A HOWARD W. SAMS PUBLICATION

FEBRUARY 1966/50¢

PF Reporter™

PHOTOFACT

the magazine of electronic servicing

- **Repair the Portable TV Quickly**
- **Amplified AGC**
- **Troubleshooting Synchro Systems**
- **Square-Wave Tests of Audio Amplifiers**
- **Antenna Changeover in CB Transceivers**
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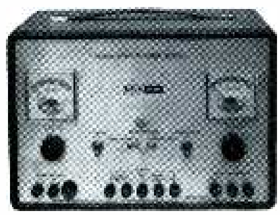

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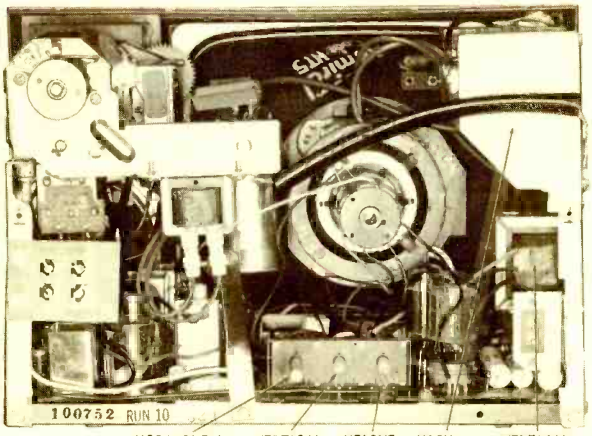
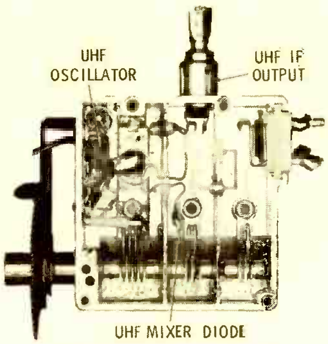
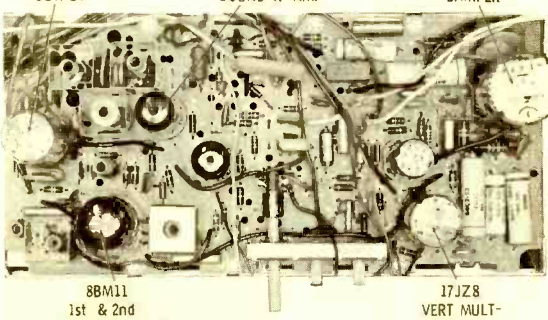
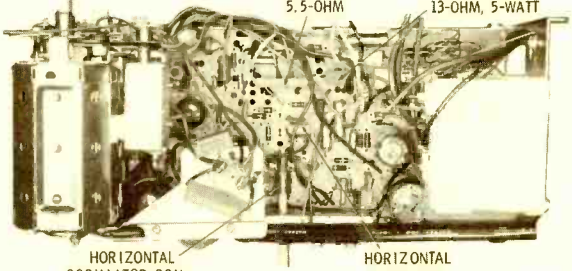


Admiral
Model—PG-927
Chassis—G2-1



INTERNAL VIEW OF UHF TUNER





The photo above shows Admiral's newly introduced 9" portable. This AC-operated, tube-type receiver features a built-in monopole antenna, earphone jack, and carrying handle.

The tube lineup in this small-screen personal portable is somewhat different than those used in the past. The two video-IF stages use an 8BM11 (a dual pentode); an 8JV8 serves as the video amplifier and the sound IF amplifier; and a 17BF11 operates in the audio-detector and audio-output stages. The vertical sweep section has a 17BF11 as multi-vibrator/output; the horizontal oscillator is an 8FQ7; and a 33GY7 performs as the horizontal output and the damper. The high-voltage rectifier may be an unfamiliar type—it's a 1BC2. Conventional tubes are used in the VHF tuner; a 6CG8A operates as mixer/oscillator and a 3GK5 as the RF amplifier. The UHF tuner uses an NPN transistor as the oscillator and a crystal diode as the mixer.

Other semiconductors include the 1N87A signal diode used as the video detector; the horizontal AFC stage has a dual-diode. The low-voltage power supply uses a single silicon for developing the 125-volt B+. Silicon protection is afforded by a 5.5-ohm fusible resistor. A 13-ohm, 5-watt dropping resistor is connected in series with the filament string. These two resistors are pointed out in one of the photos. Should it be necessary to replace either of these resistors, you must first disassemble the chassis. The chassis is held by four retaining screws—two each on the left-and-right-hand sides of the cabinet.

One large horizontally-mounted printed circuit board contains practically all the small components. A triple-section control assembly for the vertical-linearity and height controls is mounted on the board. The horizontal-hold coil form is mounted within this control assembly, and is adjustable by a shaft that extends through the cabinet rear cover. As you can see in one of the photos, the lugs on the coil are not mounted on the board, but rather the electrical connections are via individual wires running from the coil terminals to the printed board.

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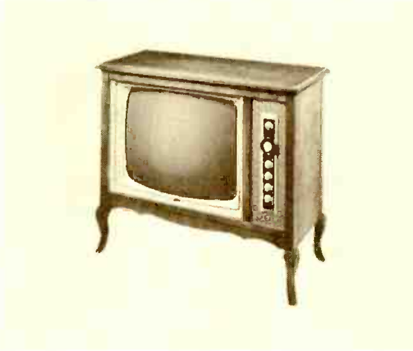
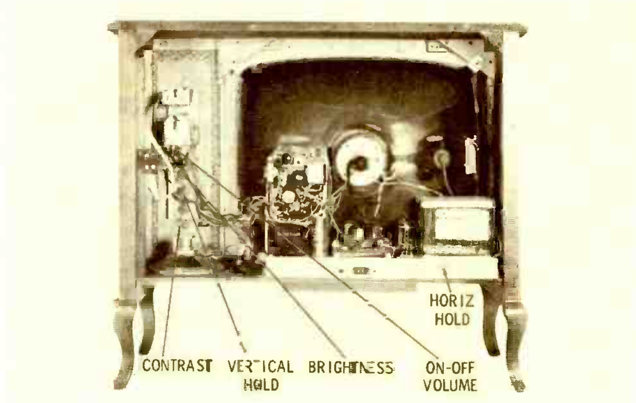
PREVIEWS of new sets





Muntz
Model—3415 EA
Chassis—AS-5003-1

Appearing here is one of the newest Muntz consolette models. This one has a transformer-powered chassis and may use either a 23DVP4 or 23GVP4 picture tube. The number of receiving tubes used in the main chassis has been reduced to nine. The requirement for fewer tubes is accomplished by using compactrons. (two of these, 6AR11 and 6AL11, feature two pentodes in the same envelope) throughout the receiver.

The 6AR11 is used as the second video--IF amplifier/sound IF amplifier and the 6AL11 serves as the audio detector/audio output. A third compactron, the 6B10, has two triodes and a dual-diode section in the same tube. This tube serves as horizontal AFC/multivibrator.

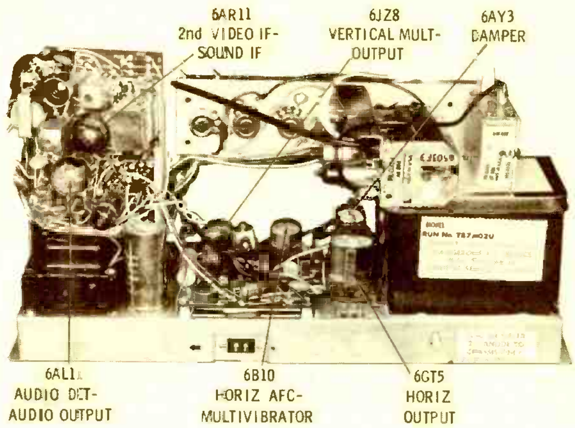
The low-voltage power supply has two silicon diodes connected in a full-wave rectifier (not a doubler) arrangement. The total B+ output of these rectifiers is 150 volts. Protective devices in the power supply include the 3.2-amp line fuse and the filament fuse wire that protects the parallel filament string.

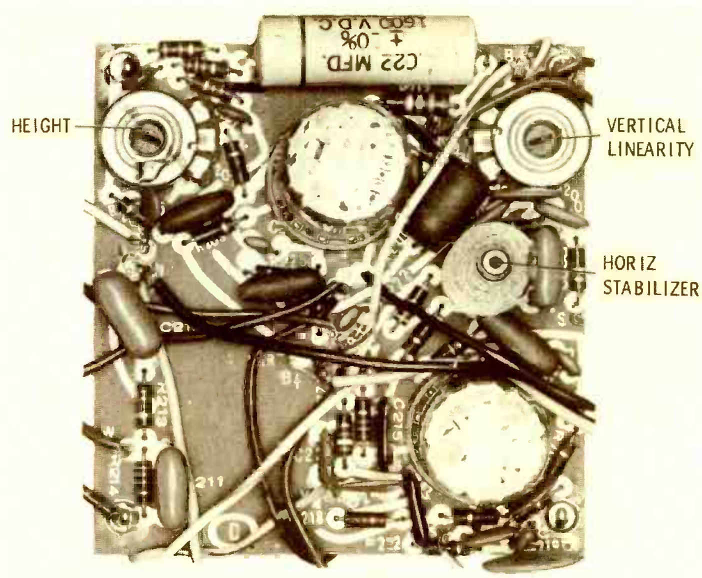
This chassis has two printed boards—one mounted vertically and one horizontally. The vertical board consists of the video, sound, and sync separator tubes. On the horizontal board are the horizontal multivibrator and vertical multivibrator/output tubes. The horizontal output, damper, and high voltage rectifier tubes are located on the main chassis pan.

Controls for on-off volume, brightness, vertical hold, and contrast are mounted on an individual panel; also mounted on this panel are the VHF and UHF tuners. Channel-selection, fine tuning, and the four controls are all adjustable from the front of the cabinet.

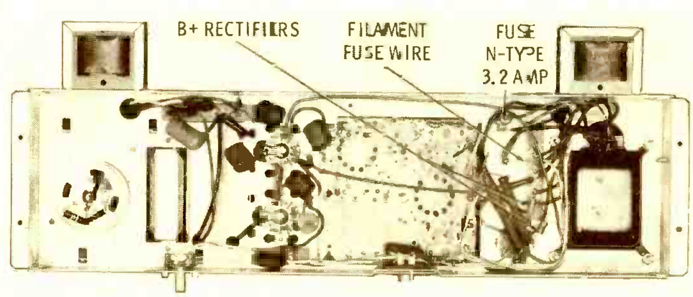
The horizontal hold control is on the rear of the main chassis and may be adjusted from the cabinet rear. The vertical height and linearity controls and the horizontal-stabilizer coil are located on the sweep printed-circuit board. This coil and these two controls are not accessible unless the cabinet back is removed.

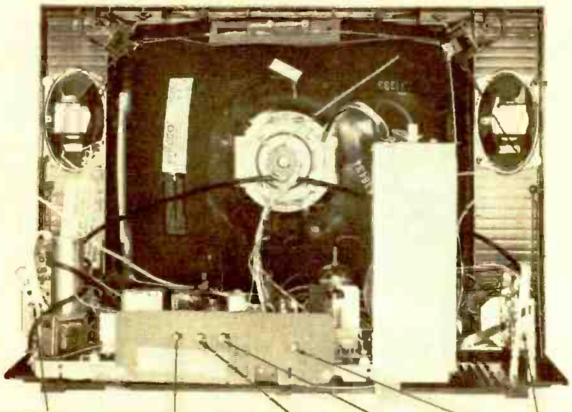
To remove the chassis from the cabinet: disconnect the anode lead, speaker leads, antenna leads, and CRT socket; remove the yoke; remove the four chassis retaining bolts and the screws holding the tuner mounting bracket.

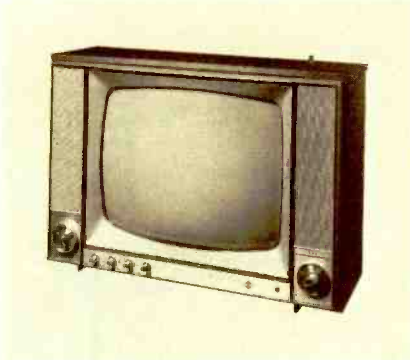




SWEEP CIRCUITS PRINTED BOARD







Philco Model—P3906WA Chassis—16JT26

One of the newest portable television receivers introduced by Philco is the 19" model shown here. This set is housed in a plastic cabinet and has such features as private listening (earphone) jack, and dual speakers—one on each side of the cabinet. The chassis in the portable is different from ones available in the past in some respects. Probably most interesting is the fact that this chassis uses both tubes and transistors. Five transistors are used in the main television chassis (three as video amplifiers and two in the AGC stages), and the VHF and UHF tuners are both completely transistorized.

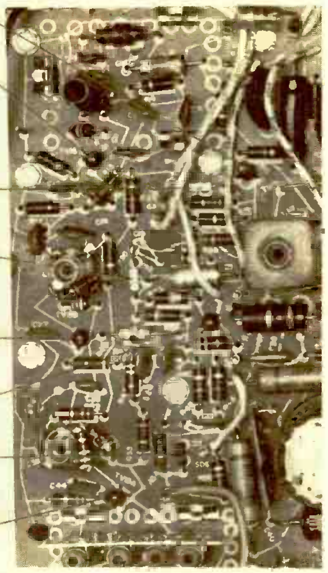
Except for the much lower positive source voltage required by the NPN transistors, the video IF and AGC circuits operate basically the same as when tubes are employed. A keying pulse, taken from the horizontal output transformer, is applied to the collector of the AGC gate transistor.

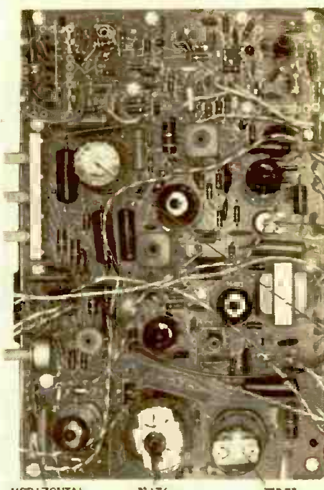
The low-voltage power supply uses a single silicon rectifier to develop the 140-volt B+. This rectifier is protected by a 1.5-ohm, 3-watt surge limiting resistor. A 43-ohm, 12-watt dropping resistor is in series with the tube filaments. A positive 12-volts DC for the transistor stages (with the exception of the AGC gate) is derived from a diode which rectifies a pulse taken from an individual winding on the flyback.

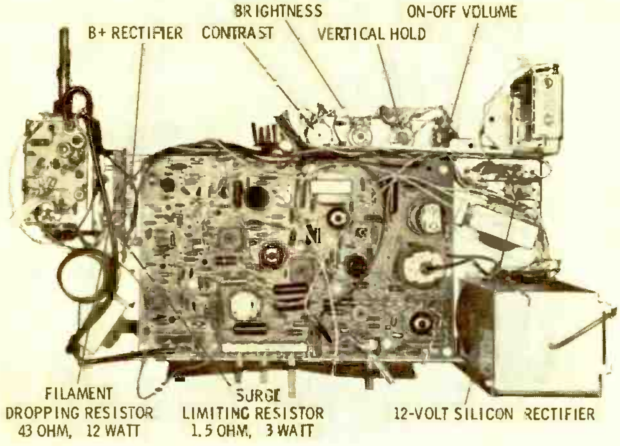
The tube stages in this receiver are quite conventional; however, some new tube types are being used. The audio output stage has a 10BQ5, the damper is a 17BZ3, and serving as the horizontal output is a 21JZ6.

One large printed-circuit board is used in this chassis; the majority of the components, with the exception of the high- and low-voltage power supplies, are mounted on this board. Also, on the board, and accessible from the rear of the receiver, are the controls for vertical linearity, height, and horizontal hold (a triple-section assembly), and width.

The on-off volume, vertical hold, brightness, and contrast controls are on an individual panel and are located in the front of the receiver at the bottom left-hand corner. Also, on the left side at the front is the UHF tuner; the VHF tuner is on the right side.







Westinghouse
Model H-K4250
Chassis V-2485-11

The 23" consolette pictured above uses a 94° 23EZP4 picture tube. Basically this chassis is similiar to earlier Westinghouse models both physically and electrically.

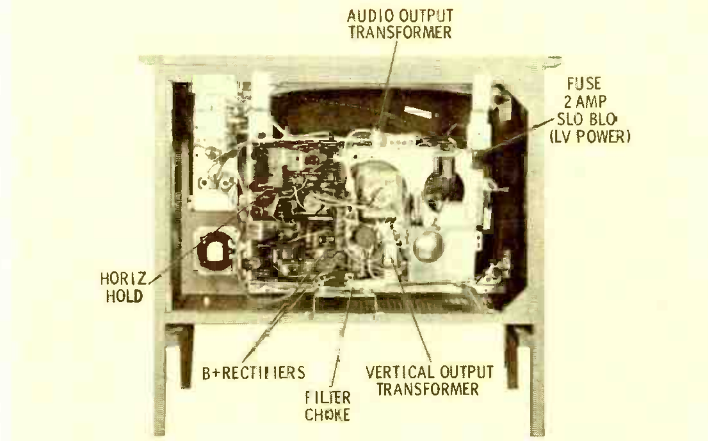
A three-stage video-IF strip precedes the video detector diode. The video-detector output is fed to the pentode section of a 10GN8; the triode section of this tube serves as the sync separator. Other dual-purpose tubes include the 6FV8A which functions as the AGC keyer/noise inverter and the 13EM7 in the vertical multivibrator/output circuits. The horizontal mulitivibrator is an 8FQ7 followed by a 21GY5 in the horizontal-output stage and the 17BE3 damper.

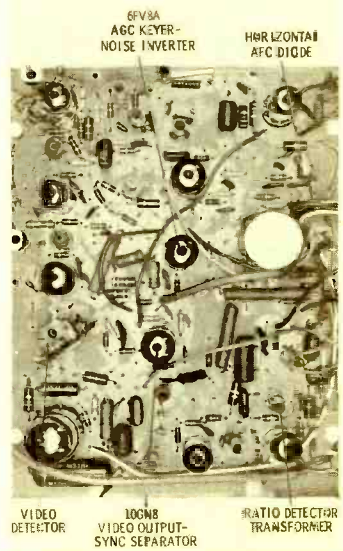
The low-voltage power supply uses two silicon rectifiers to develop the B+ voltage. These silicons are protected by a 6-ohm, 15-watt surge limiting resistor and by the 2-amp, slo-blo fuse connected in series with one side of the AC line. The series filament string is not disabled when the on-off switch is turned to off. In the off position of this twitch, the filaments are supplied a pulsating DC voltage through the *instant-on* diode. This diode is in series with the tube filaments and shunts the on-off switch. Complete power is disabled only when the AC plug is removed from the power outlet.

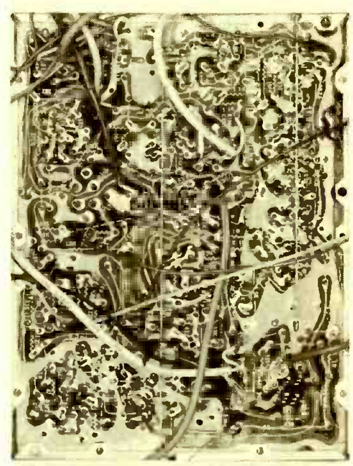
Some noteworthy features in this chassis include the voltage-dependent resistor (VDR) used in the horizontal-output stage and the neon bulb used as horizontal blanking.

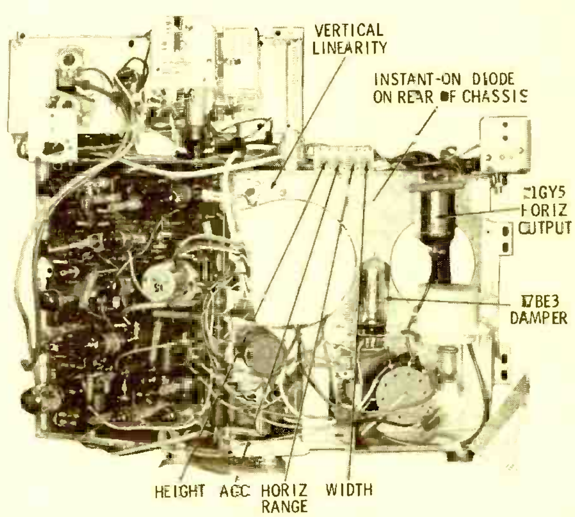
The purpose of the VDR is to maintain constant width when the brightness control is rotated, the AC line voltage fluctuates, or when the horizontal-output tube ages. The VDR increases or decreases the negative bias on the horizontal-output tube in accordance with the amplitude of the flyback pulse. An additional load on the flyback reduces the pulse amplitude and in turn causes the VDR to reduce the negative voltage on the output tube. A larger amplitude flyback pulse causes an opposite effect—the VDR increases the bias on the output tube.

A quadruple control assembly (accessible by removing the rear cabinet cover) houses the height, AGC, horizontal range, and width controls.






REAR VIEW OF PRINTED CIRCUIT BOARD—COMPONENT VALUES AND TUBE TYPES ARE LABELED.



VIDEO SPEED SERVICING

G. E.

SEE PHOTOFACT Set 729, Folder 4

SEE PHOTOFACT Set 729, Folder 4

Mfr: G. E. **Chassis No.** CY (Color)

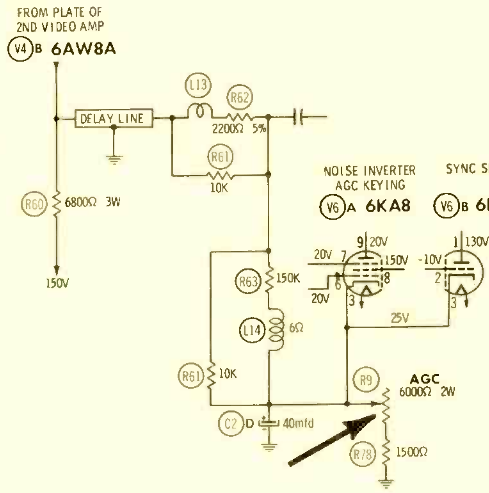
Card No: GE CY-1

Section Affected: Picture.

Symptoms: Picture overload with medium or strong signal.

Cause:
AGC control open.

What To Do: Replace AGC control R9 (6000 ohms, 2 watt).



Mfr: G. E. **Chassis No.** CY (Color)

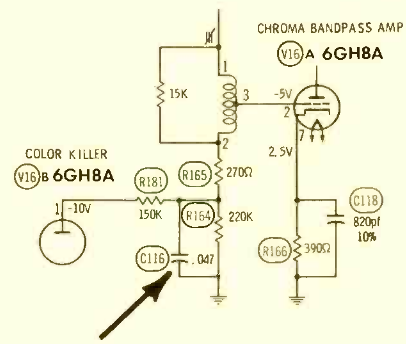
Card No: GE CY-2

Section Affected: Chroma.

Symptoms: No color on station signal; some color may be obtained with color-bar generator.

Cause: Defective capacitor in plate circuit of color killer.

What To Do: Replace C116 (.047 mfd).



Mfr: G. E. **Chassis No.** CY (Color)

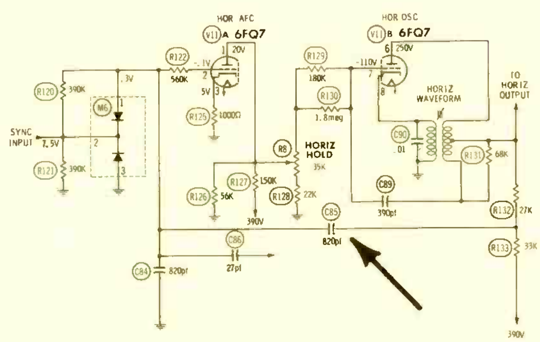
Card No: GE CY-3

Section Affected: Sync.

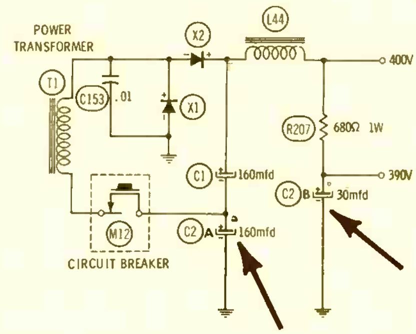
Symptoms: Loss of color sync; horizontal hold unstable.

Cause: AFC feedback capacitor leaky.

What To Do: Replace C85 (820 pf, 10%).



SEE PHOTOFACT Set 729, Folder 4



Mfr: G. E. **Chassis No.** CY (Color)

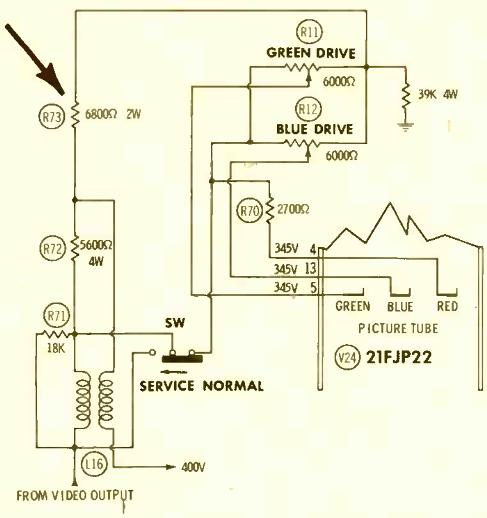
Card No: GE CY-4

Section Affected: Sync.

Symptoms: Horizontal and vertical hold both erratic.

Cause: Leaky electrolytic capacitor in power supply (390-volt source).

What To Do: Replace C2 (30 mfd).



Mfr: G. E. **Chassis No.** CY (Color)

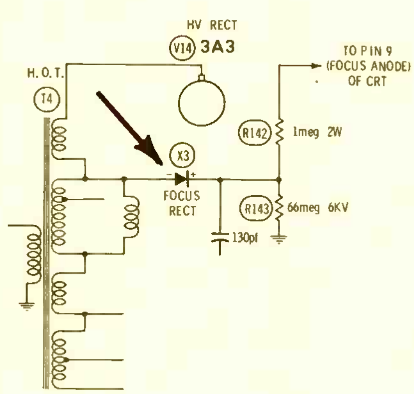
Card No: GE CY-5

Section Affected: Raster.

Symptoms: Raster blooming and poor focus.

Cause: CRT cathode bias resistor increased in value.

What To Do: Replace R73 (6000 ohms, 2 watt).



Mfr: G. E. **Chassis No.** CY (Color)

Card No: GE CY-6

Section Affected: Raster.

Symptoms: Proper focus cannot be obtained.

Cause: Focus rectifier shorted.

What To Do: Replace focus rectifier X3.

