPLES DESIGNED TO MEET RIGOROUS AIR FORCE PERFORMANCE STANDARDS—built to uncompromising JFD specifications—of AAA† Gold Bond Alodized aircraft aluminum for enduring good looks.

100% PREASSEMBLED FLIP-QUIK CONSTRUCTION—with new "tank-turret" aluminum brackets that align and double lock the elements instantly and permanently in place.

RECEIVES STEREO FM, TOO—delivers drift- and distortion-free FM stereo.

SEE THE LOG-PERIODIC LPV AT YOUR JFD DISTRIBUTOR—study the performance figures—try it—see for yourself how the LPV towers over all other broad-line antennas.

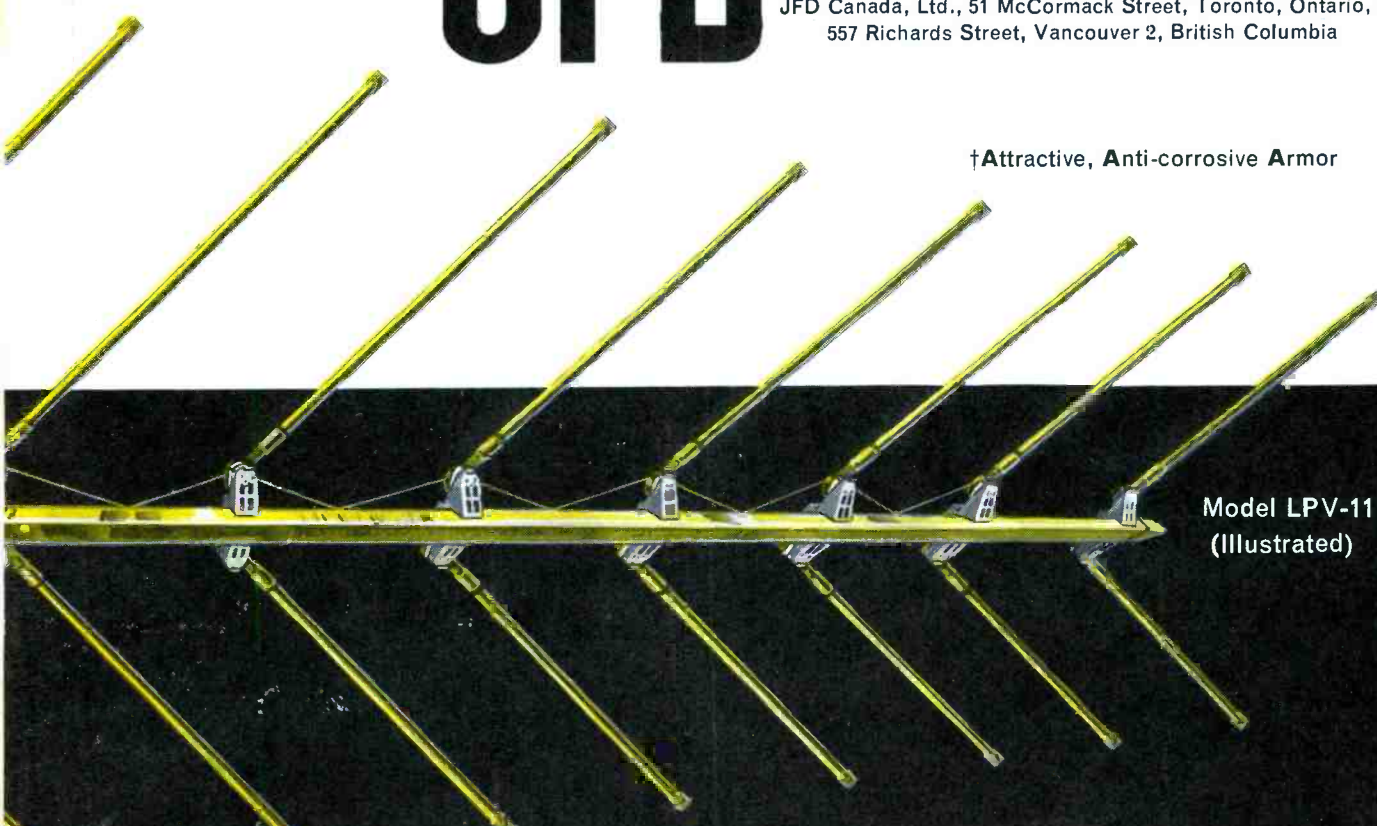
JFD

THE BRAND THAT PUTS YOU IN COMMAND OF THE MARKET

JFD ELECTRONICS CORPORATION
6101 Sixteenth Avenue, Brooklyn 4, N.Y.

JFD Electronics-Southern Inc., Oxford, North Carolina
JFD International, 15 Moore Street, New York, N.Y.
JFD Canada, Ltd., 51 McCormack Street, Toronto, Ontario, Canada
557 Richards Street, Vancouver 2, British Columbia

†Attractive, Anti-corrosive Armor



Model LPV-11 (Illustrated)

ONE BASIC CONFIGURATION SATISFIES ALL NEEDS:
Harmonically resonant V-elements operating on the Log-Periodic Cellular Principle in the Fundamental and Third Harmonic Modes:

LPV-4: 4 Active Cells—up to 50 miles

LPV-6: 6 Active Cells—up to 75 miles

LPV-8: 7 Active Cells and 1 director—up to 100 miles

LPV-11: 9 Active Cells and 2 directors—up to 125 miles

LPV-14: 13 Active Cells and 1 director—up to 150 miles

LPV-17: 15 Active Cells and 2 directors—up to 175 miles

use it for SILVER SCREEN 85® tubes...

(10 "Universal" types meet half of all renewal needs)

SILVER SCREEN 85

The "Big 10" Tubes that fill 52% of all renewal needs:

21CBP42 } 20% } 40% } 52%
21ZP4B
21ACP4A
21YP4A
21AUP4A
24AEP4
21DEP4A
21DFP4
21EP4B
21FP4C

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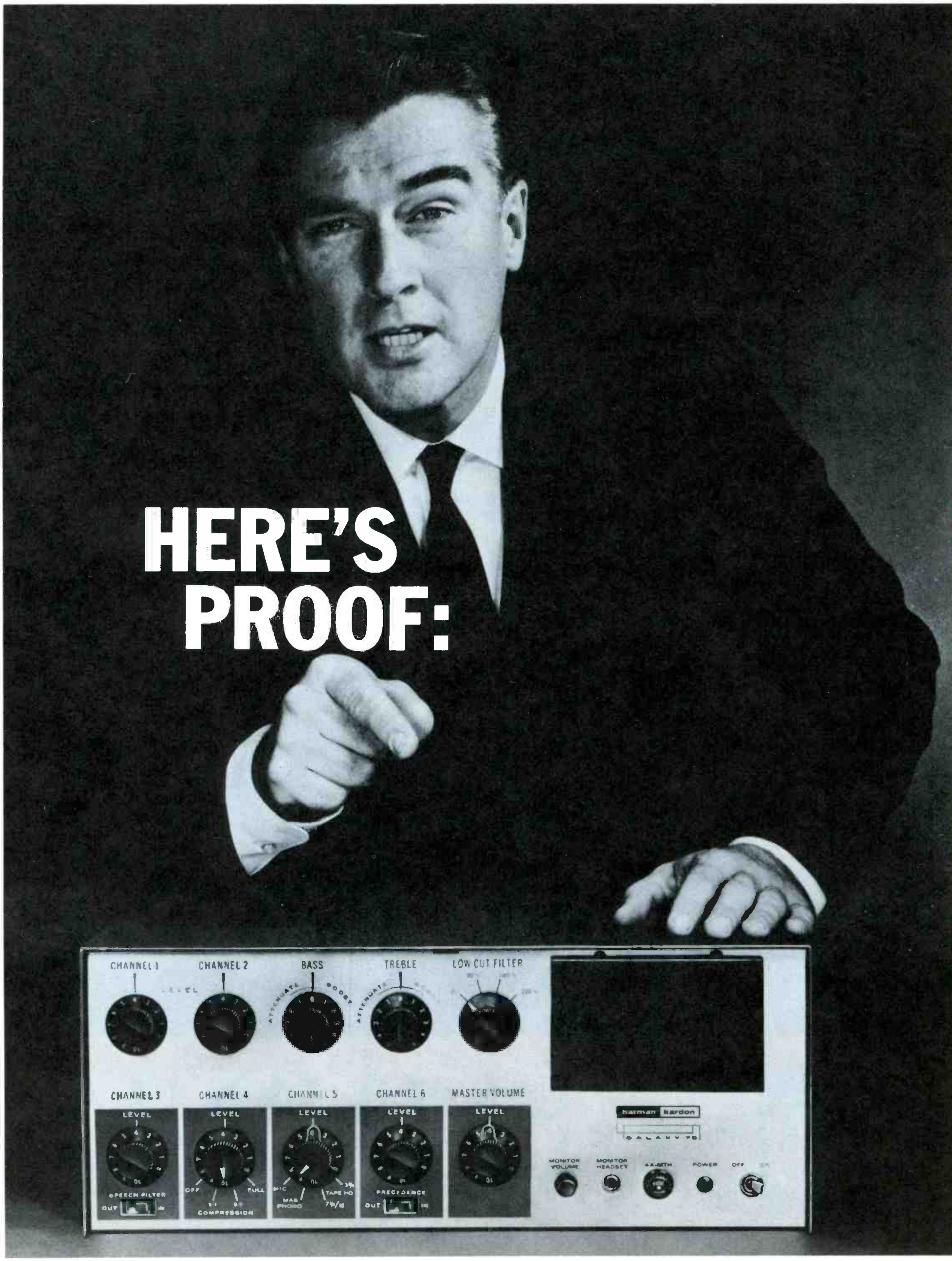
GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM


HERE'S PROOF:
CHANNEL 1
CHANNEL 2
BASS
TREBLE
LOW CUT FILTER
CHANNEL 3
CHANNEL 4
CHANNEL 6
MASTER VOLUME
SPEECH FILTER
COMPRESSION
PRECEDENCE
harman kardon
MONITOR VOLUME
MONITOR HEADSET
POWER

HARMAN-KARDON GALAXY SERIES handles more sound jobs, large or small, easier and at less cost than any other packaged public address amplifier!

■ You select exactly the number of channels, types of inputs and the power you require to fit each job! **You buy only what you need, use what you buy . . . never any waste!**

■ Expand or modify a system, anytime, with simple modules that install in minutes. Regardless of whether it's channels, inputs or power! **System never obsoletes!**

■ Apply compression or full limiting to any desired channel, on any kind of program source. Or, alternately, apply limiting action to the entire program mix. **Eliminate complaints about sound being too loud or too low; reduce the number of microphones and channels needed to achieve group coverage; prevents sound output exceeding point of feedback howl.**

■ Introduce beep, warble or continuous tones—all three if you wish—to signal time periods, fire, forced or unauthorized entry, occurrence of any disaster or emergency . . . even to signal rain, temperature, water level or other possibly significant conditions. And you can introduce these signals manually, or remotely and automatically . . . even if the amplifier is turned off! **Now a sound system can more than earn its keep by doubling as an operation and safety aid.**

■ Employ "precedence" mode of operation, with local manual switch or remotely and automatically; complete cut-out of unwanted signal or any blend of the normal and precedence signals. **Now you can have all-call, emergency messages, tone signals, periodic sales messages, etc. . . . as an integral part of the regular sound system.**

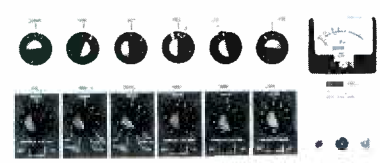
■ Monitor headset jack and monitor volume control . . . plus space and facilities on the front panel for plug-in monitor speaker or VU meter. **Takes the guesswork out of system adjustments; detects and isolates program problems quickly.**

■ Complete remote control facilities are provided . . . for control of program levels, putting the system on "standby" or turning the system on and off. **Place the equipment where it ought to be, control the system from where it's most convenient.**

■ **Professional performance, quality and construction throughout.** Power ratings are given at 1% T.H.D.—the industry practice for packaged amplifiers is **twice** this distortion. Power band-width, hum and noise level and regulation are exceptional . . . as good as you might expect from "high fidelity" amplifiers. Parts are conservatively operated; tubes are run well within manufacturers' tolerances for greatest reliability and life.

■ **Plus many other special operating and installation advantages, such as:** output to a tape recorder, independent of tone and master volume controls; four position Lo Cut Filter; bridging In-Out connections; on-chassis sockets for plug-in low impedance mike and line input transformers, phono and tape equalizers; both balanced and unbalanced 25V and 70V constant voltage outputs; choice of flush-panel, cage or rack-mounting facilities . . . and numerous other features.

POWER BOOSTERS—available covering the range from 40 to 200 watt performance.



PREAMPLIFIER-MIXER—accommodates up to 8 channels; includes VU Meter, line amplifier and power supply.

REAR VIEW 40-50 WATT GALAXY—note modular construction and arrangements of inputs. Other models: 75-85 watt and 150-200 watt output power.

HK-92

AND DOLLARS-PER-WATT PRICES THAT DEFY COMPETITION! No matter how small or how big the sound system you contemplate, you owe it to yourself to investigate the Harman-Kardon GALAXY Series before you buy. Use the coupon to get Free "Sound Headquarters" Decal that helps identify you as a source of quality sound equipment . . . plus all the facts on GALAXY!

HARMAN-KARDON INC. Commercial Sound Division
55 Ames Court, Plainview, L.I., N.Y. DESK H-12

Please send literature on the GALAXY Series immediately.

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2. Duesenberg Kit JTT 36384
3. Mr. Machine JTT 48447
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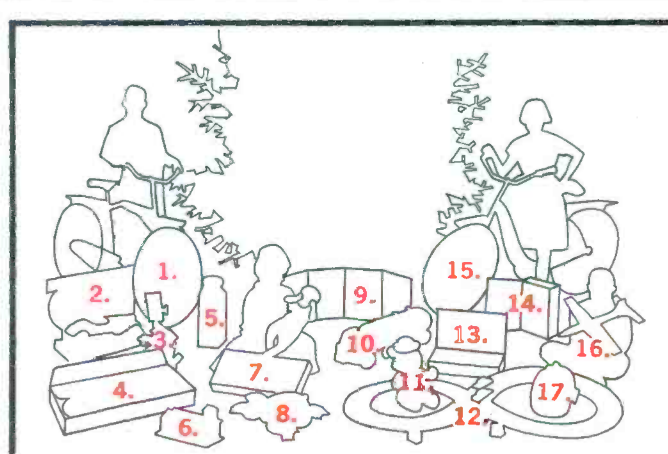
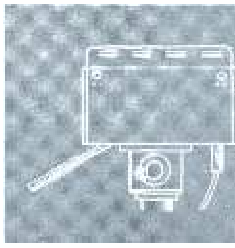
5. Rocket Launcher Erector Set JTT 10202
6. Counting School House JTT 30973
7. Crying Thumbelina Doll JTT 05157
8. Zipper Frog JTT 71050
9. Chemistry Lab JTT 12152
10. Jumbo Gasoline Truck JTT 41277
11. Smokey The Bear JTT 78667
12. Auto-Rama Speedway Set JTT 19083
13. Engineer's Erector Set JTT 10172
14. Electric Metal Zoom Microscope and Lab JTT 13099
15. Roadmaster Girl's Bicycle JTT 1685
16. American Flyer Sky Streak 7 JTT 40006
17. Astronaut Helmet JTT 42028



It's RCA's way of wishing you and your entire family a Merry Christmas!

The Electronic Scanner



More Descriptive Name

Because of the broad range of products it makes for home, office, industry, and defense use, Bogen-Presto Division of Lear Siegler, Inc., has changed its name to **Bogen Communications Division.** Located in Paramus, N. J., the division produces public-address systems, intercoms, paging systems, high-fidelity tuners, amplifiers and turntables, as well as professional recording equipment and commercial sound distribution systems.

"Roly Poly" Service Dealer (Toy)

An opportunity to boost independent service is offered, in the form of an inflatable plastic "Roly Poly" toy, by **General Electric.** Bearing the name "Independent TV Service Dealer," this 28" toy can be used as a store display and for consumer sales promotion. Made of heavy-gauge vinyl, it is available to service dealers for $1.65 from G-E tube distributors.

New Name for Paint Manufacturer

Servicemen who use spray chemicals and paints made by Sargent-Gerke will find the company referred to in the future as the **Sargent Paint Mfg. Co.** To help establish positive consumer identification of the new company, both the name and the identifying trade mark have been changed.

27" Bonded-Shield CRT Announced

The Electronic Tube Division of **Sylvania Electric Products, Inc.** is producing two new 27" CRT's, both featuring bonded faceplates. The 27ADP4 (110°) and 27ACP4 (90°) both have rectangular screens and a spherical face, are magnetically deflected, and include an aluminized screen, electrostatic focusing, and an external conductive coating.

Pricing Your Services for a Profit

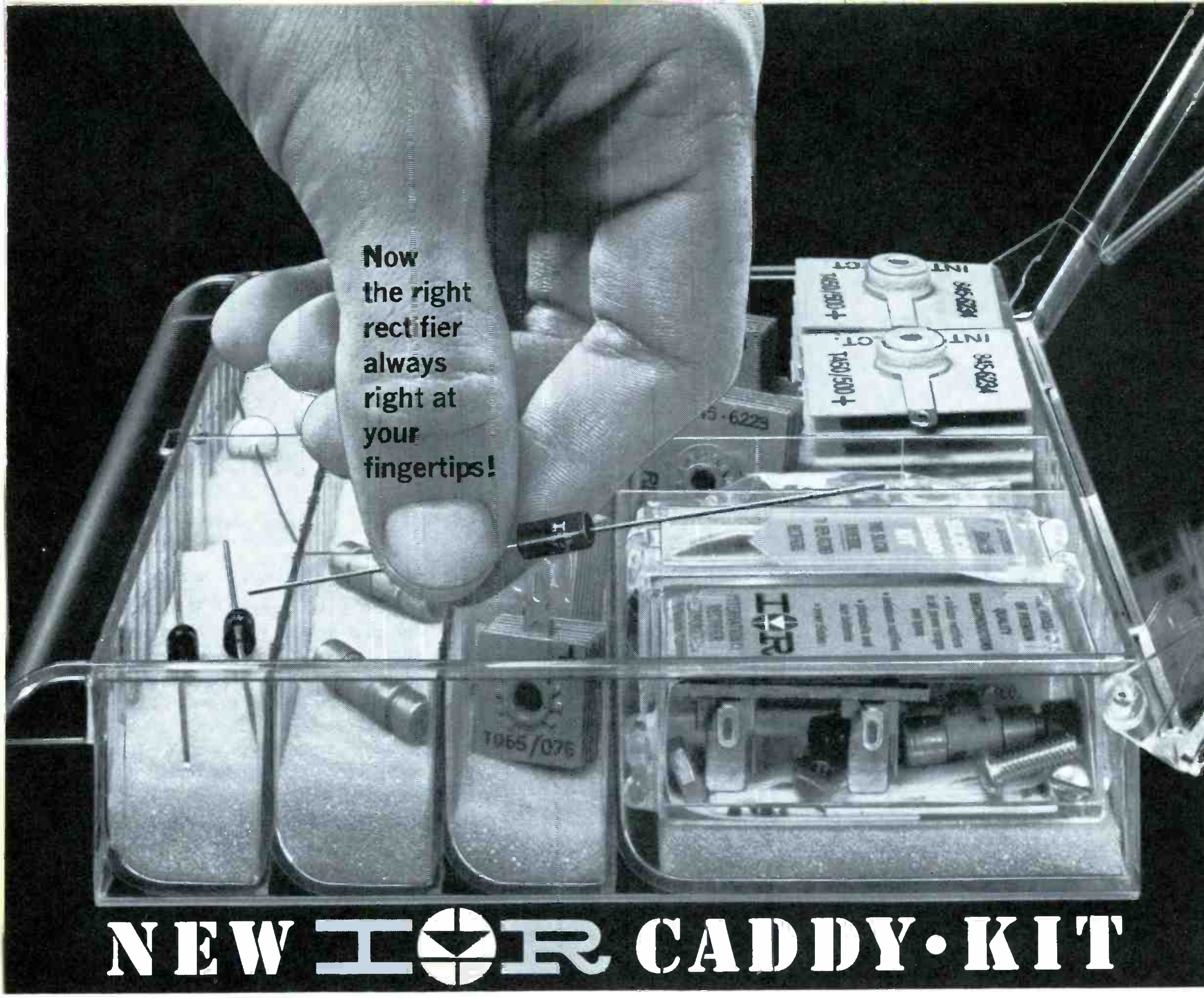
A professionally recorded tape and a set of 36 color slides are included in a new **Howard W. Sams** lecture series designed to show servicemen the way to greater profit by pricing their services properly. Distributors can borrow a "package" for a group meeting by contacting Tom Surber at Howard W. Sams & Co. Inc., 4300 W. 62nd St., Indianapolis 6, Ind. In addition to the tapes and slides, a printed handout piece is included for each person in attendance.

Ball-Point Pen Special

A ball-point desk-pen set is currently being offered with each package of 12 "Vu-Brite" television tube brighteners by **Perma-Power Co.** The special promotion, according to the company, "gives the service dealer an incentive for buying in quantity, and is our way of saying thanks for his choice of our brand."

"QT" Helps Keep Parts Moving

A unique, new inventory program called "Quick Turnover" (QT) has been announced by **RCA Parts and Accessories Div.** The new plan is designed to speed parts handling while reducing the inventory necessary for each distributor. This arrangement promises to increase the availability of products for the service dealer, and reduce costs all around, says the firm.



SAVES YOU $3.22 ON ALL RECTIFIERS YOU REPLACE IN THE FIELD (plus this $1.50 divider-case free!)

For the first time . . . the right rectifier right at your fingertips! No job time lost on service-calls to stop and shop for a needed rectifier replacement. And now, you also save $3.22 on 16 IR rectifiers and kits — 10 types you use most often for repairing color and black & white TV, radios, hi-fi, phonographs, tape recorders, citizen band and 2-way radio equipment, etc. Regularly $18.17 . . . but, for a limited time, the price is $14.95. Clear, divided carrying case is your extra free bonus!

INTERNATIONAL RECTIFIER

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SYMBOL OF QUALITY IN SEMICONDUCTORS

NEW IR RECTIFIER AND DIODE BENCH-CABINET

Save $3.15 on all rectifiers and diodes for servicing TV, radio, hi-fi, etc. . . . plus get a permanent cabinet (a $3.50 value) free!

31 widely-used rectifiers, germanium and dual diodes
Regularly . . . $28.10
Free 4 drawer bench cabinet
Valued at . . . $ 3.50
Total value . . $31.60
SPECIAL PRICE $24.95
TOTAL SAVINGS . . . . $ 6.65

HURRY! THIS OFFER AVAILABLE NOW AT MORE THAN 500 IR SERVICE PARTS DISTRIBUTORS! VALUE ENDS FEB. 15, 1963!

STEREO FM REPORT

How great a success is multiplex stereocasting?—by Forest H. Belt

In the December, 1961 PF REPORTER, "Stereo FM and the Serviceman" pointed out how stereo FM would affect technicians, and explained the compatible transmission system in considerable detail. The August Special Antenna issue then gave an analysis of antennas for use with stereo FM. Now, more than a year after the introduction of stereo FM, it is time to recapitulate and analyze the impact of this new medium on the broadcaster, the set maker, the listener, and the serviceman.

Stereo FM Broadcasting

The spread of stereo FM broadcasting, while not exactly spectacular, is most gratifying to those interested in its development. Almost 300 stations in the country—mostly in areas of heaviest population—have added the necessary facilities. Outside these metropolitan centers, stereo-equipped stations are few and far between. California, with a strong concentration of FM stations, leads the way in stereo, too, with 27 outlets—as shown in Table I. Ohio and Pennsylvania take second-place honors, each with 19 stereo FM stations comprising a fair percentage of their total number of FM stations.

Over the nation, between 20% and 25% of present FM stations can also handle stereo broadcasts. That's a pretty good percentage, and quite a few more have indicated they intend to add stereocasting. Strangely enough, it appears more activity in stereo FM is being displayed by independent stations than by those operated by, or affiliated with, major networks.

Table I — FM Stations By State

	Total	Stereo		Total	Stereo
Ala.	20	11	Mo.	25	5
Alaska	2		Mont.	0	0
Ariz.	14		Nebr.	9	3
Ark.	9		Nev.	2	
Calif.	145	27	N.C.	52	10
Colo.	15	6	N.D.	0	0
Conn.	19	7	N.H.	4	1
Del.	3		N.J.	23	6
D.C.	11	3	N.M.	7	4
Fla.	35	12	N.Y.	79	17
Ga.	19	4	Ohio	85	19
Hawaii	4	1	Okla.	15	5
Idaho	4	1	Ore.	17	4
Ill.	64	11	Pa.	74	19
Ind.	46	7	R.I.	9	2
Iowa	17	2	S.C.	14	2
Kan.	13	3	S.D.	0	0
Ky.	20	3	Tenn.	19	5
La.	9	1	Tex.	64	15
Maine	9	4	Utah	6	2
Md.	22	6	Vt.	0	0
Mass.	39	7	Va.	32	9
Mich.	44	8	Wash.	26	9
Minn.	12	4	W. Va.	10	6
Miss.	3		Wis.	43	13
			Wyo.	0	0

Equipment and Facilities

One contribution to the success of stereo FM is the fact that the station equipment is little more expensive than that used for standard FM broadcasting. Many stations which have a good, wide-band, linear transmitter need only to add a subcarrier generator and balanced modulator.

Stations that plan to initiate "live" stereo FM broadcasts from their studio facilities will have considerable expense in remodeling and rewiring. Naturally, each channel must be carefully balanced all the way to the subcarrier modulator, for true stereo reproduction. For this reason, many stations make little provision in their studios for stereo, except possibly to arrange for switching announcers' mikes from one channel to the other; stereocasts consist mainly of stereo tape and disc recordings.

For the transmitter, the most important requirement is that the bandwidth of the final RF amplifiers be broad enough to handle sideband pairs all the way to 53 kc

SENCORE
SIMPLIFIES COLOR SERVICING

NEW! CA122
COLOR CIRCUIT ANALYZER

A simple approach to a complex problem

Here is an instrument that is designed to eliminate the guesswork in color TV servicing. A complete analyzer that provides all required test patterns and signals for testing from the tuner to the tri-color tube. Additional analyzing signals for injection at each stage including audio, video and sync, brings to life a truly portable and practical TV analyzer for on the spot service; virtually obsoleting other analyzers with the advent of color. Sencore's simplified approach requires no knowledge of I, Q, R-Y, B-Y, G-Y or other hard to remember formulas. The CA122 generates every signal normally received from the TV station plus convergence and color test patterns.

The CA122 offers more for less money:

TEN STANDARD COLOR BARS: The type and phase that is fast becoming the standard of the industry. Crystal controlled keyed bars, (RCA type) as explained in most service literature, offer a complete gamut of colors for every color circuit test.

WHITE DOTS: New stabilized dots, a must for convergence, are created by new Sencore counting circuits.

CROSS HATCH PATTERN: A basic requirement for fast CRT convergence.

VERTICAL AND HORIZONTAL BARS: An added feature to speed up convergence, not found on many other color generators.

SHADING BARS: Determines the ability of the video amplifier to produce shades (Y Signal) and to make color temperature adjustments. An important feature missing on other generators.

COLOR GUN INTERRUPTOR: For fast purity and convergence checks without upsetting color controls. Insures proper operation of tri-color guns, preventing wasted time in trouble shooting circuits when CRT is at fault.

A must for color . . .

a money maker for black and white TV servicing

ANALYZING SIGNALS: RF and IF signals modulated with any of the above patterns for injection into grid circuits from antenna to detector. IF attenuator is pre-set for minimum signal for each IF stage to produce pattern on CRT thus providing a check on individual stage gain. Sync and video, plus or minus from 0 to 30 volts peak to peak, have separate peak to peak calibrated controls for quick checks on all video and sync circuits. Crystal controlled 4.5 mc and 900 cycles audio simplify trouble shooting of audio circuits.

NEW ILLUMINATED PATTERN INDICATOR: A Sencore first, offering a rotating color film that exhibits the actual color patterns as they appear on color TV receivers. Locks in with pattern selector control.

You'll pay more for other color generators only.

Dealer Net **187.50**

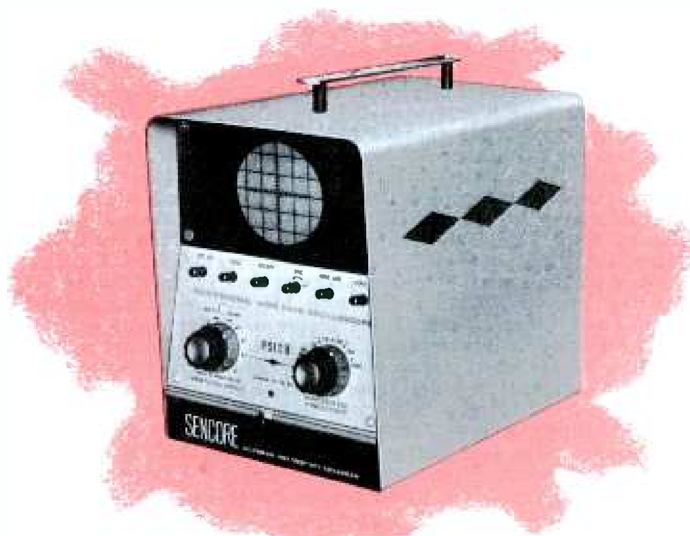
NEW! PS120 PROFESSIONAL WIDE BAND OSCILLOSCOPE

A portable wide band 3 inch oscilloscope for fast, on-the-spot testing. An all new simplified design brings new meaning to the word portability . . . it's as easy to operate and carry as a VTVM. Though compact in size, the PS120 is powerful in performance: Vertical amplifier frequency response of 4 MC flat, only 3 DB down at 7.5 MC and usable to 12 MC, equips the technician for every color servicing job and the engineer with a scope for field and production line testing. AC coupled, with a low frequency response of 20 cycles insure accurate low frequency measurements without vertical bounce. Sensitive single band vertical amplifier; sensitivity of .035 volts RMS for one inch deflection saves band switching and guessing. Horizontal sweep frequency range of 15 cycles to 150 KC and sync range from 15 cycles to 8 MC (usable to 12 MC) results in positive "locking" on all signals. New exclusive Sencore features are direct reading peak-to-peak volts —no interpretation; dual controls to simplify tuning; lead compartment to conceal test leads, jacks and seldom used switches. Rear tilt adjustment angles scope "just right" for easy viewing on bench or production line.

Size: 7"w x 9"h x 11¼"d. Weight: 12 lbs.

Dealer Net **124.50**
(with low cap. probe)

Kit **74.50**



A must for servicing color TV in the home . . . lowest priced broad band scope. All hand wired — all American made

SENCORE

SIMPLIFIES SWEEP CIRCUIT TROUBLE SHOOTING

SS117
SWEEP CIRCUIT ANALYZER

For Color and Monochrome Testing

A professional trouble shooter that helps you methodically walk the trouble out of "tough-dog" sweep circuits in monochrome and color receivers. The SS117 provides a positive but simple push button test on all circuits indicated in the block diagrams. These time-consuming circuits are checked step-by-step with tried and proven signal injection and substitution methods. All checks can be made from the top of the chassis or from under the chassis when it is removed from the cabinet.

TV horizontal oscillator check is made by substituting a universal oscillator known to be good. Horizontal output check consists of a cathode current and screen voltage test. The TV horizontal yoke is checked by substituting a universal yoke from the SS117 and viewing brightness or restoration of 2nd anode voltᵔge. Horizontal flyback is checked dynamically in circuit by measuring the power transfer to the yoke when TV is turned on. TV horizontal sync can be used to control the SS117 horizontal oscillator,providing a positive check on sync from the video amplifier to the TV oscillator. Vertical circuits are tested by simple signal injection from vertical yoke to oscillator for full height on CRT. The SS117 with the CA122 Color Analyzer provides a complete TV analyzer for virtually every stage in monochrome or color receivers.

External checks for AC, DC, peak to peak voltage readings and DC current in the upper right hand corner save using a separate VTVM. Accurate 2nd anode measurements up to 30,000 volts are made with a sensitive 300 microamp meter and the attached high voltage probe. AC outlets, all steel construction and mirror in the cover makes every servicing job easier.

Size: 10¼" x 9¼" x 3½". Wt. 10 lbs.

Dealer Net **89.50**

The SS117 checks them all

FREE—A 33 RPM half hour permanent record packed with every unit explains each test.