See PHOTOFACT Set 574, Folder 2

See PHOTOFACT Set 574, Folder 2

Mfr: Motorola **Chassis No.** QTS-576Y

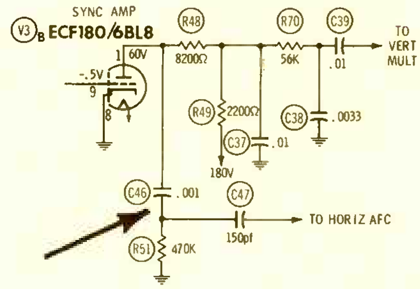
Card No: MO QTS576-1

Section Affected: Sync.

Symptoms: Horizontal tearing.

Cause: Leaky capacitor in differentiator network.

What To Do: Replace C46 (.001 mfd.)



Mfr: Motorola **Chassis No.** QTS-576Y

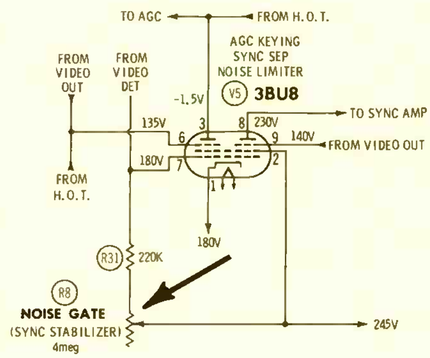
Card No: MO QTS576-2

Section Affected: Picture and sync.

Symptoms: Video overload; erratic horizontal and vertical hold.

Cause: Noise-Gate control defective.

What To Do: Replace Sync-Stabilizer (Noise-Gate) control R8 (4 meg).



Mfr: Motorola **Chassis No.** QTS-576Y

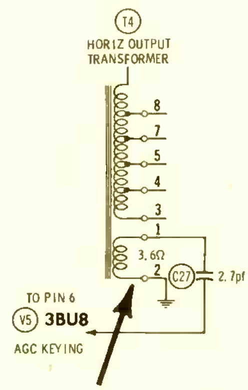
Card No: MO QTS576-3

Section Affected: Picture.

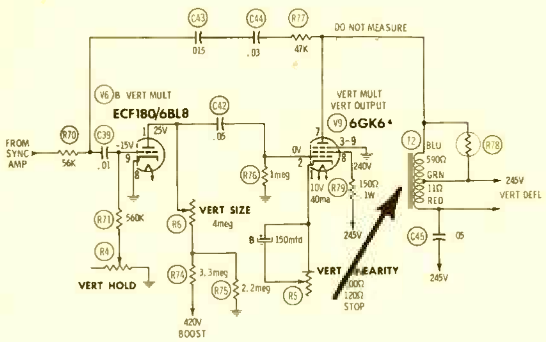
Symptoms: Video overload.

Cause: Open ground connection at terminal 2 of AGC winding on horizontal-output transformer.

What To Do: Resolder ground connection.



See PHOTOFACT Set 574, Folder 2



See PHOTOFACT Set 574, Folder 2

Mfr: Motorola **Chassis No.** QTS-576Y

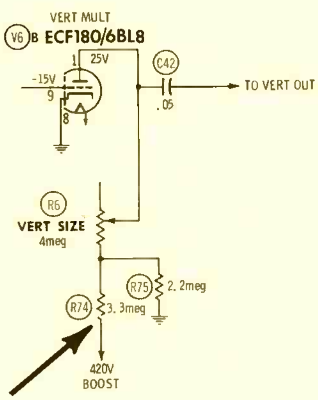
Card No: MO QTS576-4

Section Affected: Vertical sync.

Symptoms: Vertical rolling; otherwise, raster and picture are normal. All voltages and waveforms appear normal.

Cause: Vertical-output transformer defective.

What To Do: Replace T2, vertical-output transformer.



Mfr: Motorola **Chassis No.** WTS-576Y

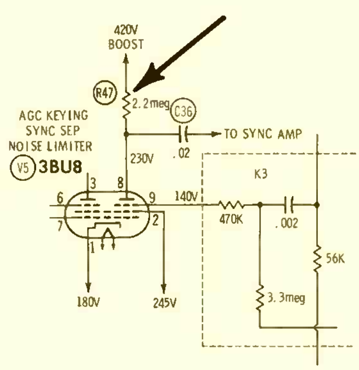
Card No: MO QTS576-5

Section Affected: Raster.

Symptoms: Insufficient vertical sweep. Plate (pin 1) of V6B has low voltage.

Cause: Voltage-divider resistor in plate circuit of vertical multivibrator has increased in value.

What To Do: Replace R74, (3.3 meg).



Mfr: Motorola **Chassis No.** QTS-576Y

Card No: MO QTS576-6

Section Affected: Sync.

Symptoms: No vertical or horizontal hold; plate (pin 8) of V5 has extremely low voltage.

Cause: Sync-separator plate resistor has increased in value.

What To Do: Replace R47 (2.2 meg).

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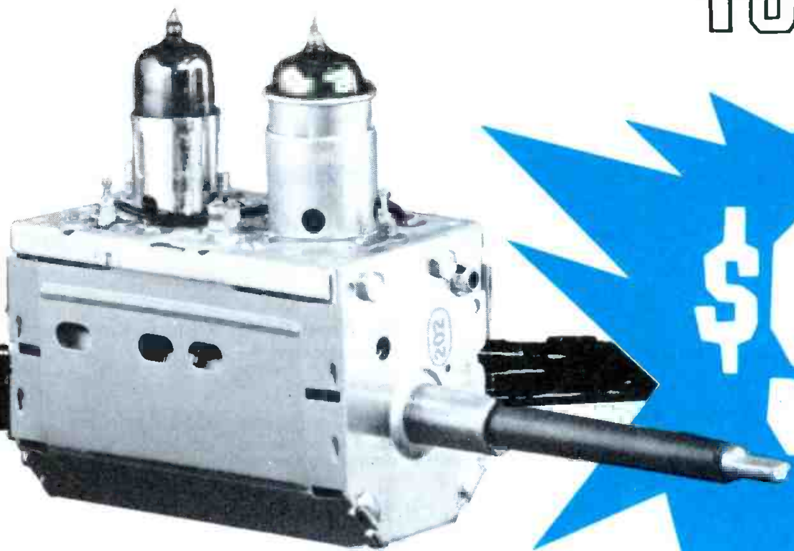

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Circle 2 on literature card

A HOWARD W. SAMS PUBLICATION

PF Reporter™

PHOTOFACT

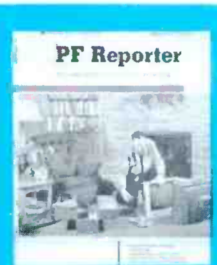
the magazine of electronic servicing

VOLUME 16, No. 2 *FEBRUARY, 1966*

CONTENTS

ABOUT THE COVER

Small-screen, portable TV receivers are commonplace items in the American home. They are found in the living room, bedroom, recreation room, etc. However, these sets shouldn't be regarded lightly by the serviceman. A quick and efficient repair on these portables will lead to increased profit and a greater volume of business. Ways for more quickly repairing these receivers are detailed in the article beginning on page 16.



Circle 3 on literature card

Letters to the Editor

Dear Editor:

I enjoy your previews of sets and circuits but can't really apply this information to servicing because of the new tubes that keep appearing. In the November, 1965 issue, the schematics in "Know Your '66 Color Circuits" showed 17 tubes. Seven of these I'd never seen before. The other ten were in a manual I'd bought two months ago as the latest out.

I've been wondering if you could run an article on all new tubes as they come out. This way we could have the information before we run across the tubes in a set.

BRUCE GREEN

Mequite, Texas

This is just one of many requests we've had on this subject. Okay, we'll do it. In the March 1966 issue, we'll begin "New Tube and Transistor Data." Included will be the latest tubes and transistors as they appear in the equipment in the PHOTOFACT *analysis lab. We hope this is what our readers need. —Ed.*

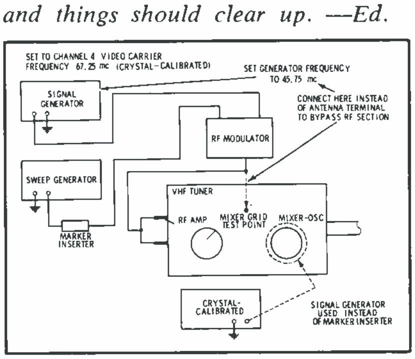
Dear Editor:

I am a student in electronics and I read your article on "Overall Alignment" (November 1965) with accelerating interest. I have obtained many valuable hints from this. However, there are also many items that baffled me and didn't quite penetrate. For instance, your block diagram (Fig. 8) on VSM is confusing with arrows pointing here and there. Try a little simplicity for us beginners the next time.

STEVE TOPLEY

Mt. Pleasant, Ohio

We agree that the block diagram (see below) would be confusing to the beginner. We included two alternative sets of connections in one diagram. However, read the text carefully as you relate it to the hookup and things should clear up. —Ed.



The Electronic Scanner

news of the servicing industry

Changes to Come

Radio-TV technicians should be challenged by this information taken from the **Electronic Industries Yearbook 1965,** published by the Marketing Services Department of the **Electronic Industries Association.** Although these statistics are taken from factory, not consumer, sales figures, they accurately reflect changes in the consumer market.

One of the most noticeable trends is the increase of electronic products in the home. In addition to the recent color TV sales boom, there has been a smaller—yet just as significant—sales boom for phonographs, high-fidelity components, tape recorders, electronic organs, and numerous other home products such as intercoms and door controls. From 1961 to 1964, factory sales in this area increased from $587 million to $863 million—a 47% increase. Items that showed the greatest sales increases were: tape recorders— $39 million to $60 million; and electronic organs—$51 million to $105 million. Although they can still hardly be called inexpensive, the decline of electronic organ prices has probably increased their popularity. The percentage increase is not so great, but high-fidelity component sales (speakers, amplifiers, and tuners) increased 19% from 1961 to 1964 which gives an excellent indication of the growing popular interest in more sophisticated electronic products.

Another trend was noted between 1963 and 1964. Phonograph unit sales increased from 5.142 million to 5.159 million units— only 17,000 units increase; yet factory sales increased from $421 million to $440 million—a $19 million increase—indicating a shift in demand toward higher-priced units. Expensive home-entertainment centers are becoming quite fashionable. In the near future such items as video tape recorders, ultrasonic dishwashers, electronic burglar alarms, and microwave ovens are just a few of the devices that may become common household equipment. Someone will have to maintain these devices. Service technicians do have unprecedented opportunities.

A further look at statistics reveals that while total electronic factory sales (consumer, industrial, and government products, plus replacement components) increased from $12.173 billion in 1961 to $16.135 billion in 1964, replacement-component sales increased from $580 million to $620 million. Overall product sales increased by 32.6%, but replacement-component sales for the same period increased only 6.9%. There are many reasons for the lag in replacement-component sales; imported components account for part of it. Increased reliability of electronic circuits—especially solid-state units—seems to be a major reason for the lag in sales. The service technician must be aware of this trend. Electronic components of the future may not require the maintenance as in the past.

In summary, the radio-TV technician is faced with the prospect of an increasing number of devices that he has opportunity to service, yet at the same time, this electronic equipment will probably require less maintenance per unit. There are exceptions: Color TV is more complex and should require more maintenance than its black-and-white counterpart; the tape recorder unit is also more complex and requires more attention than the phonograph, and new devices placed on the market will initially be less reliable and require more maintenance. No matter what, the successful service technician must keep up with electronic advances. Often, as with color TV, more elaborate (and expensive) test equipment will be needed. Most important, techniques for rapid servicing of the new equipment will have to be learned. Opportunity does exist for those who are willing to advance with the industry.

Electronic Lung Power

The New York Jets of the American Football League may have solved the problem of crowd noise that often drowns out the audible signals which quarterbacks frequently call at the line of scrimmage to change plays after the huddle.

A specially designed helmet apparently is the answer. The helmet contains a transistorized public-address system which

boosts the quarterback's voice to about three times the loudness of a TV set turned to full volume.

Six transistor-radio loudspeakers were modified by the **Jensen Manufacturing Division/The Muter Company** to handle 50 times more power than those used in a standard transistor

International Expansion

Construction contracts have been awarded by **Amphenol Corporation** for the building of modern facilities in Toronto, Ontario, Canada, and in Mexico City. **Amphenol Canada Limited,** Toronto, and **Electronica Perfeccion, S. A.,** Mexico City, will occupy 34,000-square-foot plants in early 1966. Both subsidiaries manufacture electrical and electronic components used in the aircraft, missile, communications, and computer industries. It is intended the Mexican company will constitute a base of operations for developing Central and South American markets. Amphenol's diversified operations are now conducted by 10 domestic divisions and 8 foreign subsidiaries. It is also affiliated with *Dai Ichi Denshi Kogyo* in Japan.

Call Operator 25 For Radio Service

Owners of **Admiral** radios, phonographs, and portable stereos can call Western Union Operator 25 for the name and address of their nearest servicing dealer. This service is provided at no cost to the consumer, and the company has approximately 700 locations in the United States where customers can obtain local service on these products.

New, Larger Quarters

A new building with production area four times as large as the previous one, plus room for additional expansion, now houses **PACE Communications Corp.** in the Greater Los Angeles area. Increased sales, and a substantial order backlog, made it necessary to expand sooner than previously anticipated. The company which builds CB radios, was formed about two years ago. Production facilities include automated assembly lines for increased efficiency.

UHF Antenna Shipped Parcel Post

A series of all-aluminum parabolic UHF antennas is available in a patented folding design which reduces carton dimensions

to one-fifth the size normally required to ship parabolic antennas. The savings in delivery, storage, and customer handling is said to be more than 50%. In the photo, an ordinary-size parabolic carton is compared with the packaging of **FINCO's** all-aluminum 6′ and 5′ parabolic antennas. ▲

radio. The six speakers are mounted inside the helmet, three over each of the quarterback's ears. Small vents permit the sound of his amplified voice to issue freely from the helmet. Padded enclosures far from the helmet webbing protect the quarterback's head from bumping against the speakers or amplifier. All parts of the system, including the speakers, are completely waterproofed.

When he chooses to call an audible at the line of scrimmage, the quarterback speaks into a small microphone fastened firmly to the inside of his face guard. A switch cuts off the loudspeakers while signals are called in the huddle.

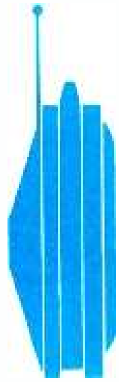
ReplaceVHF-Only Products With All-Channel Items

A new policy of replacing VHF-only products with all-channel merchandise has been announced by **Blonder-Tongue Laboratories, Inc.**, as part of its drive to help franchised distributors capitalize on the growing trend toward all-channel reception.

Blonder-Tongue is exchanging a selected number of UHF-VHF products for VHF-only products on a one-for-one basis. Distributors are requested to send the company a list of model numbers and quantities of the products they wish to exchange for U/V items.

VHF-only products eligible for exchange are: A-102 for A-102 U/V; A-104 for A-104 U/V. Cable match for Cable-match U/V. MBb for MT-238, and TF-331 for TF-331 U/V. All of the returned equipment will be subject to inspection and acceptance by the factory. Only new, resalable merchandise is acceptable.

The all-channel products line, the new distributor policy, and a supporting advertising and promotional campaign are designed to enable the TV service industry to keep pace with the spread of UHF and color.



REPAIR THE TV PORTABLE ...QUICKLY

short cuts for speedier repairs in small size receivers.

by Homer L. Davidson

There were three small portable TV receivers awaiting repair when I arrived at the shop this morning. "Just as well take them one at a time," I thought. So I hoisted number one onto the bench and turned it on. The set was completely dead —no sound, no picture, nothing. When I removed the back and inserted the cheater cord, the defect was obvious; the tube filaments weren't lighting. There are many ways to troubleshoot a series filament string. But in order to save time and make some easy money, take the quickest route. In small, portable TV receivers, heat is one of the major causes of filament burn-out. Nine times out of ten, you'll be ahead by checking the filament-dropping resistor first and then the tubes that operate at the highest temperatures.

You can find out if the filament-dropping resistor is open (it was in this set) by removing one of the tubes and placing an ohmmeter across the resistor. If the resistor isn't open proceed to check for continuity of the damper, horizontal-output, and horizontal-oscillator tube filaments. By now you will have generally found the culprit. If not, check the filaments of each tube with an ohmmeter. Two typical series-filament circuits are shown in Figs. 1 and 2. Some servicemen like to plug the suspected tube into a small series checker box; others use a tube tester. But a method should be used to repair the small portable as quickly as possible.

Another cause for the tube filaments not lighting is the small RF chokes located in the series filament strings—especially those that are molded like a resistor. A bad contact on etched boards between the socket pin and board is another common trouble. A thermal condidition within the tube filament is another trouble, but in this case the filaments will light up and then go out. You can find this trouble by placing a voltmeter, set on the 150-volt AC scale, across the heater terminals of each tube. When the meter is placed across the terminals of the defective tube, the meter will read 117 volts AC.

I always take a quick look at the filament-dropping resistor and check the terminal connections. If the resistor is burned badly and the solder has melted out of the terminals, I replace the resistor. Many times this will prevent a callback at some later date.

Horizontal and High-Voltage Section

When a set has sound but no picture or raster, the trouble usually lies in the horizontal or high-voltage section. Here are some of the methods that can be used to rapidly isolate the defective stage. First, either replace or check all tubes in the horizontal and high-voltage stages. See if there is any high voltage on the anode of the picture tube. Most of us are guilty of striking an arc with a screwdriver from the anode connection to chassis, although a high-voltage probe and a meter are much safer. If the proper high voltage is present at the picture tube, check for proper voltages at the CRT socket. If these are correct, the CRT is defective. If there is no high voltage, or if it is greatly reduced, check the grid of the horizontal-output tube. If the negative drive voltage is normal; then the trouble lies in the circuits associated

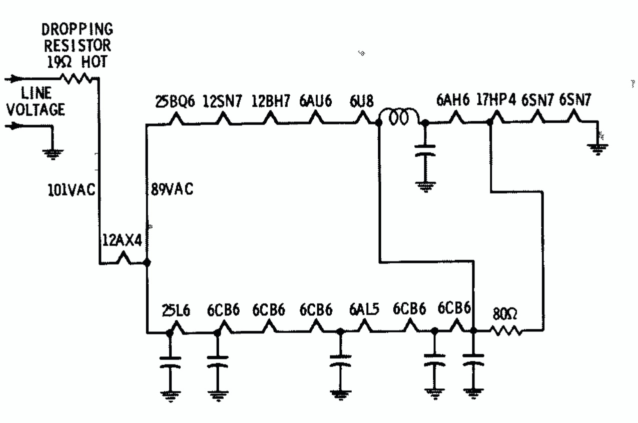


Fig. 1. Early model TV's used a series-parallel circuit.

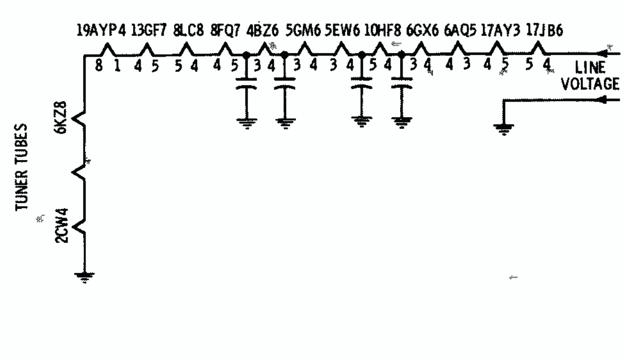


Fig. 2. Series filament circuit in modern-day receivers.

with the flyback, yoke, or high-voltage rectifier.

A horizontal drive pulse, obtained from a signal-substitution instrument, applied to the grid or plate of the horizontal output tube will tell you if the defect is before or after the output tube. If no raster is obtained with the signal connected to the output tube, the trouble is beyond this tube. A check should be made of the boost voltage, horizontal-output transformer, and yoke. You can visually inspect the transformer and yoke to see if there has been arcing. A flyback-and-yoke tester is a useful test instrument, but in case you do not have one, you can check for continuity with an ohmmeter. Of course, the most definite method of determining whether these components are bad or not is by substitution.

When there is no voltage, or only a small negative voltage, on the grid of the horizontal-output tube, the trouble is in the horizontal-oscillator section. The trouble can sometimes be located by making voltage checks on the elements of the horizontal oscillator tube. However, the analyst or scope are certainly worthwhile instruments when servicing the horizontal stages.

Many times you'll find a set that has normal brightness, but there is no picture—only horizontal lines. The horizontal-hold control shifts the lines, but the picture won't lock in. You adjust the sine-wave or horizontal-frequency coil but the picture is still out of phase. Check to see if the set uses a dual-diode in the AFC stage; if so, try substituting another.

It is advisable to make a few last minute checks before leaving the horizontal section. Take a look at the horizontal-output plate cap; if the connection is bad or the wire has been hardened by heat, replace the cap and lead.

Check and thump the damper tube. If the tube is fairly old, replace it. Many times a callback can be saved by replacing an old or arcing damper tube.

Turn up the brightness control and see if the picture blooms. A gassy or weak high-voltage rectifier tube will cause this blooming effect. Be sure to check the raster for proper width. Insufficient width can be caused by weak tubes in the horizontal or high-voltage sections or by a defective resistor in the screen of the horizontal-output tube. Also the vacuum tube, selenium, or silicon rectifier located in the low-voltage power supply can be responsible for poor width.

See if there are any horizontal drive lines, Barkhausen lines, bright vertical bars, or extreme light and dark ripple at the left edge of the screen. The quickest way to eliminate Barkhausen lines, especially on UHF, is to replace the horizontal-output tube. Horizontal drive lines or bright vertical bars may be caused by an increase in value of the horizontal-oscillator plate resistor, a change in resistance of the horizontal-output screen resistor, or an incorrect setting of the horizontal-drive capacitor. Extreme vertical ripple at the left of the screen is often caused by the shunting capacitors in the yoke.

A wedge or trapezoidal shape of the raster is normally caused by a shorted yoke. Sometimes you can check the condition of the yoke by removing the yoke cover and seeing if the resistors or capacitors are burned. Many times a shorted yoke will smoke and arc over; thus, damaging these components. Use an ohmmeter, yoke tester, or substitute a replacement yoke when in doubt.

Vertical Sweep and Sync Trouble

Most portable TV receivers use a multivibrator circuit in the vertical sweep stages. The output from the last half of the multivibrator stage is coupled back to the input of the first half of this stage. This feedback causes the circuit to oscillate. Note, too, that in most cases, only one tube functions as both the vertical oscillator and output. If components in either of these stages become defective, the circuit will not function properly. The symptoms may appear as overscan, improper height or linearity, or in some cases a complete loss of vertical sweep.

When any of these symptoms appear, first try a new vertical tube; if this doesn't cure the trouble go to the output stage and check voltages. Check the feedback capacitor connected to the plate of the output tube—this capacitor is prone to causing trouble. Voltage and resistance checks in the output stages are helpful in isolating a defective output transformer.

If the picture is stretched at the top or bottom there is distortion. This may be caused by incorrect vertical height or linearity control settings. If the raster collapses to a thin line, when adjusting either one of these controls, replace the control.

This trouble can also be caused by the vertical output transformer. It may have an intermittent open or have shorted turns. When the picture is from two to four inches high, the trouble generally lies in the output circuit. However, a resistance increase of the height control or oscillator plate supply resistor will cause the same trouble. A leaking capacitor in the vertical-sync input circuit will cause the picture to jump and bounce; a defective electrolytic in the cathode of the output stage may give the same symptom.

There are many things that can cause the picture to start roll-

• *Please turn to page 64*

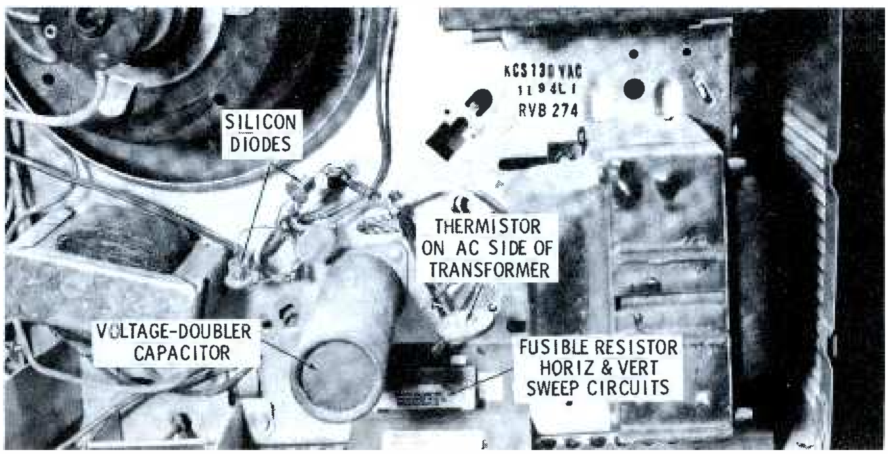


Fig. 3. Location of low-voltage power supply components used in an RCA portable.

by Allan F. Kinckner

AMPLIFIED AGC

These case histories will help you find faults that affect IF and RF gain.

The basic operation of the simple, supplemented, and peak types of AGC is easy to understand and has been described in several publications. In comparison, the development of gain-control voltage in amplified-AGC circuits is not a simple function, nor does it lend itself to simple explanations. The control loop for simpler AGC circuits contains only the IF, RF, and detector stages. However, the control loop of an amplified-AGC system encompasses the RF, IF, detector, video amplifier, and at least one AGC stage. The circuits developing the gain-control voltage of simpler AGC systems are normally straight forward, but amplified AGC circuits contain some odd tube and circuit parameters such as the presence and/or development of a negative voltage on the plate of a tube. Troubles in simpler AGC circuits are usually limited to snow, (Fig. 1A) or overload, (Fig. 1B). However, as we will see later, amplified AGC presents many other symptoms. Of equal importance is the fact that amplified-AGC troubles can result from defects in various receiver circuits, whereas in the simpler circuits troubles generally stem from faults within the AGC-voltage distribuition network.

Early Amplified AGC

A number of different amplified-AGC systems were employed in early receivers. One prototype design, used in many RCA, Magnavox, and Capehart models, as well as some other makes, will be analyzed. Although this design has not been incorporated in new sets for several years, it was used in many large-selling models and in high-priced combinations in which the TV chassis was later converted for larger screens. Hence, many of these sets are still being serviced.

Understanding the operation of this or any multistage circuit is easiest if the operation of its individual stages is thoroughly understood. The circuit in Fig. 2, used in RCA KCS-30 chassis, is presented so that the operation of each stage can be described.

The plate of V14A in section D is the source of the AGC voltage. The negative plate voltage is due to the fact that the plate is actually the tap of a voltage divider—consisting of R25, R26, and the internal resistance of the tube—from the negative 60 volts at the cathode to ground. The internal resistance of the tube is determined by tube conduction, which is controlled by the bias applied from the arm of R4. When the arm of R4 is set at the most negative end, the tube will be cut off, and no voltage will be present on the plates; with the arm set at the least negative end of R4, V14A will conduct almost to plate-current saturation, and plate voltage will increase to −40 volts. Resistors R66, R4, and R67 also comprise a voltage divider. One end of this divider returns to a fixed negative voltage, the other end to a varying low-negative voltage resulting from conducting of V15A in section C. The conduction of this tube is fairly constant, but the voltage at its cathode varies in step with the voltage on its grid—the cathode is usually about 10 volts more positive than the grid. The grid voltage of V15A depends on the conduction of V9A (section B), and this in turn is determined by the bias supplied by R42 and the rectified negative voltage from video detector V8A. The amount of voltage developed varies in accordance with the amount of signal applied to the detector cathode.

Operation of the entire circuit combines the functions of all four stages as follows: With no signal applied to the cathode of V8A, no negative voltage is developed at its plate, and the only bias on V9 is self-bias obtained through R42. The internal resistance of V9 is low enough that −30 volts is present at the plate. This voltage is applied through isolating resistor R68 to the grid of V15A. The cathode of V15A is about eight volts less negative than the grid. The voltage on the grid of V14A is determined by the voltage-divider network composed of R4, R66, and R67. This voltage varies between −60 and −90 volts at the extreme settings of R4. With the control set at the maximum negative level, V14A does not conduct, and its plate assumes a zero potential. Adjusting R4 for a less negative grid voltage allows V14 to conduct, and its plate presents a negative AGC voltage that is divided at the junction of R25, and R26.

When a signal is applied to the cathode of V8A, the diode conducts and thus increases the negative bias on V9A. This increase in grid bias

Fig. 1A. AGC trouble can cause snow.

Fig. 1B. Overloaded picture from AGC

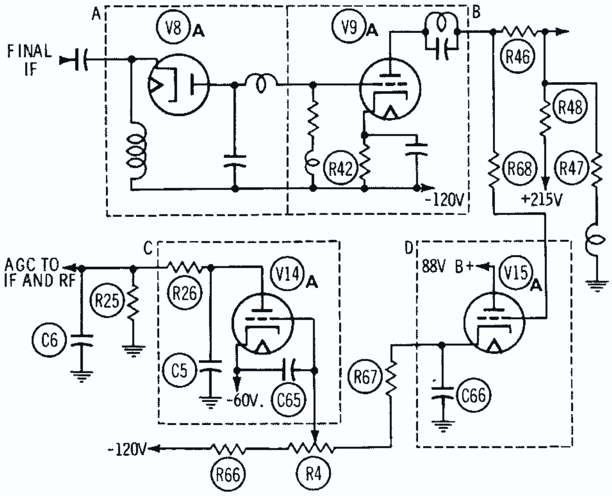


Fig. 2. Amplified-AGC circuit used in early model RCA's.

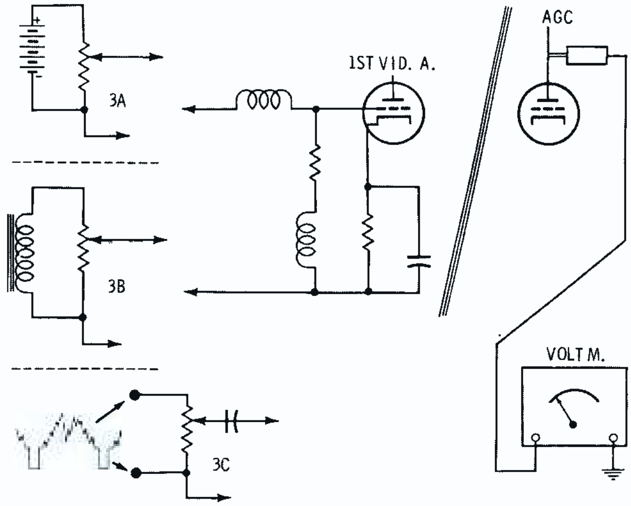


Fig. 3. How AC and DC potentials affect video amplifier.

causes the plate to become less negative, and a less negative voltage is present on the grid of V15A, which in turn causes its cathode to be less negative. The voltage at the arm of R4 is proportional to the ratio of resistances between the arm and the ends of R66 and R67. The change in voltage at this point causes increased conduction in V14A, and a more negative potential is developed at the plate of V14A and at the AGC source.

This entire circuit is a DC amplifier, and it can be demonstrated that it responds only to DC. Assume V8A is removed from the circuit and a variable DC voltage is substituted, as in Fig. 3A. Any increase in negative voltage to the grid of V9A will produce an increase in negative voltage on the plate of V14A. If, on the other hand, a variable AC voltage is applied to the grid of V9A, as shown in Fig. 3B, changing this AC voltage will have no effect on the DC plate potential of V14A. Or if a composite signal is *AC coupled* to the grid of V9A, as in Fig. 3C, varying the level of this composite signal will likewise have no effect on the DC plate potential of V14A.

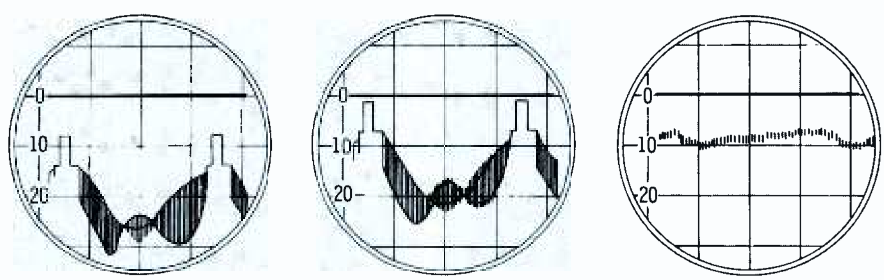
It can also be demonstrated that this DC amplifier has a variable, nonlinear affect on AGC voltage when the arm of R4 is set to different positions. At settings nearer the less negative end, a one-volt change at the grid of V9A can produce a 15-volt change at the plate of V14A. However, with the arm of R4 at a more negative setting, a one-volt change at the grid of V9A will produce a much smaller change at the plate of V14A.

The operation of V15A is modified somewhat by the inclusion of C66. When V8A detects a normal composite video signal, the plate of V9A and the grid of V15A have the signal shown in Fig. 4A. If C66 were omitted, the cathode of V15A would have the signal shown in Fig. 4B, the DC level being established by the bias developed by R4, R66, and R67. Because of C66, the waveform of 4C appears at the cathode because the time constant of C66, R66, R4, and R67 is long enough to keep charged at some sync-pulse level. Although the time constant is long enough to maintain a peak voltage level, it is also short enough to provide quick-acting AGC.

Troubles

In addition to the troubles of simpler AGC circuits, (shown in Fig. 1) this amplified-AGC system can show the symptoms in Fig. 1, plus a few of its own—whiteout, low contrast, and blackout. The latter defects are shown in Fig. 5. AGC-voltage distribution defects are less common in amplified-AGC circuits because of the low source impedance. Receivers with simpler AGC circuits often produce a negative picture; however, sets with this amplified-AGC system rarely produce so much overload. More often the raster will black out entirely before the picture goes negative.

V15 and V14 operate at low plate-current levels; therefore their emission does not usually decrease, and many original-equipment tubes are still found in these stages. Occasionally, however, these tubes do develop shifts in the knee of their Eg-Ip curves and produce some odd AGC troubles, such as too much control voltage on weak stations and not enough voltage on strong ones. Defective components, strictly within the circuit, generally produce excessive or insufficient AGC that is not correctible by adjusting R4 regardless of the strength of the received signals. Whiteout or low contrast usually results from excessive AGC and can be caused by



4 A 4 B 4 C

Fig. 4. Waveform as it appears at grid and cathode of AGC amplifier V15A.

Fig. 5A. AGC faults cause white raster.

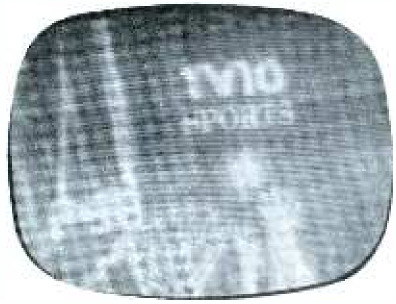


Fig. 5B. Low contrast from AGC trouble.

Fig. 5C. Blackout, an AGC symptom.

a leaky C65 or increased value of R66, R47, or R42. An open C66 or increase in value of R67, R46, or R48 will produce insufficient AGC and excessive contrast or overload. Rarely, one of these resistors decreases in value and produces an opposite complaint.

The majority of AGC complaints in sets using an amplified-AGC circuit are the result of defects in other receiver circuits, rather than in the AGC circuit itself. Invariably, sets using amplified AGC have voltage dividers (similar to Fig. 6) in both the negative and positive B supplies. The two negative voltages are especially critical, and resistors R117B and R117C are quite prone to causing trouble. Also, since these negative voltages are dependent on current drains at the B+ sources, an increase or decease in current at these points will raise or lower the negative line voltages and, in turn, the AGC control voltages. Many cases of circuit malfunction have been traced to cathode-to-filament leakage or shorts in tubes whose cathodes returned to either of the negative-voltage lines.

Troubleshooting

Because these early amplified-AGC stages are strictly a DC-voltage circuit, most of their troubles can be found by making voltage measurements with a VTVM. Initially, the voltages at the B-supply sources (Fig. 6) should be measured. Closer-than-normal tolerances are necessary for the two negative voltages. If these voltages are correct, then the voltages within the AGC circuit should be checked. Many symptoms having the appearance of AGC trouble (incorrect contrast that cannot be varied with the AGC control) are frequently found to stem from defects in other circuits. Voltage measurements in the proper circuit locate these faults.

Single-Tube Amplified AGC

In the mid-fifties, a different type of amplified AGC was employed in a few DuMont receivers and in many Zenith chassis. A typical circuit (from Zenith Chassis 17Z30) is shown in Fig. 7. Only the AGC section of the 'BU8 tube (V7) is shown. Under normal-signal conditions, the noise-canceling grid (pin 7) has minimum effect on the operation of the basic circuit. Therefore, this grid has been deleted for the more simplified circuit presentation in Fig. 8.

In Fig. 8, the voltages at the IF- and RF-AGC sources depend on the voltage drop across R23, R22, and R21 and the voltage at the plate of V7. This plate voltage is determined by the conduction of V7, which in turn depends on the bias at pin 6. This bias is the combined effect of a negative voltage through R58, R8, and R56, a positive voltage from R40, resistor R57, and to a lesser degree the charge retained on C42 (Fig. 7). The voltage through R58, R8 and R56 is variable by adjusting R8. The voltage from R40 varies in step with the conduction of the video amplifier, which is controlled by the signal level at the video detector.

With no signal applied, the conduction of V6 (Fig. 7), is controlled by self-bias obtained through R38; thus maximum tube current through load resistors R3 and R42 causes the plate voltage to stabilize at some low value — approximately 135 volts. This low voltage is applied through R40 to pin 6 of V7, where it is bucked by a negative voltage applied through R56, R8, and R58. These two voltages set the bias on V7 so that its plate voltage stabilizes at slightly less than 40 volts. The 40 volts at the plate side of R21 and the negative 80 volts at the

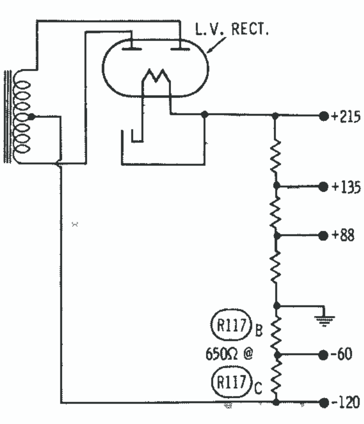


Fig. 6. Observe power-supply voltages.

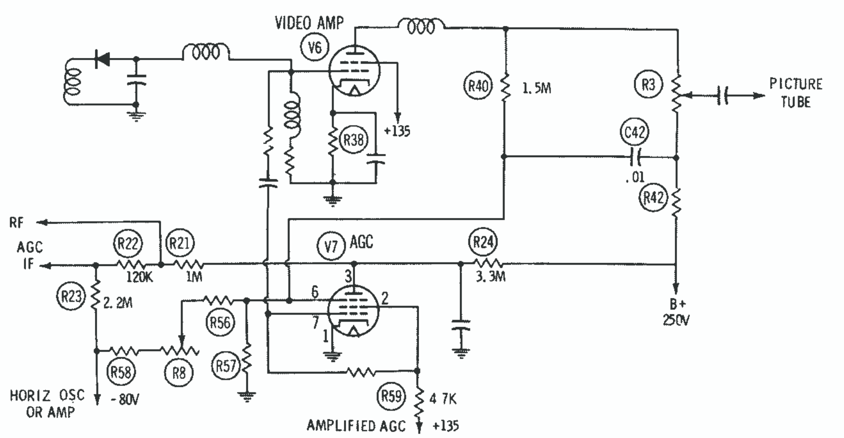


Fig. 7. This single tube amplified AGC circuit is used in Zenith Chassis 17Z30.

end of R23 divide across the voltage-divider network so that the IF AGC source point is a few volts negative. The RF AGC point, being closer to the positive-voltage end of the network, will assume a slightly less negative voltage. These voltages are obtained with R8 at its normal setting.

With signals applied to the video detector, proportionate negative voltages will be rectified and applied to the control grid of V6. The increased bias on V6 decreases current through load resistors R42 and R3 and results in increased voltage at the plate end of R40 and at pin 6 of V7. The higher voltage at pin 6 results in increased conduction of V7, a lower voltage at its plate, and more negative voltages at the RF and IF sources. Thus the AGC voltages vary in step with signal level at the video detector.

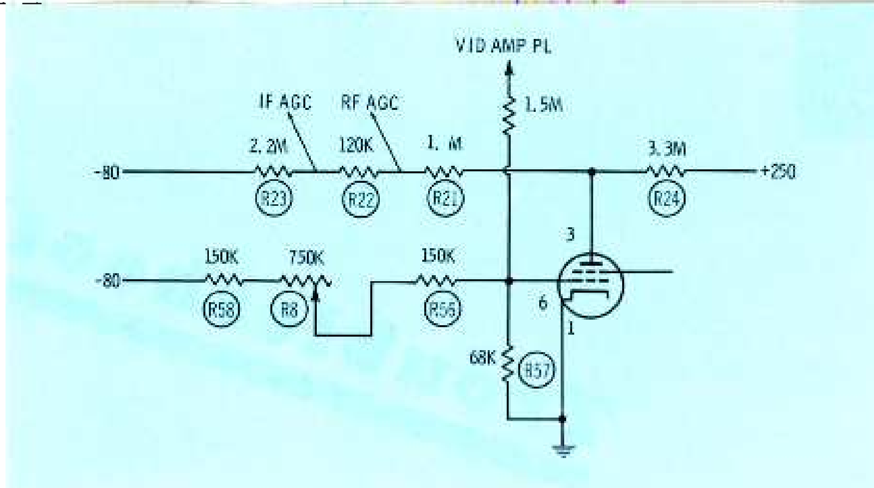


Fig. 8. Simplified schematic of 'BU8 AGC circuit—noise-cancelling grid not shown.

Troubleshooting

Because this circuit is a DC amplifier, most troubles can be found by checking the DC voltages critically with a VTVM. One preliminary test to quickly eliminate any doubt as to malfunctioning in the circuit of the noise-canceling grid is to short pins 7 and 1 of the 'BU8. In addition to the voltages, resistance values should also be carefully measured. Only as a last resort should you use an override bias, even when this technique does pinpoint an AGC fault, the circuit voltages will still require the same critical examination that could have located the trouble before using an external bias. Substitution of the AGC tube is recommended, since a tube tester will not always reveal the off-beat faults capable of causing troubles.

Case Histories

Excessive or insufficient AGC voltage are the two most common troubles in these circuits. If the voltage is just slightly excessive, the result will be weak contrast, usually accompanied with snow. Extremely high AGC voltage will cause a no-picture, high-brightness raster; slightly low AGC will produce loss of sync or twist. Extremely low or no AGC will also produce a no-picture symptom, but the picture usually contains some life, as evidenced by the lines in Figs. 9A and 9B. Insufficient or absent AGC is also indicated when it is possible to obtain a picture with the antenna disconnected, or, as sometimes is the case, by receiving the picture on the next lower channel.

One of the rare cases in which an AGC trouble could not be pinpointed with a VTVM developed in a "Z"-chassis Zenith. The picture had twist and overload similar to that caused by an insufficient control voltage. However, measurements indicated that the AGC voltage was near normal. The scope showed that the signal on pin 6 was slightly distorted. The defect was determined to be an open capacitor corresponding to C42 in Fig. 7. Other sets with a leaky or shorted C42, have produced excessive AGC and the whiteout condition shown in Fig. 5A.

One of the "doggiest" troubles encountered in one of these circuits occurred when R59 had increased in value enough to affect tube operation, but not enough to change the screen voltage beyond normal tolerance. The slightly lowered screen voltage had decreased plate current and thus increased plate voltage, which resulted in barely insufficient AGC and slight overload and loss of sync. Since R59 is also responsible for the level that keeps pin 7 from over-controlling V7, this defect caused clipping of the signal applied to the control grid of the sync separater portion of the 'BU8. Due to the low resistance value of R59 it is less likely to be suspected of value shift than the higher-value resistors in this circuit. However, all the resistors shown in Fig. 7 should be measured critically when AGC troubles occur in this circuit.

Conclusion

The one common denominator of both types of amplified-AGC circuits that have been discussed is their basic function as DC amplifiers. Despite the differences between the late and early circuits, this DC-amplifier factor suggests an inclusive troubleshooting method: DC voltage measurements. Unlike the early system, the later systems have a high AGC source impedance and are prone to defects in the voltage-distribution network. For example, there have been cases of open AGC filters in the early systems where receiver operation was only slightly affected. But if an AGC filter in the late system loses capacitance, some weird and nasty complaints will result. ▲

Fig. 9A. No picture—lines in raster.

Fig. 9B. More pronounced raster lines.

Troubleshooting

SYNCHRO SYSTEMS

by Alan Andrews

Any technician servicing industrial-electronic equipment undoubtedly has (or will soon have to) service mechanisms using synchros. These small motor-like units are one of the most common devices used to transmit angular-position information to remote locations. Even radio-TV servicemen can get vital information from this article. At the rate that electronic devices for home use are appearing on the market, it doesn't seem unlikely that devices using synchro units may someday be common in every home.

Those who are interested in a more mathematical approach to synchros and their use in servomechanisms can refer to the January 1961 PF REPORTER *article "Synchros and Servo Systems" (page 36).*

The Editor

Synchros are position transducers, resembling small motors, which are used in various forms of remote-control positioning. The usual system includes two similar units, connected electrically. One acts as a transmitter, or synchro generator; the other, the receiver, or synchro motor, is connected mechanically to a load. As the synchro generator is rotated, the synchro motor rotates the same amount in the same direction.

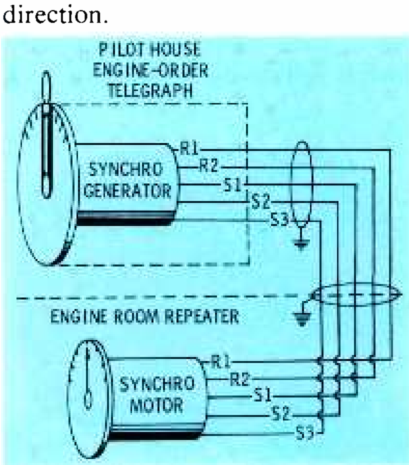


Fig. 1. Synchro system relays information from pilot house to engine room.

An example (Fig. 1) is the engine-order telegraph used aboard ships. The synchro generator is coupled to the engine-order lever located in the pilot house. If, for example, the lever were set at "full speed ahead," the synchro motor would follow and cause the engine-order repeater in the engine room to also move to "full speed ahead." A list of other applications would be almost endless because synchros are used in so many different ways on board ship, on aircraft, by the armed forces, and by industry.

Construction

Each synchro includes three stationary stator coils that are Y-connected and a rotor coil that can be rotated through a full 360°. These are not three-phase devices even though the stator-coil connections are the same as those used in three-phase power systems. Single-phase AC, at the rated voltage, is applied to rotor-coil terminals R1 and R2; voltage is induced into each of the three stator coils. Stator terminals are labeled S1, S2, and S3. A synchro can be shown in either of the ways in Fig. 2A and 2B. Fig. 2A is a wiring diagram often used in explanations of how the units operate; 2B is the usual schematic symbol. Dots are used to indicate phase relationships. For example, voltage at R1 is in phase with voltage at S2, at R2 it is 180° out of phase with voltage at S2.

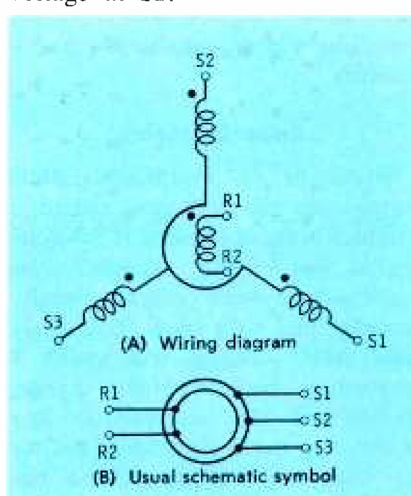


Fig. 2. Wiring and schematic diagrams for the synchro generator or motor.

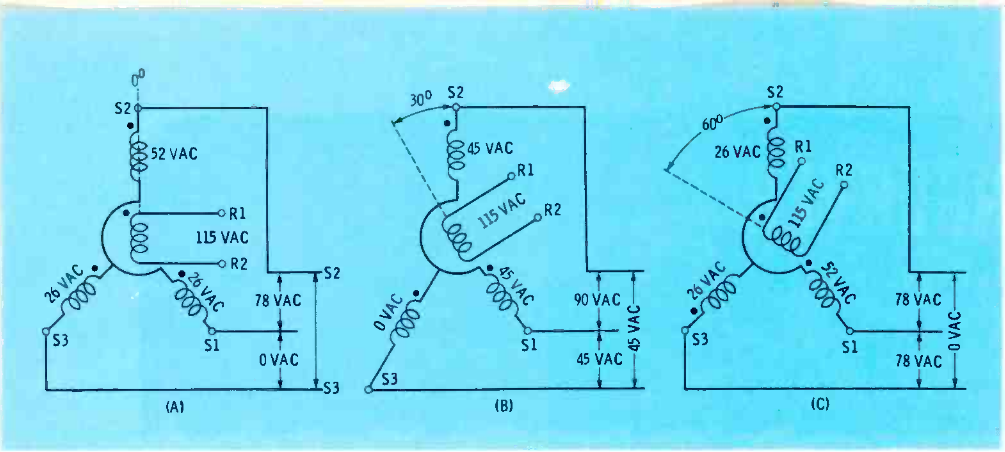


Fig. 3. Synchro stator voltages change as the rotor is turned from 0° to 60°.

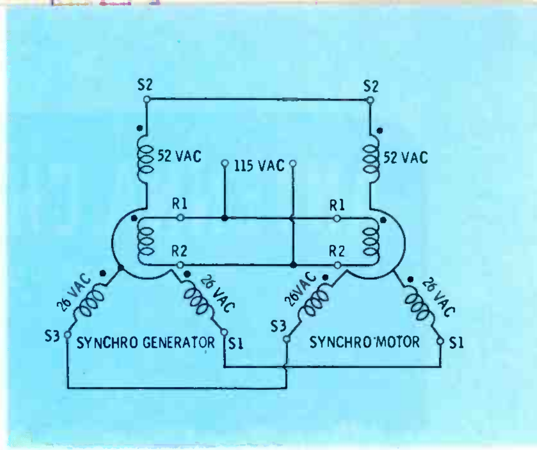


Fig. 4. Diagram shows connections.

Angular rotation is measured from S2 and positive rotation is counterclockwise; negative rotation is clockwise. R1 is the indicating end of the rotor and angular settings are expressed in terms of its angular position with reference to S2. In Fig. 2A the rotor is shown at 0°. Synchros are rated with two numbers, for example 115/90. The first number is the rated value of AC line voltage applied to the rotor. The second number is the maximum voltage that occurs between any two stator terminals when rated line voltage is applied. Synchros are also rated for a specific line-voltage frequency—most are rated for either 60 or 400 cps.

Operation

With the rotor at 0° (Fig. 3A), maximum voltage—52 volts AC—is induced into the S2 winding. S1 and S2 are positioned 60° from the rotor, and its electromagnetic field induces 26 volts AC into both windings. Phase relationships are as indicated by the dots. Since voltages at S1 and S3 terminals are equal and in phase, there is no difference in potential. Between S1-S2 and S2-S3 terminals, as the dots indicate, voltages are 180° out of phase and add to equal 78 volts.

A 30° positive (counterclockwise) rotation of the rotor (Fig. 3B) reduces the voltages induced into the S2 and S3 windings to, respectively, 45 and 0 volts. Between S1 and S2 terminals, voltage is at maximum, 90 volts.

In Fig. 3C, the rotor is turned farther positive to 60°. Voltage across S2 winding has again decreased; voltage across S3 winding has increased to 26 volts, but the phase has shifted 180°. The 52 volts across S1 winding makes the relationship similar to that of Fig. 3A; although here, maximum voltage occurs across S1 winding and that voltage is 180° out of phase with voltage at R1.

For every position of the rotor there will be specific voltage and phase relationships between the stator windings. These voltages could be applied to identical stator windings in a motor which uses a rotor with a soft-iron core. Every position of the synchro generator rotor would produce a corresponding electromagnetic field in the motor to align the rotor. The disadvantages of this system are: low torque, excessive position error, and the fact that the rotor can align itself 180° out of position.

A common synchro system is shown in Fig. 4. Both units, the generator and motor, are electrically and physically identical; the only difference between them is the use of friction damping for the motor shaft. With both rotors in the same position, voltages induced into the stator windings of the motor and generator are identical. Current flow through the stators and rotors is minimal and results from core losses and slight position errors.

In Fig. 5A, an instantaneous condition has been assumed; the generator rotor has been turned positive 30°, while the rotor of the motor remains at 0°. There is now a 26-volt difference between the S3 winding, and the resulting high current creates an electromagnetic field

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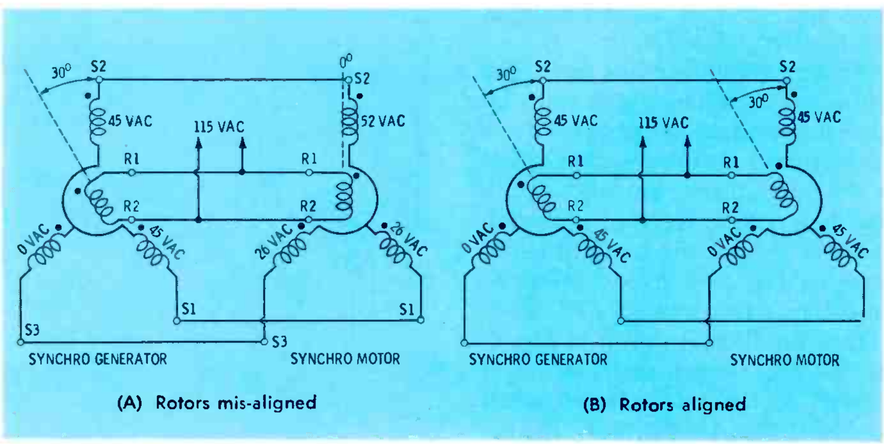


Fig. 5. High current flows until both rotors are aligned—residual current remains.