FOR FASTER MORE ACCURATE TUBE TESTING

TC114 MIGHTY MITE TUBE CHECKER

This is the famous Mighty Mite, acclaimed by over 25,000 servicemen, maintenance men and engineers as "the best they've ever used." A complete tube tester that is smaller than a portable typewriter yet finds tubes that testers costing hundreds of dollars miss, thus selling more tubes and reducing call backs. A real money maker for the serviceman and a trusty companion for engineers, maintenance men and experimenters. The Mighty Mite has been acclaimed from coast to coast as the real answer for the man on the go. Even though the Mighty Mite weighs less than 8 pounds, new circuitry by Sencore enables you to use a meter to check grid leakage as high as 100 megohms and gas conditions that cause as little as one half microamp of grid current to flow. Thus, too, it checks for cathode current at operating levels and shorts or leakage up to 120,000 ohms between all elements. And it does all this by merely setting four controls labeled A, B, C, & D with new type easy grip knobs. Check these plus Sencore features... Meter glows in dark for easy reading behind TV set... The new Mighty Mite has large size Speedy-Setup Tube Chart inside of cover—cuts setup time for even faster servicing. New stick proof D' Arsonval meter will not burn out even with shorted tube... Rugged, all steel carrying case and easy grip handle.

The improved Mighty Mite will test virtually every radio and TV tube that you encounter, nearly 2000 in all, including foreign, five star, auto radio tubes plus the new Compactrons, Novars, Nuvistors and 10 pin tubes. Has larger, easy-to-read type set-up booklet for faster testing.

Size: 10¼" x 9¼" x 3½". Weight: 8 lbs.

Dealer Net **74.50**

Fast, Accurate . . . never lets you down

A must for color

TM116 TUBE TESTER MODERNIZING PANEL

New tube adapter for testing Compactrons, Novars, Nuvistors and 10 pin tubes in any tube tester except cardomatic types. Plugs into octal socket of your tube tester enabling you to test these new tubes in the same manner that your tester checks conventional tubes. Tube set-up chart included with each adapter.

Dealer Net **24.95**

SENCORE

TRANSISTOR CIRCUIT TESTING MADE EASY & PROFITABLE

TR110 TRANSI-MASTER

A new transistor tester that will analyze the entire transistor circuit in minutes. Transistors can be checked in-circuit or out-of-circuit. Here is how it works:
First, check the batteries or power supply with the 0 to 12 volt voltmeter. Next, check the current drain with the 0 to 50 milliamp meter. A special probe is provided so that you do not need to break the circuit. Intermittents caused by cracked boards can be localized by the current check.
If trouble is not located by now, isolate the trouble to a specific stage by touching the output of the harmonic generator to the base of each transistor and note spot where sound from speaker (or scope where no speaker is used) stops or becomes weak. The generator becomes a sine wave generator for audio stages to help find distortion.
If trouble points to a transistor, check it in a jiffy with the exclusive in-circuit power oscillator check provided by the TR110. A special probe is also provided for this.
If the transistor checks bad in-circuit, remove it and give it an out-of-circuit check with the oscillator check or the more accurate DC check.
The DC check is provided for comparison reasons, experimental or engineering work and to match transistors in audio output stages. Beta (current gain) is read direct or on a good-bad scale for service work.

Dealer Net 59.50

- **COMPLETE IN OR OUT-OF-CIRCUIT TRANSISTOR TESTER**
- **SIGNAL TRACER • VOLTMETER**
- **BATTERY TESTER • MILLIAMMETER**

TR115 TRANSISTOR DIODE-CHECKER

Tests transistors for leakage, gain, opens and shorts. Reads gain as good or bad or directly in Beta. Checks diodes for forward to reverse ratios. Tests them all from the smallest transistors used in hearing aids to the power types used in auto radios. Also lists Japanese equivalents. This simple to operate, time tested checker can be used with or without set-up chart for all servicing, experimenting and lab work. The industry's most popular transistor tester, used by Bell Telephone, Sears Roebuck, Edison and many others.

Dealer Net 24.95
Kit 15.95

NEW! BE124 BATTERY ELIMINATOR

An easy to use power supply that replaces batteries during repair time of transistor radios. Tapped voltages at 1.5 volt DC intervals from 0 to 12 volts are on front panel for easy connection and to insure center tap and bias voltages when required. Function switch converts meter to a trouble shooting 0 to 50 Ma current reading device to monitor the current drain of the transistor radio. Improved regulation and voltage calibrate pot. guarantee accurate well filtered output. Also for charging nickel cadmium batteries.

Dealer Net 24.95
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HG104 HARMONIC GENERATOR

Finds Defective Stage in a Minute . . . a real time saver. Just touch the output leads of the HG104 to inputs and outputs of transistors and a clear 1000 cycle note from speakers will tell you whether or not the stage is defective. It works every time from speaker to antenna. Two leads and calibrated output (not found on pencils) are a must for speaker connection, grounding to prevent RF spray and front end checks. With batteries.

Dealer Net 9.95

A NEW VERSATILE APPROACH TO CIRCUIT TESTING

SM112 SERVICE MASTER

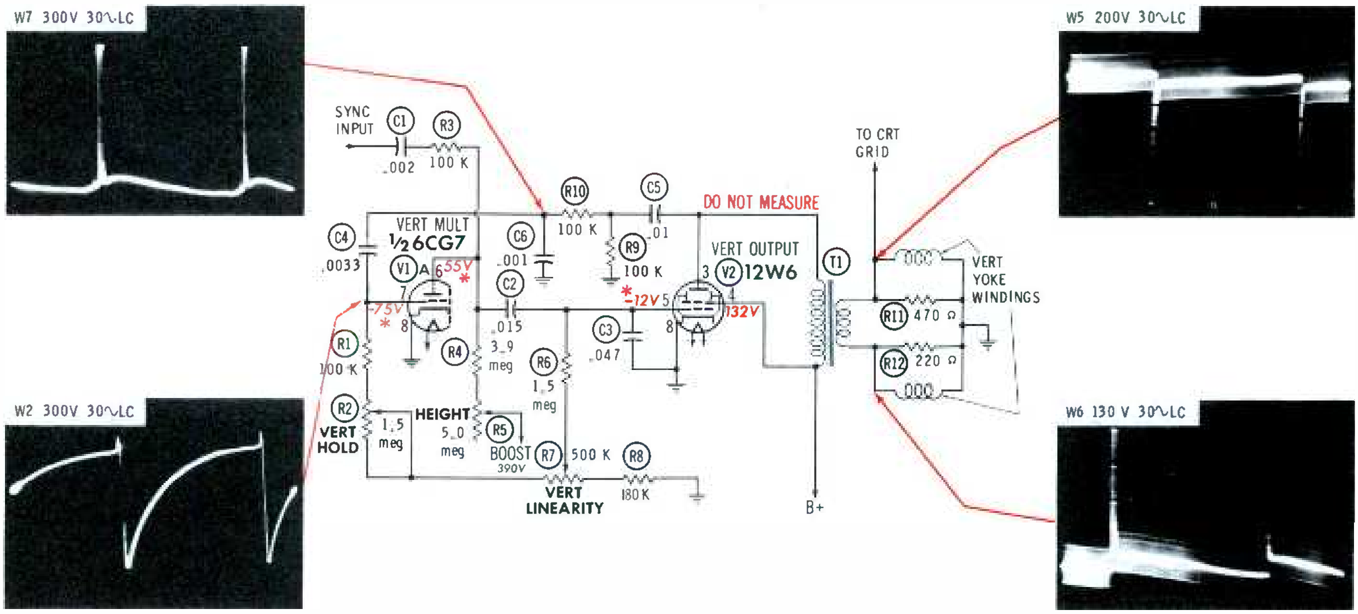
A combination VTVM and VOM in one compact unit to simplify every testing need. The SM112 offers a conventional VTVM, operating from 115 volts AC for accurate bench or lab work . . . flip the function switch to VOM and two standard flashlight batteries power the unit as it is connected to a 5,000 ohms per volt meter. This Sencore first enables you to make voltage, resistance and current measurements anywhere anytime. And to top this, indicating arrows located along the left side of meter flash on and off as the controls are rotated to indicate the exact scale to read on any VTVM position or range. Hard to remember technical data is listed in the removable cover. One permanent probe is used for every test on VTVM or VOM. High voltage probe fits on end of permanent probe for measurements up to 30,000 volts DC. Standard specifications of 11 megohm input impedance on VTVM, 6 AC and DC voltage ranges from 0 to 1000 volts on both VTVM and VOM, 6 resistance ranges from 0 to 1000 megohms on VTVM, 2 ranges on VOM, and a 2 percent six inch meter provide all requirements for fast accurate measurements. Zero center scale and peak-to-peak measurements as added features create a truly great Sencore value.

Dealer Net . . . . only 79.95

PF REPORTER Symfact

Vertical Multivibrator

Feedback and Control Circuits



DC VOLTAGES taken with VTVM, on active channel. * means voltage will vary when signal is applied or control is adjusted. See "Variations."

WAVEFORMS taken with wide-band scope; receiver controls set for 50-volt p-p video to CRT. Low-cap probe (LC) used to obtain all waveforms.

Normal Operation

All parts of combined vertical multivibrator and output circuit are shown here. Control circuits were discussed in November, 1962 *Symfact;* this coverage concentrates on feedback network and yoke circuit. Output signal at V2 plate, along with amplified sync pulses, is fed back to grid of V1A through RC network C5, R9, R10, C6, and C4. This network serves three purposes — shaping waveform, setting amount of feedback (by voltage-divider action), and determining phase of feedback (so it will sustain oscillation). Use of two capacitors in series, C5 and C4, makes circuit less susceptible to certain faults than circuits using only one series capacitor in feedback loop. Amplitude of pulses at plate of V2 is too great to permit safe checking of waveforms and voltages with normal test equipment. Output transformer is an isolated-secondary type, and center tap between the two yoke windings is returned to ground. Vertical retrace blanking pulses for CRT are obtained from one side of yoke. In combined multivibrator-output stages such as this one, many vertical rolling defects stem from faults in feedback circuit—making it a logical place to check.

Operating Variations

W2 Waveforms shown were taken with signal applied to set; without signal, pip at peak of W2 would be less pronounced, due to lack of sync pulse. Otherwise, W2 is relatively constant regardless of control settings.

VOLTAGES Voltages throughout circuit respond to control and signal changes as described in November, 1962 *Symfact.* It is well to keep these variations in mind, especially if you plan to troubleshoot by voltage-measurement method; when you know what changes to expect, you won't be confused by interaction between sections.

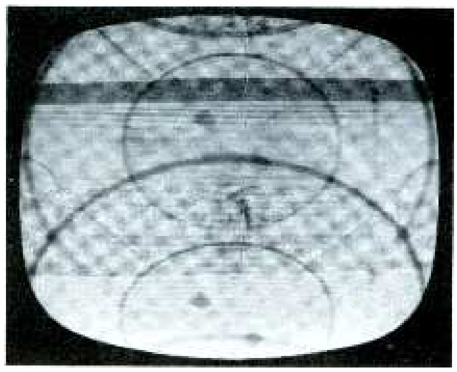
WAVEFORMS Waveforms W5 and W6 will vary in amplitude according to settings of height and linearity controls, R5 and R7. Their shape will remain essentially constant, except for slope of trace, which will often vary with changes in setting of R7. Amplitudes indicated on waveforms were taken with controls set for normal height and linearity.

SYMPTOM 1

Rapid Vertical Roll

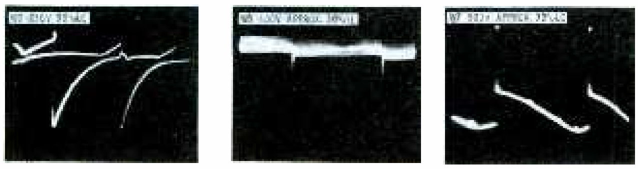
Hold Control Out of Range

R9 Open



Symptom Analysis

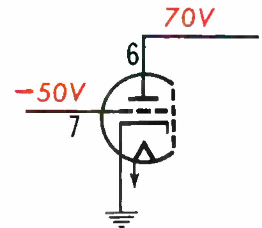
Rolling cannot be stopped, as vertical-oscillator frequency is beyond range of hold control. Slight compression of raster height is noticeable, but not serious. Key to analysis, therefore, is off-frequency condition of vertical oscillator—pointing to fault in a part which affects frequency (including C4, C5, C6).



Waveform Analysis

Sweep frequency of scope must be changed slightly to stabilize waveforms. W2 shows little change in shape, but amplitude decreases slightly; small pip (sync pulse) continuously "runs up" slope of trace. Amplitude of W5 almost doubles, but appearance is unchanged. Key to trouble is steeper slope of trace (and significant rise in amplitude) of W7. Linearity control can sometimes compensate for frequency change, but at expense of good linearity. All amplitudes increase because of change in voltage division within feedback network.

Voltage and Component Analysis



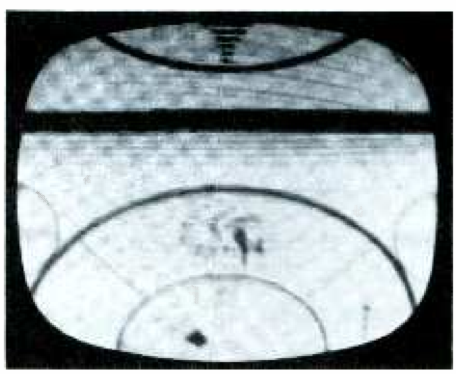
As R9 increases in value, rolling starts and picture shrinks vertically. Extreme is reached when roll is beyond control range, and picture is compressed. R9 could have been damaged by leaky C5; better check that part. Pins 7 and 6 reflect DC voltage shift in positive direction, resulting from control changes made in attempt to stop rolling. If R9 were to decrease in value, rolling would be accompanied by *stretched* picture. This last fault seldom occurs, since resistors like R9 rise in value more often than they decrease.

SYMPTOM 2

Intermittent Vertical Roll

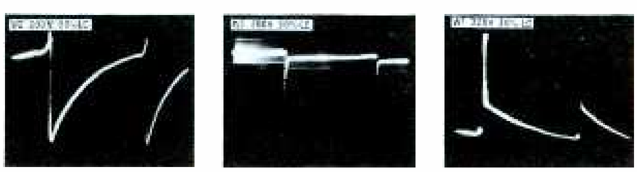
Raster Slightly Compressed

C5 Leaky



Symptom Analysis

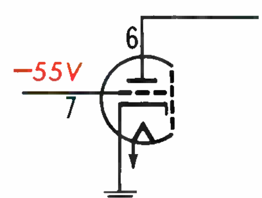
Rolling symptom shows up especially during warmup, with the hold control finally set near end of its range. As in Symptom 1, picture compression is incidental, and sometimes unnoticeable. Vertical sync is more critical than usual, because of poor waveshape fed back to grid of V1A through feedback network.



Waveform Analysis

Shape of W2 remains unchanged, except for lower amplitude. This is, once again, due to upset in voltage division within feedback network. W5 retains its normal shape and amplitude, unless circuit is extremely misadjusted. W7 shows characteristic change in slope that accompanies any alteration in section of feedback network nearer V2. This change in W7 is significant clue in determining which end of feedback network is at fault; compare its shape here with W7 in Symptom 3, and then with that of normal W7.

Voltage and Component Analysis



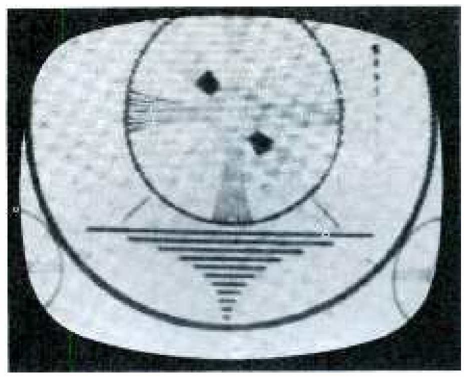
Voltage on pin 7 becomes less negative, but not significantly so; pin 6 remains essentially unchanged. Voltage on pin 3 is considerably lowered, but is still unsafe to measure. Key voltage clue is at junction of R10 and C6. VTVM will normally read less than ½ volt DC here (caused by self-rectification in meter); with C5 even slightly leaky, reading may be several volts. If C5 remains in circuit very long after becoming leaky, it will damage R9 as in Symptom 1. Good callback insurance also requires checking C4 and C6 for leakage.

SYMPTOM 3

Increased Sweep

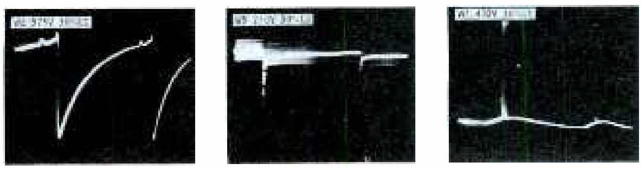
Intermittent Vertical Roll

C4 Decreased in Value



Symptom Analysis

Rolling generally increases as set warms up, signifying a defect that develops slowly "under load." Frequency drift points to some fault in V1A-grid or feedback circuit. Stretching of sweep often occurs, too; but this happens gradually, and customer may not notice it until rolling becomes severe.



Waveform Analysis

Shape of W2 stays the same, but its amplitude increases somewhat, and sync pulses are seen "running" through waveform. Amplitude of W5 is also increased, accounting for stretched appearance of raster. Suspicion of feedback trouble is raised by abnormally high peak-to-peak value of W7, and more exact clue to location of fault is given by unchanged shape of this trace. Feedback troubles of type described in Symptoms 1 and 2 produce abnormal shape in W7; absence of this distortion points to trouble between test point and grid.

Voltage and Component Analysis

NO VOLTAGE CLUES

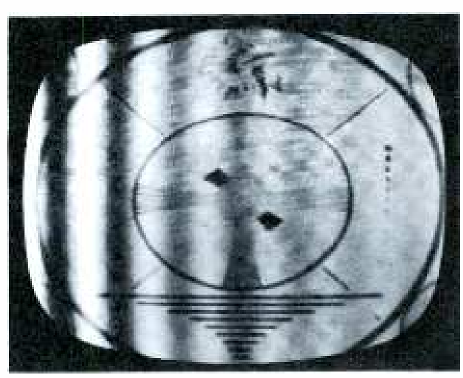
Strangely enough, DC voltages stay very nearly the same as for normal operation. Very slight shift in positive direction occurs, but not enough to serve as a clue unless *exact* voltages for a particular set were known beforehand. Value of C4 is very important to waveshaping characteristics of feedback RC network. Leakage gives same effect as lowered capacitance. If value should increase for some reason, result would be shrinkage of picture. Good idea to change C4 if it gives slightest suspicion of trouble.

SYMPTOM 4

Vertical Bars in Raster

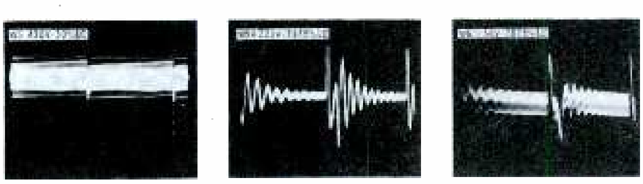
Darkest on Left Side

R11 Open



Symptom Analysis

At first thought, symptom appears to be horizontal sweep trouble. Only clue to vertical fault is slight, almost unnoticeable, shrinkage of picture. Bars are obviously caused by some form of ringing in or from horizontal circuits, and it is necessary to make further checks to determine actual source of trouble.



Waveform Analysis

Scope checks in horizontal circuit fail to give real clue, even though unnatural amount of ringing waveform is apparent. In W5, however, excessively wide band of white indicates trouble. Scoping same waveform at 7875 cps reveals the problem—excessive cross talk in vertical winding of yoke. All other waveforms in vertical circuit are normal, further isolating trouble to output transformer or yoke circuits. W6 also contains unwanted horizontal pulse, but reduced amplitude points to trouble in winding nearest W5.

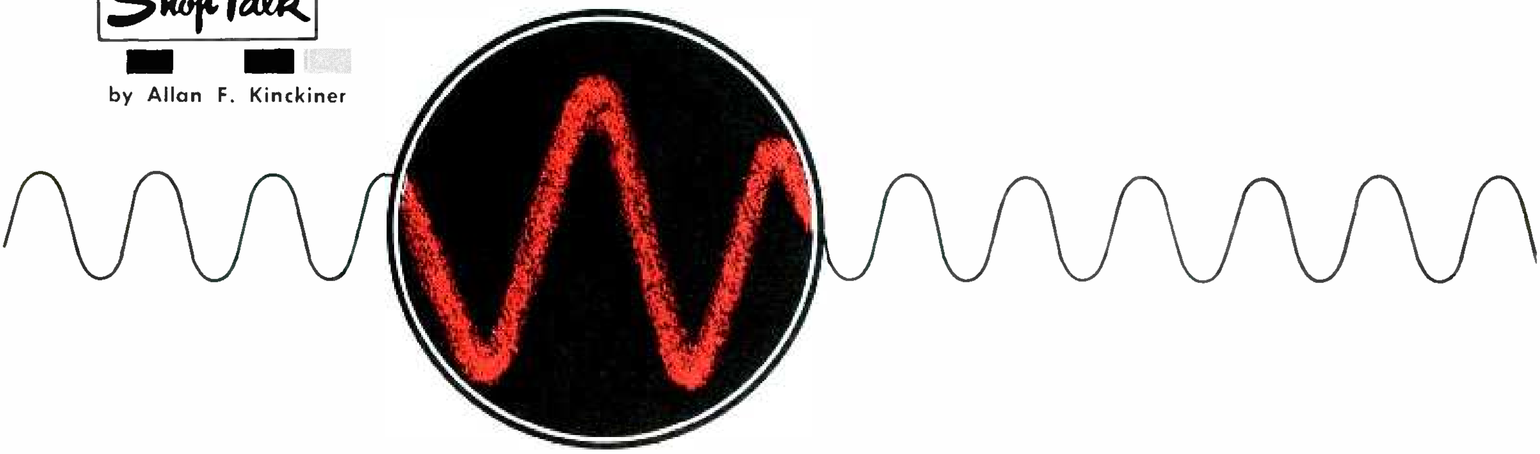
Voltage and Component Analysis

NO VOLTAGE CLUES

Voltages throughout vertical multivibrator and output stage are normal—more evidence of trouble in output transformer or yoke. Cross talk in yoke results in bars on picture tube in this particular circuit, because retrace blanking is taken directly from yoke connection. If R12 were to become open, effect would be similar, except bars would be very light—sometimes hardly noticeable. Visual inspection of R11 and R12, or unsoldering and measuring with ohmmeter, will usually be necessary to confirm this fault.

Shop Talk

by Allan F. Kinckiner



HOW RADIATION DISTORTS SCOPE TRACES

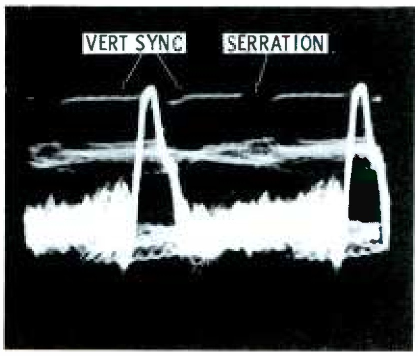


Fig. 1. Faint line at top is normal; it's traced by vertical sync pulses.

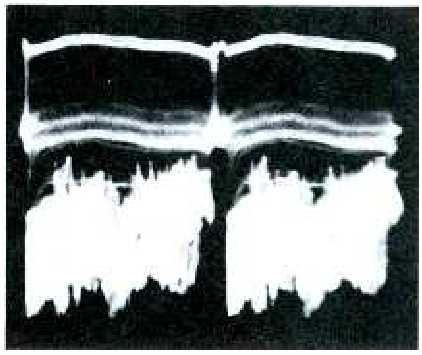


Fig. 2. Slight bending of video waveform caused by pickup of 60-cps hum.

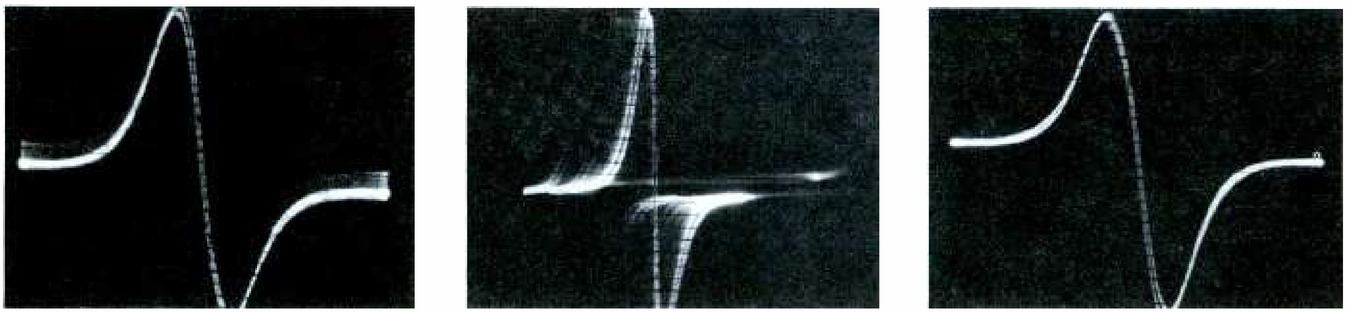
A major distraction to inexperienced scope users is the "hash" or fuzziness that appears in many waveforms. Sometimes it's a valid clue to trouble; but more often than not, it has nothing to do with the symptoms that resulted in the service call. Here are three reasons why a scope trace may include incidental, misleading information:

1. Since the scope is a more sensitive indicating device than the TV screen, it often detects slight signal faults that don't produce obvious distortion in the picture or raster. While these imperfections may be a sign of trouble in the making, they may have no bearing on the present complaint.
2. Some components of normal signals produce faint pips or lines that don't show up clearly in most photographs found in service literature. (An example is the line traced by the vertical sync pulses in a composite video waveform taken at 7875 cps—see Fig. 1.) The scope user who isn't expecting these added traces may interpret them as trouble of some sort.
3. Many trace distortions are due to unwanted pickup of signals from sections of the receiver other than the circuit being tested.

This last-named effect is especially annoying because its origin is usually difficult to pin down. Spurious radiation and cross talk can reach the scope in several different ways. The instrument's input terminals, leads, or probe can pick up radiation; signals may be induced in the circuit being tested if nearby wires are carrying large alien signals; in addition, an unwanted signal can be directly coupled into various receiver sections by defective isolation or decoupling networks.

Probably the most common interfering signal—60-cps hum—is radiated or coupled from the receiver power supply and heater circuitry, as well as from external sources like fluorescent lights. The consequent arching or bending of certain waveforms (Fig. 2) is a familiar sight. Especially during tests of high-impedance circuits, a small amount of 60-cps pickup is to be expected in the average test setup.

In every TV receiver, there are several other specific components or circuits capable of radiating signals into other sections. The circuits which give the most trouble are the horizontal and vertical deflection amplifiers; specific offenders are the



(A) Vertical-amplifier pickup. (B) Horizontal-amplifier pickup. (C) Clean trace (no blanking).

Fig. 3. Hash on the alignment curve of an FM sound discriminator.

output tubes and transformers, the yoke, the damper tube, all wiring associated with these components, and also the bell of the picture tube. Radiation from these sources cannot be eliminated entirely, but sets are designed to keep the radiation level low enough so that receiver performance will not be degraded. Radiation is usually minimized by use of careful circuit layout, critical wiring dress, isolation networks, and shielding.

Excessive radiation within a receiver has a considerably more obvious effect on scope signals than on the picture or raster. Therefore, no visual symptoms may be apparent at first glance. Nine times in ten, though, the radiation will affect receiver operation in some marginal way. For example, some receivers using vertical blocking oscillators are designed with potted-type oscillator transformers. If these are replaced with unpotted types, vertical sync will never be as good as it was originally. The poor synchronization will cause a minute vertical jitter that the average serviceman will ignore, but a critical customer will find objectionable. A scope trace will show this jitter more plainly than picture examination.

In addition to indicating marginal faults that may be bothersome to the customer, minor distortion in a scope trace can frequently forecast the failure of certain components. For example, parasitic oscillation in the horizontal output tube—evidenced by a fuzzy appearance of waveforms—often presages the not too distant failure of that tube.

In some cases when hash on a scope trace does not cause visible defects on the CRT screen, the reason is that the signal radiation coincides with the horizontal or vertical blanking period. Also, some visible corona effects appear only on the extreme edges of the raster; while they will be obvious on scope traces, they will not be apparent on the screen unless the raster is intentionally shrunk to view its edges.

Whether or not the CRT presentation is affected, every suspicious-looking scope trace should be carefully analyzed to determine if the condition is normal and can thus be ignored, or if the peculiar waveform indicates a submarginal defect (or impending breakdown) that only a critical examination of the receiver will reveal.

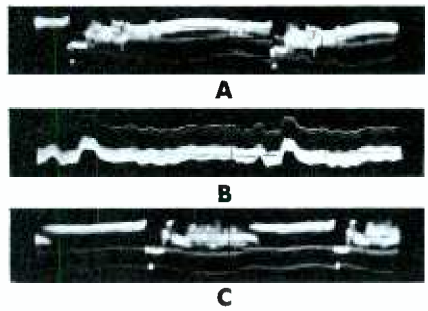


Fig. 4. Distorted video, radiated component of signal, and normal video.

Fuzzy Alignment Traces

Every serviceman who has sweep-aligned a receiver has at some time been troubled by fuzzy response-curve traces. There are several ways to combat this condition. One is to kill the horizontal or vertical circuit responsible for the hash; another is to insert a low-pass RC network in the scope input circuit (a 10K resistor in series with the vertical input lead, and a 1000-mmf capacitor across the vertical input terminals). A third method, which I personally prefer, is to use enough signal from the generator so that the scope's vertical gain can be attenuated—making it less vulnerable to radiation. The amount of signal that can be fed into the receiver is limited by the overload point of the IF amplifiers (where the peaks of the curve begin to flatten out). Generally speaking, a signal level capable of presenting a 3-volt trace amplitude on the scope will fulfill the desired conditions for aligning picture IF's. For sound IF's, a 6- to 8-volt trace is about right.

Proximity of the scope to the receiver is one more factor affecting hash on alignment curves, particularly when the scope's input posts are unshielded. Fig. 3A shows hash picked up by the vertical amplifier of a scope placed only about ten inches from the front of an operating picture tube. Another blurred trace (Fig. 3B) resulted when, in a hurry, I used an unshielded lead to couple a sweep signal into the horizontal amplifier of the scope for discriminator alignment. In both cases, correcting the faulty setup enabled the scope to display the clean response curve shown in Fig. 3C.

Shielding The Scope Input

Some time ago, while scoping the output of a video amplifier using two triode stages, I noted compressed sync pulses; so, I advanced the scope probe to the input of the amplifier. Because of the lower signal amplitude here, I switched the scope attenuator from the X100 to the X10 position. The input waveform contained an unexpected form of distortion, as illustrated in Fig. 4A. Since the first trace did not have this wavy distortion, I deduced something was wrong with the second probing. With the probe disconnected from the receiver, the scope still displayed the waveform in Fig. 4B. Cupping my hand around the vertical-input post killed this signal, indicating that the hash was being picked up by the scope itself. By moving the instrument away from the receiver, I eliminated the hash and obtained a normal composite - video waveform (Fig. 4C).

The trace distortion, in this case, was aggravated by the fact I was using a low-capacitance probe with the scope. Because of the attenuation introduced by this probe, a 10-

• *Please turn to page 89*

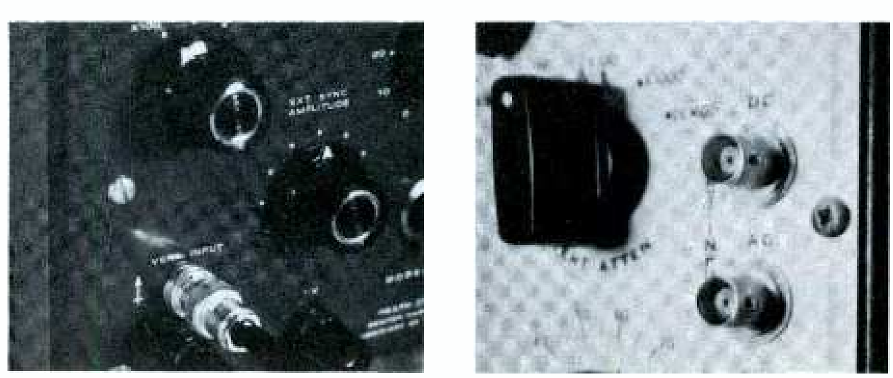
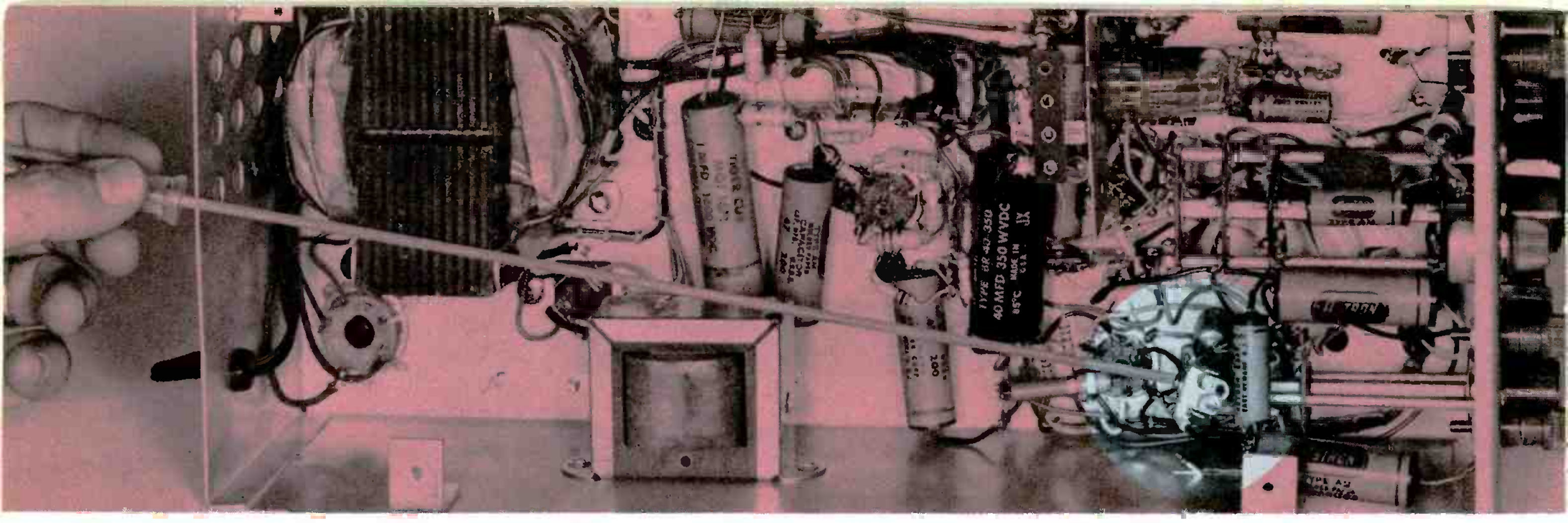


Fig. 5. Coaxial connectors installed in place of the binding posts on scopes.