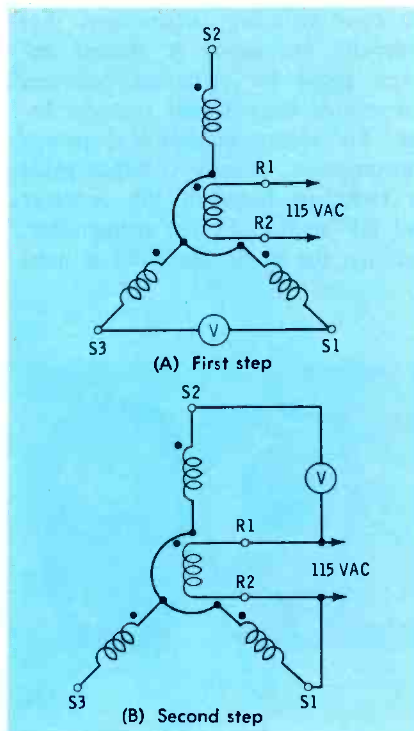


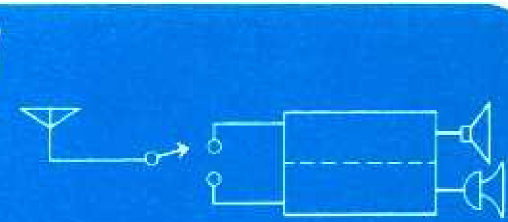
Fig. 6. Connections to locate zero.

ANTENNA CHANGEOVER

IN CB TRANSCEIVERS

A Study of RF Switching

by Edward M. Noll



Transmit-receive switching is an essential operation for all CB transceivers. This type of switching permits more economical operation (minimum power demand); also, dual use of the antenna system and various transceiver circuits in the transmit and receive modes are accomplished. Generally, the changeover between the two modes is handled by a press-to-talk switch that is mounted in the microphone case (Fig. 1).

A simple arrangement can provide all of the switching activities by this single control. The microphone switch energizes a relay which is mounted in the transceiver unit, and the multiple contacts then handle the actual transmit-receive changeover. Electronic switching is employed in the more recent CB transceivers. Switching diodes are placed strategically in the transmitter and receiver circuits to handle circuit changeover responsibilities.

In a CB transceiver, Fig. 2, there are four switching operations that generally are used. A shared antenna must be switched between transmitter output and receiver input. To assure economical power consumption, supply voltages must be switched between the receiver and RF section of the transmitter. Usually, the audio amplifier is used in both transmit and receive modes. This necessitates audio amplifier input-output and microphone-loudspeaker switching operations. Secondary switching operations may involve circuits such as squelch, tone control, speech amplifier, etc.

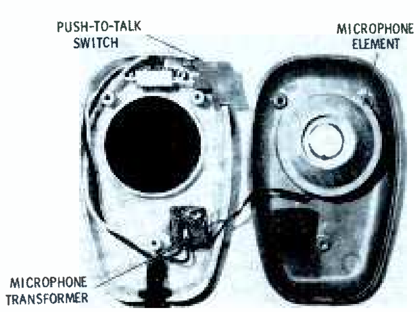


Fig. 1. Inside the microphone case.

The Direct Approach

The simplest switching system, used widely in low-cost transceivers, switches the microphone, secondary of audio output transformer, and cathode return of the RF tubes of the transmitter. In the receive position, Fig. 3, the microphone is disconnected from the circuit by the top section of the microphone switch. The second section of the switch connects the low end of the audio output transformer secondary to ground. The cathodes of the transmitter RF oscillator and amplifier tubes are removed from ground and are inoperative. When the push-to-talk switch is held down, the ceramic microphone is connected between the grid of the first audio amplifier and ground by the first section of the switch. The second section of the switch returns the cathodes of the RF and oscillator tubes to ground. In this basic plan there is no antenna switching; the pi-network tank circuit is used jointly by the transmitter output tube and the grid input circuit of the receiver RF amplifier.

Some variations of this basic plan will provide switching that shuts off key receiver circuits. Other receivers are designed so the transmit signal in the joint antenna resonant circuit will bias down receiver operation and will prevent the transmit signal from having any adverse influence on the receiver circuits.

One variation is shown in Fig. 4. In the receive position, the right section of the microphone switch connects the loudspeaker to the secondary of the audio output transformer by connecting one end of the secondary to ground. A positive voltage from the power supply is connected to the *cathodes* of the two RF tubes and the speech amplifier of the transmitter; this cuts them off. The same supply line applies positive voltage to the *screens* and *plates* of various key receiving tubes so they will operate in a normal manner.

In the transmit position of the push-to-talk microphone switch, the 90-volt supply is switched down to zero with the connection of R1 to ground through the left section of the switch. Also a return to ground is made for the transmit RF and speech amplifier tubes and they become operative. The reduction of the B+ voltage to zero on this line removes a positive voltage from certain key circuits in the receiver, and the receiver becomes inoperative during the transmit mode. The other section of the microphone switch disconnects the loudspeaker. Again there is no antenna switching and an input-output pi-network is shared by transmitter output and receiver input.

Walkie-Talkie

The usual CB walkie-talkie employs direct switching; however, this switch is part of the case as shown

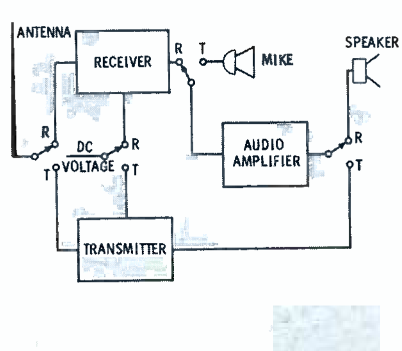


Fig. 2. Transceiver switching operation.

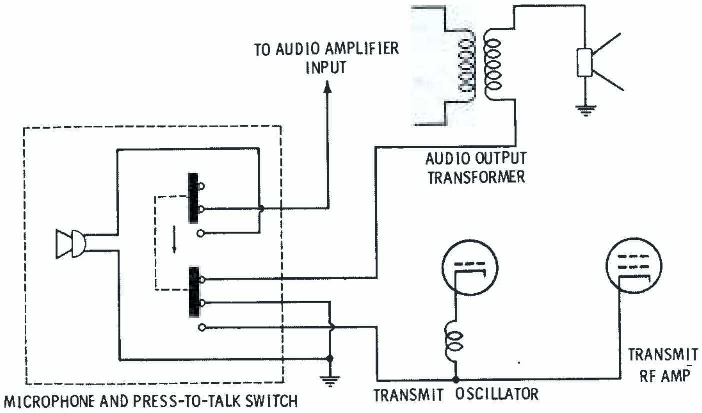


Fig. 3. A direct switching arrangement used in transceivers.

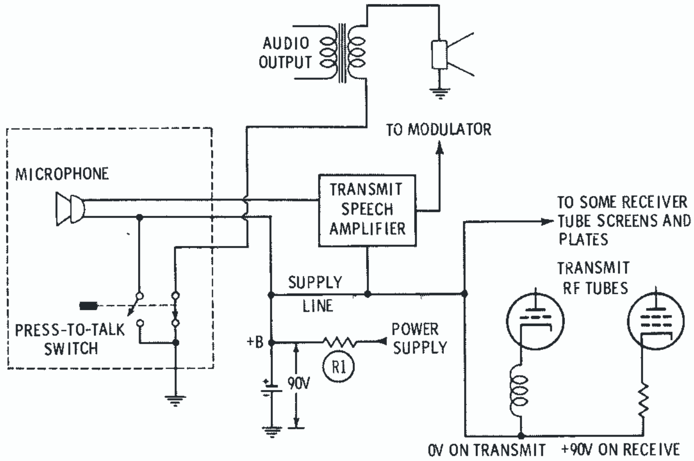


Fig. 4. Alternate direct switching method for transceivers.

in Fig. 5. Thus, it is convenient to provide a multiple-contact arrangement, and a substantial number of circuits can be switched in the interest of optimum operation and conservation of battery power. It is even convenient to provide antenna switching since the switch contacts are near the antenna.

There are four sets of contacts (Fig. 6) associated with the hand switch. One section changes the antenna between transmitter output and receiver input. This is accomplished with minimum signal loss because of the close proximity of the switch to the antenna. One of the reasons that direct antenna switching is not feasible for other than the walkie-talkie unit is the long length of RF line that would have to run between the antenna and the switch in the microphone case.

In the walkie-talkie unit the loudspeaker is used also as a microphone. The second section of the switch changes the input of the audio amplifier from the receiver detector output to the speaker when the speaker is used as a microphone.

The third section of the switch allows a supply-voltage changeover between the receiver and transmitter RF circuits. The final section of the switch, when in the receive position, connects the secondary of the audio-output transformer to the loudspeaker. In the transmit mode, a "turn on" ground return for the final RF power transistor is provided.

Relay Controls

In the 5-watt mobile or base-station installation, the same multiple switching can be accomplished with the use of a relay. Such a relay, as shown in Fig. 7, is energized when the microphone press-to-talk switch is held down. The relay switching for a solid-state, 5-watt unit is very similar to that of many walkie-talkie units. First, notice the switching that takes place in the microphone circuit in Fig. 8. Both switch positions are inactive on receive. On transmit, the bottom section connects the microphone to the input of the audio amplifier. The second section connects the supply voltage to the relay coil causing it to energize.

There are four sets of relay contacts. They are shown in the receive position. The top section connects the antenna to the input of the receiver, and the second section supplies a regulated DC voltage to the receiver transistors. Section 3 connects the loudspeaker to the secondary of the audio output transformer while the bottom section is inactive.

When the relay is energized for transmit operation, the first switch section changes the antenna from receiver input to transmitter output. The second section places a shunt (C1) across the input resonant circuit of the receiver, blocking the transmit RF energy from the receiver. Section 3 connects a ground to the transmit transistor circuits placing them in operation, and the final section of the relay contacts inactivates the receiver squelch.

The same basic technique of switching the antenna, supply voltages, microphone, and loudspeaker in solid-state units is employed in a vacuum-tube CB unit using relay switching as shown in Fig. 9. The microphone switch is shown in the receive position with one set of contacts shorting out the microphone. In the transmit mode, one set of switch contacts connects the microphone to the input of the microphone amplifier, while the second set causes current to flow through the relay coil. Again there are four sets of relay contacts. The upper

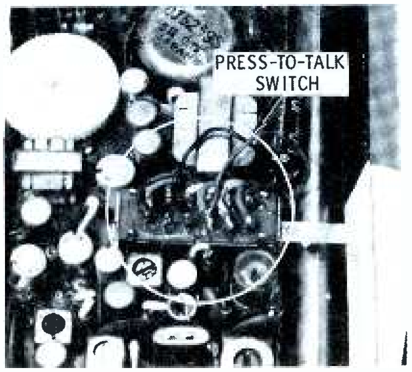


Fig. 5. Press-to-talk in walkie-talkie.

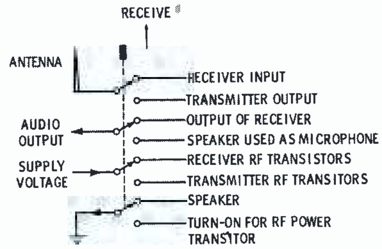


Fig. 6. Switching in walkie-talkie unit.

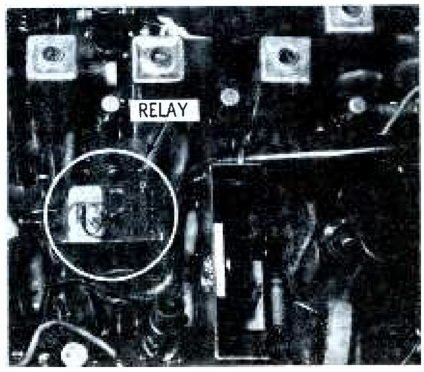


Fig. 7 Note relay on printed board.

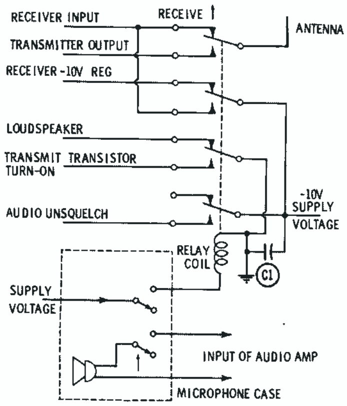


Fig. 8. Switching in 5w solid-state unit.

set does the antenna switching, while the next set switches the input of the audio amplifier between the output of the receiver and the output of the microphone amplifier of the transmitter. A third set of contacts connects the loudspeaker to the secondary of the audio output transformer on receive position and provides a "turn-on" ground return for the cathode circuit of the RF power amplifier when in transmit. The lower set of contacts affords supply voltage switching between transmitter and receiver.

A considerable amount of switching is done in many CB units. The most common switching arrangements have been shown. Although the switching functions are basic in nature, the means varies considerably among CB models. If units perform in an erratic manner that seem most pronounced when a changeover is being made between the two modes, it can well be a switching defect. Quite often the trouble makes itself evident from the inability to change over to the transmit mode without making several attempts with the press-to-talk switch. In chasing down a possible switching problem, it is advisable that you check out the switching circuits individually for each model. Because of the on-off and supply voltage switching, it is customary to show two voltage values on schematics and voltage charts for CB units. These readings refer to the receive and transmit mode voltages for those circuits which are involved in a voltage change with transmit-receive switching. This information is particularly helpful in chasing down a switching defect.

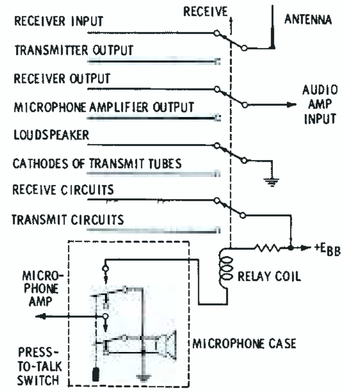


Fig. 9. Switching in vacuum-tube unit.

A defect in the switching mechanism, either relay or switch, usually means a replacement. Contact surfaces are often inaccessible and, when accessible, the cleaning of them and adjustment of their tension are often not entirely satisfactory or are short-lived.

Electronic Switching

Electronic switching is attractive because only two singlepole, singlethrow contacts may be involved in the entire transmit-receive changeover. In fact, the variety of switching activities that was covered in

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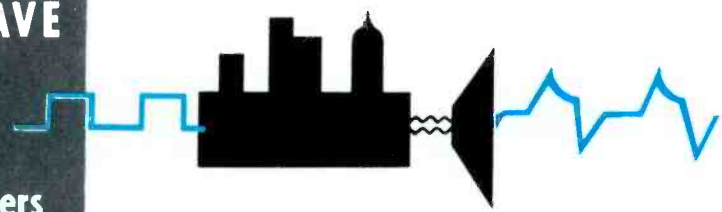
ADVANCED SERVICE TECHNIQUES

SQUARE-WAVE TESTS of Audio Amplifiers



Advanced Service Techniques—Modern ways for checking response.

by Robert G. Middleton

> Preceding articles in our "Advanced Service Techniques" series have introduced you to these basic principles of square-wave testing:
>
> 1. A square wave is made up of a fundamental sine wave plus an infinite number of its odd-order harmonics.
> 2. Square-wave analysis of components and networks will indicate the presence of inductance, capacitance, and resistance.
> 3. RC, or time constant, of a network can be determined by square-wave tests. If either value, resistance or capacitance, is known, the other can be easily calculated. Since RC measurements can test all components within a network, individual component checks need not be performed.
>
> These basic concepts may seem difficult to learn, but they must be thoroughly understood before more complex techniques are introduced.
>
> A wideband triggered-sweep scope, described in the March 1965 PF REPORTER article "Learning About Triggered-Sweep Scopes," and a fast-rise square-wave generator, described in the April 1965 PF REPORTER article "Advanced Techniques for Future Servicing," were used in obtaining the photos in this article. If you can arrange to use equipment such as this, try to do so. Even if you cannot, at present, make use of one of these scopes, follow with us. Information in this and succeeding articles of this series will be invaluable to you in the future.
>
> —The Editor.

Continuing the series on "Advanced Servicing Techniques," let's proceed to the square-wave testing of actual operating equipment. Earlier parts of the series have described the composition of the square wave and the response of simple combinations of components to square-wave voltages.

Now let's look at the square-wave response of what is probably the simplest piece of equipment you'll service—a low-cost two-tube audio amplifier. In the remainder of this series, you will investigate the response of high-fidelity amplifiers, video amplifiers, and other circuits.

Square-wave tests of small audio amplifiers are basically similar to tests of simple components, except that the number of assembled components is greater. The rise times of the square-wave generator and the scope must be adequate in order to obtain meaningful waveforms. Instruments used in the following tests had rise times of better than .02 μsec, a very short time by ordinary service standards. However, a short rise time is useful in analyzing some types of defects which do not show up clearly with ordinary instruments.

AC/DC Amplifiers

Most low-priced audio amplifiers have AC/DC power supplies. Consider the problem of power-line isolation in square-wave tests of a typical AC/DC amplifier. Both a chas-

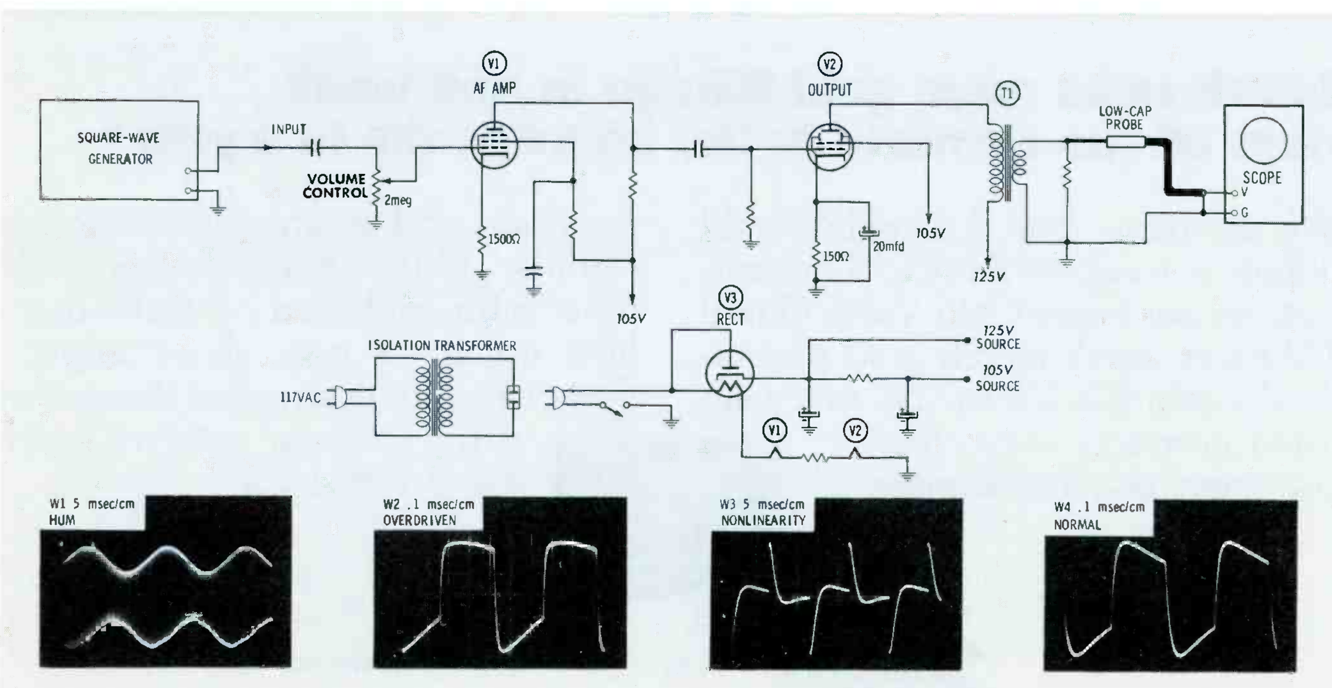


Fig. 1. Waveforms show results from defects in this low-cost two-tube audio amplifier. Square-wave tests aid in rapid diagnosis.

sis ground and a B− ground system are present, as shown in Fig. 1.

The B− ground system in the audio amplifier is connected to one side of the AC power line. Still, the ground side of the square-wave generator output could be connected to the audio amplifier chassis. No fireworks will result because the square-wave generator has a transformer-type power supply. Nevertheless, there is the possibility of severe (or worse, fatal) electric shock should the amplifier chassis be tied to the hot side of the line. For safety's sake use an isolation transformer.

If a filter capacitor in the audio amplifier is defective, a hum-modulated waveform will result (W1, Fig. 1). The 60-cps hum voltage modulates the square-wave pattern. Here, the square-wave frequency is 2kc; consequently, the low sweep rate prevents individual square-wave excursions from being visible. If you encounter this defect, simply bridge a good electrolytic capacitor across each of the suspected filter capacitors in turn. Of course, this won't affect the hum level if the defect results from heater-cathode leakage in one of the tubes.

Overload Trouble

It is possible to obtain on the scope screen a square-wave reproduction that is free from noticeable hum, as shown in W2, Fig. 1. However, this is a suspicious waveform, because the top and bottom have widely different shapes. It is likely (although not certain) that the flattened top of the waveform is caused by overdriving the audio amplifier. Reduce the output from the square-wave generator and advance the scope gain control to see if the waveshape changes. In this case, waveshape did change, as seen in W4, Fig. 1. Thus, the true 2-kc square-wave response of the amplifier is displayed when overdriving is avoided.

Amplitude Nonlinearity

It is customary to check square-wave response of small audio amplifiers at 2 kc and at 60 cps. Of course, other square-wave frequencies can also be used; however, most defects show up at either 60 cps of 2 kc. The 60-cps square-wave response of a typical amplifier is seen in W3, Fig. 1. The square wave is differentiated, indicating that the low-frequency response of the audio amplifier is poor. Note also that the positive peak voltage of the waveform is less than the negative peak voltage: *amplitude nonlinearity* is present.

Amplitude nonlinearity can be reduced by operating the amplifier with lower input voltage; however, this reduces distortion at the expense of power output. Amplitude distortion must be minimized as much as is possible. Cathode-bias voltage is a dominant factor. In this example, an ohmmeter measurement showed that the 1500-ohm cathode resistor in Fig. 1 had increased in value to approximately 2000 ohms.

The output stage in this amplifier is also cathode-biased, as shown in Fig. 1; however; the value of the cathode resistor was correct in this case. Incorrect plate and screen voltages can also cause amplitude nonlinearity. Accordingly, these must also be measured and confirmed. Bad tubes are a possibility; check them for mutual conductance. Saturation of the output transformer is still another possibility. In this case, the output transformer could be replaced by a unit with a considerably larger core area.

Poor Low-Frequency Response

The poor low-frequency response seen in W3, Fig. 1 could have been the result of a defective coupling capacitor. However, the capacitors checked satisfactorily. Note in Fig. 1 that a .005-mfd coupling capacitor is used to feed into a 2-megohm resistor, giving a time-constant of only .01 second. Good low-frequency response is impossible with this design value. Yet, a .005-mfd capacitor is used instead of a .25-mfd capacitor for two reasons. First, an AC/DC amplifier has a higher inherent hum level than a transformer-type amplifier. To minimize hum, it is helpful to employ low gain at 60 cps. It would be quite possible to redesign this amplifier to obtain good 60-cps square-wave response, but the hum level at the speaker would be annoying. Hence, poor 60-cps response is a design compromise. Second, a small amplifier usually has limited high-frequency response. Listening tests have shown that if the high-frequency response is limited, distortion is less evident to the ear when low-frequency response is also limited.

Good low-frequency square-wave response also requires adequate cathode bypassing. For example, the 150-ohm cathode resistor in Fig. 1 is bypassed by a 20-mfd capacitor. To improve the low-frequency response at this point, a 1000-mfd bypass capacitor could be used to obtain a substantial time constant. An expensive output transformer also will improve 60-cps response, since output transformers in small amplifiers usually differentiate a 60-cps square wave. Again, these are design compromises made for the reasons previously noted.

Utility Amplifiers

Although the 8-watt public-address amplifier shown in Fig. 2 is not a high-fidelity amplifier, it certainly will provide better reproduction than the AC/DC type shown in Fig. 1.

Note the negative-feedback loop in Fig. 2. Feedback is taken from the secondary of the output transformer to the cathode of V2. The amount of feedback is determined by the impedance of the speaker voice coil. If the secondary of T2 is unloaded, more voltage is fed back than if a normal load is present. With a 15-ohm voice coil connected across the 4-ohm output terminals, more voltage is fed back than if a 4-ohm voice coil is connected across the output terminals. Furthermore, the phase of the feedback voltages varies with the loading on the secondary of T2; this results because T2 has a certain amount of leakage reactance which shifts the phase of the signal. A serious mismatch of voice-coil impedance to the secondary of T2 causes sufficient phase shift to develop parasitic oscillation. For example, if a 15-ohm voice coil (or 15-ohm resistor) is connected across the 4-ohm terminals of T2, the scope pattern may display parasitic oscillation as seen in W1, Fig. 2. Always be certain that speaker and amplifier output impedances are matched; not only does this provide maximum power transfer, but it reduces the

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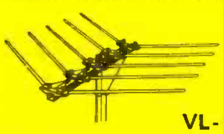

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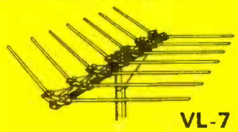

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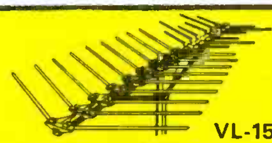

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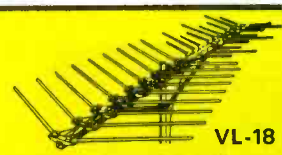

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possibility of upsetting the negative-feedback network.

The parasitic oscillation in W1, Fig. 2 has a high frequency because the feedback voltage must be 180° to produce oscillation. When T2 is unloaded, or partially loaded, the phase shift caused by its leakage reactance is less than 180°. Hence, additional phase shift in the same direction must exist before oscillation is produced. This additional phase shift is present in the circuits of V2 and V3 within the amplifier high-frequency cutoff region. In other words, the phase relation of the input to the output voltage rapidly changes at both the low-frequency and high-frequency ends of the response range. At the high-frequency end, the change adds to the phase shift caused by T2, and at a certain high frequency the phase shift is 180°: Parasitic oscillation occurs at this frequency.

Suppose that the opposite abnormal operating condition is used; in other words, suppose that a 4-ohm voice coil is connected across the 15-ohm terminals of T2. Here, parasitic oscillation does not occur because the feedback voltage is reduced by the abnormally heavy loading on the output transformer. Oscillation cannot take place unless: (1) phase shift from output to input is 180° and (2) feedback voltage is great enough to cancel the voltage drops in the feedback loop.

Tone Control and Square-Wave Response

Note M2 in Fig. 2; this is the tone-control switch for the amplifier. The switch contacts connect various frequency-discriminating components in the feedback network. The capacitors cause phase shift in addition to frequency discrimination. Thus, it is not surprising to find that when voice-coil impedance is higher than the impedance of the output transformer, parasitic oscillation can occur on one or two positions of the tone control, but not on the other positions. Moreover, when the load is correctly matched to the output transformer, the tone control has a large effect on square-wave reproduction. For example, W2, W3, and W4 in Fig. 2 show the 2-kc square-wave response for the extreme and intermediate positions of the tone control. The rated square-wave response of an amplifier is obtained when the tone control is set for normal reproduction. Note that the ringing in the waveforms of Fig. 2 will not appear unless the square-wave generator has a short rise time. This ringing frequency is 64 kc. Unless the applied square wave has a short rise time, harmonic output at 64 kc is too weak to disclose the susceptibility to ringing. This is a practical example of the desirability of square-wave generators with short rise times.

High-frequency ringing is practically eliminated in high-fidelity amplifiers, because elaborate design features are employed to minimize it. In a utility amplifier, however, expect to find some ringing. Still, note that the 64-kc ringing observed in Fig. 2 might not occur in many normal uses of the amplifier. Unless there is appreciable noise accompanying the input audio signal, there

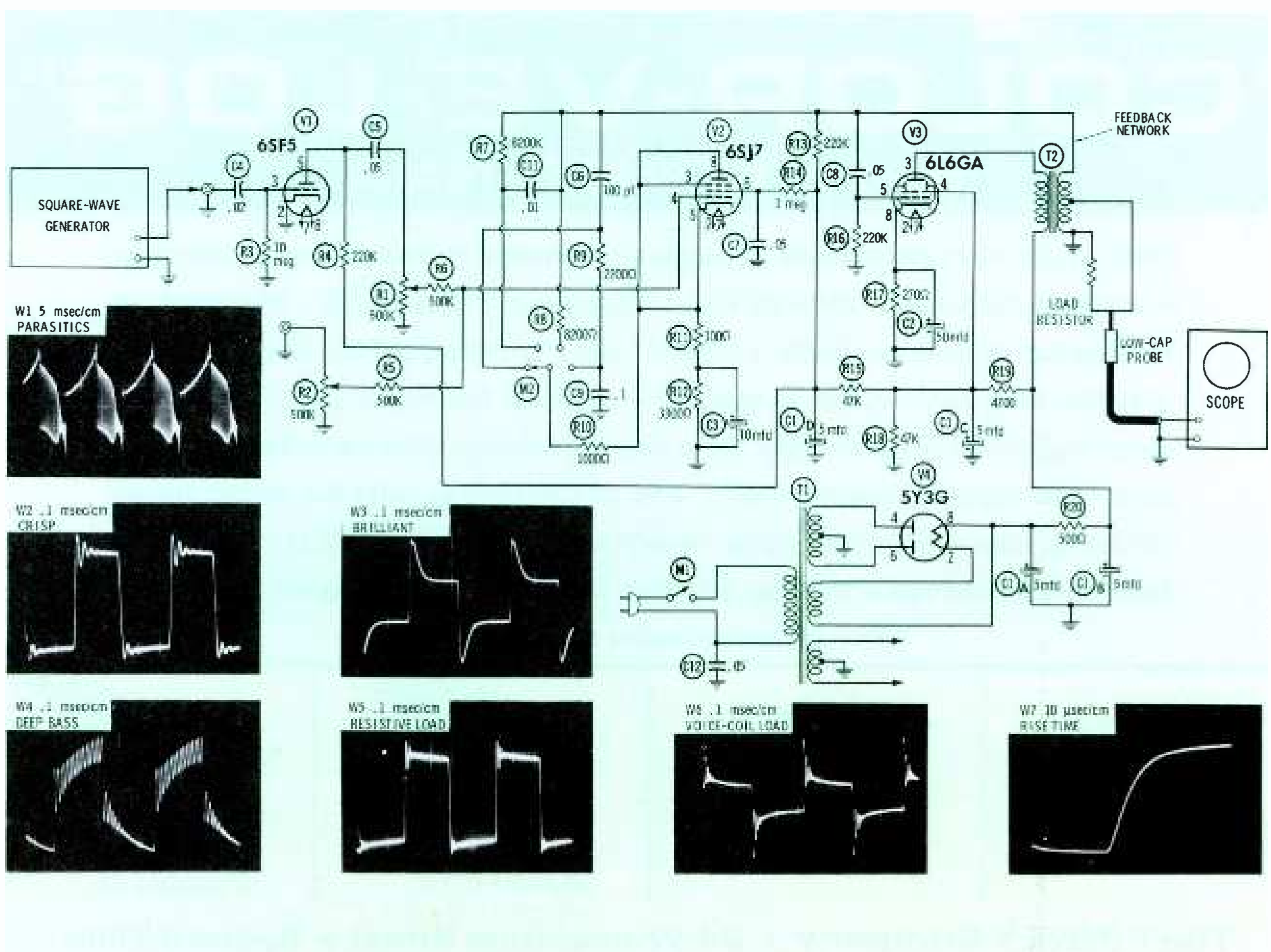

Fig. 2. Utility amplifier commonly used for public-address systems provides better reproduction than the two-tube type.

will be no 64-kc excitation. Of course, with substantial input noise present, the 64-kc component of the noise voltages will pass at a comparatively high level. Although the 64-kc component is inaudible, it will generate sum-and-difference frequencies in nonlinear stages — intermodulation distortion results.

Effect of Voice-Coil Impedance

It is customary to load an audio amplifier with a resistor for square-wave tests, as shown in Fig. 2. This eliminates the annoyance of sound output (often very loud) from the speaker. On the other hand, a voice coil is not purely resistive— it is also inductive. This inductance does have an effect on the square-wave response of the system. That is, square-wave response is altered if the output transformer is connected to a speaker voice coil.

Rise Time Measurements

In the amplifier shown in Fig. 2, pattern differences are easily evaluated. W5 shows the 2-kc square-wave response for resistive and voice-coil loads. The ringing in W5 is much less than in W6. The overshoot is also much less. No differentiation appears in W5, but is quite evident in W6. For a square-wave test, this amplifier performs much better with a resistive instead of a voice-coil load.

The rise time of an amplifier is measured by expanding the leading edge of the reproduced square wave, as shown in W7, Fig. 2. Note that the rise time remains the same regardless of the square-wave frequency. In this example, the calibrated sweep control of the scope indicates that the rise time is 45 μsec. This is comparatively long rise time for an audio amplifier, but it is typical of utility designs. The high-frequency response limit of an amplifier is equal to .35 times the reciprocal of the rise time: $F_{co} = .35/T_r$ where F_{co} is the high-frequency cut-off value, and T_r is the rise time of the amplifier. In other words, a rise time of 45 μsec corresponds to a high-frequency limit of 7400 cps.

Should rise time seem excessive, check:

(1) plate-load resistors for an increase in value;
(2) grid-circuit resistors for an increase in value;
(3) all components in the feedback network for any change in value.

Conclusion

The next installment of this "Advanced Service Techniques" series will discuss methods for applying square-wave tests to high-fidelity amplifiers. Inasmuch as consumer interest in high-quality audio products is continually increasing, the demand for effective maintenance of these systems will provide the well informed technician with an ever-increasing volume of business. Learn these techniques now: As the electronics industry advances, up-to-date knowledge will mean more than just added income; it is and will increasingly become a prerequisite for earning a livelihood. ▲

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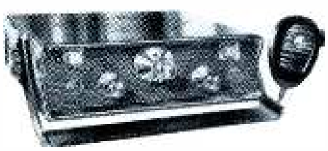

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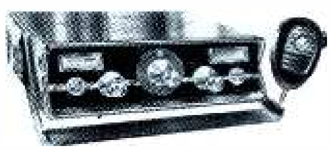

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by Arnold E. Cly

Solid-State Color-Bar Generator

The recent increase of color-TV sales has stimulated color servicing needs, and additional service instruments and tools are required. The technician always welcomes an instrument that is compact, but it must be capable of performing the job for which it was intended. The Model 1245 color generator (Fig. 1), made by B & K, meets both of these requirements.

Fig. 2 shows a block diagram of the 1245 and reveals two basic sections of the circuitry. One section consists of frequency-divider circuits which divide the output of a 189-kc crystal-controlled oscillator down to 60 cps. The other section is made up of an RF oscillator, modulator, and 3.563795-mc crystal-controlled color oscillator.

A fixed relationship between the horizontal and vertical sync pulses, and all video patterns, is provided by the frequency-divider circuits. The technique corresponds to that used by TV broadcast-station equipment; this produces a stable video pattern—a must in color convergence.

The output of the 189-kc oscillator is fed to a 189-kc shaper. This stage acts as a squaring amplifier for the 189-kc sine wave from the oscillator. One shaper output connects to the VERT LINES/COLOR AMPLITUDE control, the second goes to the color keyer, and the third feeds the 31.5-kc oscillator.

Fig. 1. Small unit provides all signals for complete color convergence setup.

To produce a vertical line, the output of the 189-kc shaper is coupled to a pulse-generator circuit. This circuit produces a narrow pulse and feeds it to the VERT LINES control, which in turn applies the pulse to the PATTERN SWITCH. The VERT LINE and COLOR AMPLITUDE controls are ganged together, and when the PATTERN SWITCH is in the VERTICAL position, the VERT LINES control, when turned in a counterclockwise direction, can completely extinguish the vertical-line or dot pattern and provide a clear raster for purity adjustments.

The square-wave pulse from the 189-kc shaper is also fed to the plate of the color-keyer diode. The 3.563795-mc oscillator signal (offset-subcarrier) is coupled through the PATTERN SWITCH when the switch is in the COLOR position) to the cathode of the keyer diode. The color-oscillator signal passes through the keyer diode as the 189-kc square-wave pulse reaches maximum on the anode.

The 31.5-kc relaxation oscillator also receives a synchronizing pulse from the 189-kc shaper. The 31.5-kc oscillator has two outputs. One is used to control the horizontal-sync and backporch generator, and the other syncs the 4.5-kc relaxation oscillator.

The 15,750-kc horizontal-sync and backporch generator consists of three transistors. Two of these form a divide-by-two multivibrator; thus the 15,750-cps signal is derived from the 31.5-kc output. The resulting signal is fed to a differentiating network, and 10-microsecond pulses are formed. A pulse-shaper transistor and another shaping network form 6-microsecond pulses for horizontal synchronization.

The 4.5-kc output signal is used to sync the 900-cps relaxation oscillator which, like the 31.5-kc oscillator, has two outputs. One output provides synchronization for the 300-cps relaxation oscillator, and the other controls the frequency of the 450-cps horizontal-line generator.

A flip-flop circuit, consisting of two transistors, produces horizontal lines one raster-line thick. The flip-flop is turned on when the 900- and 15,750-cps signals coincide: the next 15,750-cps pulse causes the flip-flop to return to its original state. The output of the 450-cps horizontal-line generator is applied to the PATTERN SWITCH and, in the appropriate switch position, is fed to the video sync-mixer circuit.

The 3.563795-mc offset-subcarrier signal of the Model 1245 and the 3.579545-mc oscillator of the color TV set are applied to each of the color demodulators of the color receiver. Since 15,750 cps separates these two signals, the relative phase

B & K Model 1245 Specifications

RF Output:
5000 uv, adjustable to channels 3, 4, or 5.

Video Patterns:
Dots, crosshatch, horizontal lines (14), vertical lines (10), color bars (10). Sequence is yellow-orange, orange, red, magenta, reddish blue, blue, greenish blue, cyan, bluish green, and green.

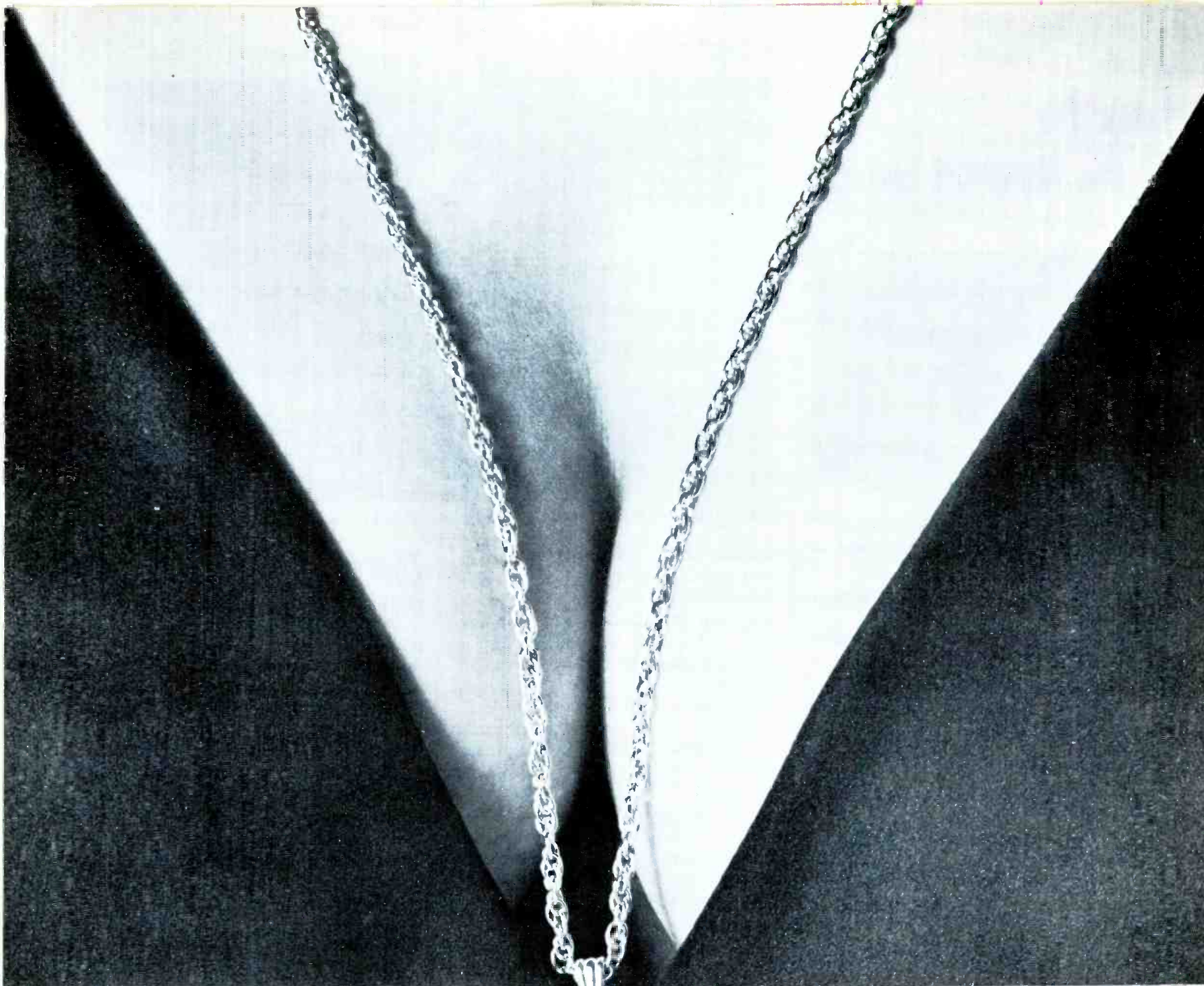
Controls:
3 gun-killer switches; 5-position pattern switch; ON-OFF switch mounted on rear of ganged COLOR/VERT LINES control.

Power Requirements:
100-140 volts, 60 cps, 9 watts (supply regulated by zener diode).

Size: (HWD)
2⅞″ x 8⅞″ x 8⅜″

Weight:
3 lb

Price:
$134.95



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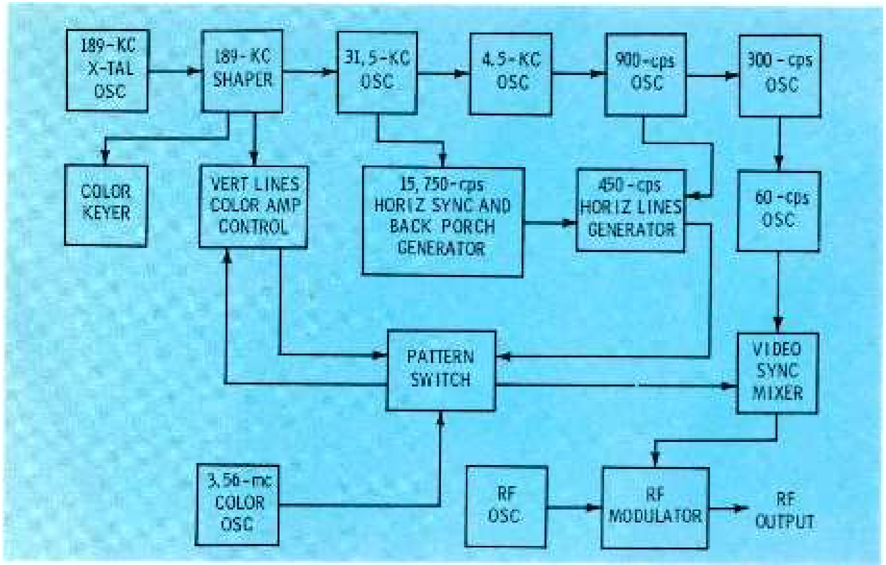

Fig. 2. Block diagram reveals signal paths of complete solid-state color generator.

between them changes from 0° to 360° during one horizontal scanning period. Thus each demodulator has a one-cycle output for each scanning period. The R-Y demodulator has a sine-wave output of maximum positive amplitude at 90°; the B-Y output is maximum at 180°, and the G-Y is maximum at 300°. As explained earlier, the color keyer interrupts these signals so they produce ten color bars on the CRT.

The output of the 300-cps oscillator provides synchronization for the 60-cps relaxation oscillator, which provides the vertical-sync pulse coupled to the video-sync-mixer circuit.

Also connected to the mixer circuit is the output of the PATTERN SWITCH. This switch has five positions: dots, crosshatch, horizontal, vertical, and color. The output of the video-sync mixer is fed to the RF modulator. An RF oscillator is coupled to the modulator, and the modulator output connects to a shielded cable. The alligator clips on the end of the cable connect to the TV receiver antenna terminals. The RF oscillator is normally set for channel 3, but it can be adjusted to channel 4 or 5 if desired. The instruction manual explains the complete procedure to use.

The Model 1245 has three GUN KILLER switches. These switches are connected to three leads that have alligator clips. For connection to the receiver, merely attach the alligator clip to the CRT control-grid leads so the needle of the clip pierces the grid lead and makes contact with the inner conductor. Attach the black lead to ground. As each of the three switches is moved from the OFF position to ON, a 100K resistor is placed from the corresponding lead to ground.

To return a CRT gun to operation, move the particular GUN KILLER switch to the OFF position.

In our lab tests, all the patterns of the Model 1245 were stable. The gun-killer leads were connectd to the CRT control-grid leads with a minimum of time, and the killer action performed as it should.

Should the Model 1245 color generator be stored at extremely cold temperatures for extended periods, a few minutes may be required for the instrument to stabilize after it is turned on. However, we found when the instrument was maintained at normal room temperature it could be used as soon as the ON and OFF switch was moved to the ON position.

The COLOR AMPLITUDE control varies the strength of the color-information output (color bars) of this instrument. This is helpful in determining the effectiveness of the TV receiver's color-sync circuit. Should the loss of color sync be experienced with a small reduction in the color information, a fault in the color-sync circuit would be suspected. Most color receivers will maintain color sync up to the point where color just begins to drop out of the color bars.

The crosshatch pattern of the Model 1245 can be used for linearity adjustments on either monochrome or color TV receivers. Observe the vertical lines for equal spacing as horizontal linearity is adjusted, and use the horizontal lines for vertical linearity adjustments.

An instruction manual, included with each instrument, explains how to adjust the counter circuits should they need recalibration. Also, an explanation of each function of the instrument is given. ▲

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CB Transceivers

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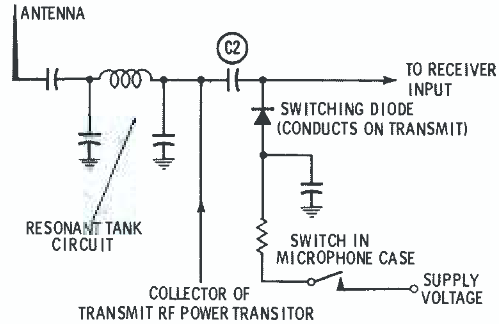


Fig. 10. Electronic antenna switching using a diode.

the previous discussion of relay switching can be accomplished with only a microphone switch. No other switching contacts need be employed.

Electronic changeover can be made with so-called switching diodes. With the application of an appropriate DC voltage, such a diode conducts and presents a very low resistance path. By removing the DC voltage, the resistance of the diode path becomes extremely high. Switching diodes are used for switching DC, audio, or radio-frequency curents.

The basic arrangement in Fig. 10 demonstrates the use of a switching diode in transferring an antenna between transmitter output and receiver input. The resonant tank circuit is shared by both the transmitter output stage and the receiver input stage. In the receive mode the incoming signal is transferred through capacitor C2 to the receiver input. The transmit-output transistor is nonconducting because its supply voltage is switched off; it doesn't attenuate the incoming signal.

On the transmit mode, the supply voltage is connected to the transmitter transistors and they operate in a normal manner; the RF-output transistor is now conducting and supplying RF energy to the resonant circuit. The same supply voltage also places a positive voltage on the anode of the switching diode; therefore, the switching diode conducts and places a low-impedance shunt across the signal path between the resonant circuit and the input to the receiver. Hence, the transmit RF energy does not enter the receiver.

In the receive mode position, it is significant that

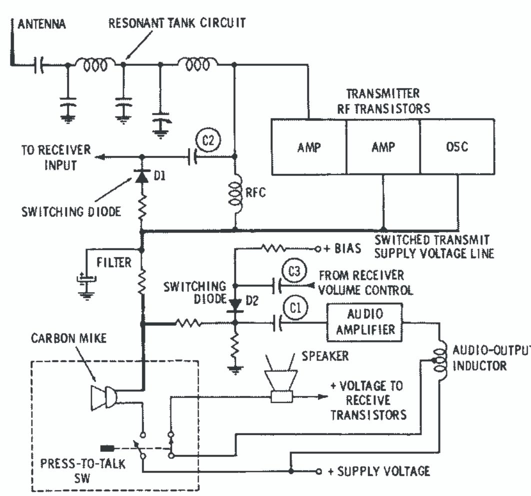
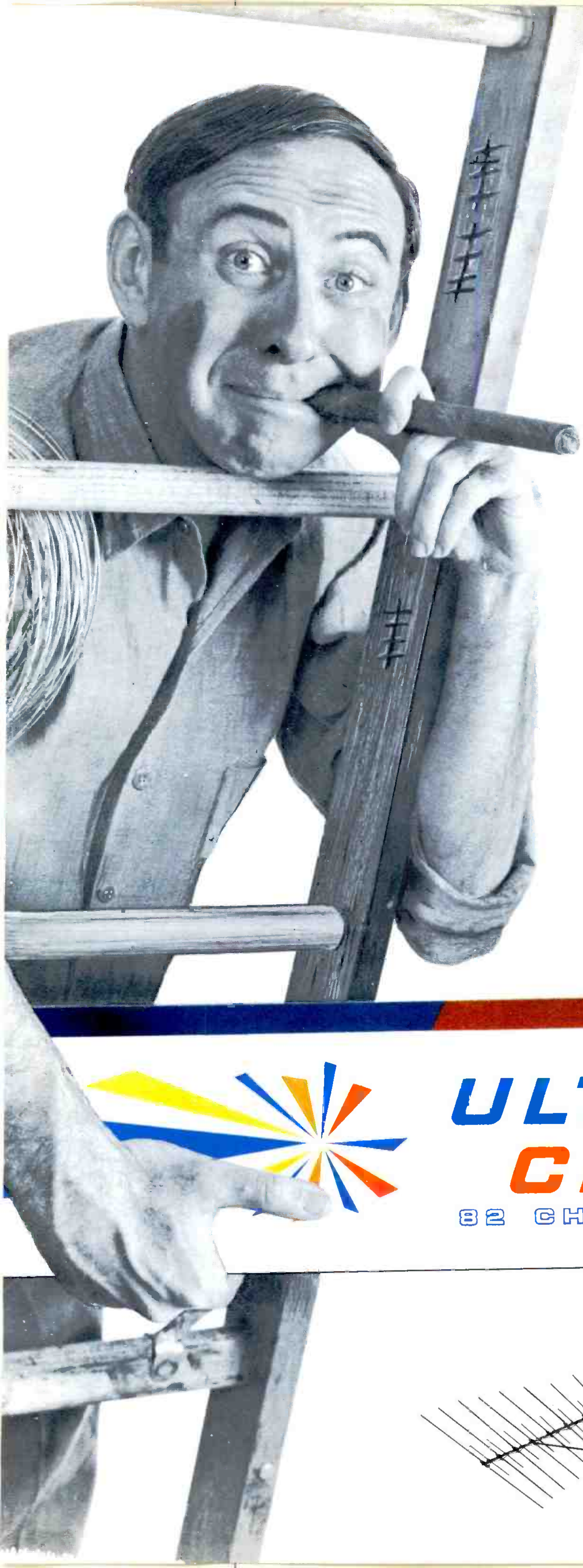


Fig. 11. Electronic switching used in Raytheon TWR-7.