Calibrate Your Own Scopes and Generators

Dependable reference sources are easy to find.

. . . by Len Buckwalter

In the September issue, we investigated several techniques for calibrating the VOM and VTVM. Other basic equipment—audio oscillators, oscilloscopes, and signal generators—may also be checked for departures in accuracy which inevitably creep into any unit over the course of extended use.

Many of the preliminary steps described in the previous article also apply to these instruments. To recap briefly: Calibrate the instrument in the same physical position as that used during routine operation. Preset the mechanical zero screws on meters. Let new tubes age for at least 48 hours. Neutralize the electrostatic charge on a plastic meter front by washing with a household detergent. Lastly, allow a one-hour warmup period before calibrating.

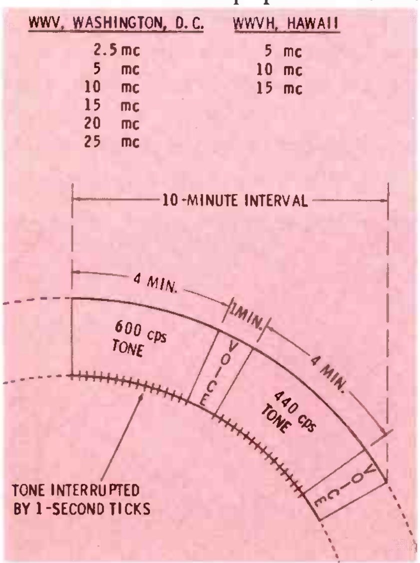


Fig. 1. Calibrating signals sent by the National Bureau of Standards.

Audio Oscillators

For most applications, extreme accuracy is not ordinarily required of an audio generator, but you may encounter new electronic devices which *do* require close audio-frequency tolerances. For example, to service the tone-signalling circuits which are finding wide usage in garage-door openers and Citizens-band systems, you need a generator that produces precisely-calibrated audio signals.

A very accurate test signal at the low end of the frequency spectrum is readily available from the 60-cps power line. Just touching a fingertip to the vertical input of an oscilloscope introduces enough 60-cps voltage to permit synchronizing the scope's horizontal sweep at 60 cycles. (Set the controls for a single-cycle display.) The output of the audio oscillator can then be connected to the vertical input of the scope and varied to produce a similar display on the scope. Under these conditions, the audio oscillator is known to be generating exactly 60 cycles.

Other audio frequencies may be checked by leaving the oscilloscope locked on 60 cps and slowly rotating the audio oscillator dial until two cycles appear on the screen. At this point, the instrument is generating 120 cps. This procedure may be continued until the oscilloscope pattern shows a series of sine waves that are spaced too closely to be counted conveniently. In each case, the generator frequency will be equal to the number of cycles on the scope, multiplied by 60.

Other spot checks can be made if you have access to a general-coverage AM receiver. This piece of equipment is an invaluable aid to audio and RF calibration. Standard test tones are transmitted by two stations operated by the National Bureau of Standards: WWV near Washington, D. C., and WWVH in Hawaii. These high-powered stations can be received throughout the country on one of their several transmission frequencies given by the chart in Fig. 1. Reference tones broadcast by these stations provide frequency standards for calibrating purposes; the frequency of the tones alternate between 600 cps and 440 cps, in the time sequence shown in Fig. 1.

After the voice coil of the receiver is connected to the oscilloscope, the sweep is synchronized, and a calibration check is made in the same manner as in the line-frequency check. Thus, if a single cycle is displayed when the test frequency is 440 cps, an unknown signal which causes the appearance of two cycles on the scope is identified as 880 cps.

The range of available calibrating frequencies is considerably expanded by the use of *Lissajous figures*. These oscilloscope patterns will indicate the frequency relationship between a variety of known and unknown audio signals. In application, the known frequency (600 cps, for example) is applied to the horizontal input of the scope, and the unknown signal from the oscillator is applied to the vertical input. The gain controls of the scope are then adjusted to form Lissajous figures—as shown in Fig. 2. (Rotate the audio oscillator dial for a stationary display on the CRT.)

Note the pattern is characterized by a number of loops along its horizontal and vertical edges. By counting them, it is possible to determine the ratio of known frequency to unknown frequency. Loops along the top of the pattern are formed by the unknown frequency applied to the vertical terminals, while those along the side result from the known frequency at the horizontal terminals.

In the example shown in Fig. 2A, the relationship is 2:1. With a known 600-cps signal fed to the horizontal terminals, the appearance of two loops along the top of the pattern indicates an unknown frequency of 1200 cps, provided only one loop appears at the side of the figure. Other Lissajous figures give additional possibilities. For example, a 900-cps signal at the vertical terminals and a 600-cps signal at the horizontal terminals will produce the 3:2 pattern shown in Fig. 2B.

In actual practice, calibration with any known signal can be done over a 10:1 range—in either an upward or downward direction. If the ratio is much greater, crowding of the pattern makes it difficult to interpret.

Oscilloscope

The key calibration point for the oscilloscope is the gain control of the vertical input. Once a given number of inches, squares, or other divisions on the scope screen is set up to represent a known voltage, the amplitude of unknown input signals is readily measured. Once this initial calibration is accomplished, the vertical-gain vernier control must not be moved unless you wish to recalibrate the scope. However, the vertical step attenuator may be changed to a higher range, so that each square will represent 1 volt, 10 volts, etc., instead of .1 volt.

Many oscilloscopes have a grid (graticule) overlying the screen, graduated in .1″ squares. If a 1-volt AC signal is introduced and the vertical gain adjusted for a trace 10 divisions high, the scope has been calibrated on the basis of .1 volt (peak to peak) per square.

The signal source to be used for calibrating depends on the degree of accuracy required. The simplest method, generally adequate for servicing, uses a 6.3-volt filament source for the calibrating voltage. The 6.3 volts is an rms value, but the scope measures the peak-to-peak amplitude. Therefore, 6.3 volts rms will be displayed on the scope as 18 volts peak to peak (derived from the formula, p-p = rms × 2.828).

Connect the scope to the filament lead in a set (or to a filament transformer) and adjust the scope gain for a specific number of vertical grid divisions. In this instance, if 18 divisions are selected, each division equals 1 volt.

The greatest useful operating range is obtained if this calibration is made with the vertical attenuator set to X10. Switching to the X1 range then makes the same deflection amplitude equal to 1.8 volts, and switching to the X100 range results in 180 volts for the same deflection (each grid division equalling 10 volts). Reading the voltage of any unknown signal is accomplished by counting the squares from the bottom to the top of the unknown waveform.

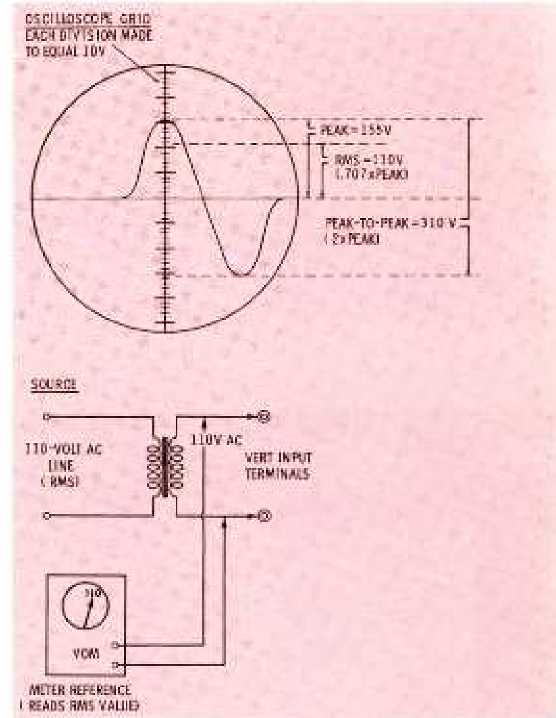


Fig. 3. Scope peak-to-peak calibration using 110-volt rms from AC line.

A cross-check of the scope calibration may be made by comparing the voltage displayed on the scope with that measured by a VTVM set to read peak-to-peak voltages. Fig. 3 gives a method for calibration using line voltage instead of filament voltage.

Calibrating an oscilloscope is considerably more convenient with the aid of a commercial calibrator made specifically for the purpose. These instruments provide a variety of reference signals for any signal-voltage range the serviceman is likely to encounter.

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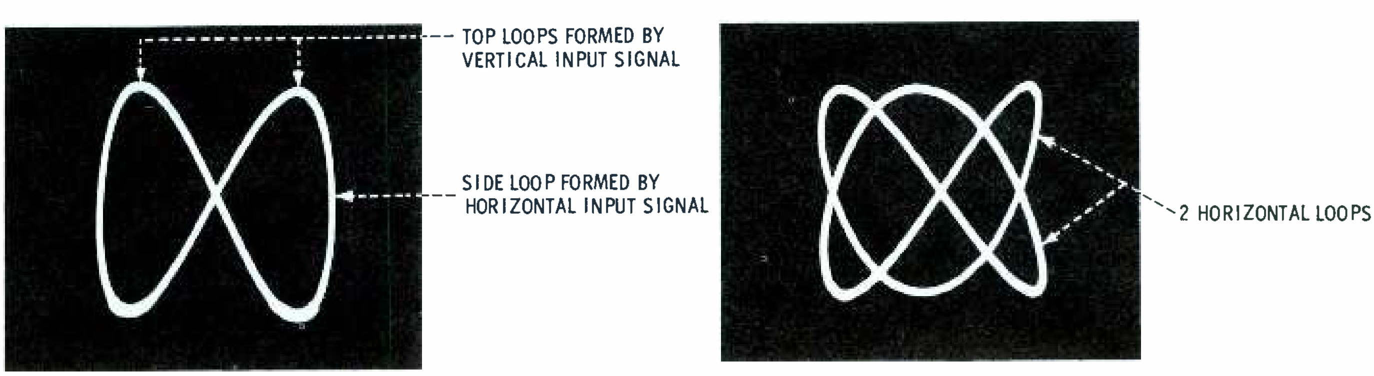
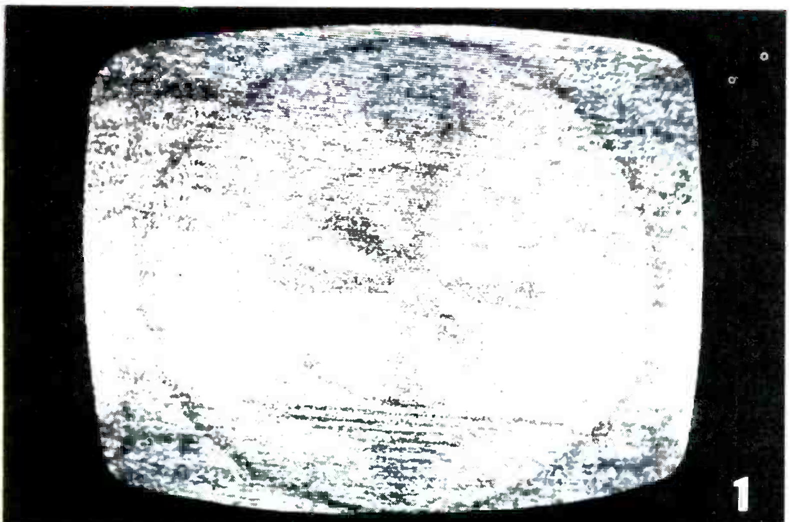


Fig. 2. Lissajous figures on oscilloscope indicate signal frequencies.

VISUAL SYMPTOMS TELL A STORY!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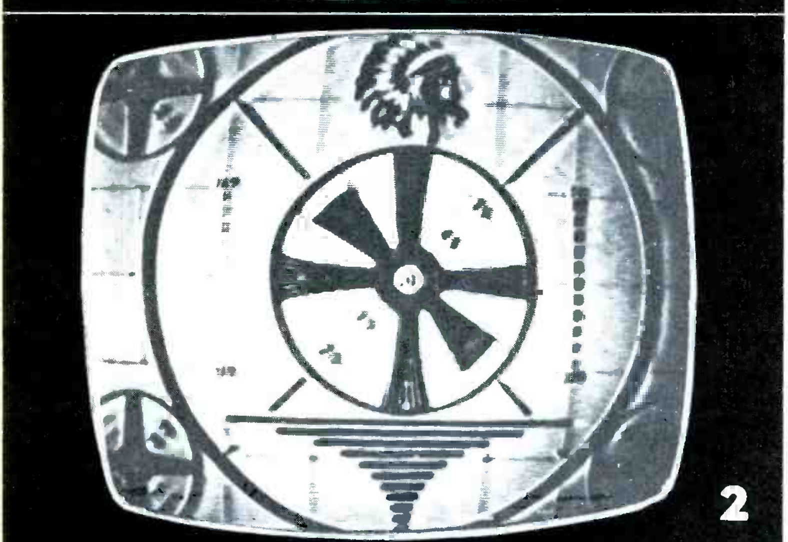
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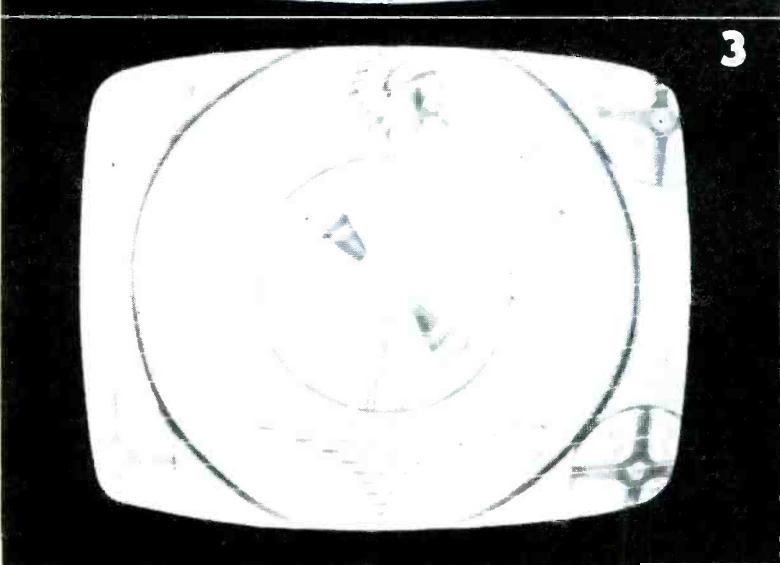
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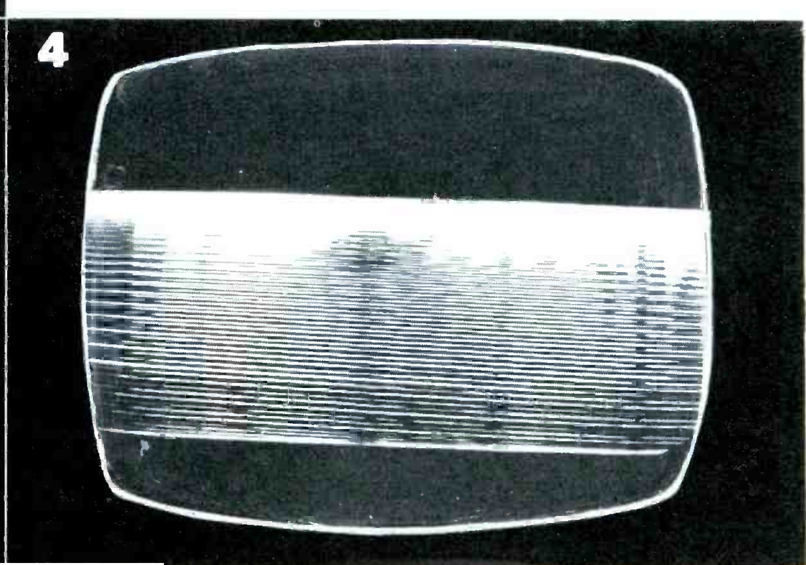
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1 Looks like a real blizzard! But heavy, black picture elements are seen through the dense snow, indicating high gain in all stages following the tuner. Removing AGC bias from the IF's—but not the tuner—causes this symptom. The AGC circuit receives a strong (though noisy) video input, and biases the tuner almost to cutoff.

2 Excessive contrast and low brightness of this picture looks like the sad result of video overloading. Sync is rock-steady, though—a clue that the fault is between the sync-takeoff point and the CRT. Look for troubles which upset the DC bias between the picture-tube grid and cathode without greatly changing video-signal amplitude.

3 A great variety of picture-circuit defects could be responsible for the weak contrast, but another symptom in this pattern is useful for localizing the fault. Except in a few old sets with no vertical retrace blanking, the presence of retrace lines on the CRT points to a blanking circuit failure which incidentally affects video.

4 Most of the raster is compressed into a single bright line, but a few dozen spread-out scanning lines prove vertical sweep is not completely dead. There is probably an open component in the waveshaping network between the vertical oscillator and output stages. A weak, distorted signal is still developed across stray circuit paths.

5 When the top of the raster is stretched and the bottom is folded over (with sync usually remaining stable), you can bet the vertical output tube has in-

Merely looking at a trouble symptom displayed on a TV screen seldom gives you enough information to "put the finger" immediately on the faulty component. However, quite a few visual symptoms are characteristic results of defects in certain small areas within the set; in such cases, a shrewd appraisal of the raster or picture can put you quite close to the trouble spot. By knowing where to start checking, you can greatly reduce troubleshooting time.

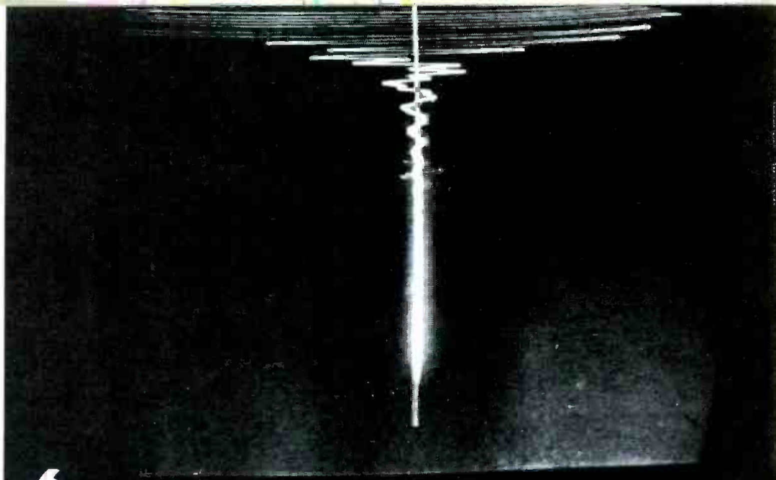
sufficient bias. The reason may be found in either the grid or cathode circuit (unless the latter is grounded). Grid-coupling and cathode-bypass capacitors are primary suspects.

6 Horizontal sweep is collapsing before your very eyes! This "Ben Casey effect" is a form of squegging (breaking in and out of oscillation) peculiar to an unorthodox type of horizontal oscillator being used in a few late-model sets. This simple circuit, a sine-wave oscillator directly controlled by dual-diode AFC, is easy to check.

7 Here, a horizontal shaking motion of the raster produces regularly-spaced bends that give the test-pattern circles a "cogwheel" appearance. The cause is almost always a faulty anti-hunt network (a capacitor or RC combination from the AFC output line to ground). This case is complicated by interaction with a 60-cps hum bar.

8 Just a wisp of a raster is left; horizontal sweep is still functioning, though badly crippled. Unequal length of faint raster lines indicates the horizontal oscillator is seriously defective and producing a weak drive signal. Raster width, height, and brightness should all return to normal when the oscillator fault is cured.

9 Loss of horizontal sync could mean trouble in any of a half-dozen stages. However, the white drive line isolates the trouble to the horizontal oscillator. Some fault is increasing or decreasing drive-signal amplitude, and also throwing the oscillator off frequency—by changing circuit constants or by improper AFC feedback.



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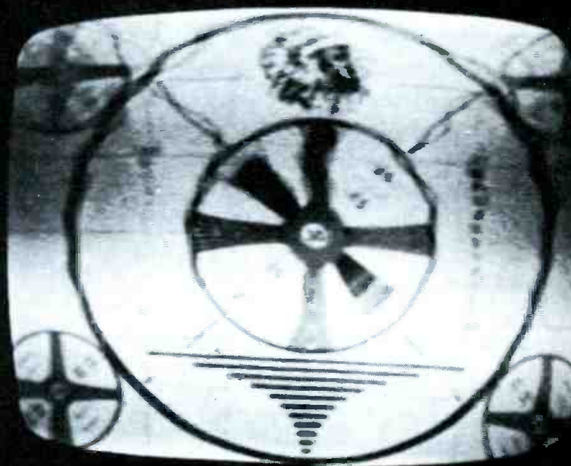

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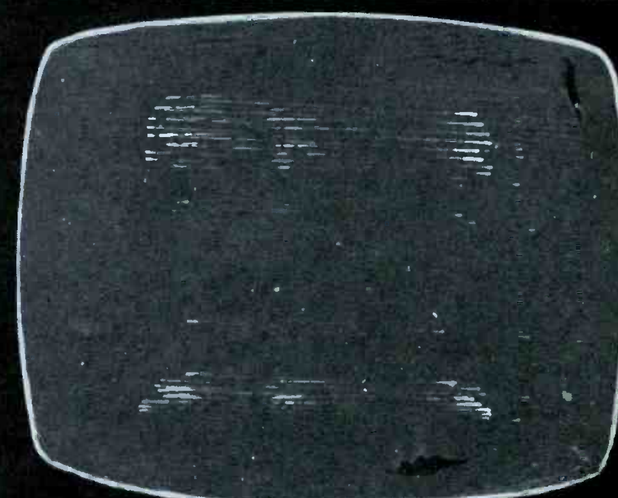

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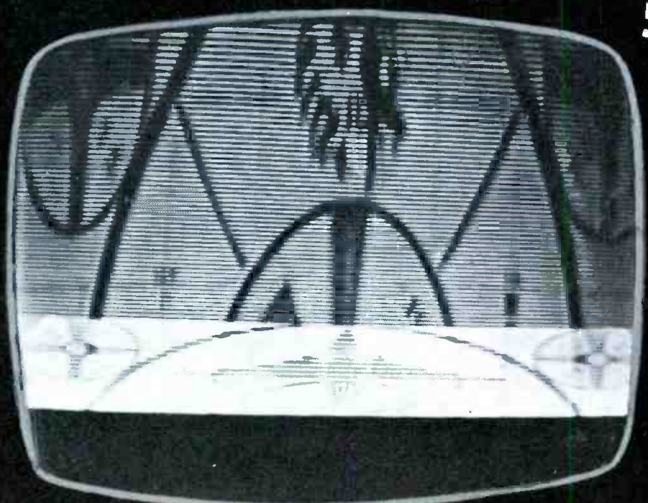

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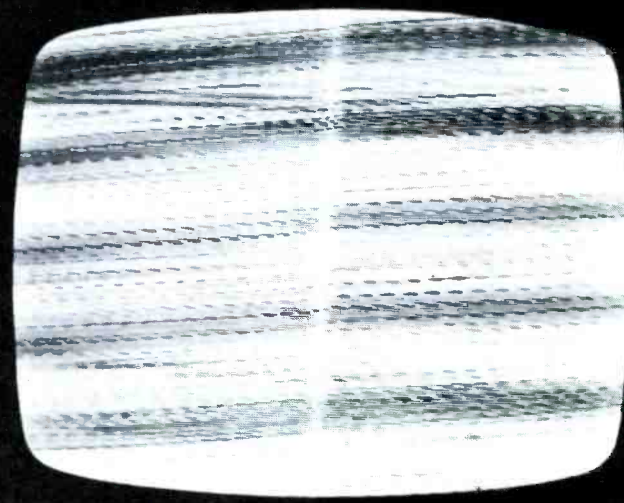

9

Got the Jitters?

Horizontal jitter is often hard to pinpoint, since it is virtually always the result of a slight component defect or a trifling maladjustment. Some examples are: slight leakage in a capacitor, a resistor a little off value, a partially open electrolytic, an unbalanced AFC phase detector, incorrect adjustment of the horizontal oscillator, and video in the sync signal. We'll cover some general component troubles first—then dig into specifics.

Resistor and Capacitor Troubles

Leaky capacitors in the horizontal oscillator, AFC, sync, or even AGC circuits can cause jitter. The trouble may not show up plainly in waveforms, except as a change in amplitude or slight "fuzziness" of the horizontal sync pulses (Fig. 1). DC voltages probably won't reveal the trouble either, since jitter may be caused by an amount of leakage too small to make a noticeable difference in voltmeter readings. Testing of all capacitors in the suspected trouble area may be the most time-saving procedure in cases where general circuit tests fail to turn up clues.

To find a faint leakage path in a capacitor, you should use a tester that places considerable voltage across it for an out-of-circuit test

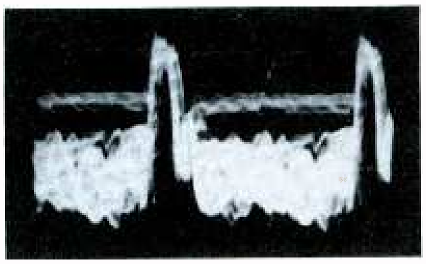

Fig. 1. Blurred sync pulses indicate fluctuations that can cause jitter.

—preferably 100 volts or more. *Do not rely on your ohmmeter.* Most ohmmeters do not apply enough voltage to the capacitor to break down such a small leakage path.

Any capacitor that has even a trace of leakage at 100 volts should be replaced. (This test should not be applied to electrolytic capacitors —especially the low-voltage type.) Even if there is no observable effect on circuit operation, leakage in a capacitor signals the end of its useful life. In addition, a 500-megohm leakage path at 100 volts might be reduced to 50 megohms or less when higher voltage is applied, since capacitors inherently tend to become more leaky as the voltage across them is increased.

Occasionally you'll find a resistor that changes in value when voltage is applied, but this doesn't happen often. Even if it does, the resistor is still likely to read off value when cold; therefore, it will be no trouble to find this fault using a well calibrated ohmmeter. Off-value resistors that can cause jitter may be found in the sync, AFC, or horizontal oscillator circuits. Frequently the off-value resistor will also show visible signs of a crack in the body, or discoloring.

Jitter can be produced by a number of different capacitor and resistor faults in the circuitry between the last sync stage and the horizontal AFC, as illustrated in Fig. 2. It may occur in circuit A if any resistor changes value, or if either C1 or C2 begins to open or develop leakage. In circuit B, a shift in the value of R1 may lead to jitter; in addition, a nearly open C2 will greatly attenuate the horizontal sync pulses, and may cause jitter as well as critical horizontal hold. Likewise, a partially or completely open C1 may cause similar symptoms. This matter of electrolytic - capacitor faults deserves further discussion.

Open Electrolytic Filter

Fig. 3 shows a circuit where an open or partially open electrolytic can let enough video into the sync circuit to cause jitter. When looking at the sync signal with a scope, you may find it all but impossible to spot any video; but you'll see it if you connect your scope across the electrolytic. It is good practice to check each electrolytic in the set when jitter is a problem. This is easy to do with a scope—you don't even have to know what peak-to-peak voltage to expect. Just place your direct probe and ground lead across each electrolytic in the set. *You should see no change in the scope pattern as the picture (video) changes.* There should never be any video across an electrolytic capacitor, no matter where it is used. Don't worry about low-frequency ripple voltage in these tests; electro-

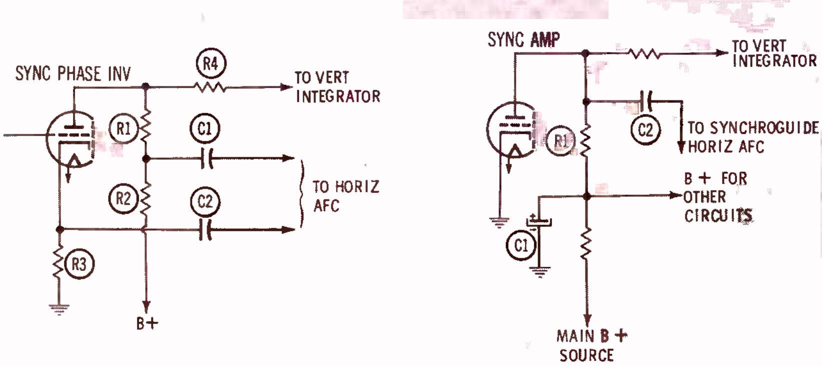

Fig. 2. Various jitter-producing troubles can occur in sync-output circuit.

Don't let unstable horizontal sweep get on your nerves.

by Wayne Lemons

lytics often stop bypassing high frequencies (including most of the video) and still do a passable job on frequencies of 120 cps and below.

Horizontal Oscillator Adjustment

As an aid in isolating defects that cause jitter, be sure to try readjusting the horizontal oscillator according to the following general procedure.

For *multivibrators* (refer to Fig. 4): If point A normally operates at nearly zero voltage, short out this point with a jumper wire. Also short out the ringing coil. Then adjust the horizontal hold control until a picture floats by. (It won't lock in, since the jumper at point A has the AFC control voltage shorted out.) If the picture won't float by slowly, you will have to check components in the oscillator to find the trouble. Next, remove the short from the ringing coil, and adjust the slug until the picture again floats by. If it doesn't, you will have to change either the ringing coil or C2. Finally, remove the short from point A. The picture should lock in. If it can't be synchronized by only a very slight adjustment of the hold control, then you'll know you have trouble in the control circuit.

In some multivibrators, point A normally runs several volts positive, and a somewhat different approach is necessary. Place your VTVM at point A. Short out the ringing coil, and rotate R5 until the picture is locked in. Note the DC voltage reading at point A. Then remove the short from the ringing coil, and adjust the slug for exactly the same voltage.

Synchroguides can be most accurately adjusted by setting up the circuit to generate the familiar waveform shown in Fig. 5. However, in the field—when you have no scope—you can nearly always stabilize a "Christmas - treeing" oscillator by simply backing the phase (waveform) slug *out* of the coil about a turn and a half. This raises the frequency of the sine wave developed by the phase coil. This signal gives trouble when it falls too close to the horizontal oscillator frequency—it must always be above it!

Synchrophase circuits in recent RCA receivers (Fig. 6) have a marked resemblance to the *Synchroguide,* but *cannot* be adjusted correctly with an oscilloscope. Adjustment, however, is simple. Short out the waveform coil, short out the grid of the sync separator tube to remove the sync signal, and adjust the horizontal hold control until a picture floats by. Remove the short from the waveform coil, and adjust it to recover the picture. When you restore the sync signal, the picture should lock in.

Ringing-Coil Problems

In a horizontal multivibrator

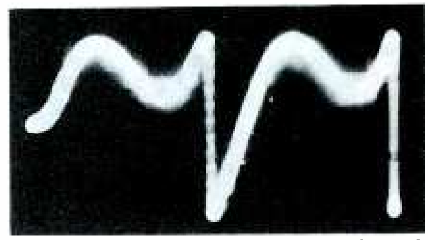

Fig. 5. *Synchroguide* is properly adjusted when waveform looks like this.

(Fig. 4), the small sine-wave voltage developed across the ringing coil combines with the sawtooth waveform at the grid of V1B to produce a trace similar to Fig. 7—*if* the sine wave has the correct phase and amplitude.

Improper operation of the ringing circuit can be responsible for jitter. Troubles which cause an error in sine-wave frequency—for instance, shorted turns in the coil—can usually be found and corrected in the process of adjusting the circuit. However, you'll probably have a harder time diagnosing jitter which results from excessive *amplitude* of the sine-wave component. This is usually a design problem, but it can often be alleviated by slightly modifying the circuit. The coil may have too high "Q"—in which case a 27K to 47K resistor may be wired across it to damp the circuit and reduce the sine-wave amplitude. It's also possible that too great a proportion of the AC plate voltage of V1A is being developed across the ringing circuit; if so, a workable remedy is to increase the value of series resistor R1. The latter change should be made with caution, since it could "backfire" — you might decrease, rather than increase, the stability of the circuit.