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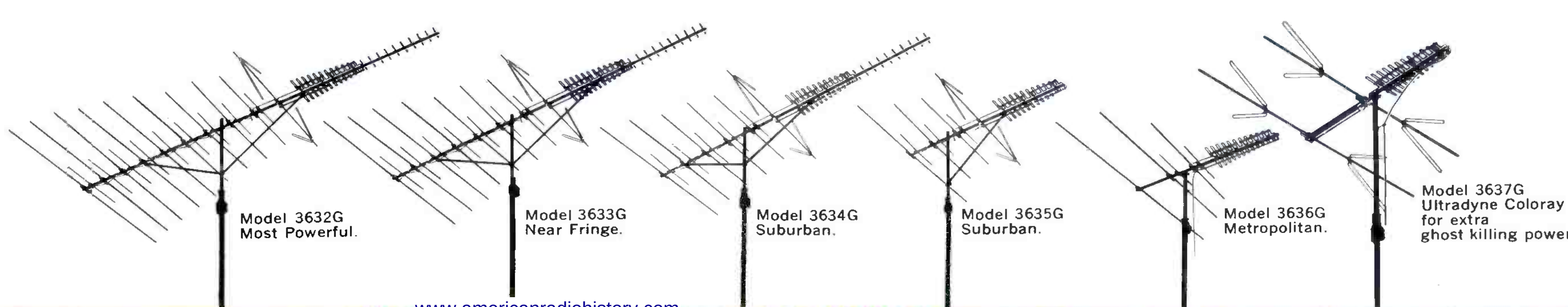

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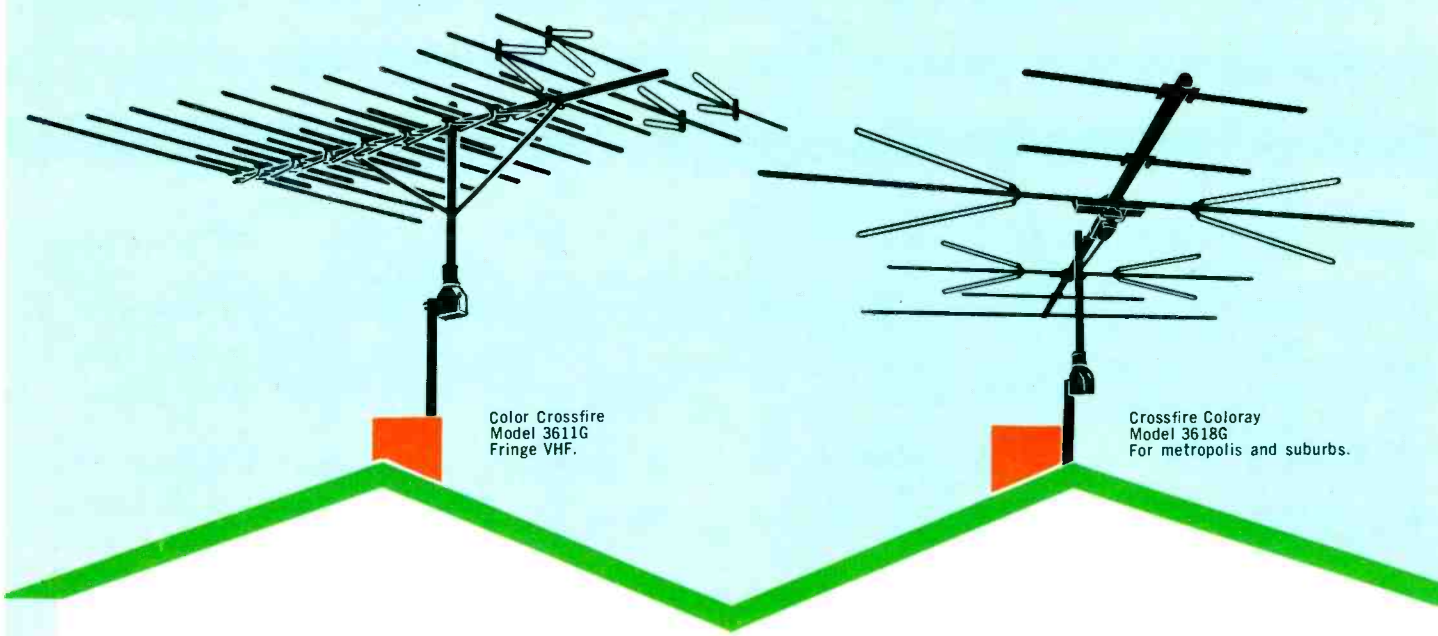

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positive voltage is not applied to the anode of the switching diode; consequently, it is nonconducting and the incoming RF signal is transferred to the input of the receiver. In effect, the switching diode operates as an antenna switch. Of course, in an actual two-way radio unit, the same activity must also handle a number of other switching assignments such as those in the Raytheon TWR-7 shown in Fig. 11.

The press-to-talk switch, mounted in the microphone case, handles all the switching activities; it is shown in the receive position. One pair of the contacts is open, while the other is closed and connects the loudspeaker to the output of the audio amplifier. On the transmit mode, this connection is broken and the loudspeaker is disconnected; the other pair of contacts connects the microphone signal thru C1 to the audio amplifier. This contact also applies a positive voltage to the transmit supply voltage line. Let us consider the operation of the circuit for the transmit and receive modes.

Transmit Mode

As mentioned previously, in the transmit position of the press-to-talk switch, the microphone is connected to the input of the audio amplifier. Also, a positive voltage is connected to the transmitter supply voltage line. This voltage turns on the transmitter transistors and also places a positive voltage on the anode of switching diode D1. This causes the diode to conduct and, as shown in Fig. 10, places an RF short circuit across the feed path to the receiver input. Thus, the transmitter energy does not enter the receiver; rather it sees an appropriate match from the output of the last RF power transistor to the antenna. The positive voltage is also applied to the cathode of switching diode D2, cutting off this diode; therefore, the path between the output of the receiver and the input of the audio amplifier is broken during the transmit mode.

Receive Mode

The loudspeaker is connected to the output of the audio amplifier and the positive voltage is removed from the supply-voltage line to the transmitter. Now, the transmit transistors are nonconducting and the RF power output transistor places no significant load on the resonant circuit. The removal of the positive voltage also cuts off switching diode D1; it is now nonconducting and does not attenuate the incoming signal that is coupled via capacitor C2 to the receiver input. Also, positive voltage is removed from the cathode of switching diode D2. Inasmuch as positive bias voltage is applied to its anode, D2 conducts and offers a low-resistance path for the demodulated voice signal that passes through capacitor C3 from the volume control.

It is anticipated that electronic switching will become increasingly popular in CB equipment. Such a technique can provide less troublesome and more versatile transmit receive changeover. More important, with ingenuity in circuit design, electronic switching can control circuit operations in such a manner that a very minimum power demand is made. ▲

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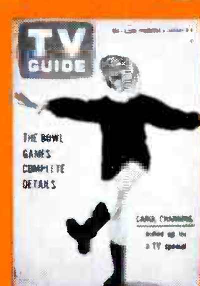

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BOOK REVIEW

Practical Transistor Servicing, Revised Edition; William C. Caldwell; Howard W. Sams & Co., Inc., Indianapolis, Ind., 1965; 190 pages, 8½" x 5⅓", paperback; $2.95.

Not only does the small size of transistor radios make them hard to service, the fact that the majority of test equipment found in service shops is designed for use in vacuum-tube circuits compounds the difficulty. In addition, service technicians often approach trouble spots using exactly the same concepts in transistor circuits that they use for vacuum-tube circuits. The results of these servicing procedures are inefficient troubleshooting techniques which increase repair time and decrease profit.

In this revised edition, the author has again outlined step-by-step methods for profitable, efficient transistor-radio troubleshooting; also, techniques suitable for repairing the new transistor AM-FM radios have been added. In chapters one and two, the discussions of basic transistor theory are always treated as means for aiding the reader to develop the basic understanding required for efficient troubleshooting.

Detailed AM transistor-radio troubleshooting methods are outlined in the third chapter. Signal tracing, signal injection, and the advantages and disadvantages of each method are fully covered. The fact that low impedances in transistor circuits limit the usefulness of much test equipment is discussed, and methods for getting the most benefit from available test equipment are then described. The fourth chapter shows methods for profitably troubleshooting AM-FM transistor radios.

Voltage and current analysis of normal and malfunctioning transistor circuits is covered in the fifth and sixth chapters. Here, comparisons made between transistor and vacuum-tube circuits help clarify similarities and differences in symptom analysis. Special techniques — such as the use of a hair drier to spot a heat-sensitive transistor — are also introduced. The seventh chapter should be quite useful to the technician who doesn't have a transistor tester; it shows a reliable method for testing transistors with a VOM.

Both AM and AM-FM auto radios are covered in the eighth and ninth chapters. The tenth chapter is an informative list of "case histories" that illustrate effective test procedures.

By studying these techniques, the technician can learn to service transistor radios rapidly and profitably. This same information will also be advantageous in servicing transistor TV receivers and other solid-state equipment. ▲

Stator lead changes:	With Generator at 0° the Motor setting is:		Comparative direction of rotation:
	Rotor leads normal	Rotor leads reversed	
S1 and S2 reversed	-120°	60°	Opposite
S2 and S3 reversed	120°	-60°	Opposite
S1 and S3 reversed	0°	180°	Opposite
S1 to S3, S2 to S1, S3 to S2	-120°	60°	Same
S1 to S2, S2 to S3, S3 to S1	120°	-60°	Same

Table 1. Angular-settings and rotation-direction changes result from changed leads.

(Continued from page 23)

which causes the rotor in the synchro motor to turn toward S3 until the generator and motor stator voltages are equal and minimum current flows. This system insures that the motor and generator rotors are aligned and provides sufficient torque for positive action.

Troubleshooting Procedures

Proper operation includes as a first step the proper zeroing, or alignment, of the synchro units. There are several different methods that can be used; only one is given here. Referring back to Fig. 3A, notice that at electrical zero the S1-S3 voltage is zero. So, the first step in zeroing would be to rotate the unit until that condition occurs. However, when the rotor is set at 180°, the S1-S3 voltage is also zero. The next step then would be to determine whether the rotor is at 0° or 180°. One method is to connect the synchro as shown in Fig. 6A. At 0° or 180° the voltmeter reads 0 volts. Reconnect the units as shown in Fig. 6B; if the rotor is at 0°, a voltage lower than line voltage will be read. If the rotor is at 180°, a voltage higher than line voltage results. Always provide a mechanical load when zeroing to prevent the unit from running away. Improper zeroing would result in a constant angular error between the two units.

Troubleshooting synchros is usually not difficult, but one of the best aids is knowing what occurs when various changes are made. So instead of progressing from a symptom to its cause, the following explanations take the opposite approach. The various types of trouble are listed under several general headings. Then for each trouble it effects on the system is listed, thus giving a more compact summary because of the grouping of similar troubles.

Varying Voltages

Nameplate ratings are given assuming that correct line voltage is being applied. If the line voltage changes, all voltages will change in the same proportion. For example, if 105 volts were applied instead of 115, all voltages would change by a factor of: 105/115 = .91. At

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electrical zero, voltage between S1 and S2 would be: 78 × .91 = 71 volts. The others would vary similarly. Slightly reduced voltage ordinarily will not harm the units, but operation may be slower and more sluggish than normal. Should the synchro motor have a heavy mechanical load, insufficient voltage may reduce torque until the rotor cannot turn; in such a case, excessive stator current may burn up both the generator and motor. If there is no voltage at all, check the fuses or circuit breakers. Each synchro may be fused separately, or one set may be used for all units. The first method is preferred because current tolerances may be decreased, and the other units would be protected in case of trouble in one unit.

If line voltage were increased, for example to 125 volts, all of the voltages would increase by a factor of: 125/115 = 1.09. At electrical zero, voltage between S1 and S2 would be: 78 × 1.09 = 85 volts. Other voltages would vary similarly. Increased voltage may speed up the operation slightly, and as a consequence, increase chatter and oscillation. With poor damping the synchro motor may run away and act as a conventional motor.

Opens and Shorts

As would be expected, open or shorted coils or connections result in improper operation. For purposes here, assume that an open coil produces the same effect as an open lead connecting to that coil. If both rotors were open, there would be no operation because there would be no induced voltages. If only one rotor were open, the operation may be almost normal. The motor would still follow the generators movements; it might be at the correct setting, or its position might be displaced by 180°. Operation might be sluggish; rotor-core hum and temperature might both increase because of higher current flow through the stator coils.

When a stator coil is open, the motor oscillates back and forth between two limits as the generator is rotated a full 360°. If S1 is open, the motor oscillates between 0° and 120° or between 180° and 300°. If S2 is open, the limits are 120° and 240° or between 60° and

−60°. If S3 is open, the motor oscillates between 60° and 180° or between 0° and −120°. Notice that in each case the range of movement is 120°, and that the axis of the open coil is at the center of that range. Hum level of the rotor core may increase slightly if one stator is open. However, if two or more stator coils are open in the same unit, there is no operation at all.

If a rotor is shorted, the line fuse will probably be blown because of the short across the AC line. If S1 and S3 are shorted together the synchros will lock at either 0° or 180°. If S2 and S3 are shorted together the synchros will lock at 120° or 240°. If S1 and S2 are shorted together the synchros will lock at 120° or 300°. In all three of these cases there will be excessive heat and hum. With all the stator terminals shorted together there will be definite overheating and possible damage. Shorted leads are usually more plausible than shorted terminals, especially when all of the conductors are part of a single cable. But, as mentioned previously, the results are the same.

A short within a stator coil can be determined by measuring all the terminal voltages and comparing For example, if there were a short them with a normal set of readings. in the S1 coil, the S1-S3 voltage would not be correct, neither would the S1-S2 voltage. But the voltage between S2—S3 should be correct.

Improper Connections

Improper connections may change either the direction of rotation, the angular setting, or both. Assuming that rotor and stator leads are not interconnected both units turn the same number of degrees regardless of the combination of connections being used. Torque is normal, and there is no overheating nor damage because of the changed connections. This four-step summary can be used to determine the characteristics for any possible set of lead changes.

1. Reversal of any two stator leads causes the units to rotate in opposite directions with respect to each other.
2. Changing all the stator connections is the same as two reversals so both units rotate in the same direction.

3. For any possible connection of stator leads the motor rotor points in the direction of the stator coil that is connected to S2 of the generator.
4. If R1 and R2 are reversed, the direction of rotation is not affected, but the motor setting is changed by 180° from that dictated by the stator interconnections and the generator setting.

All of the connection possibilities and the results of them are listed in Table 1. On the two lower lines the generator connection is listed first in every combination. For example S1 to S2 means that S1 of the generator is connected to S2 of the motor. Opposite rotation means that if the generator is rotated clockwise, the motor will rotate the same number of degrees counterclockwise, and vice versa.

Mechanical troubles can also enter into operation of a synchro system. These may include worn bearings or shafts, bearings that are too tight, loose couplings, worn parts, or other similar problems. And, as in all types of servicing, visual inspection can be a valuable aid. Such inspection may show loose connections; broken, frayed, or burned wires; overheated components; loose, bent, or broken mechanical couplings; "frozen" bearings; etc. In some cases the brushes and slip rings used to connect the rotor coil to the external terminals may be worn or broken.

Conclusion

Synchros are simple devices; yet, unless their operation is thoroughly understood, much time can be wasted correcting troubles which should be easy to troubleshoot. Since synchros and synchro systems are an integral part of servomechanisms and automatic control devices, a basic knowledge of synchro-system operation is essential for industrial maintenance. ▲

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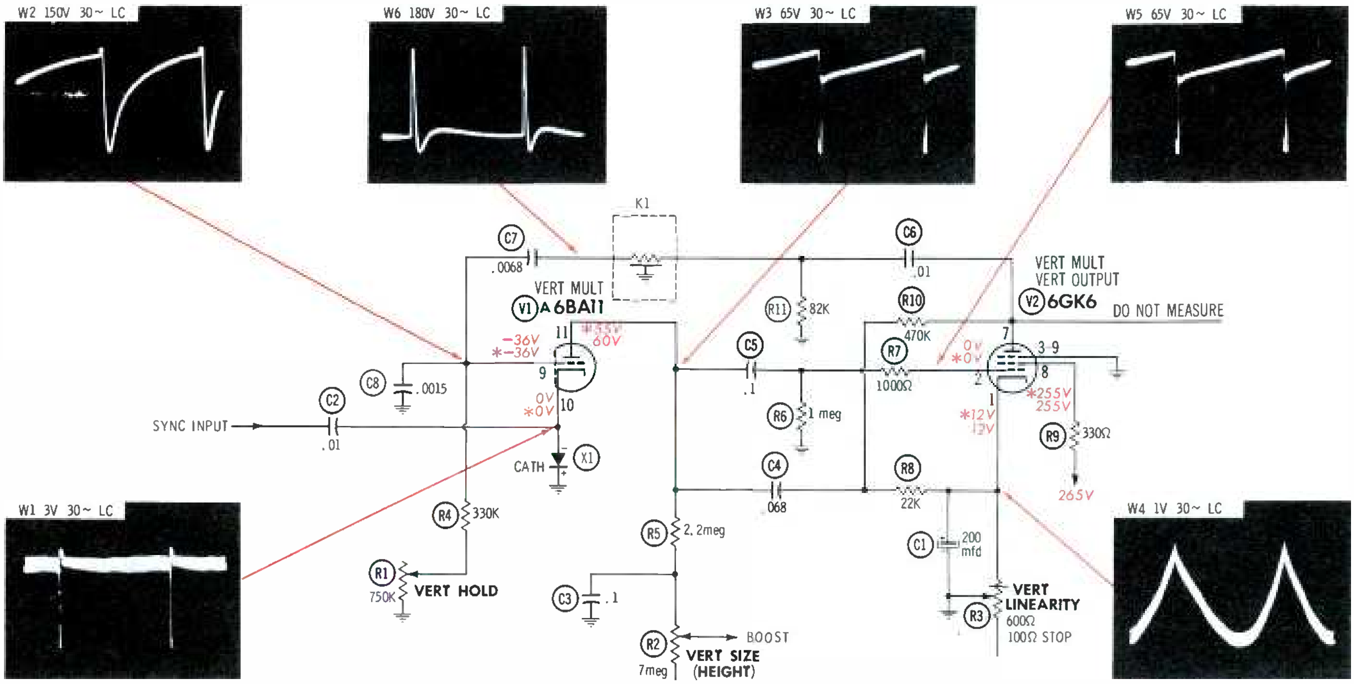


DC VOLTAGES taken with VTVM, on inactive channel; antenna terminals shorted. *Indicates voltages taken with signal present—see "Operating Variations."

WAVEFORMS taken with wideband scope; TV controls set to produce normal picture and sound. Low-capacitance (LC) probe used throughout circuit.

Normal Operation

Triode section of 6BA11 (compactron) combines with pentode to form vertical-multivibrator-output stage in Zenith Chassis 14N26. V2 starts conducting, feeding negative pulse thru C6, K1, and C7 to grid of V1A cutting it off. This negative voltage bleeds to ground thru R4 and R1 (vertical hold varies time period) and negative bias on pin 9 of V1A is reduced. At same instant vertical-sync pulse is coupled via C2 and applied to pin 10 across X1, assuring V1A will conduct. (X1 offers little resistance for V1A conduction; however, as negative sync pulse arrives thru C2, X1 conduction ceases, providing infinite load for sync pulse to cathode.) Voltage present on C3 and C5 now discharges through V1A; negative pulse appearing on pin 11 of 6BA11 couples thru C5 and R7 causing V2 to cease conduction. Plate voltage on V2 increases when conduction stops and collapsing field from yoke and vertical-output transformer applies a strong positive pulse on pin 7 of 6GK6. This positive pulse charges feedback network to grid of V1A allowing it to conduct for short interval until pulse collapses; remaining charge cuts V1A off. Negative voltage on pin 9 bleeds to ground via R4 and R1 which starts oscillator cycle again. During V1A cutoff, boost voltage feeds thru R2 and charges C3 at a rate to provide linear drive voltage via R5, C5, and R7 to pin 2 of V2. Vertical-linearity (R3) determines V2 conduction time. Parabolic voltage (W4) aids linearity.

Operating Variations

Pin 10 V1A CW or CCW rotation of vertical-hold control causes −.2 volts reading. No voltage changes as R2 or R3 is adjusted.

Pin 9 V1A Variation of −25 to −45 volts is observed when R1 is adjusted. Rotation of R2 or R3 reveals −30 to −35 volts.

Pin 1 V1A Range of 30 to 85 volts read with complete rotation of R1. Turning R3 reveals voltage change of 35 to 74 volts, and adjusting R2 shows spread of 37 to 110 volts.

V2 Cathode reading varies from 11 to 13 volts when adjusting R1; R3 causes swing from 6 to 14 volts; R2 produces variation of 11 to 15 volts. Adjusting R1 and R2 reveals no voltage change on pin 2; however, setting R3 for more cathode resistance reveals −1.5 volts. Pin 8 is unchanged by control rotation.

Wave-Forms W1 varies from 2 to 10 volts P-P when adjusting R1, while R2 and R3 rotation shows no voltage change. Turning either control causes swing of 100 to 195 volts P-P for W2. W3 and W5 vary from 30 to 55, 40 to 110, and 35 to 70 volts P-P with rotation of R1, R2, and R3 respectively. Also, W4 reads .5 to 2, .3 to 1.5, and .8 to 1.5 volts P-P by moving R1, R2, and R3 respectively. R1, R2, and R3 vary W6 amplitude from 140 to 240 volts.

Symptom 1

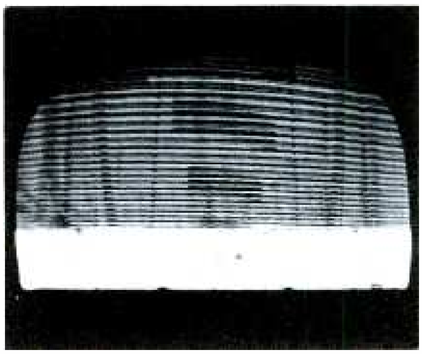
Extreme Nonlinearity

**Top Stretched—
Bottom Compressed**

C4 Open

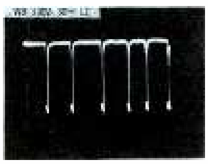
(Waveshaping Capacitor—.068 mfd)

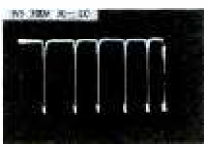
Symptom Analysis

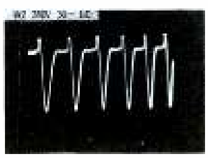


Picture up one-third from bottom and appears to have foldover and multiple images. Vertical scanning uneven with top half of screen extremely stretched. Vertical hold will sync picture; however, vertical height and size controls have no effect on raster.

Waveform Analysis

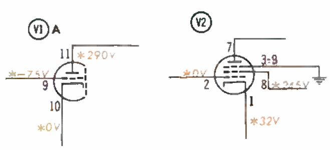






W3 and W5 amplitude has increased from 65 to 300 volts P-P. Linear slope of W5 has disappeared and resembles square wave, accounting for nonlinearity of sweep. W5 shows six negative-going spikes compared to two of normal waveform. This indicates frequency has tripled, resulting in multiple image on screen. W2 also reveals distortion and increased amplitude from improper feedback. C4 develops linear slope of W3 and W5.

Voltage and Component Analysis



No voltage change pin 2 V2 or pin 10 V1A. Grid 6BA11 reads −75 volts indicating strong feedback pulse that charges feedback network to greater degree, resulting in larger bias. Plate V1A shows 290 volts. Defective R2 and R5 could cause abnormal plate voltage, but check good. C5 is okay, verified by pin 2 voltage. C4 must be culprit and is found open. Normal C4 presents low impedance for boost during charge time; however, if open, little impedance encountered on pin 11, except drop across R2 and R5.

Best Bet: Scope is more conclusive.

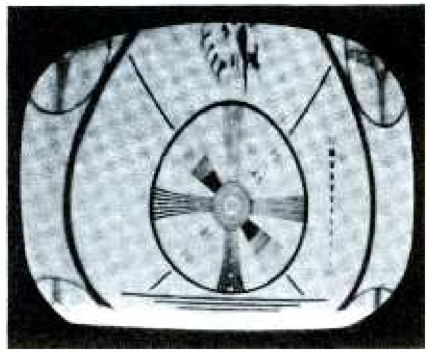
Symptom 2

Bottom Foldover

Stretched at Top

C1 Leaky

(Cathode Filter Capacitor—200 mfd)

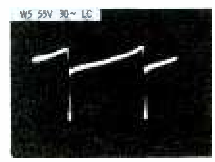


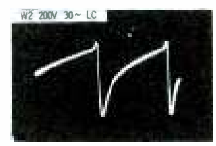
Symptom Analysis

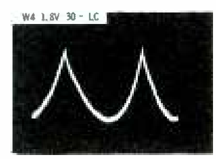
Vertical hold will sync picture but must be positioned near one end of rotation. Height control affects bottom of picture; however, vertical linearity has no influence on top of raster. Adjustment of either size or linearity controls causes uncontrollable roll.

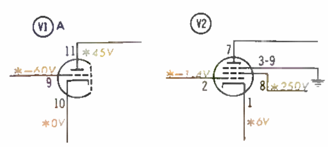
Waveform Analysis

W5 shows 15-volt P-P decrease in amplitude. Slope of waveform reveals nonlinearity with slight leveling off near top which represents foldover portion of picture. W3 identical to W5. Result of improper feedback noted in W2. Amplitude W2 has increased 50 volts despite decrease grid waveform W5. This indicates grid bias V2 has decreased. Parabolic waveform W4 increased to 1.8 volts P-P. Insufficient filtering likely; C1 strong suspect.









Voltage and Component Analysis

Grid of V1A measures −60 volts. V2 must be conducting more, providing greater feedback, causing increased bias of 6BA11. Pin 8 6GK6 has insignificant voltage change, but pin 1 voltage has dropped 50%, reducing bias on V2. This permits conduction to start on lower nonlinear portion of drive pulse and explains stretched top portion of picture. Negative voltage on pin 2 V2 indicates grid drawing current, resulting in foldover at bottom. Resistance check at pin 1 shows C1 has 100-ohm leakage.

Best Bet: Scope then VTVM.

Symptom 3

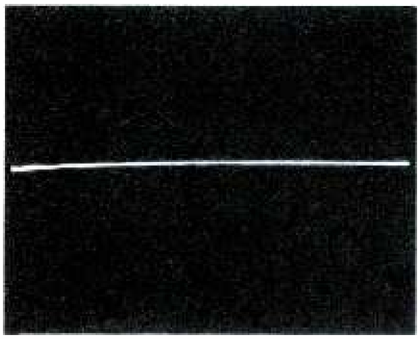
Thin Horizontal Line

No Vertical Sweep

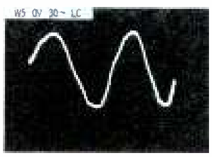
C7 Open

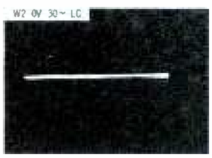
(Feedback capacitor—.0068 mfd)

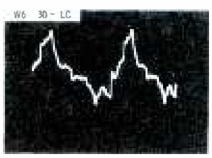
Symptom Analysis



Narrow horizontal line through center of screen indicates absence of vertical sweep. Vertical linearity or size controls have no affect on bright horizontal line. Turning vertical hold produces no change. Rotation of controls renders no helpful hints.



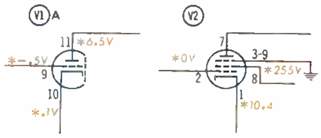




Waveform Analysis

Scope check reveals no waveforms through entire vertical circuit. Oscillator stage is inoperative. Connecting 60-cps signal (W5) from filament of V2 through .1-mfd capacitor to pin 2 of 6GK6 produces partial nonlinear sweep on screen. Moving scope to grid of V1A uncovers absence of feedback pulse W2. Using scope to monitor W6 reveals distorted 60-cps pulse that was injected on pin 2 of V2, proving that C7 is open.

Voltage and Component Analysis



Pin 2 V2 has zero volts and screen grid has normal 225 volts. Cathode voltage 6GK6 dropped to 10.4 volts. Pin 10 6BA11 shows .1 volt, but grid voltage changed to −.5 volts and plate has lowered to 6.5 volts. Since plate resistor R5 is very large, slight increase in V1A conduction will lower plate voltage considerably. Voltage readings are inconclusive and each component in oscillator stage would need checking to determine defective one. Scope analysis and 60-cps signal injection is quick way to pinpoint faulty component.

Best Bet: Scope and signal injection.

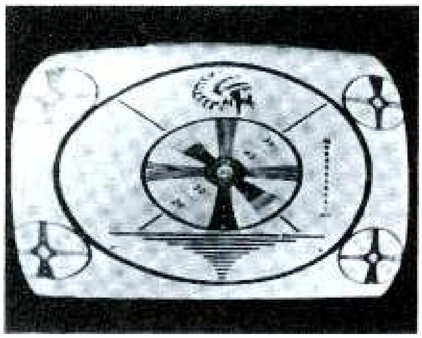
Symptom 4

Top and Bottom Compressed

Compression Equal

R7 Increased Value

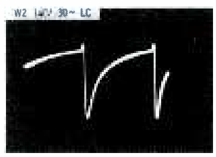
(Grid resistor—1000 ohms)

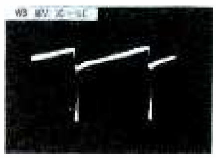


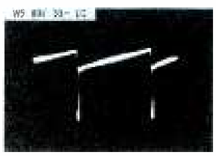
Symptom Analysis

Raster equally compressed at top and bottom. Vertical hold has ample range and syncs picture at center of rotation. Height and linearity controls adjustable so picture fills screen linearly. Even though controls compensate for trouble, component breakdown indicated.

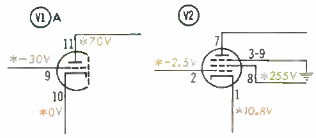
Waveform Analysis







Scope check of W2, grid of V1A, shows waveform has decreased slightly in amplitude; however, shape of wave hasn't changed. P-P voltage of W3 increased somewhat. This seems to indicate more V1A conduction. W5 reveals waveform identical to W3. Scope checks give no help since all waveforms are same as normal except for slight change in amplitude. Voltage and resistance measurements must be made to determine defect.



Voltage and Component Analysis

Pin 10 V1A measures normal zero volts. Grid 6BA11 has dropped 6 volts and reads −30 volts, while plate shows slight gain to 70 volts. This indicates some attenuation of feedback pulse, causing V1A to conduct less. Screen grid V2 reads normal, but cathode measures 10.8 volts. Pin 2 6GK6 has acquired −2.5 volts from a normal zero reading. Since both height and linearity of raster are affected equally, components off control grid 6GK6 are suspected. Resistance measurement reveals R7 has increased to 150K.

Best Bet: VTVM for resistance measurements.

Symptom 5

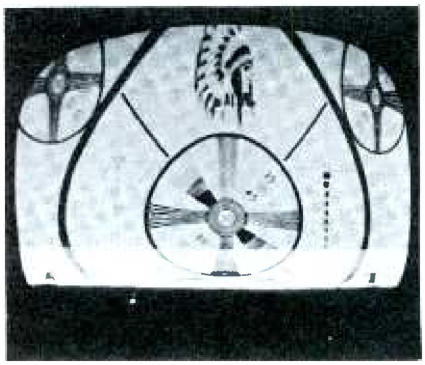
Nonlinearity

Extreme Bottom Foldover

C5 Leaky

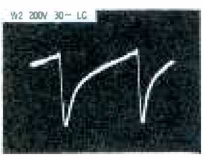
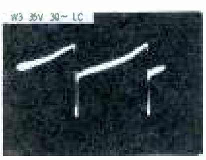
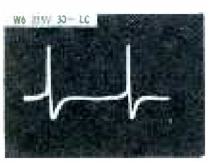
(Coupling capacitor—.1 mfd)

Symptom Analysis



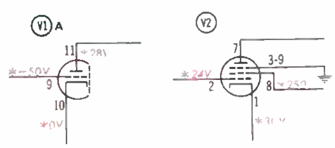
Vertical hold will sync picture but does so near one end of its rotation. Attempt to adjust height and linearity controls prove fruitless and produces uncontrollable loss of vertical sync. Very pronounced foldover present at bottom of picture.

Waveform Analysis

Increased P-P voltage of W2 reads 200 volts. Feedback pulse is greater than normal; also, distortion can be noted at top of slope near small positive pip. W3 reveals nonlinear slope drive signal (W5 waveshape and P-P voltage same as W3). W6 has 255 volts P-P and slight hump can be noted at beginning of sharp positive pulse. This represents foldover at bottom of picture. DC voltage and resistance checks are required.

Voltage and Component Analysis



Bias voltage on grid V1A shows increase to −50 volts while pin 10 voltage remains zero. 6BA11 plate reads 28 volts, 50% down. This decreased voltage could be result of increased tube conduction—larger negative voltage on V1A grid indicates greater feedback driving pulse—or defective component in V1A plate circuit. Cathode voltage of 6GK6 has jumped to 30 volts. Leaky C4 could cause voltage change on pin 1, but C4 checks okay. Pin 2 measures 24 volts. C5 suspected and found leaky.

Best Bet: Voltage and resistance checks.

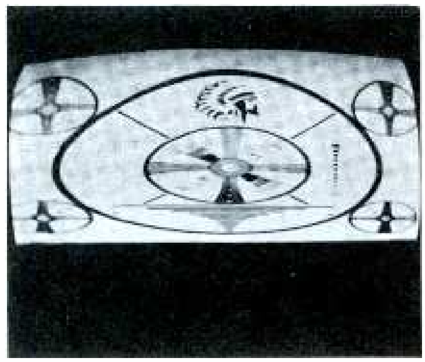
Symptom 6

Top and Bottom Compressed

Height Inadequate

R7 Value Increased

(Plate resistor—2.2 meg)

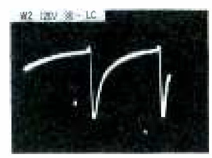
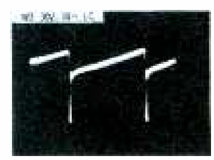
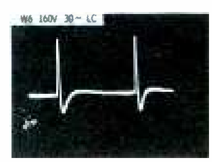


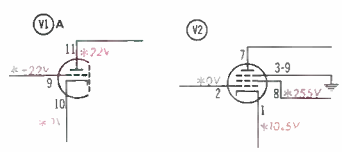
Symptom Analysis

Insufficient vertical scanning top and bottom of picture. Vertical hold locks picture solid. Linearity control increases top of raster; however, nonlinearity (stretched top) results. Adjustment of size fails to provide complete vertical sweep at bottom of CRT.

Waveform Analysis

Grid V1A waveform W2 shows good shape and linearity but measures only 120 volts P-P compared to normal 150 volts P-P. W3 and W5 are identical waveforms with proper linearity; however, their amplitude reveals attenuation over 50%—reads 30 volts P-P. Feedback pulse W6 has normal linearity but below-normal amplitude of 160 volts P-P. All waveforms have proper shape but lack amplitude. Scope will not locate trouble.



Voltage and Component Analysis

Cathode V1A reads normal zero volts; pin 9 measures −22 volts, 35% change, and plate reveals 22 volts. Voltages V2 show no change except pin 1 which has dropped to 10.5 volts. Reduced voltage on pin 11 6BA11 could result from increased tube conduction since grid bias has decreased. Also, plate-circuit component defects can reduce B+ voltage. C4 considered okay and not leaky since cathode voltage V2 has actually dropped. C5 ruled out because pin 2 voltage 6GK6 is normal. Resistance check R5 measures 9 meg.

Best Bet: VTVM and component analysis.

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The Troubleshooter

answers your servicing problems

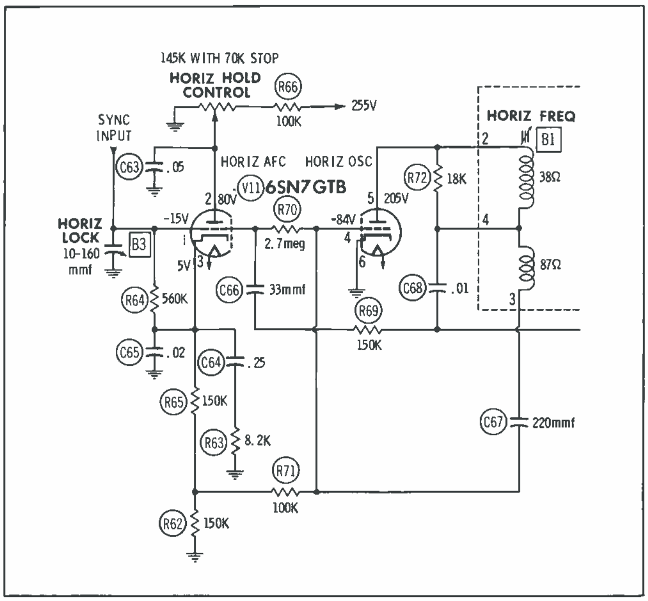
Doesn't Like It Hot

I am having trouble with a Crosley TV Model H-17TOBH (covered in PHOTOFACT Folder 279-3). The set works normally when it is removed from the cabinet and placed on the service bench. The trouble begins in about two or three hours, after the set is installed in the cabinet.

When the set is first turned on, the raster does not fill the screen for two or three minutes. After the set operates a couple of minutes, everything is normal for about three hours then there is a haze on the left side of the screen and the raster pulls on the right side. I can get a normal picture by adjusting the horizontal-hold control, but in a few minutes the trouble occurs again.

I have replaced the picture tube, horizontal-output transformer, vertical-output transformer, electrolytic capacitors C1, C2, and C3, and capacitors C63, C64, and C65.

DAVID E. ROWE
Cleveland, Ohio



It sounds as though a component, probably a capacitor, is breaking down due to heat. This occurs only when the chassis is in the cabinet because the components are exposed to a lower temperature if the set is operating on the service bench. With the set on the bench, you can use a heat lamp, directed toward the chassis, to simulate the heat conditions that exist within the cabinet.

You can determine if the trouble is in the horizontal-AFC or sync-separator stage by connecting a clip lead from Pin 1 of V11 to ground. Adjust the horizontal-hold

control until the picture floats slowly across the screen. If the pulling is present under these conditions, the trouble is in the horizontal-AFC or oscillator circuits; should no pulling be observed, the defective component is located ahead of or in the sync-separator stage.

Waveform checks and voltage measurements in the proper stage should prove helpful in locating the faulty component.

CRT Neck Cracked

I have in my shop a Dumont color television receiver that is 1½ years old; this set was covered in PHOTOFACT Folder 724-3. The picture tube cracked about 1½" from the socket. I installed a new CRT, and a month later the new tube cracked in the same place as the old one did. The crack appears as though it had been cut with a knife. I hesitate to put another new picture tube in this set. I'm wondering if it was a coincidence that the second tube cracked exactly like the original.

J. POOLS

Harriman, Tenn.

It would certainly seem a coincidence that both picture tubes cracked in the same place. A possible cause of this condition is that when the convergence assembly and blue lateral magnet were installed, especially the blue lateral magnet, the neck of the tube may have been scratched. The combination of the scratched neck and the pressure of clamping the dynamic convergence assembly and blue lateral magnet onto the neck, along with the heat of the filaments, could have caused the glass to crack. When installing the next tube, make certain the glass is not scratched and only enough pressure is applied to the neck to hold the assemblies in place. ▲

ing: insufficient sync, defective integrator network, resistors increasing in value, and other unstable conditions. If the vertical hold control has no effect in locking the picture in sync, check the resistors in the grid and plate circuit of the vertical oscillator. Many times when the picture rolls after the set is on awhile, the plate supply resistor has changed value. Check the voltage on the plate of this tube when the receiver is cold and then again when the picture starts to roll. Vertical roll can also be caused by leaky coupling capacitors or improper setting of the vertical height and linearity controls. Remember the height control has the greatest effect on the bottom of the picture; the linearity control causes the most change at the top of the screen.

If the portable is operating in a fringe area, solid vertical sync is a must. Vertical sync can sometimes be improved by shunting a resistor of the same value across one of the integrator resistors.

When a receiver has poor vertical and horizontal sync, the trouble is in the sync separator circuits—before the take-off to the vertical oscillator tube. Scope waveform checks are almost a must for intermittent or weak sync troubles.

Miscellaneous Troubles

A no-sound, no-picture condition is usually caused by power-supply failures. Most portable TV's have a fusible resistor or fuse in the AC lead. This resistor, the voltage-doubler capacitor, or the rectifiers cause most troubles of the power-supply. The locations of some of these power-supply components are pointed out in Fig. 3. The voltage-doubler electrolytic may dry out or lose capacitance, resulting in decreased B+ voltage and increased ripple. In the older portables, selenium rectifiers were used in the voltage-doubler circuits, but late-model sets use a silicon rectifier. The selenium rectifier would increase in resistance or show burnt spots on the plates, when defective; also, an unpleasant odor identifies a bad selenium. Silicon diodes usually short out. A good silicon diode will measure ten ohms or less in one direction, and several thousand ohms with the ohmmeter leads reversed.

Hum

Sixty-cycle hum can be caused by dried-out power-supply filters, tubes with heater-to-cathode shorts, or a shorted audio-output tube. A defective input-filter capacitor will cause 60-cycle pulling in the picture—this symptom can be mistaken for AGC trouble. One way to separate the two troubles is to remove the VHF-oscillator tube. This will show the plain white raster and you can see the hum bars going up the screen if the input filter is defective. In an AC-DC chassis, removing one tube causes them all to go out. In this case, it is best to turn the channel selector to an unused channel and check the rastor for hum bars. Another method is to short out the IF input from the tuner. Sometimes when the picture is pulling, a 60-cycle hum can be heard in the speaker. Other times the hum may not be audible; yet, the input filter is causing the 60-cycle ripple in the picture. A shorted video, IF or tuner tube will also cause 60-cycle pulling in the picture.

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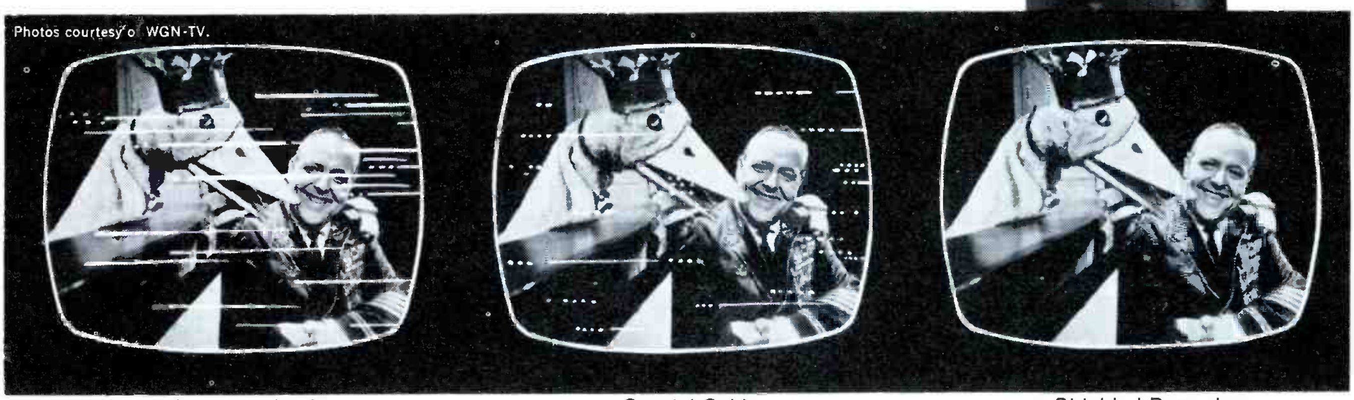

Unshielded twin-lead	Coaxial Cable	* Shielded Permohm
Severe picture disturbance due to ignition noise.	Ignition noise minimized—but not eliminated.	Eliminates automobile ignition noise.

New 8290 Shielded Permohm TV Lead-in combines the strong signal strength of twin-lead with the clean signal protection of shielded cable. Because it is a balanced line for 300 Ohm TV antennas and receivers, *costly matching transformers and connectors are eliminated.*

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Ask your distributor about 8290 Shielded Permohm TV Lead-in cable, today! Or, write P. O. Box 5070-A for complete information.

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8-9-5

BELDEN MANUFACTURING COMPANY **Belden** **P.O. Box 5070-A · Chicago, Illinois 60680**

Circle 41 on literature card

Snow

A snowy picture can be caused by the tuner, video IF, or AGC sections. Many tuners have antenna coils that are easy to burn out; lightning strikes nearby will ruin them and cause a snowy picture. The RF amplifier causes snowy conditions more than any other tube in the portable receiver. The RF amplifier can short and burn out the plate-supply resistor. If you find this tube is shorted, be sure and check the plate voltage and plate-supply resistor—these checks may prevent a callback.

A UHF tuner is now installed in all TV receivers. In new portable receivers, a transistor is used as the UHF oscillator and a crystal diode is the mixer. A defective crystal will cause a snowy picture, usually more noticeable on the higher end of the UHF band. Many times if a UHF transistor shorts, the voltages will be the same on all three elements. When replacing the UHF transistor, use one with the same part number or use the replacement listed in PHOTOFACT.

Negative Picture

A negative picture can be caused by incorrect AGC control setting, trouble in the AGC circuit, defective video-detector diode, or the picture tube. Be careful when removing and replacing the small picture tube socket—the pins on the base of the tube are easily bent.

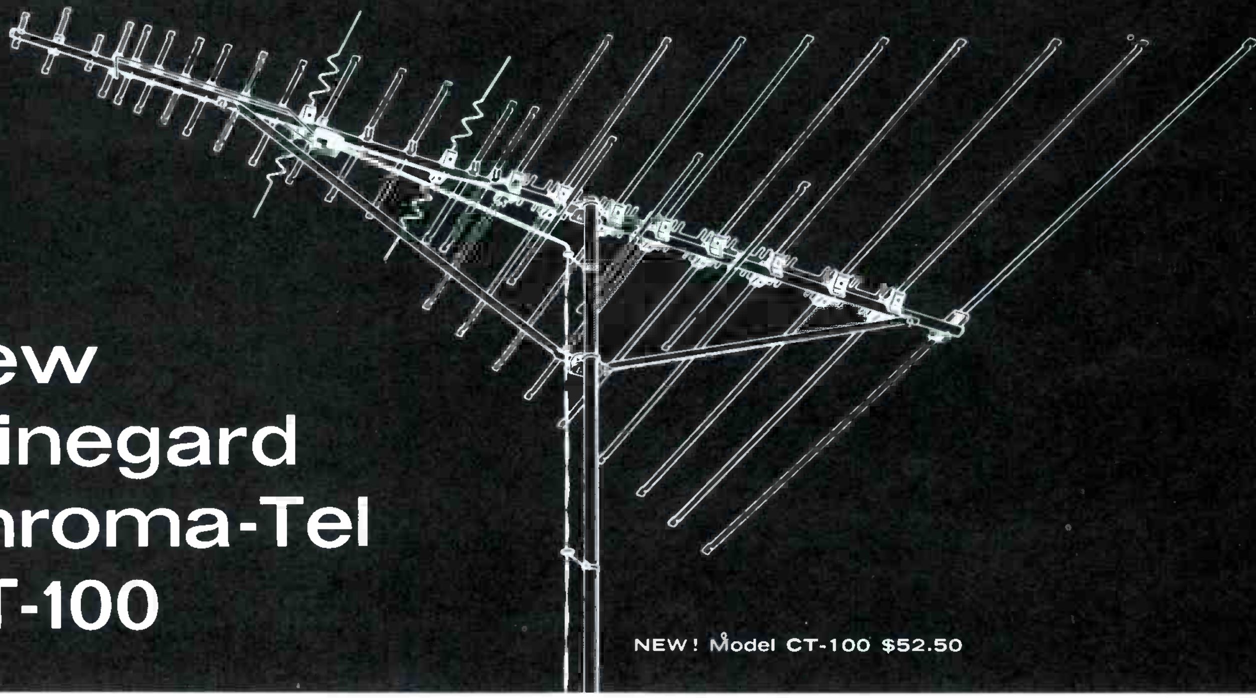
Sound

Make a quick check of the sound before replacing the back cover. Touch up the ratio-detector and sound-limiter coils to eliminate garbled sound. Check the small speakers and speaker covers for rattles and vibration.

Conclusion

Portable television receivers are more popular today than ever before; thus, a large potential income lies ahead for the shop that repairs these portables. And, of course, the greatest profit will be realized by those who do the job most quickly and most thoroughly. Don't miss your share of these dollars. Prepare now to service these receivers more rapidly by using the short cuts given here and developing some of your own. ▲

First UHF/VHF/FM 2-83 antenna that really works in fringe areas



New Winegard Chroma-Tel CT-100

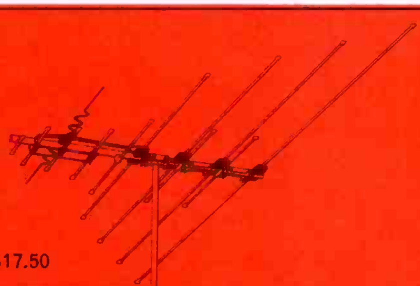
NEW! Model CT-100 $52.50

Wingard's sensational new CT-100 Chroma-Tel has 29 elements in all. And they're all working to provide the finest all-band reception (UHF-VHF-FM) even in difficult fringe areas.

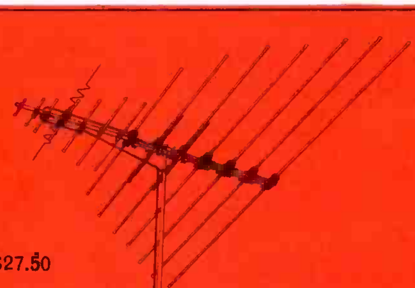
In addition to those 29 elements, the CT-100 incorporates a unique matching network that guarantees maximum signal transfer to the download—and on all channels 2-83 plus FM. Gives sharpest color and black & white reception.

And like all Chroma-Tels, it has Winegard's exclusive Chroma-Lens Director System (intermixes both VHF and UHF directors on the same linear plane without sacrificing performance) . . . and our Impedance Correlators (special phasing wires that automatically increase the impedance of Chroma-Tel's elements to 300 ohms).

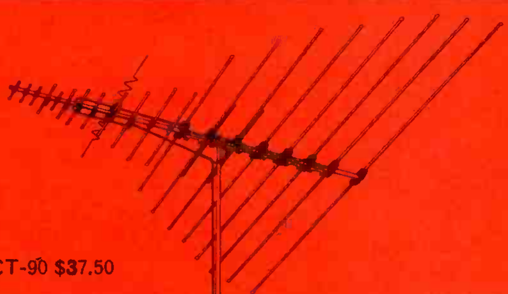
That's Winegard's new CT-100 Chroma-Tel. Bigger and better. But not too big. The full-line of Winegard Chroma-Tels still offers half the bulk; half the wind loading; half the truck space; and half the weight of all other all-band antennas—and at much lower prices. No wonder Winegard Chroma-Tels (now 4 models) are the hottest performing, hottest selling all-band antennas on the market! Better call your Winegard distributor or write for Chroma-Tel Fact Finder 242.



Model CT-40 $17.50

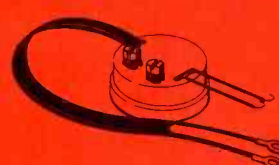


Model CT-80 $27.50



Model CT-90 $37.50

FREE!



Every Winegard Chroma-Tel, including the new CT-100, comes complete with free CS-283 UHF-VHF Signal Splitter. Hangs behind set and separates UHF and VHF signals coming from antenna to the two pairs of set terminals.

Winegard ANTENNA SYSTEMS Winegard Co. • 3000 Kirkwood • Burlington, Iowa 52602

Circle 44 on literature card

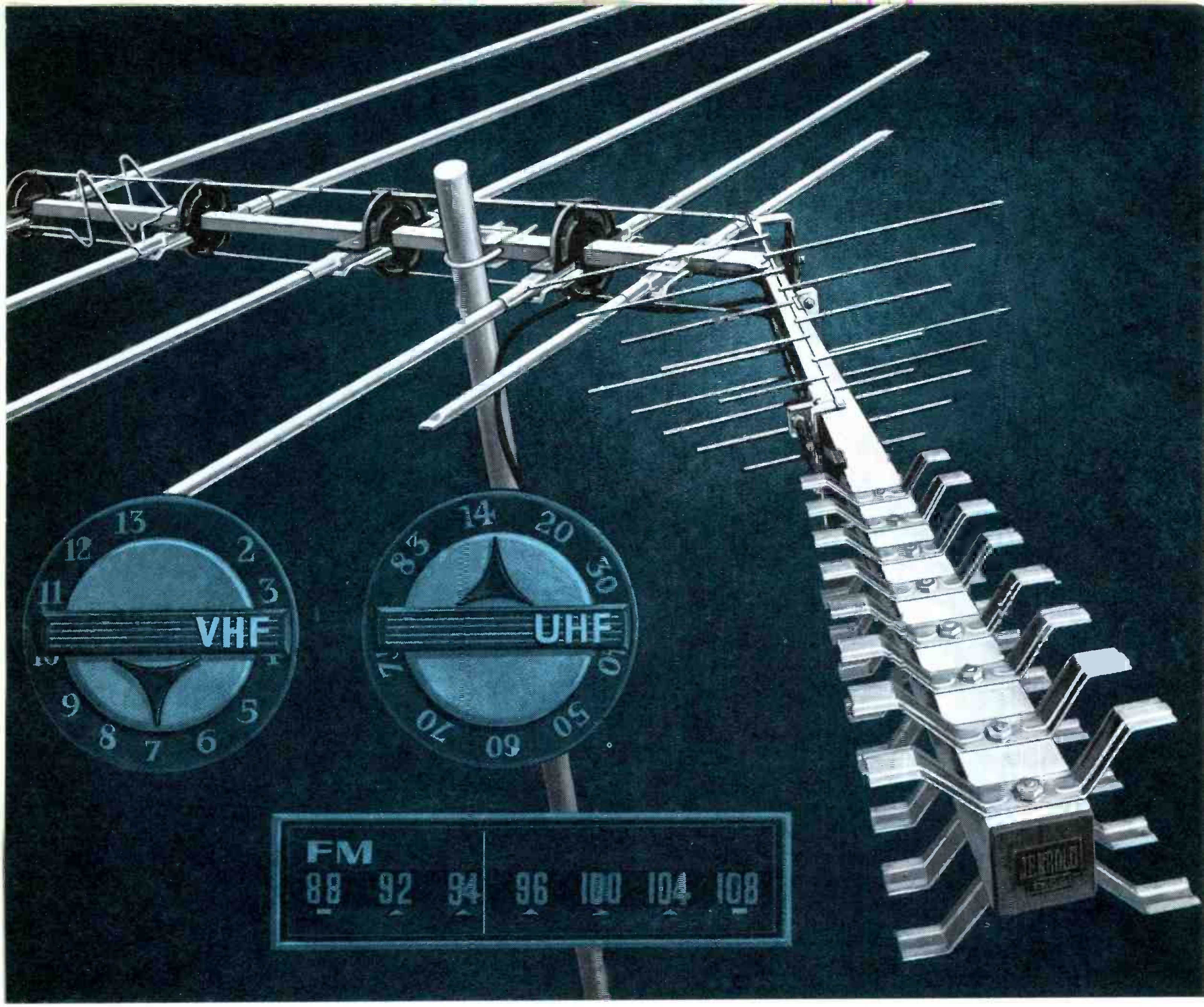
Product Report

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

Paging System
(65)

Key personnel, carrying small pocket radio receivers, may be alerted by a tone signal and then hear a voice message broadcast by the base station operator. This new radio paging system requires no encoder or special paging transmitter; it may be used with either the **Johnson** "Messenger Two" 5-watt Citizens-band transceiver or the "Messenger 202" 10-watt business/industrial two-way-radio transceiver. The "Page Alert" system works best in medium-to-small industrial plants and businesses where only a few individuals, usually less than 10, need to be contacted.