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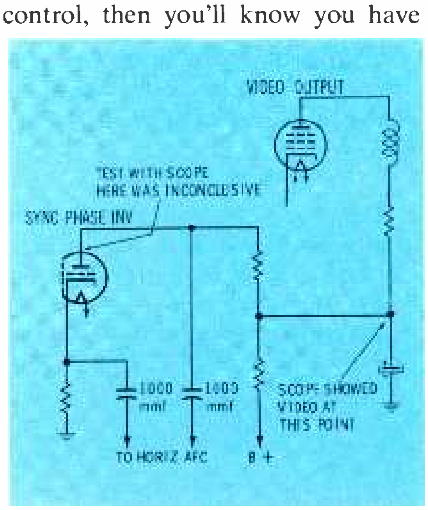


Fig. 3. Defective B+ filter capacitor may let video appear in sync signal.

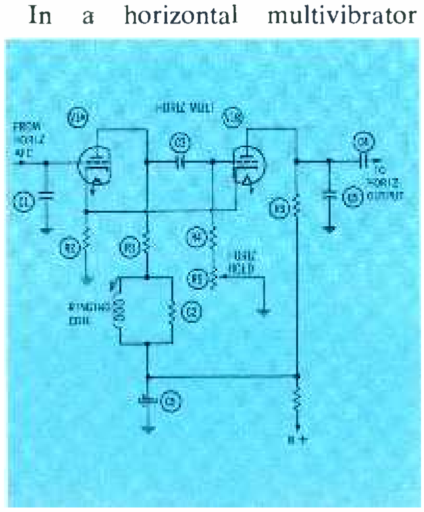


Fig. 4. Grid of V1A is usually grounded to permit adjusting multivibrator.

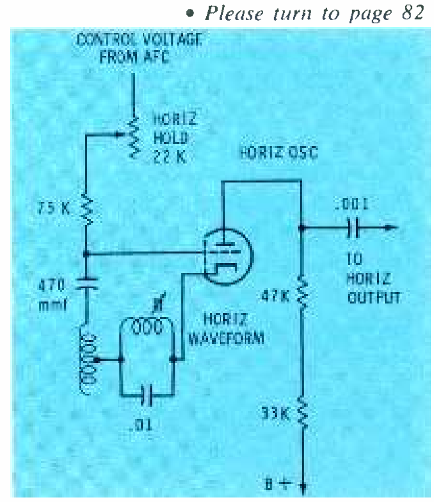


Fig. 6. A scope is not necessary for adjustment of the *Synchrophase* circuit.

PROFIT *from flat rate service calls*

by Ernest Tricomi

Wouldn't it be rather silly to:

1. Pay a clerk or dispatcher to receive a call for service and make out the necessary paperwork;
2. Take down the parts needed from a $3,000 or $4,000 inventory;
3. Load them into an expensive truck, along with tools and test equipment;
4. Slide a highly-paid service technician behind the wheel, and send him off to the customer's home;
5. Pay the technician's wages and the overhead expenses to get him to the door, and pay him while he is working on the set—

Only to find that, after subtracting your costs from the amount paid to you by the customer, *you lost 65c?*

Maybe you're chuckling at the poor brainless shop owner who would permit such foolishness to drive him to the poorhouse; yet, I'll bet this has happened in your town more than just once or twice—*this very week!*

Have you ever stopped to think how many profitable service calls it takes to make up for just one of these "no profit" calls? You must not only make up for the actual amount lost (65c in the example above) but also earn the profit you should normally make, anyway. The inevitable answer is that you never quite make up for lost profits, unless you overcharge the next customer—a very poor practice.

A Short Course in Profits

Take a look at the following facts, which are based on an expected profit margin of 25%: A 2% drop in your gross profit (caused by an occasional no-profit call) must be offset by an 8.7% increase in the number of service calls if you are to earn the same dollar profit. A 10% drop in your gross profit (caused by too many no-profit calls) must be offset by a 66.7% increase in service calls to earn the same dollar profit!

Would you, in today's tightening competitive situation, find it easy to make five calls for every three you're now doing? It's not very likely you could even attract that many extra calls, let alone find time to make them. The better, easier, and more businesslike way is to be sure that every service call is a profitable one. This can be done by establishing a flat-rate service charge on a sound basis, and then using it sensibly.

We won't go into the mathematics of figuring profit ratios; however, we can set up a procedure by which you can arrive at a flat-rate figure which will provide you with a margin of profit on service calls. We will first concern ourselves with how to apply and use a flat rate, once it has been established.

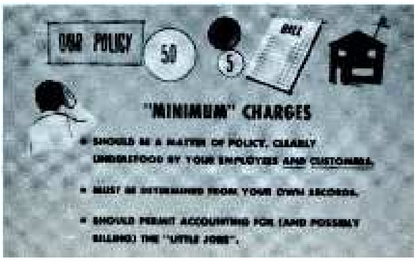
Flat Rate Defined

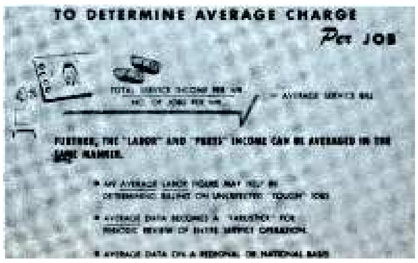
What do we mean by a flat-rate service charge (also called a minimum charge)? A flat rate is a fixed amount charged by the shop to cover the first 15 or 30 minutes the technician spends in the home repairing a product. It is for labor only; parts are extra. Any time spent on the job over and above the initial period is generally charged for at an hourly rate. Existing flat-rate service charges vary with geographic location, but most of them fall within the range of $3.95 to $6.95 for black-and-white TV sets. A chart comparing color-service charges with those for monochrome sets appeared in the November issue of PF REPORTER.

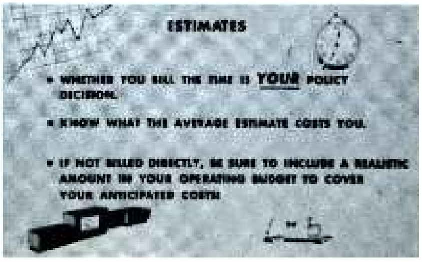
There are three important items you should weigh when establishing a flat-rate charge, apart from consideration of what is normal in your area. These items are overhead costs, direct costs, and a margin for profit. Overhead costs are, of course, items such as heat and light, rent, office-personnel salaries, truck expense, reserve for depreciation, reserve for bad debts, and a host of others, all of which must be prorated over the total number of service calls. Direct costs would be mainly the technician's hourly wage.

Making It Work

One thing you will have to overcome, when you first start using a flat-rate charge, is customer resistance. There are two customer ob-







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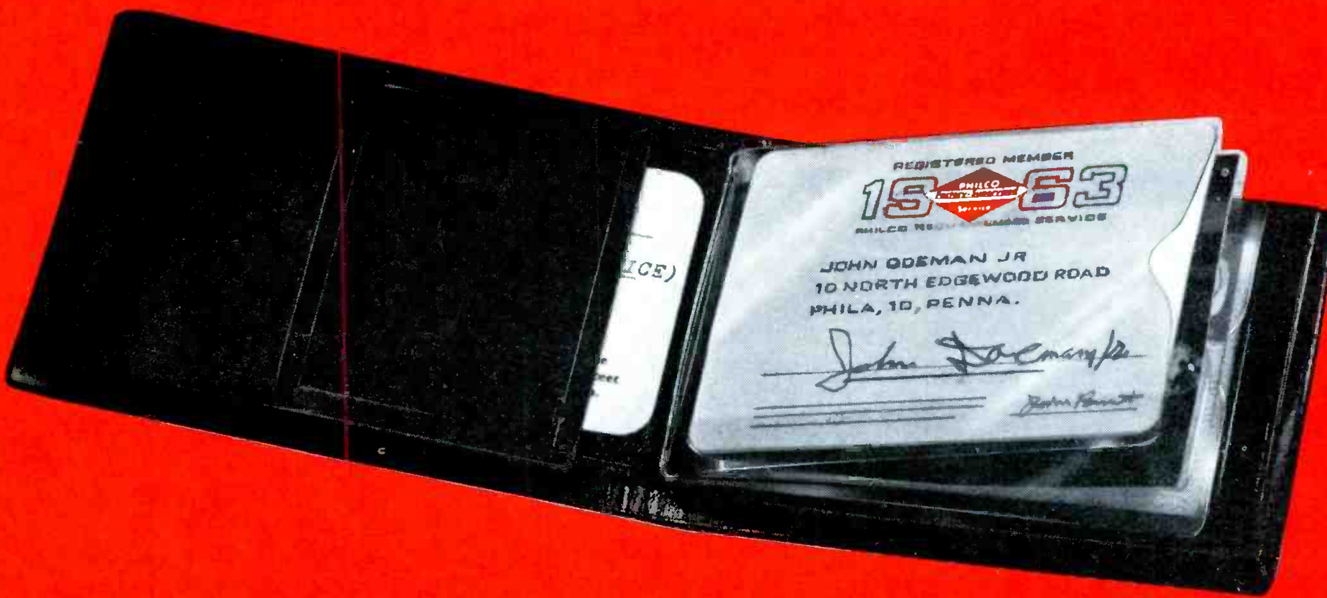

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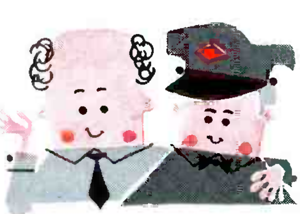

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jections most frequently encountered in conjunction with the flat rate. The first is raised when the trouble appears minor and the technician spends only a few minutes on the job. The second objection occurs when the customer decides not to let you fix the set because the cost will be too great. Let's examine these objections, one at a time.

Take the Bull By the Horns

The best way to avoid misunderstandings is to make your terms clear to the customer from the beginning. When a customer phones in for service, you might say this:

"Thank you for calling, Mr. Jones. We'll schedule your call right away. Meanwhile, I'd like to point out that we charge a flat service fee of $5.95 for the first half-hour of work, in addition to any parts your set may need. Except in cases of more serious trouble, most of our service calls are completed in less than a half-hour. However, if we find that we must remove the chassis and bring it to our shop, we then charge our shop rate of $4.50 an hour. The $5.95 charge then applies as a service-call, pickup, and delivery charge. What time today will you be home so our serviceman can make the call?"

This approach, although it may seem that it would discourage the customer, actually smoothes the way —sidestepping any future misunderstandings. If the message is conveyed in a friendly, cheerful tone, the customer will not be likely to object. The use of a flat-rate charge is not new to him by any means, and if he approves, he will be less apt to raise a fuss if the service call happens to be brief.

Print It on Your Invoice

Another approach is a bit more defensive, but it also works. A statement is printed in bold type right on the face of the invoice, so the customer can't fail to see it: "Work performed in the customer's home during the first half-hour of a service call is charged for at our standard flat rate of $5.95." Some service shops, in a bid for better customer understanding, have also printed a short explanation of the reasons for the flat charge, citing some of the expenses entailed in getting the technician to the home. However, this kind of explanation usually appears on the back of the invoice.

The drawback to this approach is, of course, that the customer doesn't get to see it until the work is already done, when it's too late to avoid an objection and too late to do much about it. But the information on the invoice at least proves to the customer it's a standard practice of the shop and he isn't being "taken."

If you're good at stories, tell this one to an objecting customer: A plumber was called in to repair a balky furnace boiler. He stood back and studied it a few minutes, then took out a smaller hammer and tapped the boiler lightly a couple of times. He then made out a bill for $10.10, and left. Pretty soon, he got a phone call from the customer, who acknowledged that the boiler was now working fine, but wondered how the plumber could justify such an outsized bill for so little

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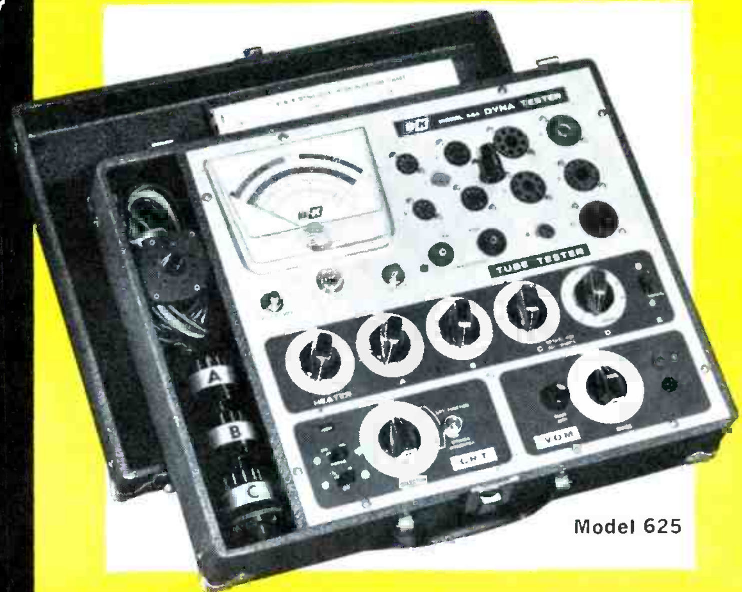

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1 TUBE TESTER 2 VOM 3 CRT

Unique new B&K design now simplifies servicing in the home or in the shop. Combines Tube Tester, Volt-Ohm-Milliammeter, and Cathode Rejuvenator Tester in one compact, professional quality instrument—at low cost!

1 TUBE TESTER SECTION is fast and accurate. Tests the *newest* tube types as well as all of the *old* commonly used tubes in TV and radio sets. Tests the Nuvistors and Novars, the new 10-pin tubes and 12-pin Compactrons. Tests voltage regulators, thyratrons, auto radio hybrid tubes, European hi-fi tubes, and most industrial types. Checks for *all* shorts, grid emission, leakage and gas. Provides *adjustable* grid emission check with exceptional sensitivity to over 100 megohms. *Checks each section* of multi-section tubes separately. Checks tube quality and capability of cathode emission under current loads simulating actual operating conditions.

2 VOM SECTION provides the 7 most-used ranges for convenient TV testing:

3 DC Ranges: 0-10, 100, 1000 volts
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1 Resistance Range: 3 k center scale

3 CRT SECTION spots picture tube trouble and corrects it in a few minutes right in the home, without removing tube from set. Tests and rejuvenates picture tubes at correct filament voltage from 1 to 50 volts. Checks for leakage, shorts, and emission. Removes inter-element shorts and leakage. Restores emission and brightness. (Checks and repairs color picture tubes with B&K Accessory C40 Adapter.)

Model 625 Dyna-Tester complete in handsome, lightweight, leatherette-covered carry-case.
Size: 11¾" x 15" x 4½". Net, $\$139^{95}$

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

Model 960 Transistor Radio Analyst

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Model 1076 Television Analyst

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work. The plumber sent the customer the following itemized bill:

For services, tapping boiler with hammer	$ 0.10
For the education, know-how, and experience that taught me where to tap and how hard	10.00
Total	$10.10

Estimates

The other possible objection to the flat service charge may come from customers who decide not to go ahead with repairs when they are told the possible cost. The best answer to this dilemma is to develop a policy on estimates, and then stick to it. Here are some of the possibilities:

No charge for estimates. This is much more costly than you may think. The profit margin—even on profitable calls—is too narrow, the individual sale is too small, and costs are too high for the average service shop to be able to provide free estimates. Some charge must be made.

Nominal estimate charge — deductible. This is the most popular course, in which a special flat charge is made for estimates. Then, if the customer decides later to go ahead with the repair, the estimate charge is deducted from the final bill.

Full flat-rate charge. This might be the toughest course to pursue, since it is the hardest charge for the customer to swallow. No one likes to pay for intangibles, and nothing could be much more intangible than an estimate. However, if the charge is carefully explained when the customer asks for an estimate, there is little room left for argument.

Shop Jobs

How does all this affect the shop job? A flat-rate service charge is usually applied to a call made at the customer's house. Bench work at the shop is billed at an hourly rate, since bench jobs are presumably more complex than calls that can be completed in the home. With today's television sets being constructed as they are, pulling a chassis is often only a few minutes' work, and again you may run into a price objection:

"You charged me $5.95 for 15 minutes' work," says the customer.

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TESTS Nuvistors and Novars

TESTS the New 10-Pin Tubes

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DYNAMIC MUTUAL CONDUCTANCE TUBE TESTER

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

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

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

Makes complete tube test in seconds. Checks average set in a few minutes. Discovers weak tubes that need replacement. *Satisfies more customers. Sells more tubes. Saves call-backs. Insures your reputation. Pays for itself over and over again.* Net, $169.95

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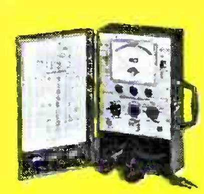

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"That figures out to $23.80 an hour. I don't even pay my psychiatrist that much!"

If you must pull a chassis, and are using the flat-rate service charge, explain it this way:

"Mr. Jones, I'm going to remove the chassis of your set and take it to our shop so we can service it with the benefit of our bench equipment. This is more economical for you in the long run, because I might have to spend hours trying to repair it in your home. The additional charges, over and above that for the first half-hour, would be wasteful, when we could fix it much faster in the shop. The flat-rate charge includes the time and expense of delivering and reinstalling the chassis. Thus, your overall bill will be less than if we tried to make such a complex repair in your home."

If this doesn't pacify your customer, then he probably should spend the money with his psychiatrist!

A New Slant on Profits

Since tube sales lost to the do-it-yourself tube testers *are* significant, you had better analyze your profit picture from a new standpoint. The television service technician is now being called in only when all else fails—including the tube-testing station! Gone forever, perhaps, are the parts profits of earlier years. (An article in the October PF REPORTER tells how you can help yourself recapture some of these profits.)

The best way to figure your flat-rate service charge is to ignore parts sales completely. Do it this way: Divide your total number of service calls during a certain period—say 6 months—into your total expenses for the same period. The result in dollars is the amount you have to receive from every service call to break even. Add to this a calculated percentage for your profit margin, plus a small additional safety margin, and you have a flat-rate service charge that will guarantee you a profit from every service call.

Once you have arrived at your figure, stick to it. With patience, courtesy, sincerity, and competent work, you can convince even the flintiest customer that you deserve a fair profit—and that you're determined to have it. ▲

take these boosters

in this caddy/pak

on every service call

NEW BLONDER-TONGUE CADDY/PAK BOOSTS BOOSTER SALES

TV Technicians — here's a bright new profit idea from Blonder-Tongue. Called the CADDY/PAK, it holds two indoor TV/FM boosters—one a transistor model, the other tubed — and fits easily in your tube caddy. The boosters are: the new all-transistor, model IT-4 Quadra-booster; and the industry's most reliable tubed model, the B-24c.

This combination makes it easy for you to give your customer the right booster for any reception situation. Remember, transistor boosters provide higher gain and are more rugged, but they have one problem — overload (windshield wiper effect, loss or sync). If you use a transistor booster in an area with one or more strong TV or FM signals — you may be buying too much booster. On the other hand, tubed boosters perform very well in these areas.

With the Blonder-Tongue CADDY/PAK you can demonstrate both tubed and transistor models in a jiffy, by connecting them to the terminals of the set. Either way your customer gets the finest indoor booster — a Blonder-Tongue.

The CADDY/PAK fits in your tube caddy. It's imprinted with the profit-producing words — "WANT A SHARPER TV PICTURE? ASK ME." You can place it on the set you are servicing and let it sell for you. And it reminds you and all your technicians to mention boosters on every service call.

You just can't help selling more — having more satisfied customers too — because they have the right booster.

Today, see your Blonder-Tongue distributor and get details on how you can get a free CADDY/PAK booster demo kit—the sure-fire approach to boosting booster sales.

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ANALYZING CLOSED LOOP SYSTEMS

Any technician's first encounter with a closed-loop control system can be challenging and informative, or disturbing and confusing — depending on his ability to analyze such systems. Only if he is armed with a knowledge of closed-loop theory, and acquainted with the concepts of error sensing and error correction, can he competently maintain and service such systems.

A closed-loop system is like other electronic circuits in that the amount of input determines the amount of output. However, it is distinguished from other systems by the fact that *the amount of output also has a direct bearing on the amount of input.* Because of this characteristic, the system is capable of maintaining its output at a constant, preselected value. If the output should attempt to change for any reason, the input will change accordingly, and the output will then be restored to its preset value.

A generalized block diagram of a closed-loop control system is shown in Fig. 1. As indicated, a portion of the output is fed back to the *error detector,* where it is compared to a reference input. If the feedback does not exactly match this reference input, the error detector produces an output signal. This is amplified and then applied to the error corrector, which alters the output of the system.

In a voltage-controlling system, for example, the phasing of the feedback is such that the error corrector will *reduce* the system output voltage if the feedback is greater than the reference input, or *increase* the output voltage if the feedback is less than the predetermined reference. In either case, the corrective action continues until the feedback exactly matches the reference input. At that time, the output of the error detector becomes zero and the corrective action stops. Such a system is said to be *degenerative* in its action.

The generalized block diagram in Fig. 1 is the basis for all closed-loop systems. Of course, countless variations and refinements of the basic system are possible, as required by the intended application. Regardless of the complexity of the system, however, the technician will experience little or no difficulty in analyzing and working with the equipment if he can recognize the basic components: error detector, reference input, amplifier, error corrector, and feedback.

The devices used as error detectors and correctors depend on the application of the closed-loop system. The quantity to be controlled may be temperature, pressure, rate of flow, mechanical position, motor speed, or almost any other element. Accordingly, the error detector might be a thermocouple, a pressure gauge, a rate meter, a feeler gauge, or a tachometer, while the error corrector might be a furnace heating element, a pump, a flow valve, or a motor.

To the control system, the reference input to the error detector represents the "desired" value of output, and the feedback represents the "actual" value of output. The error detector therefore produces a signal representing the difference between the desired and actual output quantities.

Feedback to the error detector may be mechanical, electrical, or both. In the case of the temperature controller, for example, the feedback may be a voltage from a thermocouple in the furnace. In the case of a pressure controller, feedback may be the mechanical position of a bellows, a Bourdon tube, or some other pressure-sensitive transducer.

Similarly, the reference input (also known as the *set point)* may be either electrical or mechanical. It may be a DC voltage that cancels the voltage of the thermocouple, or it may be the mechanical position of a potentiometer slider that matches the setting of a bellows-controlled potentiometer. To illustrate these variations, let's examine some typical examples.

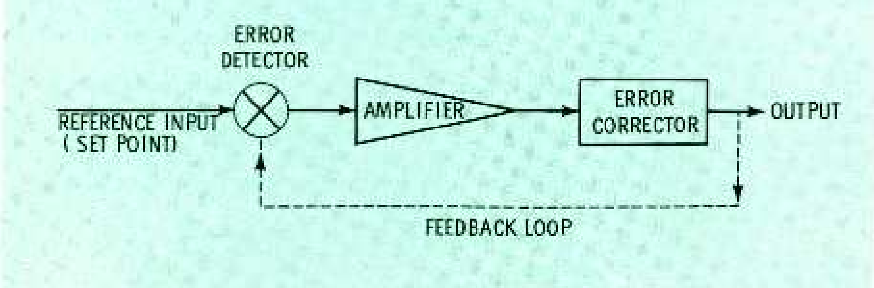

Fig. 1. Block diagram of closed-loop control system shows functional parts.

Error Detectors

A common system of error detection and correction for closed-loop temperature controllers is illustrated in Fig. 2. Potentiometer R, the *set point* control, supplies the reference voltage to which the feedback voltage is compared. This feedback voltage is derived from a

Our truck works on TV.

"Well, you see, the picture just went all fuzzy, and there's the big bowl game on tomorrow, and if you could get out right away, and . . ."

Sound familiar?

It does, if you're in the service business like Dick Searle. Dick's company (Searle Appliance of Seaside, California) has 3 Volkswagen Trucks.

Each VW is stocked with about 1000 pounds of spare parts (including the weight of the bins).

Yet, the surprising thing is: there's still room inside to tote 800 pounds more.

Which comes in handy when a bulky TV console can't be fixed in the owner's house.

Now then. Suppose you're on the way to fix that set for the guy who wants to see the big game.

And suppose there's a lot of snow and ice on the road.

If you're driving the VW, you'll have a pretty clear channel.

(Because our engine's in the rear. For extra traction.)

Which could very well keep you tuned in to an ultra high frequency of business.

Get the picture?

thermocouple placed in the furnace whose temperature is to be controlled.

When temperature is at the desired value, the reference voltage and the feedback voltage exactly cancel. As a result, there is no input to the amplifier and no corrective action. Should the temperature vary, however, the thermocouple will sense this variation, and the feedback voltage will change accordingly. Since the feedback voltage is then greater or lesser than the reference voltage (depending on whether the temperature has increased or decreased), the difference of these two voltages appears as an input to the amplifier. The amplified signal then actuates the error corrector to restore the temperature to the desired value. This corrector may be a fuel-flow valve or a saturable reactor (as described later) depending on the heating device.

In this manner, the control system tends to maintain the feedback voltage at a value equal to the reference voltage. Since the reference voltage can be adjusted by the *set point* control, the "desired" temperature can be easily obtained.

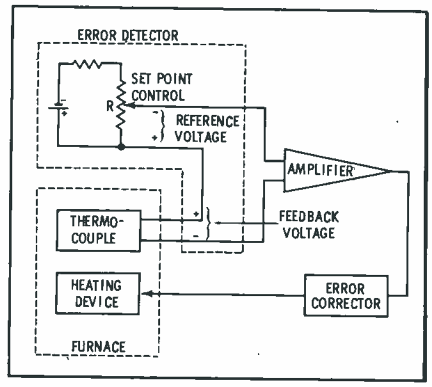

Fig. 2. Typical furnace-control system.

A pressure-control system is illustrated in Fig. 3. Here, two *differential transformers* produce the reference and feedback voltages. A differential transformer has two "bucking" secondaries and a movable core known as the armature. When the armature is centered, equal voltages are induced in the two opposing secondaries, and transformer output is zero. If the armature is moved away from its center or neutral position, unequal voltages are induced in the two secondaries of the transformer. Output is then equal to the *difference* between the two secondary voltages.

The armature of one of the transformers in Fig. 3 is positioned by a pressure-responsive bellows, and the other armature is manually positioned (by the set-point control) to represent the desired value of pressure. The outputs of the two transformers are connected series-opposing so the reference voltage will exactly cancel the feedback voltage as long as the pressure is at the desired value. Should the pressure attempt to change, however, the bellows will expand or contract and

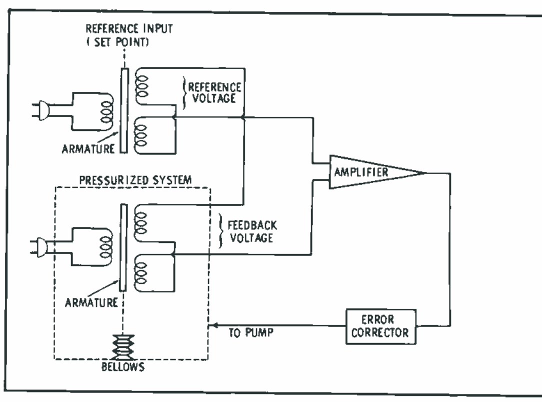

Fig. 3. Differential transformers are part of this pressure-control system.

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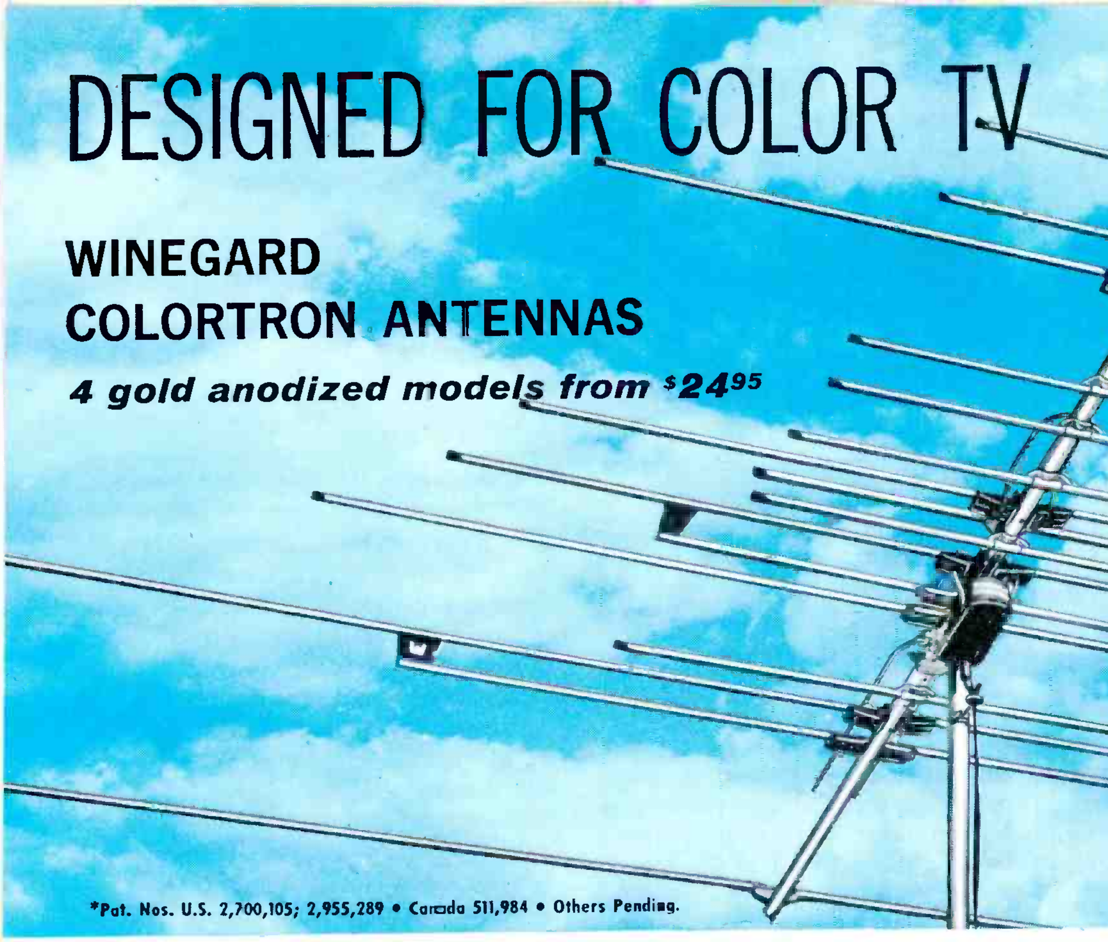

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New Winegard Colortron twin-nuvistor amplifier perfectly matches Colortron antennas. Gives added gain and sensitivity on both color and black and white. Ultra-low noise, high gain Colortron Nuvistor Amplifier can easily drive 6 or more TV sets.

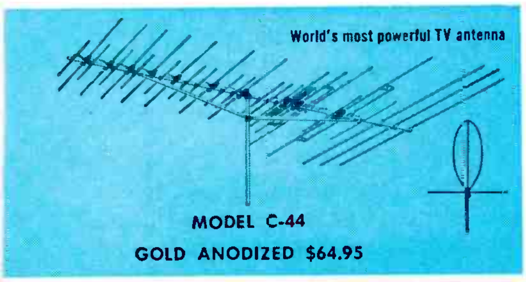
With revolutionary twin-nuvistor circuit, Colortron amplifiers can handle up to 400,000 micro-volts of signal without overloading. *This is 20 times better than any single transistor amplifier.* The Colortron Amplifier will bring the weakest signals up out of the snow, yet strong local TV & FM signals will not overload it. A special life saver circuit gives the two nuvistors a life of 5 to 8 years.

This amplifier is completely trouble free and the finest performing antenna amplifier you can own.

Completely weather sealed, nothing is exposed to corrode and cause trouble . . . has all AC power supply with 2 set coupler. (Model No. AP-220N, $39.95 list). Twin transistor model also available up to 80,000 micro-volts input. *New type circuit protects transistor from static electricity built up in lightning flashes.* (Model No. AP-220T, $39.95 list).

Colortron Amplifier can be added to any good TV antenna for sharper, clearer TV reception.

Ask your distributor or write for technical bulletin.



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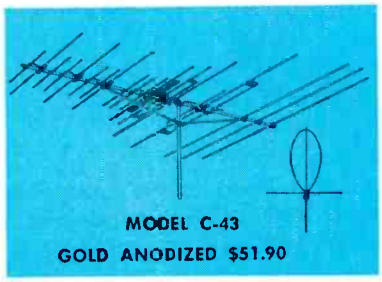

MODEL C-43
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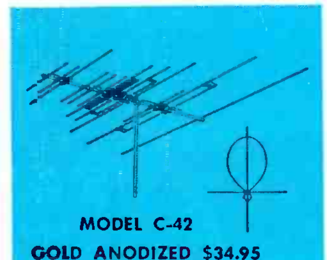

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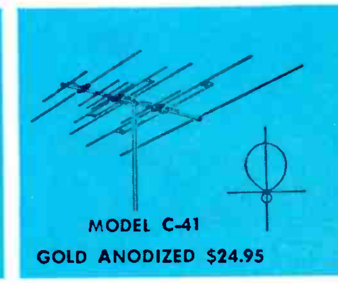

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will reposition its armature. Since the reference and feedback voltages no longer exactly cancel, an error signal will appear at the input of the amplifier. The amplified signal then actuates the error corrector (usually a motorized pump or plunger) to restore the pressure to the desired value.

When the quantity to be controlled is mechanical position, the system shown in Fig. 4 can be used. Such systems are used in machine-tool controls and for other applications requiring precise positioning of a mechanical object or load. The error detector is a simple bridge consisting of two potentiometers; R1 can be adjusted manually, while R2 is controlled by the position of the load. If the sliders of the two potentiometers are at corresponding positions, the reference and feedback voltages cancel exactly. But a shift in the position of the object connected to R2 will cause an error signal to appear at the input of the amplifier. The amplified signal then drives a servomotor which moves the load back into its proper position. Through a mechanical linkage, this repositioning of the load also repositions the slider of feedback potentiometer R2. When this slider arrives at a position corresponding to that of the set-point control, the corrective action stops and the load is left in the desired position.

Error Correctors

In response to an error signal, the error corrector must restore the output of the system to the desired value. Relays, saturable reactors, solenoid-operated valves, and two-

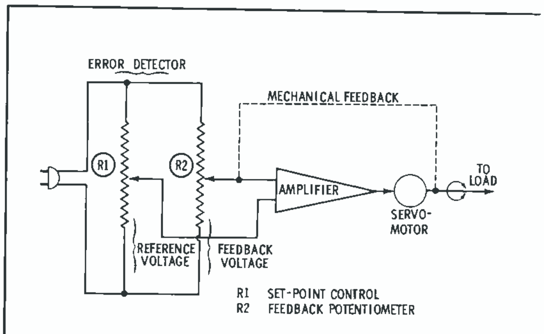


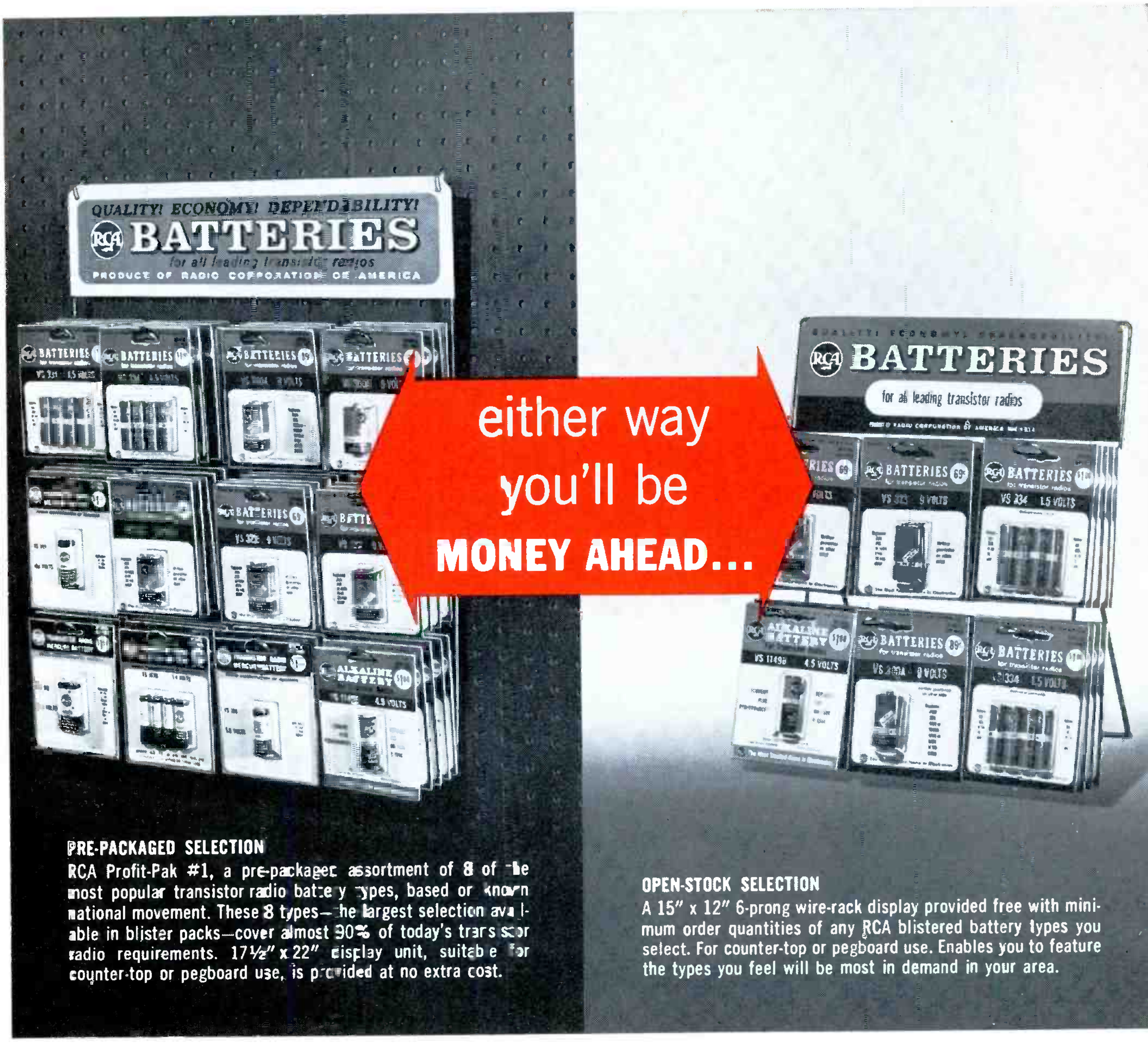
Fig. 4. Position of load object feeds control information to bridge circuit.

phase servomotors are typical error-correcting devices. Examples of these are illustrated in Fig. 5.

The relay is the simplest error corrector, but it is merely an on-off device and is not capable of *proportional* control. The furnace heater in Fig. 5A can be either on or off; it cannot be "partially on." The advantage of simplicity is therefore achieved at the sacrifice of closeness or sensitivity of control.

Much more accurate control can be attained by the use of a saturable reactor (Fig. 5B). Here, the furnace heater can be turned partially on to correct even slight deviations in temperature. The saturable inductor functions as a variable reactance in series with the furnace heater. The value of this reactance is determined by the core saturation, and because the degree of saturation depends on the amount of DC current in the control winding, the DC error signal ultimately determines the AC current in the furnace heater.

A flow-rate type of error corrector is illustrated in Fig. 5C. Depending on the polarity of the error signal, the "stepping" solenoid either opens the valve wider or



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Patterns: Color bars, White dots, Crosshatch, V bars, H bars. **RF Output and Sound Carrier:** Available on channel 3 or 4; field adjustable. RF output 50 mv max. Sound 10% of picture carrier. **Simple 300-Ohm Connection** to antenna input terminals of receiver. **No External Sync. Signals** required to lock in test patterns. **Master Voltage-Regulated, Crystal-Controlled Oscillator** operating on 189 kc assures stability of displayed patterns. **Easier Convergence Set-Ups:** Separate vertical and horizontal bar patterns. **Optimum Convergence Adjustments:** Extremely fine, well-defined dot pattern. **Color Bars:** A reference test signal, precisely controlled, produces 10 equally spaced color bars across face of TV receiver under test. Included are the color bars corresponding to R-Y, G-Y, B-Y, I and Q signals.

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For mechanical position control, a two-phase servomotor is commonly employed. As shown in Fig. 5D, the motor has two windings: the main field and the control field. The main field is connected to the power line, and the control field is energized by the error signal. The direction of rotation for the motor is determined by the phase of whatever signal is applied to the control field, and since the phase of this signal is determined by the direction of error in the system, the motor rotates in the direction necessary to reduce the error to zero.

Amplifiers

Amplifiers for closed-loop control systems are not unusual either in theory or in circuit configuration. They are, in fact, essentially similar to amplifiers used in audio equipment. The basic requirements are that the amplifiers have sufficient gain to respond to a low-level error signal, and the output power be adequate to drive the error-correcting device. These requirements can be met by either vacuum-tube or transistor amplifiers, both of which are used in practice.

When required for a particular application, certain special features can be incorporated in the amplifier. If, for example, the output of the error detector is DC rather than AC, coupling capacitors or transformers cannot be used in the amplifier; the stages must be direct-coupled to handle the DC error voltage.

Since direct-coupled amplifiers tend to be critical and unstable with respect to power-supply and temperature variations, a *chopper* amplifier is often preferred as an alternative to a direct coupling. The chopper is an electromechanical device resembling the vibrator of an automobile radio. Its vibrating reed literally "chops" the DC error voltage by periodically interrupting the input to the amplifier. As a result, the DC error voltage is converted to a proportionate pulsed voltage which can then be amplified in a conventional RC- or transformer-coupled circuit. If necessary, this pulsed error voltage can be rectified at the amplifier output to produce a DC correction voltage.

Another special feature sometimes included in the amplifier is a differentiator/integrator network. These RC circuits are sometimes referred to as lead or lag networks. A differentiator improves the corrective ability of the system by making its action primarily dependent on the *rate* at which the error is occurring or output is changing. An integrator network relates the corrective action to the *length of time* the error has existed. These features can thus compensate for the time lag of the control action, improve the response time of the system, and stabilize the system against sustained oscillation (known as hunting).

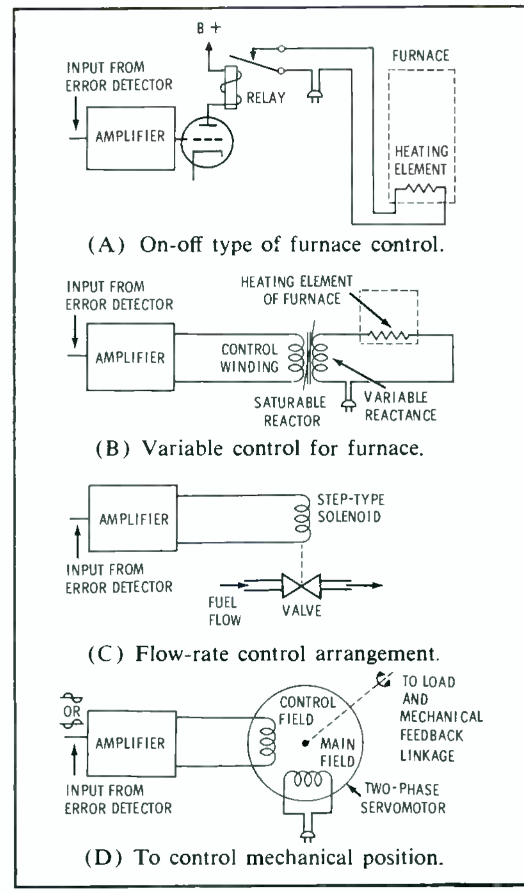

Fig. 5. Various error-correction units for use in closed-loop control systems.

Conclusion

The radio-TV technician needn't be reluctant to tackle the closed-loop control systems used in industry. He will find that the mystery of closed-loop control vanishes as soon as he has learned to identify the basic functional components: error detector, amplifier, error corrector, feedback, and set-point control. Once he has done this, he can approach the task with a feeling of confidence and competence. ▲

by George F. Corne, Jr.

CIRCUIT TRACING PRINTED BOARDS

Many technicians still have a great deal of difficulty tracing circuits on printed boards, for a number of reasons: unfamiliarity with the layout of foil patterns, trouble in lining up components on one side of the board with foil connections on the other side, and partial concealment (in some cases, inaccessibility) of portions of the board. But, these difficulties can be overcome by greater familiarity with typical board construction, and adopting some of the following proven methods of board tracing. When you know several different tracing techniques, you won't be stymied by any type of board layout or mounting arrangement.

Light As an Aid

If the underside of the board is not obstructed by a shield or solid baseplate, your best means of tracing component connections and circuit wiring is to shine a bright light on one side of the board, while viewing the other side. (This is the standard method adopted by most service technicians—simply because it's the quickest and easiest.)

Fig. 1 shows this method in operation. A bright light, placed beneath the underside of the board, illuminates it sufficiently to let you see the outline of the printed foil from the top side. The tip of a soldering aid can now be used to pinpoint a particular junction on either the top or the bottom side of the board. By moving the light to the other side, you can see the outline of the components while inspecting the foil conductors.

The area of the board in Fig. 1 is fairly large, so a large light was used. In tight places, or if you're servicing small printed boards, try using the lighting aids shown in Fig. 2. A 7-watt light bulb, inserted into a pencil iron in place of the heating

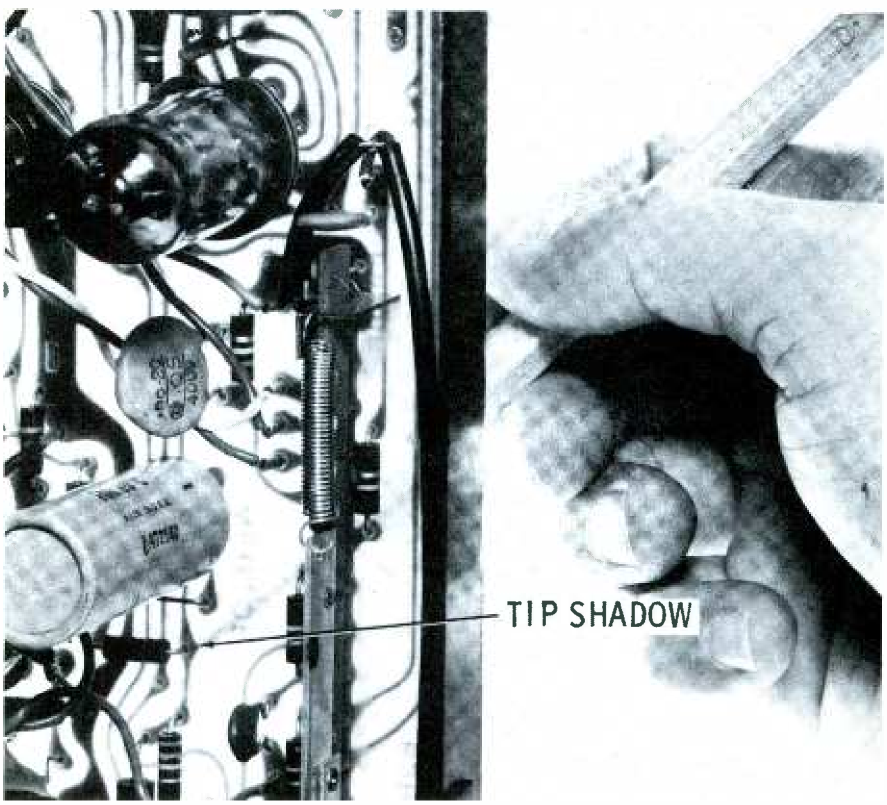

Fig. 1. Bright light makes copper foil pattern visible through board.

Fig. 2. Small lights aid tracing.

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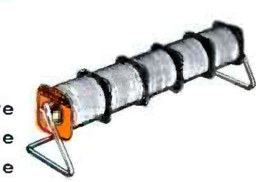

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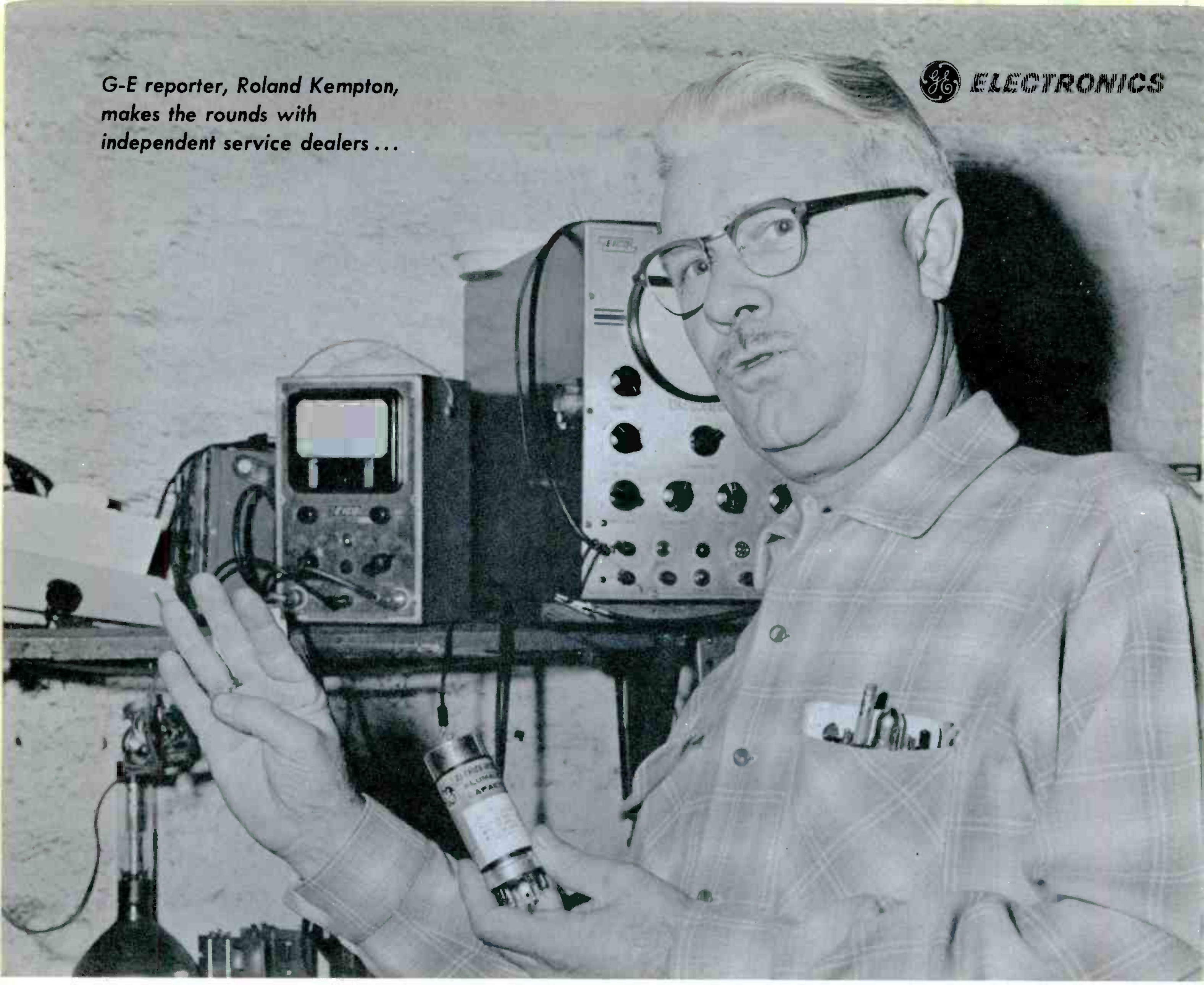

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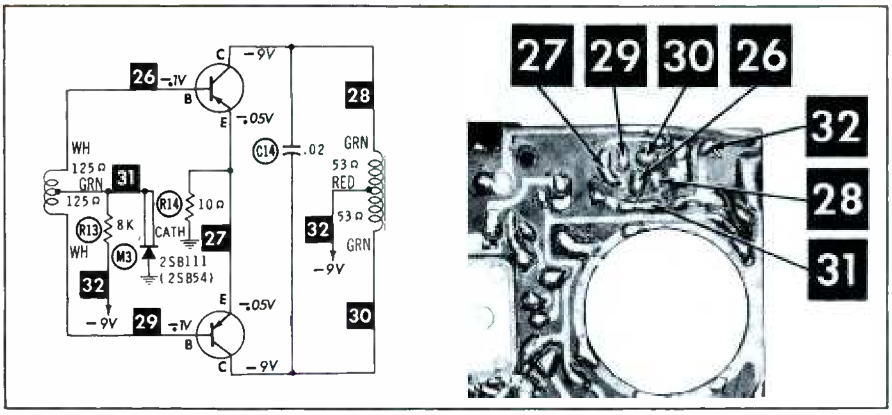


Fig. 3. CircuiTrace feature of schematic is an excellent aid to measurements.

element, permits small-area lighting in confined places. The small pencil-like inspection lamp in the lower photo can be used to the same advantage. (Incidentally, the radio being serviced in this photo is supported on an ingenious homemade test jig made from a pegboard base, dowel-rod supports, and wooden mounting brackets. This device simplifies the task of "getting at" the printed board and its components.)

Tracing by Numbers

While you're tracing a circuit, do you make the most of the *CircuiTrace* feature in PHOTOFACT Folders? Correlating the special numbers marked on the schematic with a separate photograph provided for this function (see the example in Fig. 3) can be an invaluable aid to servicing. For instance, it's a simple matter to place your ohmmeter leads on two numbered points and check the resistance of the circuit between them.

Hidden Paths

Pointed out in Fig. 4 is a hidden circuit path of a type found in many sets today. The B–minus connection to two capacitors is completed via an IF-transformer shield, rather than by a copper-foil conductor. If one of the ground tabs on the shield happens to be making poor contact (as from a cold-soldered joint), the B–minus circuit to the two capacitors will also be broken.

IF shields aren't the only components used in this manner. Also look for similar ground paths through filter cans or the cases of iron-core transformers. The latter components, due to their bulk and weight, are prone to break copper-foil connections more often than other components. Don't overlook these "hidden circuits," especially in imported equipment.

Top-Side Servicing

The printed board in Fig. 5 (from an imported transistor tape recorder) is mounted on a solid metal plate which blocks access to the underside of the board. Equipment constructed in this manner requires a switch in tracing tactics, since you're restricted to *component-side* tracing unless you wish to remove the entire board from its mounting.

A cross-reference between the schematic and the components on the board will enable you to continuity-trace the foil wiring without actually being able to see the underside of the board. Just about your fastest method of tracing the circuit is to connect one lead of your ohmmeter to an identified component lead, touching the other meter probe to different component leads in the same area; when you find zero resistance, you've located a point common to the circuit you're

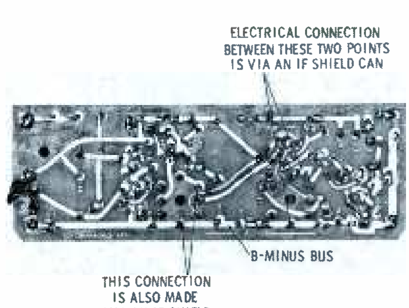
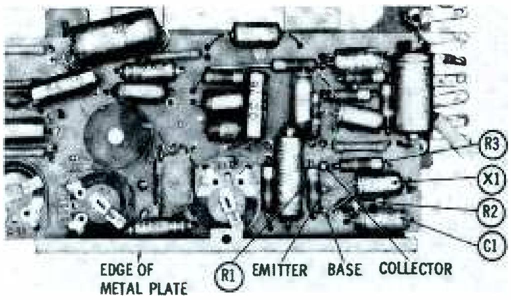


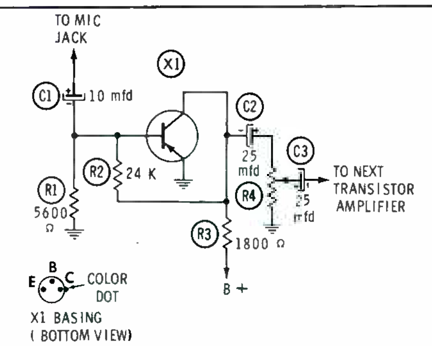
Fig. 4. Circuit continuity is "hidden."

checking. (A word of caution: when tracing through equipment containing transistors, keep your ohmmeter range switch above the R x 1 scale. The voltage applied to the circuit when this range is used might be enough to cause excessive current to flow through a transistor, ruining it.)

Referring to Fig. 5 again, let's see what *landmarks* would be good to use, if we need to trace the amplifier circuit. The transistor in this instance, and in the majority of other transistorized equipment, is your best starting point. Its elements are easily identified by reference to the basing diagram shown on the schematic. Most times, the external circuit components are mounted in close proximity to the related transistors or other major components (though you can't *always* assume they are). Large components, such as the signal-coupling electrolytics C1, C2, and C3, are easily identified; readable values are normally printed on each. Resistor values are another aid, even when these components are not mounted physically



(A) Board and mounting plate.



(B) Schematic of X1 circuit.

Fig. 5. This printed board requires servicing from the component side.

close to other parts in the same stage. Resistor values don't usually repeat too many times in one circuit; even when they do, a continuity check makes it easy to distinguish which is which.

The remaining stages in this recorder, and in any other equipment containing obscured printed circuit boards, can be traced in a like manner. It's almost always faster than board disassembly!

Methods of replacing components from the top side of printed boards appeared in the July, 1962 issue of PF REPORTER. The reader may wish to review the service tips contained in that issue.

Board Markings

Some manufacturers print service information on one or both sides of a printed board. The extent of the markings varies among sets; a "road

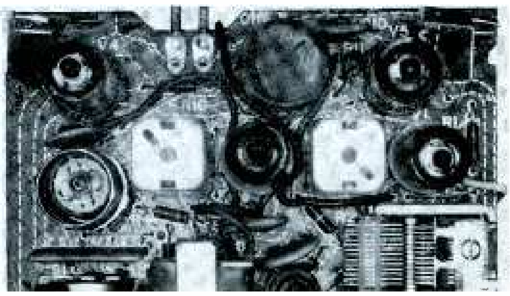
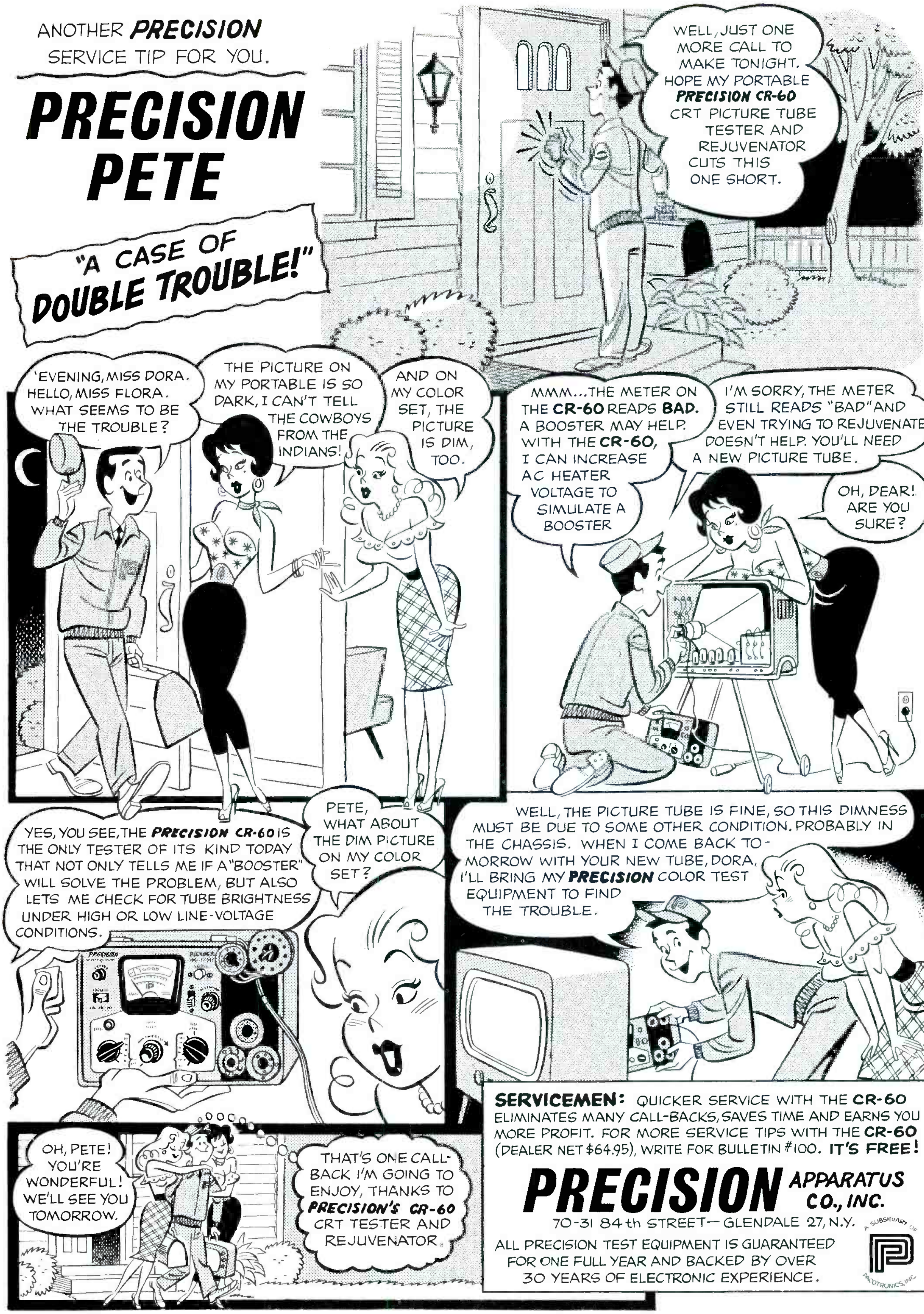


Fig. 6. Dotted lines on the top side of the board indicate foil circuits.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PRECISION PETE
"A CASE OF DOUBLE TROUBLE!"
WELL, JUST ONE MORE CALL TO MAKE TONIGHT. HOPE MY PORTABLE PRECISION CR-60 CRT PICTURE TUBE TESTER AND REJUVENATOR CUTS THIS ONE SHORT.
'EVENING, MISS DORA. HELLO, MISS FLORA. WHAT SEEMS TO BE THE TROUBLE?
THE PICTURE ON MY PORTABLE IS SO DARK, I CAN'T TELL THE COWBOYS FROM THE INDIANS!
AND ON MY COLOR SET, THE PICTURE IS DIM, TOO.
MMM... THE METER ON THE CR-60 READS BAD. A BOOSTER MAY HELP. WITH THE CR-60, I CAN INCREASE AC HEATER VOLTAGE TO SIMULATE A BOOSTER
I'M SORRY, THE METER STILL READS "BAD" AND EVEN TRYING TO REJUVENATE DOESN'T HELP. YOU'LL NEED A NEW PICTURE TUBE.
OH, DEAR! ARE YOU SURE?
YES, YOU SEE, THE PRECISION CR-60 IS THE ONLY TESTER OF ITS KIND TODAY THAT NOT ONLY TELLS ME IF A "BOOSTER" WILL SOLVE THE PROBLEM, BUT ALSO LETS ME CHECK FOR TUBE BRIGHTNESS UNDER HIGH OR LOW LINE-VOLTAGE CONDITIONS.
PETE, WHAT ABOUT THE DIM PICTURE ON MY COLOR SET?
WELL, THE PICTURE TUBE IS FINE, SO THIS DIMNESS MUST BE DUE TO SOME OTHER CONDITION. PROBABLY IN THE CHASSIS. WHEN I COME BACK TOMORROW WITH YOUR NEW TUBE, DORA, I'LL BRING MY PRECISION COLOR TEST EQUIPMENT TO FIND THE TROUBLE.
OH, PETE! YOU'RE WONDERFUL! WE'LL SEE YOU TOMORROW.
THAT'S ONE CALL-BACK I'M GOING TO ENJOY, THANKS TO PRECISION'S CR-60 CRT TESTER AND REJUVENATOR.
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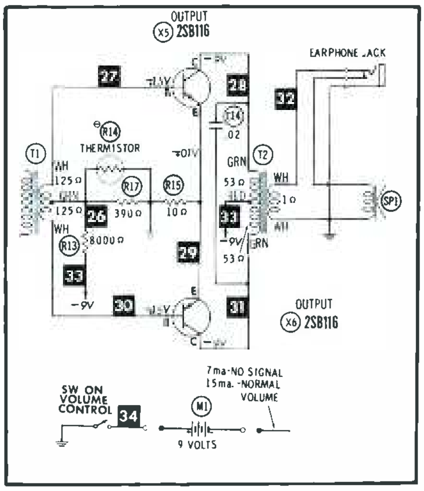
map" of dotted or solid lines may follow the complete foil-side pattern (see Fig. 6), component-identification numbers or symbols may be printed on the top or bottom of the board, and pin 1 of a tube socket may be marked with an arrow or indicating tab. Often, in transistorized sets, the elements of the transistor—B, E, and C—are the only marks which appear on the foil side of the board.

Fig. 7 shows a printed board with markings of the latter type. This particular radio, a *Realtone* (covered in PHOTOFACT Folder 575-12, had an unusual symptom: the radio remained *on,* with very low volume, after the switch was moved to the *off* position.

The first thought that enters your mind at this time might be the same one that occurred to the technician servicing the radio—perhaps the on-off switch was defective and was remaining in the closed position. But this wasn't the case here.