The device is a tone-generating unit attached to the base station transceiver. All persons on the system hear a tone through their personal radio receivers when the operator presses the key of the "Page Alert," and press a voice-message switch on their receivers. The operator announces by name the person being called, then transmits the message or instruction. The receivers may be carried in a coat or jacket pocket, or can be worn on a leather belt pack.



NOW...FIRST ALL-CHANNEL ANTENNA WITH INDIVIDUAL UHF and VHF ORIENTATION, 75- OR 300-OHM OUTPUT

New JERROLD Coloraxial™ *Pathfinder*™

Here's *the* antenna to answer every VHF, UHF, and FM reception need from metropolitan to deep-fringe areas . . . Jerrold's new Coloraxial PATHFINDER.

The new PATHFINDER (Series PAB and PXB) is a unique combination—a cascaded-periodic VHF antenna plus an advanced-design UHF section, all in one pre-assembled unit. Both 75-ohm Coloraxial and 300-ohm models for every taste and budget. And look at the prices—as low as $21.95!

JERROLD

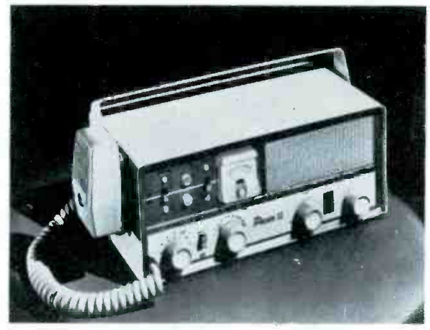
VHF and UHF sections may be individually oriented for maximum directivity. While you get all the flexibility of separate VHF and UHF antennas, PATHFINDER eliminates the splitters (with their inherent losses) needed to couple separate antennas with a common downlead.

Take advantage of the growing UHF and FM stereo markets by selling this all-purpose high-gain antenna. Rugged square-boom construction and Golden Armor corrosion-resistant finish assure long life. Flat response across entire band (channels 2-83), low VSWR, excellent front-to-back ratio make PATHFINDER a "natural" for easy sales and satisfied customers. Talk to your Jerrold distributor today, or write for complete information. *Jerrold Electronics Corporation, Distributor Sales Division, 15th & Lehigh Ave., Philadelphia, Pa. 19132.*

Circle 46 on literature card

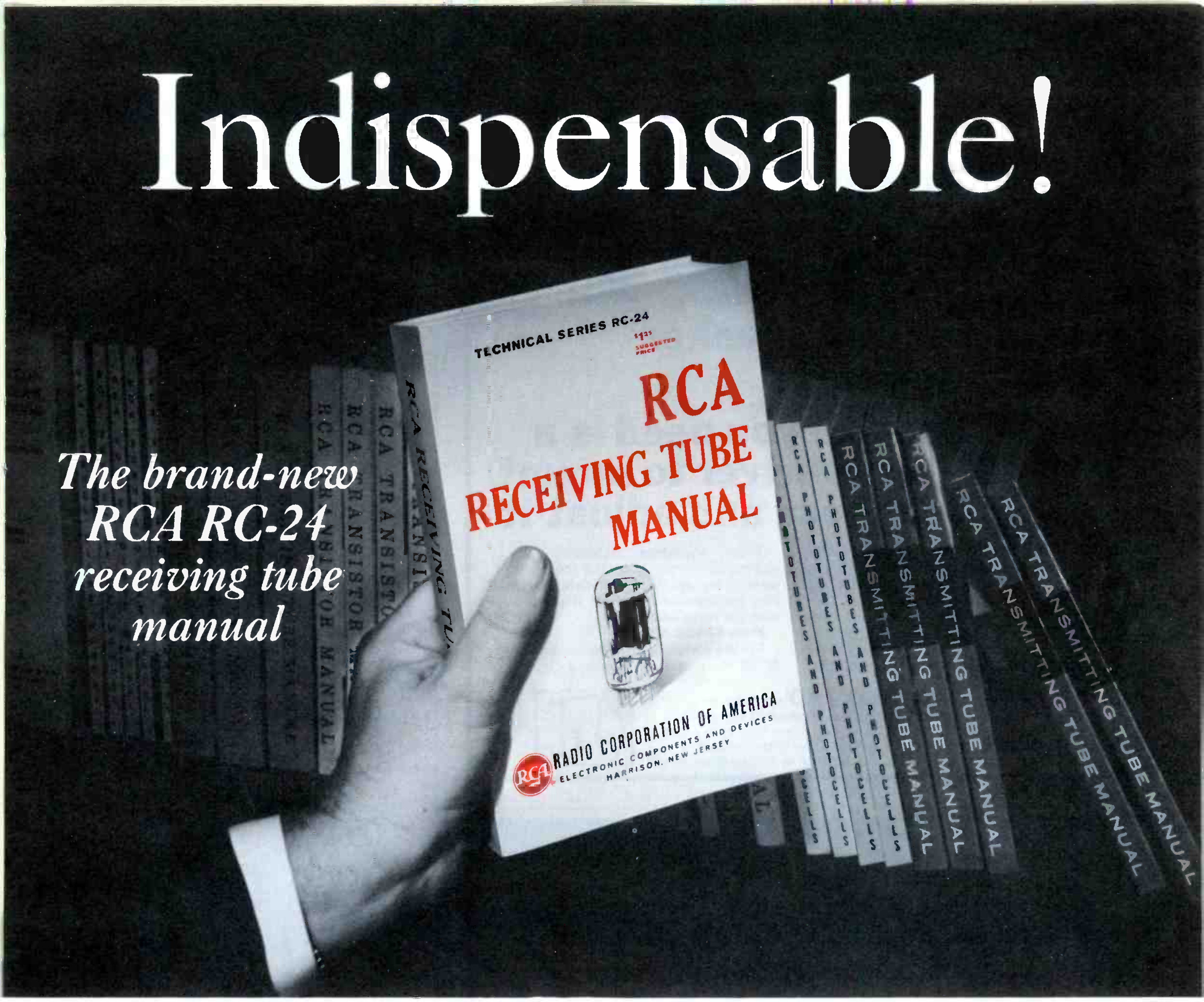
Speaker Systems
(66)

An 8-ohm tweeter has been installed in **Jensen's** TF-3 bookshelf speaker system. The system, now designated TF-3A, is designed to improve power output above 10,000 cps as effectively as a 3-db increase in amplifier output at these frequencies. The unit contains a 10″ woofer that covers the range from 25 to 2000 cps, while two 3½″ mid-range speakers cover 2000-10,000 cps. The tweeter covers the range from 10,000-20,000 cps. The system is rated at 25 watts. High-frequency balance may be adjusted with a control located on the rear of the enclosure. Measuring 13½″ x 23¾″ x 11⅜″, the TF-3A is also available in unfinished gum hardwood cabinetry for building in or custom finishing. Price with oiled-walnut finish is $115.50, and the unfinished model is $99.50. Speaker components, crossover networks and all electrical accessories of the TF-3A are available in kit form. Price for the kit, KTF-3A, is $69.50.



CB Transceiver
(67)

Eleven-channel crystal-controlled transmit and receive and a 23-channel tunable receiver are incorporated in this CB transceiver. The **Metrotek Electronics** Pacer II features an automatic noise limiter with on-off switch and an illuminated "S" meter. The transmitter's frequency range is 26.965 to 27.227 mc (channels 1 to 23). Audio output is 3.5 watts, and sensitivity is 0.5 microvolts, 30% modulation at 1000 cps for 10 db SINAD. The power supply can be either 117 volts AC or 12 volts DC. The unit measures 4¾″ x 11$^{13}\!/_{16}$″ x 6¾″ and is priced at $99.95.



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Technical design and applications data on more than 1200 receiving tubes. Check these NEW features and improvements not included in previous editions:

- ✓ Additional data on 100 new tube types
- ✓ Revised circuits section with new, simple format
- ✓ Updated picture tube characteristics chart
- ✓ Revised and updated Applications Guide
- ✓ New tube index section for ready reference
- ✓ Data section on active types only. (Discontinued and replacement types appear in a separate section.)
- ✓ Additional text material on TV in the tube applications section

Everyone concerned with electronics needs this manual... service technicians, engineers, radio amateurs and hobbyists. Order yours today from your nearest Authorized RCA Distributor. **Only $1.25***

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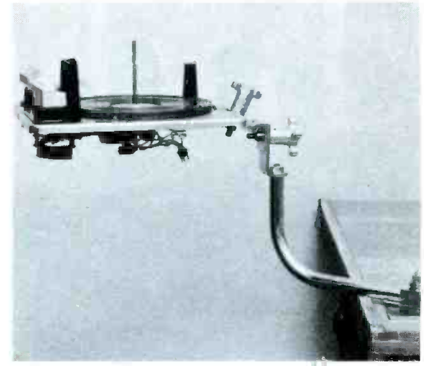

Work Holder
(68)

The work holder shown here secures parts and products in any desired position during repair. Originally designed for handling of record changers, it also serves as a third hand to hold a variety of other items. The "Uni-Swiv", made by **E. Konigslow Stamping & Tool Co.,** mounts to the workbench top. It consists of a 1"-diameter nickle-plated "L" shaped bar and tube that swivels in a 22" horizontal arc around the base. The bar curves upward 7¼" to a clamp-holder and clamp. containing Neoprene pads. which permit rotation of the work 360° in both horizontal and vertical planes. Hand-locking knobs provide for adjustments and clamping the work. Price is $24.95.

Transistorized Microphone
(69)

A new transistorized base-station microphone features an adjustable output level. The **Turner** Model +2 microphone has a volume control and allows the operator to dial the output level that is best for his set. The output can be varied to suit the loudness of the operator's voice and his distance from the microphone. A screwdriver adjustment allows terminal wires in the base to be connected for electronic or relay switching. The unit has a one-piece die-cast case with blue enamel finish and blue coiled cord. The price is $49.50.

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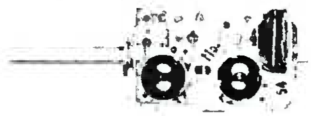

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Circle 54 on literature card

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CHANNELLOCK, INC. *Meadville, Pennsylvania*
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TV Antenna Cable
(70)

"Durafoam" antenna twin lead has two tubes of yellow foam polyethylene that surround the conductor wires. Made by **Columbia Wire & Supply Co.,** this transmission cable can be used for both VHF and UHF television reception. Impedance of the cable is 290 ohms, and signal attenuation is 1.04 db at 100 mc, 3.5 db at 500 mc, and 4.5 db at 900 mc. It measures .410" in width.

Oops!

In the December Product Report, the incorrect size and price were shown for the Workman Transistor/Diode Checker (Key No. 59, Page 69). The correct size is 3¾" x 6¼" x 2⅛" and the dealer net price $19.50.

PORPOISE JAW OIL

Nature's Most Stable Lubricant . . . now available to TV and Electronic Service Engineers!

The dolphin oils, used for years in sensitive stepping switches in complex telephone and communications equipment, now packaged for electronic servicemen as . . .

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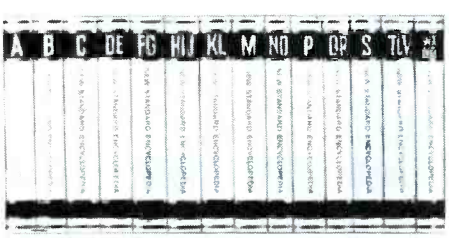

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Component Parts Inventory
(71)

Here is a handy 18" x 24" rack which provides many of the different **Workman Electronic Products, Inc.** components frequently used in a TV and radio service shop. The "Benchmate" holds an assortment of fusible, globar, filament, and wire-wound resistors; belimiters, circuit breakers, rectifiers, and 455-kc IF transformers are also included in the package. ▲

INDEX TO ADVERTISERS

FEBRUARY, 1966

FREE Catalog and Literature Service

**Check "Index to Advertisers" for further information from these companies.*

Please allow 60 to 90 days for delivery.

ANTENNAS & ACCESSORIES

80. *ALLIANCE* — Colorful 4-page brochure describing in detail all the features of *Tenna-Rotors*.
81. *ANTENNACRAFT*—Literature featuring 3 new 75-ohm, all-channel TV antennas available in factory-built or kit form.
82. *EBY*—Flyer covering two-set and four-set coupler/splitter for UHF-VHF color TV and FM. Catalog listing line of terminal blocks.
83. *FINNEY* — Catalog 20-337 covering U-Vert series UHF converters and catalog 20-338 on Model 65-1 distribution amplifier.*
84. *JERROLD* — 28-page booklet showing how to choose antenna systems for each reception area and reception problem.*
85. *JFD* — New 1966 dealer catalog covering complete line of log-periodic outdoor antennas, indoor antennas, rotators, converters, amplifiers, masting, splitter-couplers/combiners, matching transformers, lightning arrestors, antenna mounts, and hardware.
86. *KRECO ANTENNAS*—Catalog No. 68 supplying data on full line of vertically polarized antennas covering frequency range 25 to 470 mc.
87. *LANCE ANTENNA* — New 30-page catalog detailing complete line of UHF-VHF-FM antennas, telescopic masts, and accessories.
88. *MARK PRODUCTS*—New catalog CB-659 describing complete line of Citizens-band base-station and mobile antennas, mounts, and accessories.
89. *TRIO*—Brochure on installation and materials for improving UHF translator reception.
90. *WINEGARD* — 12-page brochure "Color Spectacular" featuring antenna products designed for color TV use.
91. *ZENITH* — Information bulletin on antennas, rotors, batteries, tubes, power converters, record changers, picture tubes, wire, and cable.*

AUDIO & HI-FI

92. *ADMIRAL* — Folders describing line of equipment; includes black-and-white TV, color TV, radio, and stereo hi-fi.
93. *ATLAS SOUND* — Catalog No. 565 illustrating public-address loudspeakers, microphone stands, and accessories for commercial sound applications.*
94. *ELECTRO-VOICE* — Data sheet giving specifications for new "Line Radiator" loudspeaker which provides controlled area coverage for public-address and sound-reinforcement system use.
95. *GROMMES-PRECISION*—Catalogs listing 1966 line of custom-stereo-system equipment, public-address amplifiers, and sound-system accessories; price lists also included.
96. *HARTLEY*—4-page 1966 brochure featuring speaker systems including test-report excerpts.
97. *JENSEN* — Multicolored 24-page catalog No. 165-L featuring speakers and headphones. Also, 22-page catalog No. 6801 supplying phono-cartridge list and cross-reference.
98. *KOSS/REK-O-KUT* — Catalog on full line of audio products and accessories.
99. *NUTONE*—Two full-color booklets illustrating built-in stereo music systems and intercom-radio systems. Includes specifications, installing ideas, and prices.
100. *OAKTRON* — "The Blueprint to Better Sound," an 8-page catalog of loudspeakers and baffles giving detailed specifications and list prices.*
101. *OXFORD TRANSDUCER*—4-page catalog describing three lines of automobile rear-seat speaker kits.
102. *PHONOLA*—Full-color 18½" x 12" brochure depicting full line of phonographs, tape recorders, and consoles.
103. *QUAM-NICHOLS* — Catalog 65 listing replacement speakers for public address systems, hi-fi, auto radio, and radio-TV applications.
104. *SAMPSON*—Specification sheet on the Waltham Micro-8 transistor radio.
105. *SONOTONE* — Specification sheets for replacement phono cartridges, compact speaker systems, and nickel-cadmium batteries. Brochure featuring manufacturers' facility for batteries.
106. *UNIVERSITY SOUND* — 1966 catalog covering stereo-high-fidelity products, commercial-sound products, and microphones.
107. *VIDAIRE*—Catalog sheets detailing prerecorded cartridge tapes for use in automobile playback units.

COMMUNICATIONS

108. *COMMUNICATIONS COMPANY* — Brochure supplying specifications for VHF-FM two-way radios; also dealership information.
109. *EICO* — Data sheet on Model 753 *Tri-Band* transceiver and other ham gear, plus full-line catalog.*
110. *GENERAL RADIOTELEPHONE*—Operation and instruction manual for 50-watt business-band transceiver.
111. *MOSLEY ELECTRONICS*—Catalog covering complete 1966 line of Citizens-band equipment.
112. *PEARCE-SIMPSON* — Specification brochure on IBC 301 business-band two-way radio, *Companion II*, *Director*, *Escort II*, *Guardian 23*, and *Sentry* Citizens-band transceivers. "The Modern Approach to Business Communications" concerning land mobile radio service for businessman.
113. *SONAR RADIO*—Data sheet providing specifications for hand-held-2-watt Citizens-band transceiver.

COMPONENTS

114. *BUSSMANN*—Bulletin SHF-11 on new waterproof in-the-line fuseholder designed for use in circuits located in exposed areas, such as yard lights and marine equipment.*
115. *GC ELECTRONICS* — Cross-reference FR-605-G for TV-knob replacement. Catalog FR-66-TD listing TV antennas and accessories. Brochure FR-171-A and catalog FR-66-A covering audio accessories and solid-state modules. Wall chart FR-250-W providing cross-reference for tape and phono drives and belts. Wall chart FR-029-E listing test prods, plugs, and jacks.
116. *3M*—Brochures and stuffers depicting products, specifications, and installation methods for electrical tapes, connectors, splicing kits, and flat-cable systems for audio equipment.
117. *SPRAGUE* — Latest catalog C-616 with complete listing of all stock parts for TV and radio replacement use.*
118. *SWITCHCRAFT* — New-product bulletin No. 156 describing "Lamp Jax" for use in circuits requiring ballast lamps.*

SERVICE AIDS

119. *CASTLE*—How to get fast overhaul service on all makes and models of television tuners is described in leaflets. Shipping instructions, labels, and tags are also included.*
120. *CBC INDUSTRIES* — Data sheets featuring power-outlet boxes containing circuit breakers or fuses, switches, and pilot lights.
121. *CHEMTRONICS*—Flyer sheet detailing cleaner for use with all TV tuners.*
122. *CLEVELAND INSTITUTE OF ELECTRONICS* — New pocket-sized, plastic "Electronics Data Guide" of formulas and tables, including frequency and wavelength, db formulas and table, antenna lengths, and color code.*
123. *PRECISION TUNER* — Literature supplying information on complete low-cost repair and alignment service for any TV tuner.*
124. *YEATS*—The new "back-saving" appliance dolly Model 7 is featured in a four-page booklet describing feather-weight aluminum construction.*

SPECIAL EQUIPMENT

125. *ATR* — Descriptive literature on selling new all-transistor *Karadio* Model 707, having retail price of $29.95. Other literature on complete line of DC-AC inverters for operating 117-volt PA systems and other electronic gear.
126. *GREYHOUND* — The complete story of the speed, convenience, and special service provided by the Greyhound Package Express routes.
127. *PERMA-POWER* — Four-page catalog, GB281, illustrating solid-state garage-door operator using pulse tone modulation.*
128. *TERADO* — Bulletin on *Trav-Electric* Model 50-160 solid-state DC-AC inverter.

TECHNICAL PUBLICATIONS

129. *HAYDEN-RIDER* — Catalog listing paperback and hardbound books for the electronics technician and hobbyist.
130. *HOWARD W. SAMS* — Literature describing popular and informative publications on radio and TV servicing, communications, audio, hi-fi, and industrial electronics, including special new 1966 catalog of technical books on every phase of electronics.*
131. *RCA INSTITUTES* — 64-page book, "Your Career in Electronics" detailing home study courses in telecommunications, solid-state electronics, and drafting. Preparation for FCC license, and courses in mobile communications and computer programming also available.*

TEST EQUIPMENT

132. *B & K*—New 1966 catalog featuring test equipment for color TV, auto radio, and transistor radio servicing, including tube testers designed for testing latest receiving tube types.*
133. *HICKOK* — New flyer detailing selected items of service test equipment.*
134. *JACKSON*—Folder showing complete line of service test equipment.
135. *MERCURY* — Folder supplying information on complete line of test equipment.*
136. *PRECISE* — Specification sheets for VTVM and regulated power supply.
137. *SECO*—Catalog sheet No. 90065 describing Model 900 color-bar generator and Models 88, 98, and 107B tube testers.
138. *SENCORE* — New 1966 4-color catalog showing latest equipment including models CR128A, SS137, and SM112A.*
139. *SIMPSON*—Flyer giving specifications of Model 604 Multicorder for measuring and recording volts, amps, milliamps, and microamps.*
140. *TRIPLETT*—New test-equipment catalogue 48-T featuring VOM'S, VTVM's, tube testers, and transistor analyzers.
141. *WORKMAN* — Catalog sheet No. 92C describing transistor/diode checker which uses a tone signal to indicate condition of unit under test.*

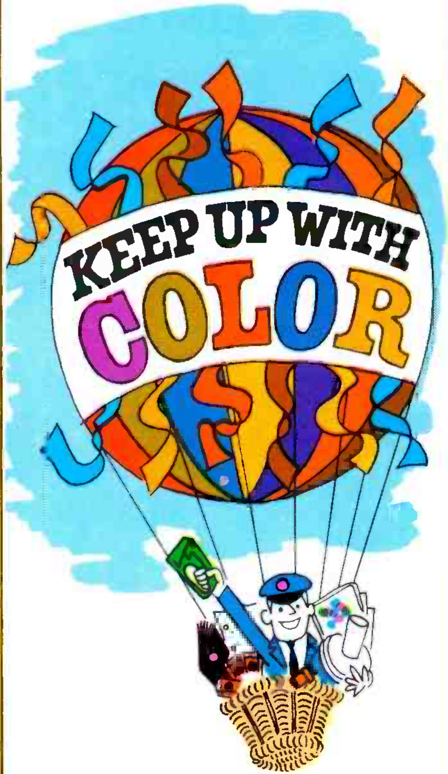
TOOLS

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

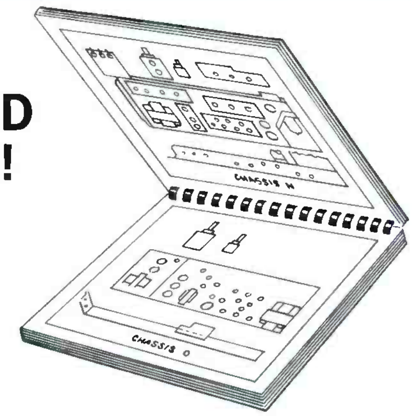
TUBES AND TRANSISTORS

143. *IEC*—Flyer sheet listing line of tubes for use in home-entertainment equipment.
144. *SEMITRONICS* — New 1966 wall-chart replacement and interchangeability guide for transistors, rectifiers, and diodes.*

Only RCA helps you keep up with the color TV boom all these ways:



BRAND NEW!



Color TV Service Handbook (1A1553)

In one handy book . . . all the information you need to do routine adjustments and preliminary troubleshooting on many makes of color sets (1960 to 1966 models). Just look up the chassis number of the set you're working on and turn to the proper section. Chassis layouts, adjustments, fuses and circuit breakers, everything is here, based on the manufacturer's own service notes. You'll want to carry a copy on every color TV service call! Fits easily into your tube caddy.

For a quick and easy aid to troubleshooting, RCA offers the Color TV Troubleshooting Pict-O-Guide (1A1389). With its many true-to-life color photos, this book makes it possible for you to recognize and understand visible symptoms of troubles and maladjustments in color sets.

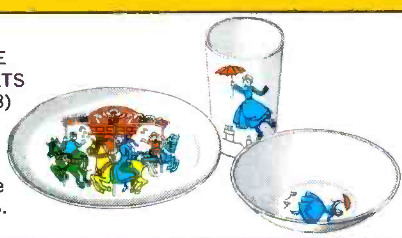
The Color TV Home Study Course by RCA Institutes (1A1325) is your best bet for a basic understanding of the principles and practices of color TV.

New RCA "Cycolac" Tube Caddy (1A1560)—Lightweight, with superior impact strength and unequalled durability because it's made of "Cycolac", the tough, hard plastic produced by the Borg Warner Corp. Has popular two-wing construction; holds up to 362 receiving tubes; resists scuffs, mars and staining. Boasts a color TV message on one side.

The **RCA Color TV "Quik-Measure" Kit** (1A1569)—Helps you measure both voltage and current at any tube pin in a color set without pulling the chassis from the cabinet or unsoldering leads. The kit contains 7 and 9 pin socket adaptors for miniature tubes, an 8 pin socket adaptor for octal tubes, a top cap extension lead and a current measuring probe.

New Window Display—Promote your color TV service capability with this striking day-glo circular wheel battery-operated motion display. (1A1566)

WALT DISNEY MELAMINE CHILDREN'S DINNER SETS—Mary Poppins (1A1568) shown; Mickey Mouse (1A1567)
Colorful, break resistant DISNEYWARE. Kids adore these loveable characters.



Also ask your local RCA tube distributor about: • RCA Tool Holder (1A1561) • Swingline Staple Gun (1A1570) • Four color postcards on color TV service (1A1572A, B, C) • Newspaper ad mats (1A1573A, B, C) • All weather plastic floor mat strip (1A1565)

Your local RCA tube distributor goes all out to help you KEEP UP WITH COLOR! See him for quality RCA receiving tubes for color and black and white TV, radio and hi-fi. Ask him how to obtain the items mentioned in this ad.

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