Refer to Fig. 7 once more; this time, closely examine the partial schematic and the close-up photo of the board. Notice that an excess of solder has placed a short from



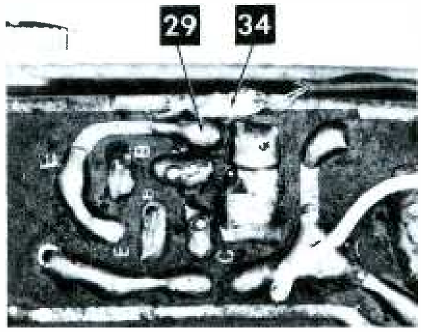


Fig. 7. "Blob" of solder caused short circuit between the strips of foil.

point 34 (the positive battery lead) to point 29 (the common connection for the emitters of X5 and X6). The 10-ohm common emitter resistor, R15, completed an electrical path from the positive side of the battery to ground. This, in turn, permitted the radio to remain operative—with low volume, but still playing.

Here's a final tip, applicable to transistor radios: Be sure you reconnect leads from external components—especially speaker leads—to their original connection points on the printed board. Several transistor radios developed a howl or squeal (due to a feedback loop) when this practice was not followed. This trouble seldom happens, but it's time-consuming and frustrating to locate if it does!

Cure for Broken CRT Lead

Many times a service technician is faced with the problem of how to repair a picture tube when a lead breaks off flush with the glass base, or just below its surface. Attempts to solder a small wire onto the remaining stub sometimes result in temporary success; but the connection usually fails in a short time,

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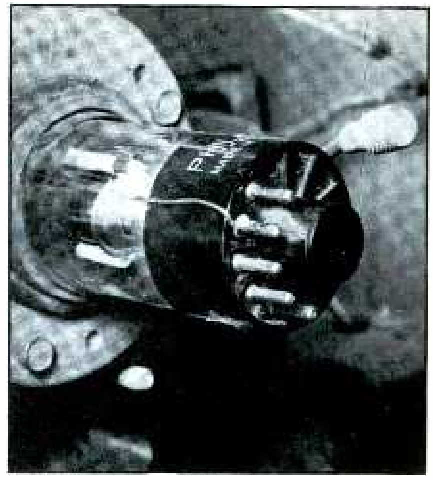


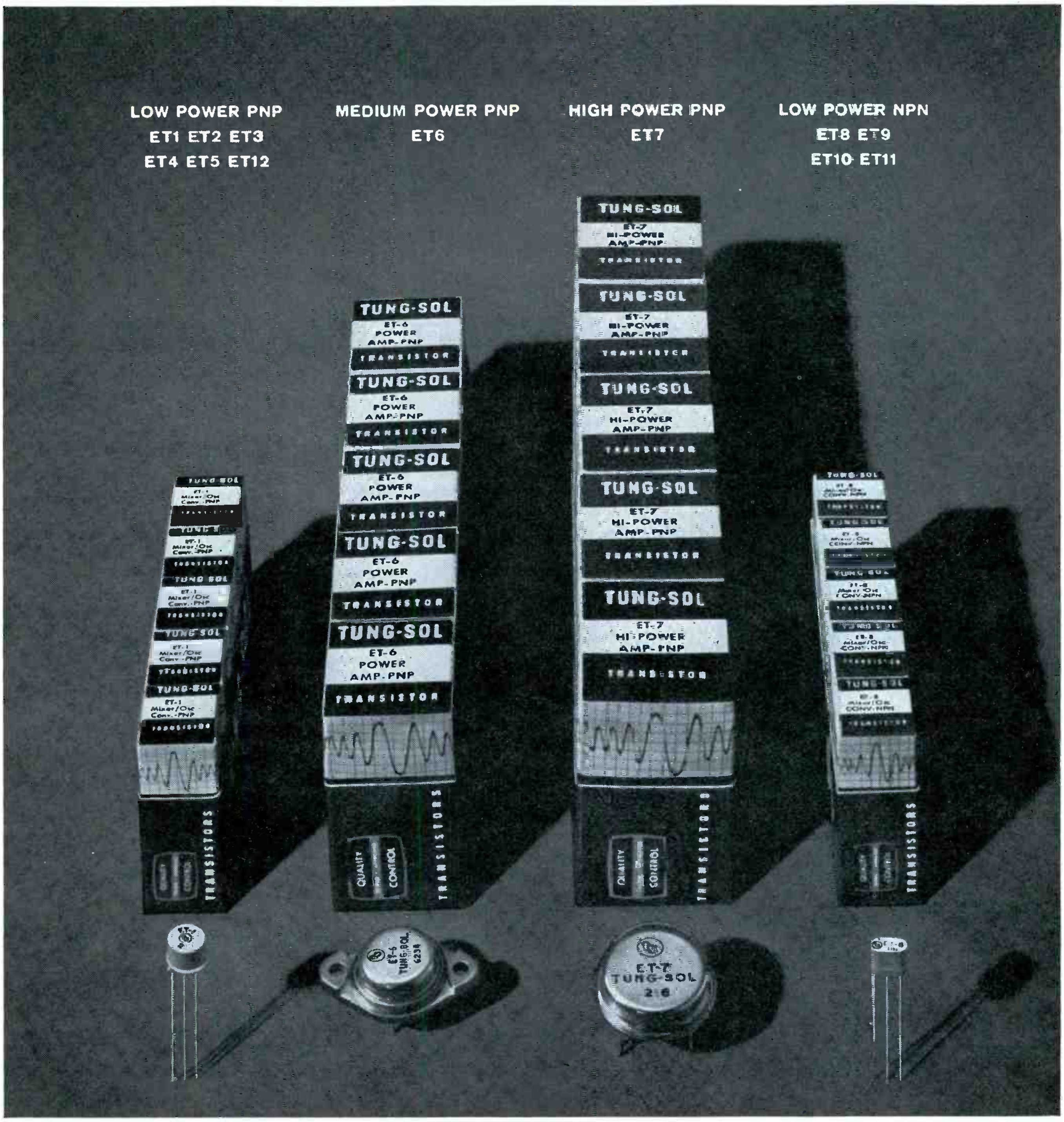
due to crystallization of the solder connection. In most cases where the break occurs below the surface of the glass, attempts to repair the lead by soldering usually waste time and result only in frustration.

What the technician seems to need in this instance is some conductive material which would flow down into the glass around the remainder of the wire lead, without requiring solder or heat. A substance which answers this description is G-C *Silver-Print,* which consists of pure silver in a liquid suspension that can be applied just like paint. When dry, it has virtually zero resistance, and resembles a strip of printed-circuit foil. Solder connections can be made to it, using the same low-heat precautions that apply to printed wiring.

To repair a CRT base connection, thoroughly clean the area around the lead and place a small drop of the *Silver-Print* over the broken end. Force as much as possible of the paint down around what is left of the lead. Then, from that point, apply a strip of the conductive paint around the bottom of the glass, and up onto the neck of the tube. Allow it to dry thoroughly for at least an hour.

Replace the CRT base as usual, and solder the rest of the leads.

After the paint has dried, solder a small wire onto the strip of paint extending up onto the neck; run this wire back to the appropriate base pin, and solder. Cement or tape the CRT base tightly in place, and tape over the silver strip to hold the wire in place. This results in a permanent repair, and eliminates the tedious task of trying to solder onto broken leads. ▲



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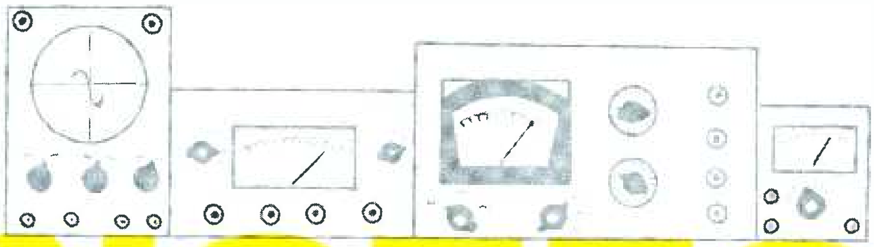

NOTES ON TEST EQUIPMENT

by Forest H. Belt

Travelin' Tester

Basic test facilities for home service calls are contained in the Model 625 *Dyna Tester* (Fig. 1), made by B & K Mfg. Div. of Dynascan Corp. In one portable package, it combines the functions of a tube checker, CRT tester-rejuvenator, and volt-ohmmeter.

Specifications are:

1. *Power Required—105-125 volts AC; 50-60 cps.*
2. *Tubes Tested—receiving types, including compactrons, 10-pin units, novars, and nuvistors; TV picture tubes.*
3. *Tests Performed — interelement shorts and cathode emission of receiving tubes and CRT's; grid emission, gas, and high-resistance grid-cathode leakage in receiving tubes.*
4. *Other Features —* DYNAMIC INTENSIFIER *circuit removes interelement shorts and reactivates cathodes in CRT's; volt-ohmmeter section allows utilizing panel meter for making voltage and resistance checks.*
5. *DC Voltmeter—three ranges: from 0 to 10, 100, and 1000 volts DC; sensitivity 1000 ohms per volt.*
6. *AC Voltmeter—three ranges: from 0 to 10, 100, and 1000 volts rms; sensitivity 1000 ohms per volt.*
7. *Ohmmeter—one range, for measuring values of 1 megohm or less; center-scale reading approximately 3K ohms; maximum voltage impressed across ohmmeter leads, 3 volts (derived from AC supply of instrument).*
8. *Panel Meter—face size 4½"; sensitivity 1 ma; scales:* GRID EMISSION-REJECT *and* REPLACE-?-GOOD, *for receiving tubes;* BAD-GOOD, *for CRT's; 0-120 numerical scale, for all tubes; 0-1M, for ohmmeter; 0-10, for all AC-DC voltmeter ranges except 10 volts AC; special 0-10 scale for 10-volt AC range.*
9. *Controls and Terminals—*POWER OFF-ON *switch;* SELECTOR *switch; G-2* LO-HI *switch and* DYNAMIC INTENSIFIER *push button for CRT functions; five rotary switches (*HEATER*, A, B, C, and D) and one slide switch (E) for setting up receiving-tube tests;* GRID EMISSION *and* QUALITY *push buttons for testing receiving tubes; neon* SHORTS *indicator; 10 receiving-tube sockets; 7-and 9-pin straighteners; duodecal CRT test socket, on 3' extension cable; "A," "B," and "C" socket adapters for testing various 110° tubes (color-CRT tests require separately available C-40 Adapter); volt-ohmmeter* RANGE *switch,* OHMS ZERO *potentiometer, and two pin jacks labeled + and –; black and red VOM leads, each 44" long, terminated in alligator clips with insulated finger grips.*
10. *Size, Weight, Price—15" x 12" x 4⅞" overall; 11 lbs.; $139.95.*

The slim case, covered in charcoal-gray leatherette, has large metal bumpers on all corners to help it withstand rough handling. Setup information for receiving and picture tubes is printed on 7½" x 10" loose-leaf sheets fastened inside the cover. A spring clasp snaps over the right edge of the pages to hold them in place while the tester is being transported. The cover can be separated from the tester—almost too easily—if you should want to hold the chart up to a light for easier reading.

The master SELECTOR switch is located on the CRT section of the panel; in addition to choosing the tube-tester, CRT,

Fig. 1. "All-in-one" instrument is good item for home service calls.

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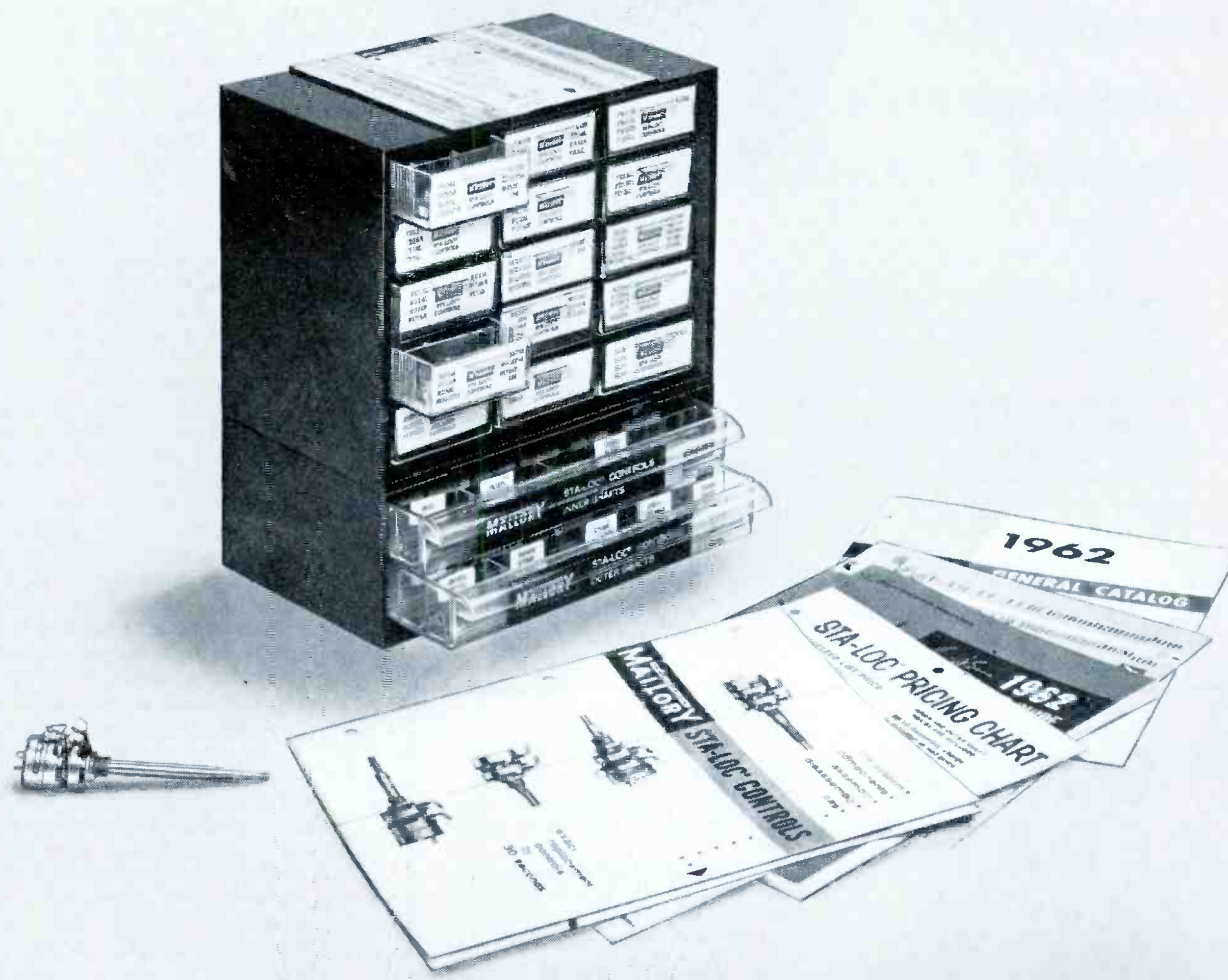
*U.S. Patent 2,958,838



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or VOM modes of operation, it is used for setting up the various CRT-test functions. The only other controls to be operated during most picture-tube tests are the HEATER switch and 12-position switch C. (The latter is rotated through all its positions to check for shorts on individual tube elements.) For the relatively few tube types that require an accelerating-grid voltage of less than 100 volts, the G-2 slide switch next to the SELECTOR is thrown to the LO position.

When the SELECTOR is turned from the SHORTS to the EMISS position, the meter immediately reads cathode emission. Two scales are provided: BAD-GOOD and a 0-120 linear scale. Our tests indicated that multiplying the numerical reading by 10 gives an approximate indication of the beam current in microamperes.

The next two positions, REMOVE SHORTS and DYN INT, are used in conjunction with the DYNAMIC INTENSIFIER push button. In the first of these positions, the CRT heater is de-energized, and a high voltage is applied to the electron gun to burn away shorts between elements. The DYN INT function, or cathode rejuvenation, is accomplished with heater power applied to the tube. The procedure is similar to that used in the B & K Model 440 *Cathode Rejuvenator Tester*.

We tried rejuvenating several picture tubes, with fair success. Best results were obtained with a metal-cone 17GP4, the *original* picture tube in a 10-year-old RCA set. The preliminary emission test

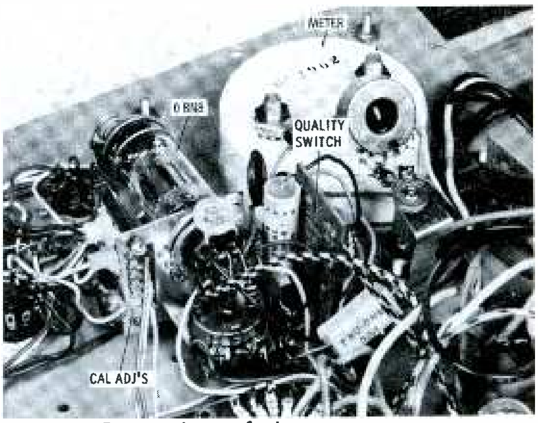


Fig. 2. Open view of the component arrangement in combination tester.

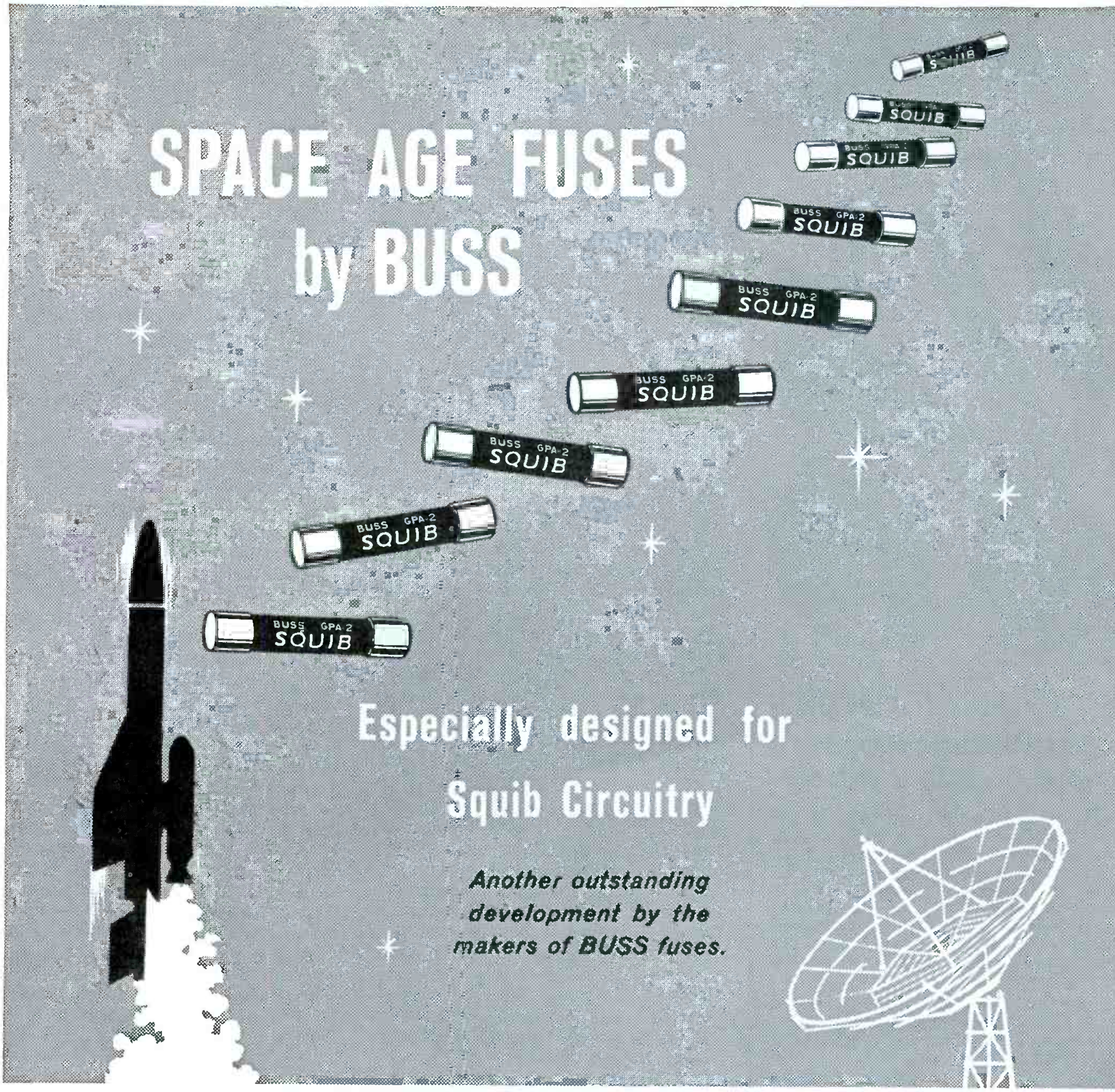
gave a reading of 15 on the 0-120 scale —definitely weak. After switching to DYN INT and holding down the button for 10 seconds, we retested the emission and noted a reading of 40. After several hours of receiver operation (on-off cycling), we checked emission again and found it had decreased to 22. However, the raster was still definitely brighter than before, and the tube's agonizingly slow warmup had been greatly speeded up. The only remaining fault was a washing out of highlight areas at the highest brightness-control settings—still not bad results for a tube that has been running on borrowed time for years.

For tests of receiving tubes, the Model 625 is quite similar to the "switch" section of the B & K Model 700 *Dyna-Quik* tester, covered in July, 1962 PF REPORTER. The sensitive grid-emission test circuit using a 6BN8—described in that article—is also found in the 625.

The 6BN8 is mounted on a bracket underneath the panel, as shown in Fig. 2. Adjoining it is a printed-circuit dual control whose sections are used to calibrate the separate 10- and 100-volt scales of the AC voltmeter. Behind the tube is the multisection slide switch actuated by the QUALITY push button.

Only three controls besides the heater switch ordinarily need reseting each time a tube is tested. These are the A potentiometer, which serves as a load adjustment to calibrate the REPLACE-?-GOOD scale, and the 12-position B and C switches, which set up the desired element connections. (Incidentally, the numbered position of the C switch corresponds to the pin number of the control grid in the tube section being tested—a handy way to identify which portion of a multisection tube is being tested.) The D and E switches at the right side of the panel are seldom moved from the position marked NORMAL, except for testing a few tvpes (such as novars) that require special element hookups. The SELECTOR is left in the TUBE TEST position.

As with CRT's, the check for shorts is made by rotating the C switch and watching for the neon SHORTS indicator to light. If it doesn't, the QUALITY button is pressed for an emission test; then it is released, and the GRID EMISSION button is operated to detect grid-circuit



The space-age speeded the need for Squib circuitry—and to meet the need for protection and control of such circuits, BUSS engineers worked closely with the engineers who design and produce Squib circuits.

The result is a line of BUSS Squib fuses that have the needed electrical characteristics and are almost unbelievably accurate and dependable.

Squib fuses are another example of BUSS leadership in the development of the complete line of fuses to keep pace with the needs of *science* and *industry*.

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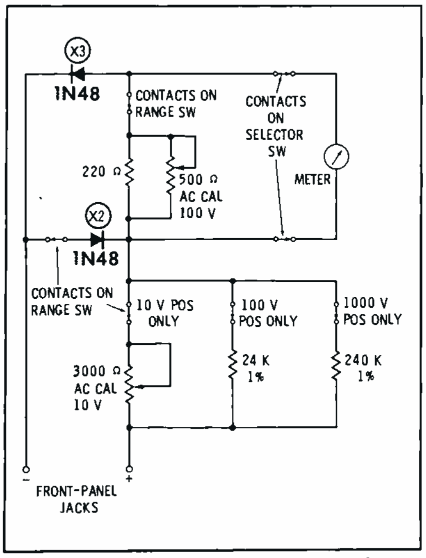

Fig. 3. Simplified schematic shows AC portion of VOM in Model 625.

faults (not only grid emission, but also gas and leakage).

We tried testing 25 tubes from our fiendish assortment of old "dogs" with known defects. The Model 625 completely missed only four of these, which have such subtle flaws that even our most complicated lab-type tester has trouble spotting them. However, we had to take considerable care with several other tubes to make them show up as defective. Quite a few of them will pass an emission test with flying colors, but they can be caught by the 625 in one of four other ways:

1. The highly sensitive *shorts* test. Even a moderate amount of leakage shows up as a faint glimmer of the neon bulb.
2. The *grid-emission* check, which detects even small leakages. The slightest grid fault in any of our tubes caused the meter pointer to kick upscale when the GRID EMISSION button was pressed. Although a small "good" area is marked at the left end of the grid-emission scale, we would suggest being suspicious of any tube that causes any meter action, *even if the pointer quickly drops back to zero.* Really severe grid troubles cause the pointer to come to rest in the REJECT area of the scale. Leakage in diodes also registers a reading in this test.
3. *Reducing heater voltage,* and checking emission to see if the reading dips or fades. (This is the same principle as employed in the "life" test of the Model 700 tester, although the 625 has no specific setup for a "life" test.) In some cases, the emission will fall off and then slowly climb back to the original value; in other cases, it will remain low. Most of the old, tired tubes in our collection showed this action; on newer tubes with reasonably normal transconductance, the lower heater voltage did not materially decrease the emission. This test is not foolproof; but, according to our observations, it correlates well with transconductance tests in numerous cases where a simple emission test is misleading.
4. *Increasing heater voltage* or using other means of thoroughly warming up the tube. Gas or grid emission is sometimes the only thing wrong with the tube, and no evidence of trouble may appear until the tube is actually hot to the touch. In stubborn cases, it takes several minutes to warm the tube up to this point. (During such extended tests, we got sore fingers from the tube-test buttons — which have hard metal edges and strong return springs. Finally we devised plastic caps for the buttons to ease this minor discomfort.)

Test results can be made more useful by keeping a record of the emission reading given by good tubes of various common types. In certain types, a moderately low emission indication—although still well within the GOOD area—is the main clue to a faulty tube.

The VOM section of the instrument is a simplified test unit, but nonetheless useful for the type of tests that would be made on a receiver while the chassis is still in the cabinet. Although the single ohmmeter scale is calibrated as high as 1 megohm, readings above 20K are too closely crowded to be used with any degree of accuracy; the center-scale reading is 3K. However, the meter can be used to check for continuity and to measure values of such components as power resistors. The test voltage is low enough (about 3 volts) to be safe for checking most transistors, diodes, and associated components.

The voltmeter (AC section shown in Fig. 3) is not sensitive enough to be fully satisfactory for detailed DC voltage checks or signal-amplitude measurements, but it can furnish much useful information during preliminary diagnosis of troubles. For instance, it can measure B+ and boost, check filament voltages (including drops across individual tubes in series strings), and test for the presence of voltages or signals at key check points. More and more of the new TV's are being built in such a way that a large number of points are accessible with the chassis still in the cabinet.

To summarize, the Model 625 contains a good complement of dependable test facilities that you can conveniently take with you wherever you go.

Sound Meter

A completely portable, battery-powered, transistorized sound-level indicator—the Model 450 Sound Meter (pictured in Fig. 4)—has recently been introduced by H. H. Scott, Inc., of Maynard, Mass. Specifications are:

1. *Power Required—single 22.5-volt battery; calibrating voltage taken from*

Fig. 4. Small-sized sound meter is useful for a large number of jobs.

117-volt AC line.

2. *Decibel Meter—ten ranges, in 10-db steps, from 40 db to 140 db (.0002 dynes/cm² reference).*
3. *Frequency Response — from 35 to 8000 cps; A, B, and C weighting conform to 1961 ASA standards.*
4. *Panel Meter—face size 2½"; 200-ua, 3000-ohm movement; scale reads from –2 db to +12 db, with* CAL *area and* BAT *check area.*
5. *Microphone — Rochelle-salt crystal type.*
6. *Controls and Terminals—rotary range switch, reading* OFF - CAL - *40 through 140; slide* WEIGHTING *switch; miniature push-button* BAT *switch for battery check; two "Tiniplug" jacks, labelled* INPUT *and* OUTPUT*: two-prong jack for calibrate cord (standard TV cheater cord);* CAL ADJ *potentiometer, accessible through hole in front panel.*
7. *Size, Weight—2" x 3" x 6"; 1 lb., 8 oz.*

Its small size makes the Model 450 Sound Meter a "pocket" instrument, easily taken along for almost any sound-system job—installation, new-system survey, noise elimination, hi-fi installation tuneup, or intercom system planning. Anywhere the need arises for measuring sound is a place for the Model 450, which can make many sound measurements previously requiring instruments that cost considerably more.

Fig. 5 shows the various stages in the instrument. The circuits utilize eight transistors in an extremely stable ampli-

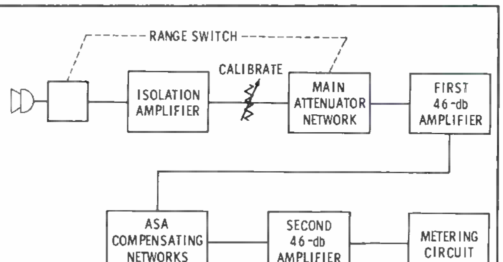

Fig. 5. Block diagram shows the relationships between various stages.

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Two-Way Radio Expedites Service

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Symfact — on 6DT6 Sound Detector

1962 Annual Subject Reference Index

fying arrangement. The crystal microphone picks up sound and/or noise, and feeds the signal through a portion of the main attenuator (range) network to he input amplifier. The two transistors that comprise this amplifier are wired as emitter followers, and serve only for isolation and stabilization. The output of this isolation amplifier goes through a calibration potentiometer, which is set to pass a predetermined portion of the signal voltage into the main attenuator—a network of resistors mounted on the range switch (visible in Fig. 6).

Fig. 7 shows a schematic of the 46-db amplifiers. X1 and X2 are common emitter amplifier circuits, in cascade, using direct coupling. Feedback network C2-R3 couples a small amount of signal from temperature-compensating resistor R4 back to the base of X1, improving the linearity of the first stage. X2, where most of the gain is developed, uses a bypass capacitor C3 across its emitter resistor. X3 operates in a common collector (emitter follower) circuit which isolates the 46-db amplifier from the circuit following—the compensating networks or the metering circuit. R8 furnishes an inverse feedback loop around the entire stage (via C2-R3) to hold the overall gain essentially constant under widely varying load conditions.

Following the first 46-db amplifier are the ASA compensating networks. ASA Standards were set up to approximate the human ear's response to sounds at varying levels. The Model 450 has a choice of A, B, or C weighting — respectively conforming with sound levels below 55 db, between 55 db and 85 db, and above 85 db. The weighting consists mostly of altering the response of the meter to frequencies below 1000 cps, since the human ear responds differently to these frequencies at different sound pressures (volume levels).

The metering circuit, which follows the second 46-db amplifier, is a VU meter of the type commonly used for sound and broadcast monitoring, modified to provide the accuracy needed for dependable sound-level readings.

Uses for the Model 450 are many and varied. Here are a few of the uses to which we put the instrument, and our results and conclusions:

Intercom planning. We made a survey of various office areas using the 450 to determine the ambient noise levels under different conditions. After finding the normal noise level, we were able to compute the requirements for a proposed intercom system. The average noise levels fell between 55 db for quiet offices and nearly 70 db for offices where typewriters were clattering. Since we decided to try for an intercom level 40 db above surrounding noise, it was obvious we would need equipment capable of providing a 110-db punch. This was an approximation, but useful for our purpose.

Paging system. In a certain factory area, noisy machinery ran the noise level to 85 db. To provide a 60-db paging

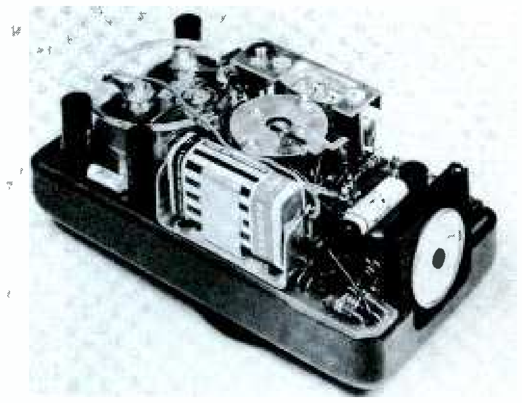

Fig. 6. Open view demonstrates the compact layout within the sound meter.

volume, we would have to provide 145 db of sound power in that area. This would be the job of the amplifier and speaker arrangement. Further tests could have been made with an amplifier and a few speakers, finding the best location for the speakers by measuring their effectiveness with the Model 450.

At the bench. Just for the novelty, and to test the usefulness of the instrument for such an application, we tried the Model 450 as an output meter during alignment of a couple of small transistor radios. We found we had the advantages and accuracy of "metered" alignment (instead of by ear) without making troublesome connections to the speaker leads. We merely placed the 450 near the set, turned up the volume, and adjusted the coils for maximum readings.

Hi-fi system. We also tried using the 450 to check the phase of speakers in a stereo system. Feeding a 1000-cps note to both channels—in phase—simultaneously, we found a point approximately equidistant between the two speakers and moved the Model 450 around in that area, noting the readings. Reversing the connections to one of the speakers resulted in a very noticeable drop (in one spot, from a reading of almost 75 db to 64 db) in sound level, caused by out-of-phase operation of the identical speakers.

For the audio technician, the hi-fi enthusiast, and the serious sound engineer, the Model 450 offers features heretofore found only in more expensive instruments. We found numerous uses for it in our lab, and consider it a useful item for anyone involved in sound work. ▲

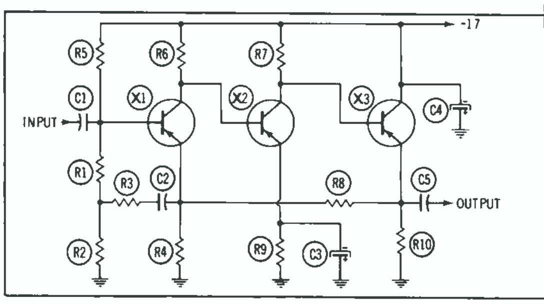

Fig. 7. This very stable amplifier is designed for gain of exactly 46 db.

FUSIBLE RESISTOR / CROSS REFERENCE GUIDE

Failure of fusible resistors is not an uncommon fault in television receivers and other home entertainment equipment. Of course, they usually fail for an obvious reason—a tube, rectifier, or some other component shorts and causes excessive B+ current. However, some failures are due to nothing more than physical deterioration brought about by power surges and continued usage. I'm sure you've replaced many fusibles for which you could locate no apparent cause of failure.

Regardless of the reason, a *correct* replacement is always necessary before the set can be restored to dependable operation. Determining the correct replacement (ohms and wattage) of a fusible resistor is not always an easy task. The manufacturer places a part number on the body of the resistor, but seldom adds the information you really need to know—the *value*. You could solve this problem by carrying a complete file of service literature on every home call. But this is hardly practical, so what's the answer?

The cross-reference chart on this page will fill the bill! Clip it out and place it in your tube caddy, so you'll have it handy for future reference whenever you need it. ▲

CROSS-REFERENCE GUIDE TO FUSIBLE RESISTORS

Manufacturer	Part No.	Value Ohms	Value Watts
Admiral	61A19	7.5	5
	61A19-2	7.5	5
	61A28-3	5	5
Airline	E2311†	22	5
	B154089-1-6	7.5	5
	R-1409	5.5	5
	14135†	47	5
	20E1042	7.5	5
	43X380	7.5	5
	43X397	7.5	15
	43X431	4.7	*
	46M-20681	5.6	5
	46M-22301	9.1	5
	46M-23018	9	5
	259V002H01	7.5	*
	259V004M01	4.7	5
Ambassador	24-1073	5	5
Artone	24-1073	5	5
	24B1116	4.7	5
Bendix	268021-1	5.6	5
Cadillac	7270608†	.47	* TC
Capehart	453924B-1	7.5	5
CBS	31000472	7.5	6
Chevrolet	7270608†	.47	*
Coronado	TRP-28	4.7	5
	024-201116	4.7	3
	24B1116	4.7	5
	46M-23018	9	5
	46M-25577	4.7	5
	816†	22	5
Crosley	154089	7.5	5
DuMont	397148†	22	5
	02310001	7.5	5
Emerson	394158	5	5
	397103	1	*
	397118	6	*
	397133	22	5
Firestone	24B1116	4.7	5
	43X380	7.5	5
	46M-23018	9	5
Hallicrafters	024-201116	4.7	3
	24-1073	5	5
	24-1116	4.7	5
	24B1011	7.2	5
	24B1116	4.7	5
	25B1004	7.5	5
Hoffman	4762	7.5	*
Hyde Park	25B1011	7.2	5
Magnavox	240074-1	5.	*
	240601-1	7.5	5
	24077-1	5	5
Majestic	B-6, 326-1	7.5	5
Meteor	S431007	7.5	5
	24-1073	5	5
Motorola	1K1027	7.5	5
	1K711027	7.5	5
	1K711574	5	5
	17A700149	5	5
	17A711027	7.5	5
	17A711500	7.5	5
	17A791166	7.5	5
	17A791696	5	5
	17K738862	7.5	5
	17K742136	5	5
Muntz	RW-005-13	5	5
	not avail.	4.7	5
Olympic	R-1409	5.5	5
	RE 3823	7.5	5
Packard-Bell	not avail.	7.5	5
Philco	33-1366	4.7	*
	33-1366-2	5.6	5
	33-1366-3	5.6	5
RCA	100117	5.6	5
	103824	4.7	5
Raytheon	46M-23018	9	5
Sentinel	B154089-1-6	7.5	5
	20E1042	7.5	5
	240074-1	5	*
	240601-1	7.5	5
Silvertone	S43-1007	7.5	5
	T43-1007	7.5	5
	24-1073	5	5
	24-1116	4.7	5
	25B1011	7.2	5
	43-4-1	22	3.25
	43-1007	7.5	5
	43-1008	7.5	5
	43-1009	5	5
	43-1011	5	*
	61-191-0	4.5	10
Sonora	R1409	5.5	5
Spartan	240074-1	5	5
Sparton	PA4227	7.5	5
Sylvania	187-0028	7.5	5
	187-0053	4.7	5
	189-0046	4.7	5
TraVler	F6	5	*
	F6-1	5.6	5
	F8	7.5	5
	TV-F-6	5	5
Truetone	not avail.	7.5	*
	024-201116	4.7	3
	24B1116	4.7	5
	43X380	7.5	5
	43X397	7.5	*
	43X398	7.5	*
	46M-20681	5.6	5
	46M-23018	9	5
	46M-2557	4.7	5
	224-200002	10	10
	816†	22	5
Wells-Gardner	43X380	7.5	5
Westinghouse	V-16023-1	7.5	5
	25V020H73†	100	3
	251V020H66†	5.6	5
	259V002H01	7.5	5
	259V002M01	7.5	5
	259V004M01	4.7	5
Zenith (1)	63-3269	7.5	5
	63-3287	6	5
	63-3644	6	5

* Wattage Not Given by Mfr.
† Non-TV Equipment
TC Temperature-Compensating
(1) Original Not Declared as Fusible by Mfr.

THE TROUBLESHOOTER

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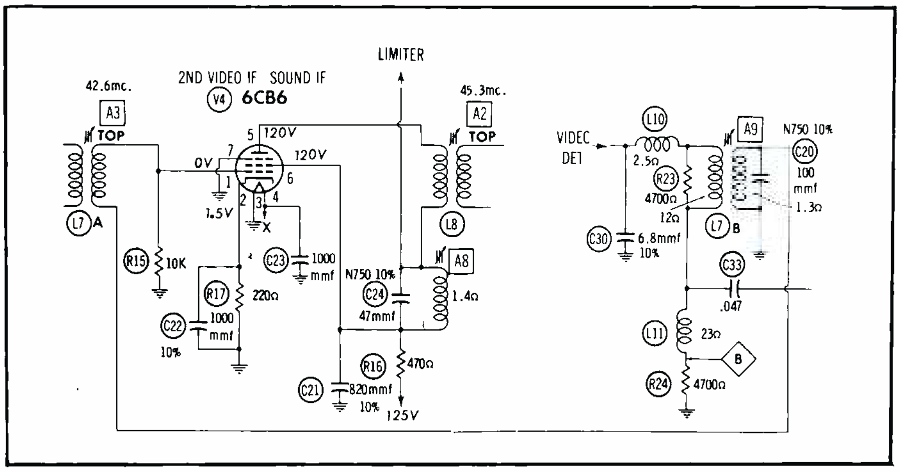
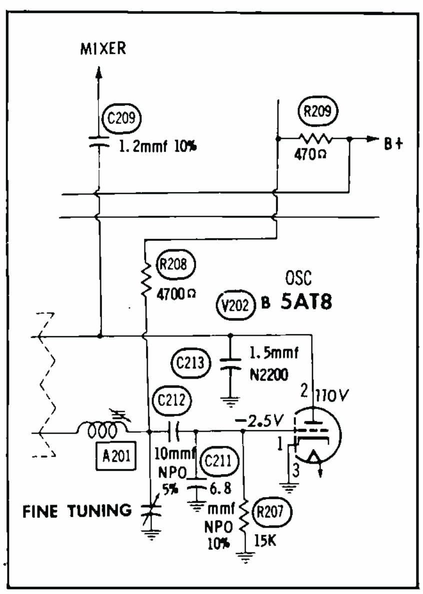


Sound on the Rebound

In the Emerson sets covered in PHOTOFACT Folder 384-2, what is the resonant frequency of the sound-detector transformer? This information isn't given in the alignment instructions (which suggest aligning the sound section while using a weak TV signal as an input). I suspect these sets are of the split-sound type, since the sound-takeoff point is in the second video IF stage; but I'm not sure about this.

DANE ULRICH
Sharpsville, Ind.

These sets have an unusual sound-IF system, called a reflex circuit, which is actually a form of intercarrier circuit. The sound-takeoff coil is L7B, at the output of the video detector. The 4.5-mc signal induced in the secondary of this coil is fed back to L7A, which also serves as the interstage coil between the first and second video IF stages. V4 then amplifies both the 40-mc video IF signal and the 4.5-mc sound IF signal. The two outputs are developed across separate windings of plate transformer L8, and the 4.5-mc output is coupled through a 150-mmf capacitor (not shown in schematic) to the grid of a limiter stage that drives a conventional 4.5-mc discriminator circuit.



No High End

An Emerson Model 1514 (covered in PHOTOFACT Folder 456-2) plays normally on all channels, except that both picture and sound on Channel 13 will occasionally fade out. Usually this occurs only after the set has operated for awhile. The program can be made to reappear by switching the tuner to a different channel and then bringing it back to 13, but the fadeout occurs again at various intervals.

The tuner tubes have been checked and also substituted; the local oscillator has been retuned; the contacts have been cleaned with a suitable solvent; and visual checks for shorts or opens have been made. However, none of these have been any help. I have come across this particular symptom before in Olympic sets using the same switch-type tuner.

R H. MCCARTY
Albuquerque, N. Mex.

The trouble may be due to a loose or bent contact, or any one of several electrical faults that could be present. Perhaps the value of oscillator injection capacitor C209 is too low. Another possibility is that the B+ applied to the oscillator might be less than normal, making the circuit critical. (Check to see if R208 or R209 has increased in value.) Also try substituting for the mixer-oscillator tube again, and check the values of C211 and C212.

Shrunk All Around

A recent home call involved a General Electric Model 21C3440 which had shrinkage of the raster on all sides, and slight ringing on the left side, but normal brightness and contrast. The trouble was an *open* heater in the 6AX4 damper tube. How could the set produce a raster with the damper burned out?

DEAN ELDER
Green River, Wyo.

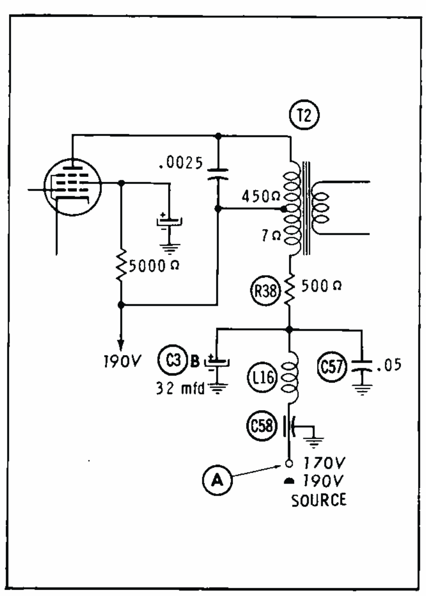
The faulty tube probably had a cathode-to-plate short that allowed B+ to reach the boost line. The sweep stages could continue to operate from the B+ source, though with reduced efficiency.

Unusual Power Source

I have a question about the output circuit in a Blaupunkt Type 9798 auto radio, covered by PHOTOFACT Folder 562-8. In the set I have in my shop, the transformer is open between the screen tap and plate. Can I substitute another transformer? Why is T2 tapped, anyway?

ROBERT VAN DUSEN
Rockford, Ill.

If you'll notice carefully, the tap is not a screen tap, but actually the source connection—it goes to the 190-volt power supply, as also does the screen-supply resistor. The lower half of the winding is used as part of an additional filter for a 170-volt power source. For AM operation, point A is connected through the bandswitch directly to the 190-volt supply, and stages that are supplied from this point receive the full 190 volts. However, when the switch is in the FM position, the lower part of T2, R38, L16, C3B, C57, and C58 all make up a filter net-



work that also drops the voltage at point A to 170 volts. Circuits which obtain power from this point are then operated at reduced voltage—widening their band-pass response.

Disagreeable Buzz

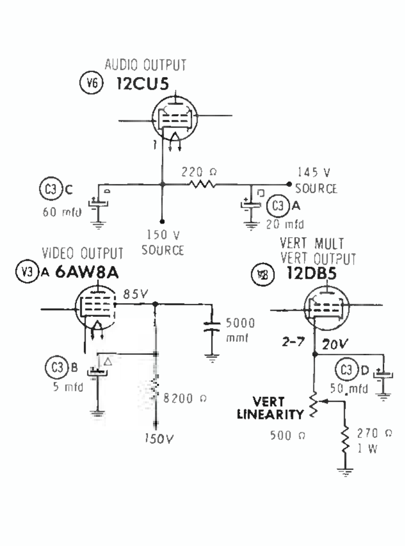
In my shop, I have an Admiral 15C1 chassis (covered in PHOTOFACT Folder 424-1) with a very disagreeable buzz. Turning the fine tuner has very little effect on this noise. The picture is good and clear, except for white lines across the top of the screen. I've checked everythink I can think of, with no results. Help, please!

JIMMIE MCDANIEL
McDaniel's TV Service
Claude, Texas

The buzz you hear is probably caused by vertical sweep pulses getting into the sound circuits. If it were intercarrier buzz, it would be affected by the setting of the fine-tuning dial. A common cause of this trouble stems from leakage between the sections of some electrolytic capacitor which is common to the vertical sweep circuit and the sound stages. C3 qualifies in this respect, since section D is part of the vertical output stage, section C is part of the audio output stage, section B acts as a bypass in the video output stage, and section A is the filter for the secondary B+ source in the audio output stage. Interaction between sections A, C, and D could create the buzz in the sound, while leakage to section B could cause poor blanking of the vertical retrace (the white lines you see). By all means, replace the entire can—don't just bypass certain sections.

Car 54—Reporting

You helped me solve the interference problem with our church amplifier earlier this year ("Car 54, Where Art Thou?"—March Troubleshooter), but now we have another problem. We have recently changed pastors, and the sound system no longer can handle the job. Our new



pastor's voice range is so varied—first loud, then soft—the amplifier just can't keep up with it. Sometimes he speaks so low you can hardly hear, and in the next sentence he overdrives the amplifier. Is there some sort of volume expander I can add to the system to keep the output level more constant?

G. E. Lantz

Lantz Radio & TV
Little Rock, Ark.

What you need is some type of constant-volume amplifier. Several makers of PA equipment produce amplifiers which have this characteristic; the units are variously called limiter-expanders, compression amplifiers, or any of several trade names. In addition, a couple of manufacturers make units which can be added to existing systems to equalize the volume output over a wide dynamic input range. The Howard W. Sams book "Commercial Sound Installer's Handbook" goes into this problem to some extent; perhaps you'll want to consult the book before deciding how you want to solve the problem.

Kann Ich Stereo Haben?

I have a German-made AM-FM radio (Kaiser "Stereo Ready" Model W648), and would like to connect a stereo multiplex adapter to it. Can you advise me

COLOR COUNTERMEASURES

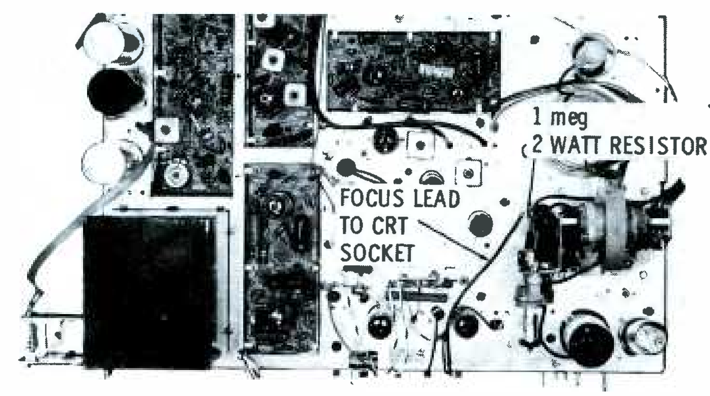
Symptoms and service tips from actual shop experience

Chassis: RCA CTC9

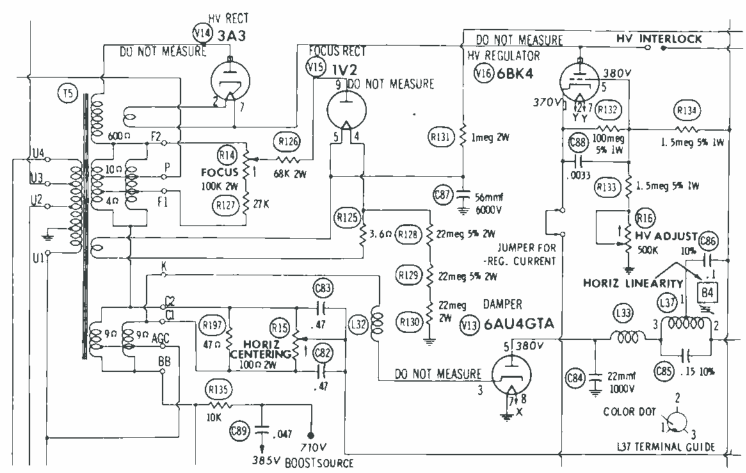
Symptoms: Loss of focus—control has no effect.

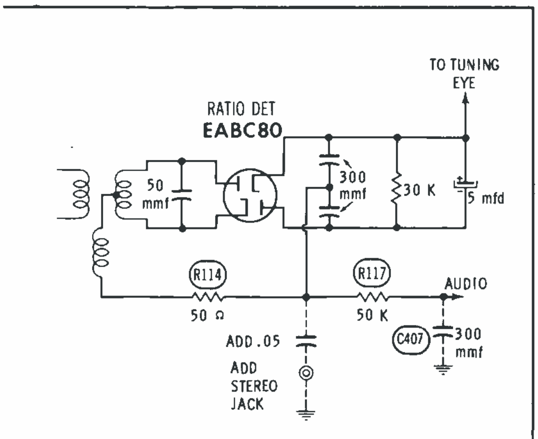
Tip: If high voltage seems to be normal, measure the focus voltage at pin 9 of the CRT socket, using a VTVM equipped with a high-voltage probe. You should obtain a reading of approximately 3 kv. If the focus voltage is low, check the following three defects which have accounted for this condition in several instances: First, the 56-mmf filter capacitor, C87, sometimes becomes shorted; secondly, R131—a 1-meg, 2-watt unit wired in series with the focus lead to the CRT—may be dressed physically too close to the chassis, producing a possible arcing path; and lastly, this lead (dressed under the edge of the flyback cover) becomes pinched and shorts to the cover or chassis.

If one of the latter two defects should occur, you may hear a slight arcing sound—but not always. It's a good idea to replace the 1V2 focus rectifier after repairing any of these faults.



FLYBACK COVER
REMOVED FOR PHOTO



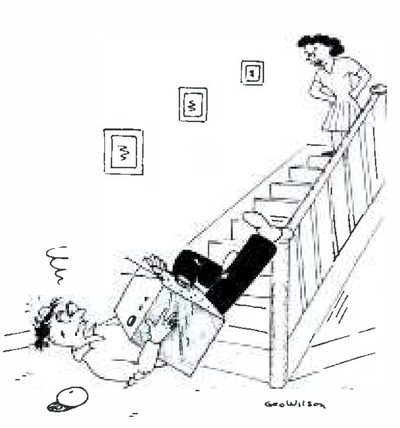


if this conversion is feasible, and tell me the correct point to install a multiplex jack?

JOSEPH G. LOFGRAN
San Bernadino, Calif.

You could tap off a signal ahead of the de-emphasis network in the ratio detector (at the junction of R114 and R117) and feed it to a multiplex jack through a fairly large capacitor. Use at least .05 mfd to avoid losing the low-frequency audio components in the combined L + R and L − R signal you need at this point.

The manufacturer's term "Stereo Ready" probably refers to stereo phono, and does not assure you that the RF-IF bandpass of the FM radio is broad and flat enough to pass the entire stereo signal without frequency distortion. Therefore, before you buy an adapter, you'd be well advised to make an overall sweep alignment check. If the detector output is a symmetrical S-curve with a bandwidth of nearly 200 kc between the positive and negative peaks, you're probably safe to go ahead. One other factor to check is the voltage amplitude of the signal delivered to the multiplex jack. (A good signal source for this measurement is a test tone transmitted by an FM station.) When you have determined the approximate output of the FM detector, choose an adapter designed to work with this level of input signal.



"You clumsy slob! I'll bet you've scratched that cabinet!"

Scopes and Generators

(Continued from page 37)

RF Signal Generators

Off-the-air signals picked up on the aforementioned receiver afford the most inexpensive, accurate means for checking dial calibration of a signal generator. Numerous stations throughout the RF spectrum produce strong signals of known frequency. The general-coverage receiver need not be elaborate or have accurate dial calibrations; its prime qualification is coverage from the broadcast band through 30 mc. Many inexpensive shortwave receivers meet this requirement. For calibration in the higher frequency ranges, TV and FM sets may be used.

Standard broadcast stations provide excellent signals for calibrating the low end of the signal generator's range. These stations, complying with FCC regulations, are not permitted to drift more than a few cycles from their assigned frequencies. To check the generator frequency, tune your radio to a broadcast station of known frequency, and place the generator leads near the receiver antenna. Then vary the generator frequency until a zero beat is heard in the receiver loudspeaker. If the instrument dial is correct, it will indicate exactly the frequency of the station.

Since signal generators are often rich in harmonic output, it is possible to use the broadcast band for calibrating frequencies below 500 kc. For example, setting the generator on 285 kc will produce enough energy at 570 kc (within the broadcast band) to perform the zero-beat calibration check. It is necessary only to know the frequency of the station and divide by two to determine the correct generator setting.

For frequencies above the broadcast band, a shortwave receiver may be tuned to communications services which operate at known, crystal-controlled frequencies. As mentioned previously, WWV and WWVH provide several reliable check points. In addition, the marine band is useful if you are located near a large body of water; although individual channels vary in

TV VIDEO CARRIER FREQUENCIES

Channel	Frequency (mc)
2	55.25
3	61.25
4	67.25
5	77.25
6	83.25
7	175.25
8	181.25
9	187.25
10	193.25
11	199.25
12	205.25
13	211.25

Fig. 4. VHF frequency checkpoints available from TV broadcast stations.

different parts of the country, 2182 kc is a standard Coast Guard, calling, and distress frequency. It may not be possible to receive every frequency check point at a given time (due to propagation conditions), but this is of little concern for your purpose — the harmonic output of the generator may be used for calibration. For example, a single WWV pickup on 10 mc can check the generator dial at the following points: 10 mc, 5 mc, 2500 kc, 1250 kc, 625 kc, and 312.5 kc.

TV and FM stations can be used to fill the gap between HF and high-VHF ranges. For example, a TV station on Channel 2 is known to transmit a video carrier at precisely 55.25 mc. If the generator is set approximately to this frequency and *slowly* varied, a series of light and dark bars will appear on the TV screen. This is the visual counterpart of the audible beat note described earlier. When the fewest bars appear, the generator frequency is nearest to that of the video carrier.

The calibrating process may be extended by checking the generator dial at 27.625 mc (half the video carrier frequency) in the same fashion; enough harmonic output should be available to allow zero-beat calibration. Thus, the TV receiver, with its channels extending over a band from 54 to 216 mc, yields quite a few check points of high accuracy. This method, of course, can be used only when local stations operate on the channels that will provide the desired test frequencies. A complete list of video carrier frequencies is

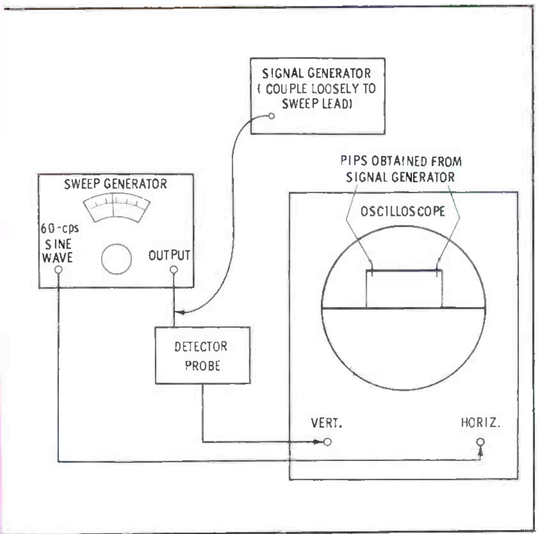


Fig. 5. Setup for checking the sweep width and response of a generator.

shown in Fig. 4.

AM and sweep generators can both be calibrated with the techniques just described. However, in the case of the latter instrument, additional checks need to be made. These concern the sweep width and the ability of the sweep to maintain constant amplitude as the frequency shifts. The setup for this test is illustrated in Fig. 5.

The output of the sweep generator is coupled to a detector, or demodulator probe, and then to the vertical input of an oscilloscope. It is essential that the sweep generator be equipped with an internal blanking feature to establish a zero reference line on the screen trace. (Horizontal sweep for the scope is a 60-cps sine wave, provided by the generator.) If the output amplitude is linear, the pattern should be practically rectangular (with no dip or slope of the top line), as shown in Fig. 5. Note, too, that sweep width may be accurately checked during this same procedure by the addition of marker pips obtained from an accurate marker generator.

These simple tests make it possible for any serviceman to check the accuracy of his test instruments, without expensive investment in special standards. Equipment that is slightly inaccurate can be repaired and adjusted, or a chart can be made (as described in the September article) to show the amount of correction necessary to allow for the inaccuracy. With these facts at hand, no shop need be plagued by poorly calibrated equipment. ▲

Got the Jitters?

(Continued from page 41)

Unbalanced Phase Detector

This AFC fault is a common cause of jitter and also of critical horizontal hold. Dual semiconductor diodes are most notorious for becoming unbalanced. You can usually check the diode sections by measuring front-to-back ratio with a good ohmmeter. High readings are not particularly important, but be sure both diodes have *similar* readings. If one diode has a back resistance of 100K, and that of the other is 400K, they both should be replaced; however, if one diode measures 100K and the other 110K, chances are they are working correctly.

An obscure cause of jitter or critical hold has sometimes been traced to someone inadvertently putting in the wrong AFC dual-diode package. Fig. 8 shows the two most common configurations. The unit in A, with the diodes "face to face" is presently the most popular type. It is almost impossible (unless you

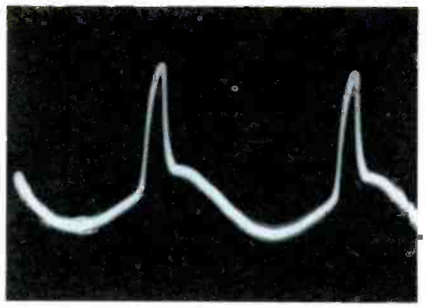


Fig. 7. Sine wave developed across ringing coil is seen at grid of V1B.

work at it) to wire this type incorrectly. In unit B, however, both diodes face in the same direction—and it is not too uncommon to find these installed in reverse. It helps to remember that a flattened corner always indicates a cathode.

Other reasons for unbalance in an AFC phase detector can be leaky or open capacitors, defective sync or other tubes, and poor wiring connections.

Faulty Sampling Pulse

The "sampling pulse" is a signal voltage which is fed back to the AFC stage from either the flyback circuit or the output of the horizontal oscillator, and compared with the incoming sync pulses so that the correct horizontal frequency (and phase) is maintained.

If this pulse is either too small, too large, or of incorrect shape or polarity, the result will usually be jitter accompanied by critical horizontal lock.

The sampling pulse can best be checked with a scope. To view only the sampling pulse—not a composite of sampling and sync inputs— eliminate the sync signal by turning the set off channel, pulling an IF tube, or grounding the sync separator grid.

The most common cause of low sampling-pulse voltage is a faulty resistor or a leaky capacitor in the AFC feedback circuit. Trouble can also occur when the sampling pulse has too much amplitude; this can

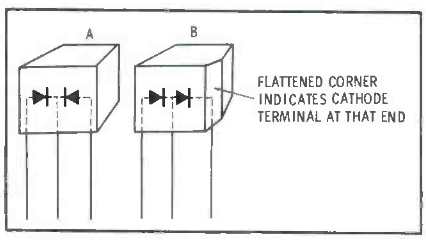


Fig. 8. Flattened corner of series-type AFC diode unit indicates cathode.

happen if resistors change to a low value or when a shunt capacitor opens. About the only way you can have incorrect *polarity* of the sampling pulse is by making the wrong connections to a replacement flyback. Incorrect polarity will make the picture tend to lock in with the horizontal blanking bar in the center of the screen. Low or high sampling voltage may also bring the blanking bar into sight, but it will tend to jitter sideways.

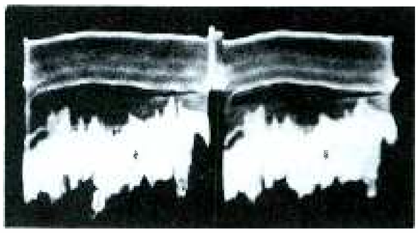
Video in the Sync

Any change in the sync-pulse signal that occurs with a change in picture content will almost surely result in jitter. Unfortunately, video interference can enter via several circuits. One of the most common routes, as we have already discussed, is through inadequate bypassing of the B+ line or the AGC line. These lines can be checked with your oscilloscope as outlined previously.

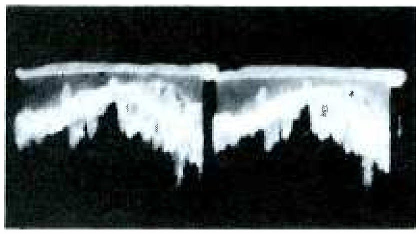
Video can also get into the sync because of improper action of the sync separators or amplifiers. A scope will nearly always give a good indication of this trouble, although the waveforms in a few circuits may be a little hard to interpret unless you are familiar with the peculiarities of both the particular circuit and your scope. If scope checks seem to indicate sync trouble, first check tubes for leakage with a tester having a sensitive check (able to indicate leakage resistances of 25 megohms or more). Check coupling capacitors for even the slightest leakage, and look for off-value resistors.

Another cause of video in the sync is signal compression in the video IF or output stages. This is easy to check with a scope. At the plate of the output stage (using a low-capacitance probe), the sync pulses should stick out above the video by 25% or so—as in Fig. 9A. If the sync pulses are almost level with the video (Fig. 9B), it is impossible for the sync circuits to strip the sync off without also picking up some video. Check for correct voltages in the video output amplifier. Also check the screen-bypass capacitor, especially if it is an electrolytic.

If compression likewise shows up



(A) With normal sync at top.



(B) Sync pulses compressed.

Fig. 9. Composite video signals.

in the video-detector output waveform, look for IF or AGC faults. Also remember that crystal diode detectors are notorious offenders in cases of sync compression, even though they may seem fairly good when tested with an ohmmeter. The best way to check these components is to replace them (you can use almost any germanium diode known to be good) and see if this eliminates the signal distortion.

Arcing

An arc too small to be noticed can cause jitter. Such an arc is usually concealed; for instance, one common spot for it to occur is from a width sleeve to the yoke winding. If arcing is causing sync jitter, you will see a spurious pip riding along the waveform at the output of the sync separator. As proof that arcing is the trouble, disable the high voltage and see if this pip disappears.

Some spots where arcing frequently takes place are around filter resistors in the CRT high-voltage anode circuit, in the windings of the flyback or yoke, through foreign matter around the CRT anode connector, and (in old metal picture tubes) across the insulated mounting. Another place not to forget is the top-cap connector of a horizontal-output or high-voltage tube.

Though this article has mainly concerned itself with the causes of horizontal jitter, similar troubles in some circuits might cause vertical jitter or poor interlace. To close, we say again, "Don't forget to check electrolytics"; they are, almost without question, the most common source of jitter! ▲

Stereo FM Report

(Continued from page 26)

on each side of center frequency. In addition, some stations include SCA facilities for background music (storecasting) on a 67-kc subcarrier, which increases the bandpass requirement even more.

The FM broadcast antenna must be able to handle—without attenuation— the wide range of sideband pairs which are produced by the stereo FM transmitter. In addition, special care must be taken that the gain and radiation pattern are correct for the area to be covered. This is especially important with stereo, since coverage is not so extensive as with standard FM.

Programming

Among the different stations, time devoted to stereo FM ranges from just an hour or two of special programs to full-time, 24-hour programming. The full-time stations are located primarily in metropolitan areas, such as New York, Philadelphia, St. Louis, and Los Angeles. A number of all-music stations broadcast all their selections by stereo, merely combining the two channels when a monophonic tape or recording is played.

Receiving Stereo FM

There is much equipment available now for receiving stereo FM—add-on adapters, custom-tailored adapters, full-fledged stereo receivers, and other variations. Field experience with stereo FM reception has led to certain conclusions regarding the equipment which must receive stereo FM broadcasts.

Equipment Requirements

Starting with the tuner, you'll find its bandwidth must be broad enough to handle the full range of sideband components which comprise stereo FM signals. The bandwidth requirement mentioned for broadcast equipment applies equally to the receiver or tuner used to receive stereo FM. Certain older tuners—to which many people wish to add a stereo adapter—have too narrow a bandwidth to handle properly the complex composite stereo FM signal. When an FM receiver comes already equipped to receive stereo, you can safely assume correct bandpass has been included in the design of the set.

Conversions

There are quite a few stereo FM adapter kits, as well as factory-wired units, designed to be added to existing FM tuners or receivers. In addition to the "universal" adapters, there are several adapters designed to go with specific equipment. They are not complicated to connect, provided certain precautions are followed. Attaching these adapters to existing sets was discussed in detail in the December, 1961 article.

Kit-type adapters have to be aligned and adjusted by the installer. Special stereo-signal generators are now available to provide a test signal for aligning adapters. A future article will describe a number of different stereo alignment techniques—some requiring special equipment, and others that utilize standard audio test equipment.

Reports from servicemen around the country differ widely as to the success of adapter conversions. While some tell of poor performance, many servicemen report excellent results with adapters. As one expert puts it, "There's nothing magical about having the stereo adapter on the same piece of sheet metal with the receiver." And he's right: most manufacturers employ, in the multiplex section of complete receivers, circuits identical to those in add-on adapters. Difficulties occasionally do arise when an adapter is used with a set other than that for which it was designed.

Installing and Operating

Many problems concerning the reception of stereo FM were anticipated well ahead of their actual appearance—such things as multipath "ghost" reception, noise problems, and reduced service-area coverage. In many cases, the problems have occurred as predicted; in many other cases, very few of the expected troubles have appeared. We'll examine some of the anticipated problems and see how servicemen around the country have solved them.

Multipath Reception

By now, most of our readers are familiar with the term *multipath reception*. In August, we described its causes, anticipated its effects, and offered suggestions on how to eliminate it. Servicemen in many areas report no trouble whatever from this type of reception. The stations themselves often are unjustly blamed for whatever reception problems occur, whether they be multipath distortion, audio distortion, or just noise.

Nevertheless, in metropolitan areas where large buildings exist, multipath is a very real and troublesome problem. It is a phenomenon that is quite difficult to explain to a disgruntled set owner who switches from perfectly good reception on monophonic FM to noisy, distorted reception on stereo. The customer's natural reaction (sometimes aided by the salesman) is first to blame the equipment and then to blame the installer.

In cases of true multipath reception the last allegation has some basis; the installer should have checked for multipath reception and taken action accordingly — usually by installing a proper antenna. Most important — the installer shouldn't blame the station for this type of trouble; stations have their technical problems, but most of these problems have been ironed out long ago.

Service-Area Problems

The complaint heard most from servicemen all over the country is that stereo FM stations don't provide a prime signal over as wide an area as do regular FM stations of equivalent power. A great deal of the effective radiated power from a stereo FM station is contained in the additional sideband pairs which are generated in the present system of developing the stereo FM signal. The result is very limited range for quite a number of low-power stereo FM stations.

The answer to this problem is a high-gain receiving antenna, elevated and well oriented to receive the stations a listener desires. An antenna rotator may be necessary where stations are located in several directions from the receiver location. This, too, is hard to explain to a listener who can receive monophonic FM stations with no such requirement; but an explanation is worthwhile as a "callback saver."

Customer Difficulties

The most common problem which involves customer understanding is in the use of panel controls during reception of stereo FM broadcasts. There are two recurrent misconceptions by customers (or listeners) which should be explained away when the set is installed.

The first has to do with the function of the left and right channels. Some customers have difficulty understanding that more music will come from the right channel during certain musical passages, and that more sound will come from the left during certain other passages. Somehow, they have the notion that one channel is for high-pitched notes, while the other is for low-pitched notes. Thinking this, they attempt to readjust what they consider to be the "balance" by adjusting the tone controls; naturally, they fail. It should be explained to them that the tone controls affect both channels simultaneously and have no bearing whatsoever on "stereo effect."

The separation control on the front panel of certain receivers is another completely misunderstood device. Listeners seem to have the idea that, by cranking it "all the way up," they'll get greater "stereo effect." Generally, all they get is an overdose of the L–R signal, which is a very poor substitute for the stereo program, and totally lacking in bass response. The separation control affects only the L–R channel of the adapter, controlling it so that in the final matrixing circuit (where the L signal and R signal are recovered) the L–R signal will have the same relationship to the L+R signal as in the original broadcast signals.

This separation adjustment is not easy to make without a stereo signal generator, although an approximation can be made if a station in your area provides a test signal. A telephone call to the station is sometimes necessary to get the test signal you need. Certain other stations use the unique device of putting their announcer on one channel only, which he proceeds to identify; thus, during voice announcements, the adjustment can easily and quickly be made by adjusting the separation control so the announcer's voice comes from only the correct channel.

There is another control—the balance control—which the customer can adjust, and it is best done during a monophonic program. Have someone sit or stand in a position exactly equidistant from the two speakers. Adjust the balance control until the sounds from the two speakers seem to blend "in the middle." Once this has been done, the audio channels of the receiver are balanced, and the listener should be warned against trying to readjust the balance during stereo shows.

It is easy to see that a number of problems with stereo FM can be eliminated before they have a chance to cause listener dissatisfaction. Again, it is important to remember that certain problems occur in specific areas, and the servicemen in those areas are learning to cope with them. Understanding the cause is the first step in eliminating any problem; the next step, in this instance, is to educate the listener—your customer—to understand the unusual circumstances which sometimes surround stereo FM reception.

What Next?

Stereo FM still has quite a way to go, but all sorts of preparations are being made to accommodate it. New receiver and adapter designs are popping up regularly. Some are more elaborate versions of present equipment; some represent less complicated ways of recovering the stereo signal. Still others offer special innovations such as automatic indication of stereo reception or automatic stereo-only reception.

As test equipment becomes available for stations to use in checking standards and improving the quality of their transmissions, more and better stereo FM programming is bound to result. The number of stereo FM stations is expected soon to exceed three hundred, with more to follow. Certain segments of the industry feel that sooner or later, all FM stations will broadcast at least a portion of their programming in stereo. The serviceman who keeps up with stereo FM, like the serviceman who keeps up with other advancing phases of the electronics industry, will be assured a place in this rapidly expanding market. ▲

Radiation

(Continued from page 35)

volt video signal at the probe tip was reduced to only 1 volt at the vertical-input post of the scope. On the other hand, the radiated hash was picked up directly on the input post, without attenuation.

The most obvious way to prevent pickup of stray signals on the scope terminals is to use shielded input connectors. Some instruments are already equipped with coaxial leads and fittings which provide excellent shielding; other models, originally having unshielded banana jacks or binding posts, can be converted to the durable and practical hookup shown in Fig. 5. The probe lead is a length of RG-62 coaxial cable, terminated in a "twist-on" shielded connector.

For my personal use, I have assembled a group of interchangeable probe tips (Fig. 6), also utilizing coaxial connectors for attachment to the scope cable. While this arrangement is a bit more expensive than other types of plug-and-jack assemblies, the improvement in performance is well worth the cost.

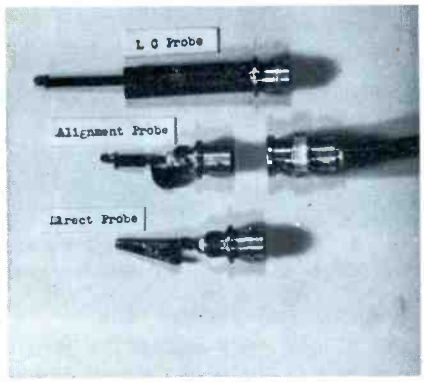


Fig. 6. Author's own assortment of scope-probe tips with coaxial fittings.

The probes are conveniently small in size (with a minimum of unshielded surface area); the RG-62 coax has low cable capacitance; and the entire assembly is practically invulnerable to radiation pickup.

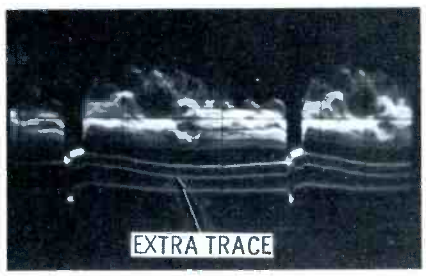


Fig. 7. Extra trace line (arrow) is normal in certain older RCA receivers.

Odd Traces Caused By Set

Even when no hash is picked up by the scope, spurious signals may mix with the waveform via the receiver circuits. In a few TV models, the composite video signal fed to the picture tube normally contains some hash or extra traces. For example, the line midway between the sync-tip and blanking levels in Fig. 7 is perfectly normal for the RCA Chassis KCS47, -48, and -49. In these models, damper leads carrying high pulse voltages run close to the video amplifier and induce this spurious trace.

It's not necessary to do anything about the radiation, in this particular case. Most other times, however, you'll improve set operation by investigating and removing the causes of fuzzy waveforms. To give an example, an Admiral 19B1 with marginally poor sync presented a slightly distorted trace (Fig. 8) at the plate of the video amplifier. (By "marginally poor sync," I mean horizontal tearout each time channels were

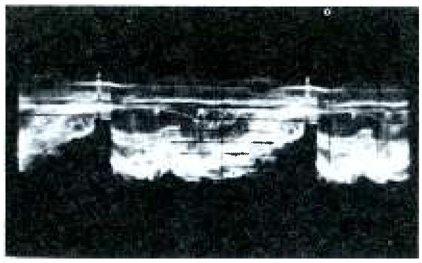


Fig. 8. Missing tube shields caused this video distortion in Admiral set.

changed, and vertical flipping except at one very critical setting of the contrast control.) Surprisingly, both the scope trace and the sync action came back to normal when I merely replaced some tube shields that the customer had removed and thrown away. The IF tubes in this receiver are right under the bell of the picture tube and definitely require shields.

In a different case of inadequate shielding, a Silvertone Model 52060 portable had a strong tendency toward vertical roll when the contrast control was turned down slightly. Before I disassembled the set, I tried a preliminary scope check at the output of the video section, and saw something unusual at the peak of the waveform (top photo, Fig. 9). Removing the cabinet top for further troubleshooting, I noticed that the tuner shield was missing. Inserting a metal plate between the tuner and the nearby picture-tube bell cleaned up the trace and removed the rolling. I made a new shield for the tuner, but before installing it, I made a point of seeing how the sync-output signal looked. The vertical sync pulses (indicated by arrows in the lower photo of Fig. 9) were definitely too low as a result of the picture-signal distortion.

"That Miss Winthrop's set must be on the blink again—you never look like that when old Mr. Crockett calls you at this hour!"

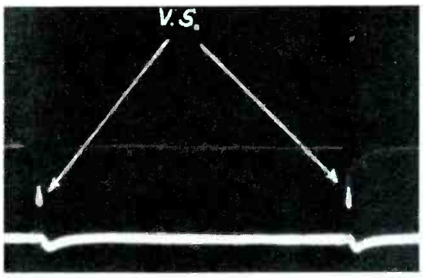


Fig. 9. Distortion due to unshielded tuner attenuated vertical sync pulses.

One other interesting example of extra traces concerns a Motorola 534. This set had recently been repaired and the flyback replaced. It operated normally for about one week, but then the picture "whited out," leaving a perfectly blank raster. After making sure the video amplifier was working, I found a bias of over 20 volts on the grids of the video IF's. All indications pointed to AGC trouble, so I went on to the 6AU6 AGC keying tube. All DC voltages read normal, but there was a strange waveform (Fig. 10) at the plate of the 6AU6. The bright trace in the middle is a 400-volt keying-pulse signal—normal for this set. What's unusual is the dim but much larger trace indicated by the arrows.

At first I was inclined to think

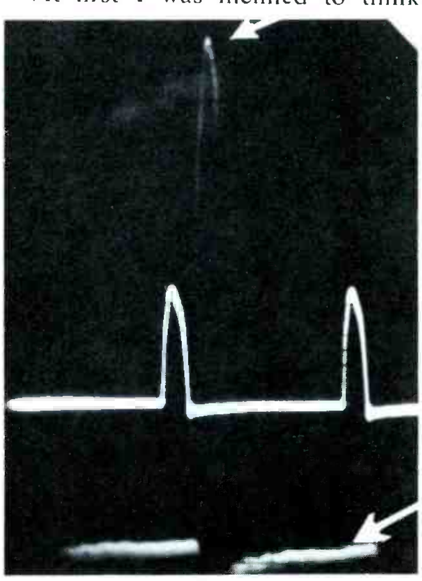


Fig. 10. Strong radiated pulse appears as dim trace at plate of AGC tube.

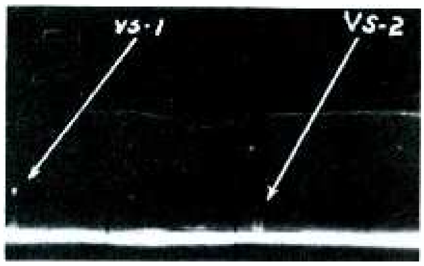


Fig. 11. A radiated signal virtually cancelled the vertical sync pulses.

the new flyback had developed a fault, since this component is responsible for developing the AGC pulse. But further checking led to examining the yoke socket and the yoke leads. Probing in this area led to the discovery that grounding the shielding sleeve on the leads brought receiver operation back to normal. The sleeve, originally grounded through a wire riveted to the shield foil, was repaired by adding a clip to the foil and soldering the ground wire to this clip.

This Motorola job illustrates a puzzling aspect of radiation troubles: It is not always easy to determine where the radiation is originating, and it is still harder to find the point in the set where the radiation is being picked up.

Radiation In Test Setups

Multiple-chassis receivers, or portables with cabinet-mounted picture tubes, are usually serviced with the various sections joined together by extension cables. One of these, the yoke cable, is exceptionally prone to cause radiation troubles. Vertical and horizontal deflection pulses can be picked up at various sensitive points in the receiver, producing some pretty weird effects. Some models, such as the Philco 1960 and 1961 receivers, are especially susceptible to this condition. Unless the yoke harness is critically dressed away from the receiver chassis, the set displays sync and contrast faults that are not present when the set's own short cables are used without extensions.

One trouble I recently had with an RCA portable, caused by the use of extension cables, really had me guessing. Vertical rolling at less than maximum contrast was the complaint, and I figured I could find the cause with a few scope checks. Plate signals on the video-output and sync-separator tubes were okay, but the output of the sync amplifier looked like Fig. 11. The arrows point to the vertical sync pulses. One pulse in each frame was reduced to less than half the normal amplitude (VS-1), and the other was practically cancelled (VS-2). Finally, I noted that shifting the position of the yoke cable improved the appearance of the sync pulses; so, on a hunch, I put the chassis back in its metal case, connected the various leads, and happily noted the disappearance of sync trouble.

The usual type of yoke extension is an eight-wire cable terminated in an octal plug and socket. This particular harness can be used on numerous models, including many where not all the wires are used. When connected to the Sylvania Model 521 (a 24" set), this cable will create an oddball defect.

One such receiver was being worked on to clear up a snowy picture. Actually, I found the cause of this condition without turning the set on; an ohmmeter check revealed an open supply resistor in the tuner. However, to check the results of replacing this part, I hooked the picture tube to the chassis by means of the usual extension leads, and applied power to the set. It produced the picture in Fig. 12. Because of the obvious twist along the right edge, I guessed at hum in the video or sync signal, and scope-checked the video output for confirmation of this idea. No soap—this trace was perfectly normal. Scoping at the grid of the sync preamplifier (pin 2 of V14A in Fig. 13) yielded another normal trace. At pin 1 of V14A, however, I found flattened sync pulses, as shown in the upper photo of Fig. 14. Consequently, the sync-output signal was badly distorted (lower photo). A new V14 made no difference. After tube changing and some very assiduous sleuthing,

Fig. 12. Hum was mistakenly assumed to be the cause of this twisted picture.

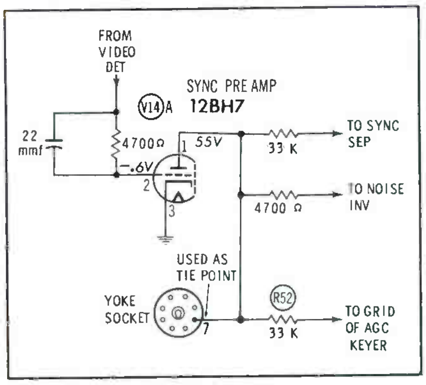


Fig. 13. Sync interference was introduced via tie point on the yoke socket.

I noted that a wire ran from pin 1 of V14 to an unused connection (pin 7) on the yoke socket. Removing the wire and the lead of resistor R52 from this tie point resulted in a normal picture, as well as normal waveforms in the sync section.

Here's what happened, in case you haven't already guessed: The yoke uses only five socket connections—pins 1, 3, 4, 5, and 6. When I used an eight-wire cable for a connecting harness, pulses were induced in the wire going to pin 7 of the socket, and were in turn coupled to the plate of V14A. From Fig. 14, it appears that the stray pulses almost completely cancelled the sync pulses in the plate signal.

Summary

As the preceding examples have demonstrated, radiated signals can produce many freakish trouble symptoms and confusing scope traces. Whenever a serviceman is puzzled by odd-looking distortion in a waveform, he should check his test setup to see if stray signals are responsible. This involves such precautions as making sure all shields are in place, checking for radiation from extra cables, and protecting the scope's input circuit from direct pickup of radiated hash. ▲

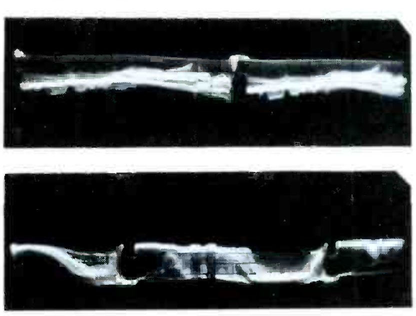


Fig. 14. Flattened pulses at sync-pre-amp plate, and resulting sync output.

PRODUCT report

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

Audio for Community TV (44U)

A device capable of adding sound channels to master-antenna and community-TV systems has been developed by **Blonder-Tongue.** It requires no extra distribution equipment, and enables any TV receiver on the system to pick up audio from a variety of sources. Termed the Model AM "Audio Master," the unit carries a net price of $175.

Little Black Box (45U)

A base-station antenna amplifier for Citizens band, designed by **Antenna Specialists,** is called the "Black Box." A four-tube amplifier is mast-mounted near the CB antenna, and is connected by regular transmission line to the antenna and to the "Black Box" near the transceiver. The Model M-82 is said to boost effective output power by 10 db, and to increase the antenna's receiving ability by 20 db.

Leakage Tester (46U)

A three-position range switch is featured in this capacitor checker recently introduced by **Watsco Inc.,** Hialeah, Florida. Nicknamed "Cappy," this unit detects leakage in capacitors, rectifiers and cable insulation. Another feature is the current-leakage test for large capacitors and electrolytics of high working voltage. "Cappy" will sell in the East Coast area for approximately $10.00.

Airport Vehicle Radio (47U)

A single-frequency, crystal-controlled UHF two-way radio for use in airport vehicles has been introduced by **Comco.** The Model 700 operates on any single frequency between 225 and 400 mc—in the military UHF communications band—and is interchangeable among vehicles with 6-, 12-, or 24-volt electrical systems. The mobile unit uses the same case, control head, and accessories as the Model 278 (a VHF radio); it is also available in a hand-carried case or for rack mounting.

Amplifier Module (48U)

A unique 2-watt amplifier, completely encapsulated in an epoxy block only ⅞" x 2" x 3½", has been developed by **Saxton Products, Inc.** The unit will amplify a .5-volt signal to full output. Dubbed the "Mity-Amp 2," the tiny amplifier is shockproof, waterproof, and sealed against dust and dirt. It requires 6 to 12 volts DC for power, draws from 300 to 700 ma, and can work into an impedance of from 3.2 ohms to 45 ohms.

New Master Catalog (49U)

The 1963 edition of the well-known Radio-Electronic Master catalog is now available from electronics parts distributors. Published by **United Catalog Publishers,** this 27th edition contains 1680 pages of the latest specifications, descriptions, and prices of electronic equipment and products. There are 32 product sections, listing more than 185,000 items from 308 manufacturers. A new feature is the foreign-tube interchangeability guide, cross-referencing more than 1300 foreign tubes with their American equivalents.

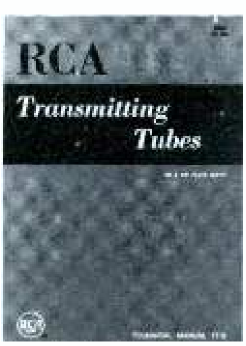
AC in the Car (50U)

The Model RME vibrator-type inverter is only one of the many models available from **ATR**. They manufacture DC-to-AC inverters in numerous power ratings, with input voltages from 6 volts DC to 110 volts DC, and 60-cps outputs as high as 220 volts AC. These units can be used in autos, boats, and planes to power tape recorders, test equipment, and even television sets. Net prices start as low as $16.63, for a 6V DC-110V AC 40-watt inverter.

All-Transistor Preamp (51U)

An all-transistor stereophonic preamplifier — designated the "Citation A" — has been introduced by **Harman - Kardon.** Using 33 transistors mounted on 11 epoxy glass module boards, the unit boasts an undistorted frequency response from 1 cps to 1 mc, within ¼ db. The Citation A is called a "solid-state stereo control center," because it's capable of handling all the functions of a complete stereo system. The factory-wired version is priced at $350, but a kit will soon be available at $250.

Transmitting-Tube Manual (52U)



A new 320-page guide to transmitting tubes is available from the Electron Tube Div. of **RCA.** Priced at $1.00, Technical Manual TT-5 is the largest edition yet. It contains much information not found in earlier editions—including sections on single-sideband techniques, two-tone modulation, and many other topics. Specifications are also provided on the latest transmitting tubes, including the new "cermolox" family of ceramic-metal types.

Antenna Preamp for Color (53U)

An antenna preamplifier with bandpass sufficient for color-TV signals has been designed by **Winegard.** Utilizing two nuvistors in a special low-noise circuit, the "Colortron" can handle signals as strong as 400,000 uv without overloading. Thus, the unit can be used to amplify weak signals from far-away stations, even in the presence of strong local signals. Depending on signal strength, as many as ten sets can be fed from one "Colortron." The preamp is completely weather-sealed, and a built-in heat sink controls temperature of the nuvistors. List price of the device is $39.95, complete with AC power supply, in either 75- or 300-ohm models.

INDEX TO ADVERTISERS

December, 1962

Latest Jackson Tube Test Data

MODEL 648 Tube Type	Fil	D.	E	Plate Test	MODEL 598 A.	B	C	Fil Cont	D	E	F.	G
6AR11◆	6 3	A2357	C689'	33XZ								
	6 3	AB39	124'	33XZ								
6HC8	6 3	125	AC389	40WZ	6 3	4Y		5	6	3	7	20
		127	AC46	62XY		4Y			9	1Z		66
6M11◆	6 3	AC1	AB278	22WY								
		AC6	A58	29YZ								
21GY5◆	25.	AC7	126	22Z								
7867	6 3	124	AB369	34VW	6 3	2YZ		7	0	5	8	35

MODEL 658

Tube Type	Sec.	Heater	Circuit H-K	Circuit P-G	Plate	Grid Test	Heater Current
6AR11◆	P	6 4K	2358	ab670	63R	10WY•	
	P	6 4K	834	129	63R	10WY•	
6HC8	P	6 4L	125	ac389	22Q	70VY•	
	T	6.4L	127	ac46	28R	10XY•	
6M11◆	P	6 4L	C7	b128	40R	10WY•	
	T	6 4L	C6	a50	36R	10WY•	
	T	6 4L	C3	a49	36R	10WY•	
21GY5◆	P	22.J	C7	126	17R	80VY•	A30.G Z450
7867	P	6 4M	124	ab360	11Q	95VY•	

CATALOG AND LITERATURE SERVICE

ANTENNAS & ACCESSORIES

1U. *ANTENNA SPECIALISTS*—Brochure describing new *Black Beauty Fiberglas* Citizens-band antennas, plus pocket card listing CB frequencies, districts, and radio codes.

2U. *JERROLD ELECTRONICS*—Catalog sheet showing system applications for TV/FM broad-band amplifier designed to feed up to 40 receivers.

3U. *JFD*—Brochures on LPV log periodic TV antenna and *Transis-tenna;* also bulletins and catalogs showing entire line of TV-FM indoor and outdoor antennas and accessories. See ads pages 15-17.

4U. *SURFACE CONDUCTION INC.*—Brochures listing UHF antennas and accessories, and new "G-Line" transmission line.

5U. *TACO*—Sheet giving specifications and performance information on Taco's *T-Bird Electra antenna.*

6U. *WINEGARD*—New *Colortron* antenna and amplifier dealer catalog; can be used as display. *See ads pages 53, 86, 93.*

AUDIO & HI-FI

7U. *ATLAS SOUND*—Catalog No. 562 listing specifications on microphones and loudspeakers for public address, commercial, and industrial use.

8U. *EICO*—New 32-page catalog of kits and wired equipment for stereo and monophonic hi-fi, test equipment, Citizens-band transceivers, ham gear, and transistor radios. Also "Stereo Hi-Fi Guide" and "Short Course for Novice License." *See ad page 87.*

9U. *KARG LABORATORIES, INC.*—Sheets listing complete line of stereo FM equipment—including tuners, multiplex adapters, and multiplex signal generators. *See ad page 88.*

10U. *SWITCHCRAFT*—Catalog 124 describing Model 338 Audio Adapter, which allows use of American phono plugs with foreign tape recorders. *See ad page 84.*

COMMUNICATIONS

11U. *SONOTONE*—Sheet No. SAH-60, giving specifications and information on ceramic CB microphones. *See ad page 77.*

COMPONENTS

12U. *BUSSMANN*—Bulletin SFH-8 giving information on new GMW-HWA subminiature fuse-and-holder combination for use on panels or printed-circuit boards. *See ad page 71.*

13U. *PERMA-POWER*—Latest Britener selector guide, showing the correct brightener to use with every type of picture tube in general use. *See ad page 62.*

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

SERVICE AIDS

15U. *CASTLE*—Leaflet describing fast overhaul service on television tuners of all makes and models; also illustrated lists describing universal and original-equipment tuners. *See ad page 48.*

16U. *ELECTRONIC CHEMICAL CORP.*—Catalog and brochure listing electronic chemical line, including new formula EC-44 for cleaning and lubricating electrical contacts. *See ad page 88.*

17U. *GC ELECTRONICS*—Free catalog FR-62-S, new products supplement for general catalog FR-62; lists replacement antennas, test equipment, and service aids.

18U. *PRECISION TUNER*—Information on repair and alignment service available for any TV tuner. *See ad page 54.*

19U. *TECHNI-PARTS CORP.*—Brochure describing *Mak-a-Belt* Kit and other products.

20U. *YEATS*—Literature describing the new Model 14 appliance dolly, featuring all-aluminum I-beam construction. *See ad page 94.*

SPECIAL EQUIPMENT & SERVICES

21U. *ACME*—Illustrated catalog sheet 24B01 listing specifications and applications for control-type magnetic amplifiers; includes units with capacities from 5 to 1000 watts and voltage ranges from 24 to 160 volts. *See ad page 95.*

22U. *TERADO*—Catalog sheet describing line of converters, battery chargers, and relays. *See ad page 90.*

23U. *VOLKSWAGEN*—60-page illustrated booklet, "The Owner's Viewpoint," describing how various business enterprises use VW trucks in their operations; also booklet giving complete specifications on VW truck line. *See ad page 51.*

TECHNICAL PUBLICATIONS

24U. *CLEVELAND INSTITUTE OF ELECTRONICS*—Information on careers in electronics (both military and civilian); also, handy pocket book listing commonly used electronic conversion factors, formulas, tables, and color codes. *See ad page 24.*

25U. *HOWARD W. SAMS*—Literature describing all current p blications on radio, TV, communications, audio and hi-fi, and industrial electronics, including new Fall-Winter 1962 Book Catalog and descriptive flyer on 1962 Test Equipment Annual. *See ads pages 65, 86.*

TEST EQUIPMENT

26U. *ACCURATE INSTRUMENT CO.*—6-page brochure describing complete line of tube testers, VOM's, VTVM's, and signal generators. *See ad page 92.*

27U. *ANTRONIC*—Detailed information on the CA-378 *Kine-Color* Circuit Analyzer.

28U. *B&K*—Catalog AP20-R, giving data and information on Model 850 *Color Analyst*, Model 960 *Transistor Radio Analyst*, Model 1076 *Television Analyst*, *Dyna-matic* 375 VTVM, V-O-Matic 360, new Model 625 3-in-1 *Dyna-Tester*, Models 600 and 700 *Dyna-Quik* tube testers, Models 440 and 420 CRT Tester-Reactivators, and Model 1070 *Dyna-Sweep* Circuit Analyzer. *See ads pages 45, 47, 52, 64.*

29U. *HICKOK*—Specifications and information on new 6000A tube tester for compactrons, novars, nuvistors, 10-pin, and other vacuum tubes, and on Model 661 Color Generator.

30U. *MERCURY*—Master catalog describing regular and self-service tube testers, component substitutor, CRT tester, and other service equipment. *See ad page 83.*

31U. *PEL ELECTRONICS*—Technical bulletin describing DM201 Transistorized "Grid" Dip Meter and SG101 Transistorized Signal Generator.

32U. *PRECISION APPARATUS*—20-page, two-color catalog featuring extensive line of electronic test equipment. *See ads pages 56, 57, 63.*

33U. *SECO*—"How to Test Tubes" folder; includes chart diagram of tube elements and how to test for their malfunctions. *See ads pages 78-79.*

34U. *SENCORE*—Complete literature on the CA-122 Color Circuit Analyzer and the PS-120 wide-band scope. *See ads pages 27-30.*

35U. *TRIPLETT*—Catalog No. 44-T containing specifications of new test equipment.

TOOLS

36U. *BERNS*—Data on 3-in-1 picture-tube repair tools, on *Audio Pin-Plug Crimper* that lets you make pin-plug and ground connections for shielded cable without soldering, and on *ION* adjustable "beam bender." *See ad page 86.*

37U. *CHAMPION DeARMENT*—General catalog No. 361 covering complete line of *Channellock* and *Champion DeArment* hand tools.

38U. *ENTERPRISE DEVELOPMENT CORP.*—Literature from Endeco on improved desoldering and resoldering techniques for use on PC boards. *See ad page 72.*

39U. *ONEIDA*—Literature describing soldering-gun attachment for servicing printed-circuit boards.

40U. *EVERSOLE INDUSTRIES*—Sheets describing and listing prices of *DeSod* desoldering tools for removing and replacing parts on printed-circuit boards, including new tip for compactron sockets.

41U. *UNGAR*—Eight-page, fully illustrated, four-color catalog with specs and prices of *Imperial* soldering iron and complete line of interchangeable *Imperial* components.

42U. *XCELITE*—Bulletin N762 describing new compact Nut Driver set that contains 10 sizes with torque-amplifier handle. *See ad page 54.*

TUBES & TRANSISTORS

43U. *AMPEREX*—16-page semiconductor catalog describing Amperex Post Alloy Diffusion Process (PADT) for manufacturing transistors; also basic specifications on full line of semiconductors. *See ad page 13.*

Complete rescreening means sharp, clear TV pictures from each RCA Silverama

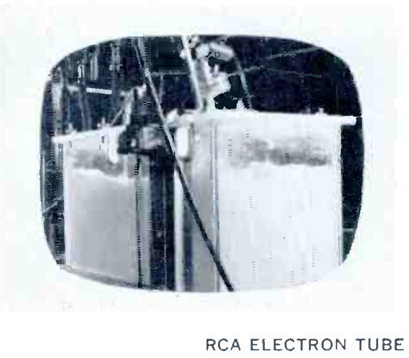
These RCA Silverama picture tube bulbs are getting a new phosphor screen—the "face" they will one day show to your customers.

As they inch their way along this vibration-free settling belt in our Marion, Indiana picture-tube plant, a suspension of phosphor particles settles slowly from a chemical solution in each bulb, depositing a smooth new screen over the faceplate.

This is one of the final steps in the rescreening process. Prior to re-use each glass envelope has been rigorously inspected. Its exterior has been buffed and polished to mirror-smoothness. Then in a series of acid baths and water rinses, the interior has been scoured of its former coatings and delicately etched to restore it to the peak of its optical capability. Only when chemically clean inside and out is it ready for its new screen.

These exacting techniques—and the precision engineering behind them—provide every RCA Silverama picture tube with the best picture-making capabilities modern technology can produce. They are your assurance that you install the finest when you install Silverama.

Phosphor blending tanks. Here the proper blend of screen phosphor particles is mixed with a solution of ultra-pure demineralized water and settling chemicals. Mechanical blenders, providing a uniform suspension, help assure the perfectly even screen that characterizes Silverama.



Final screen quality and focus check. Here on an automatic test unit, a trained inspector examines a test pattern on a finished picture tube to determine screen quality and picture focus. This is but one of 26 different tests each Silverama must pass at this test unit before it is okayed for sale and distribution. Tubes failing a single test are automatically rejected.

RCA ELECTRON TUBE DIVISION, HARRISON, N. J.

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