JANUARY, 1970 ☐ 75 cents

A HOWARD W. SAMS PUBLICATION

Electronic Servicing

Formerly PF Reporter

TUBE CIRCUIT OPERATION...

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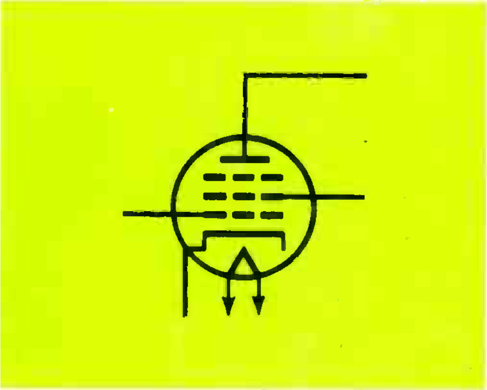

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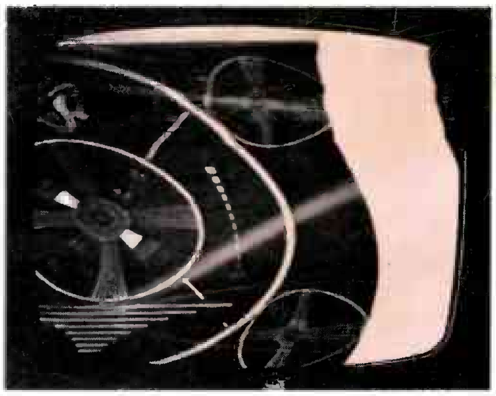

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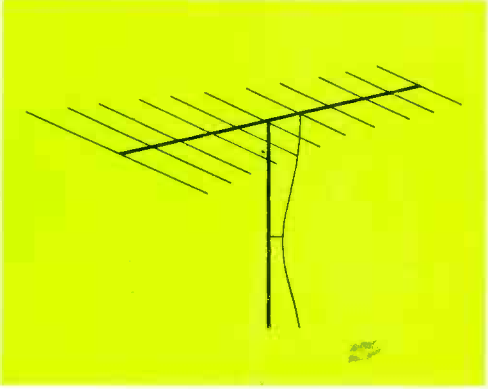

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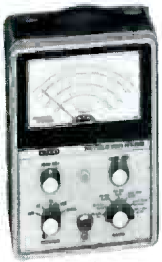
240


379


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150


330

EICO 240 Solid-State FET-VOM $59.95 kit, $79.95 wired.
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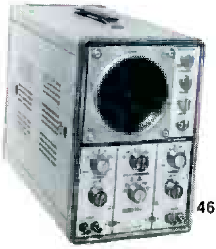
New EICO High Performance Instruments


443


465


635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1025


633

EICO 385 — Solid-State Portable Color Generator $79.95 Kit, $109.95 Wired.
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PST-2


PSI-1


HVP-5

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Circle 1 on literature card

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See it soon at your B&K distributor or write us for advance information on the product that makes TV alignment procedures of old a fearless operation: simple, fast, accurate. The new Sweep/Marker Generator, Model 415, Net: $399.95

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Circle 4 on literature card

January, 1970 • Volume 20, No. 1

Electronic Servicing

Formerly PF Reporter

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50 Facts About Basic Home TV Antenna System Components. A review of the fundamental characteristics of basic designs of TV antennas and lead-in, plus tips on installation. **by Bruce Anderson.**

DEPARTMENTS

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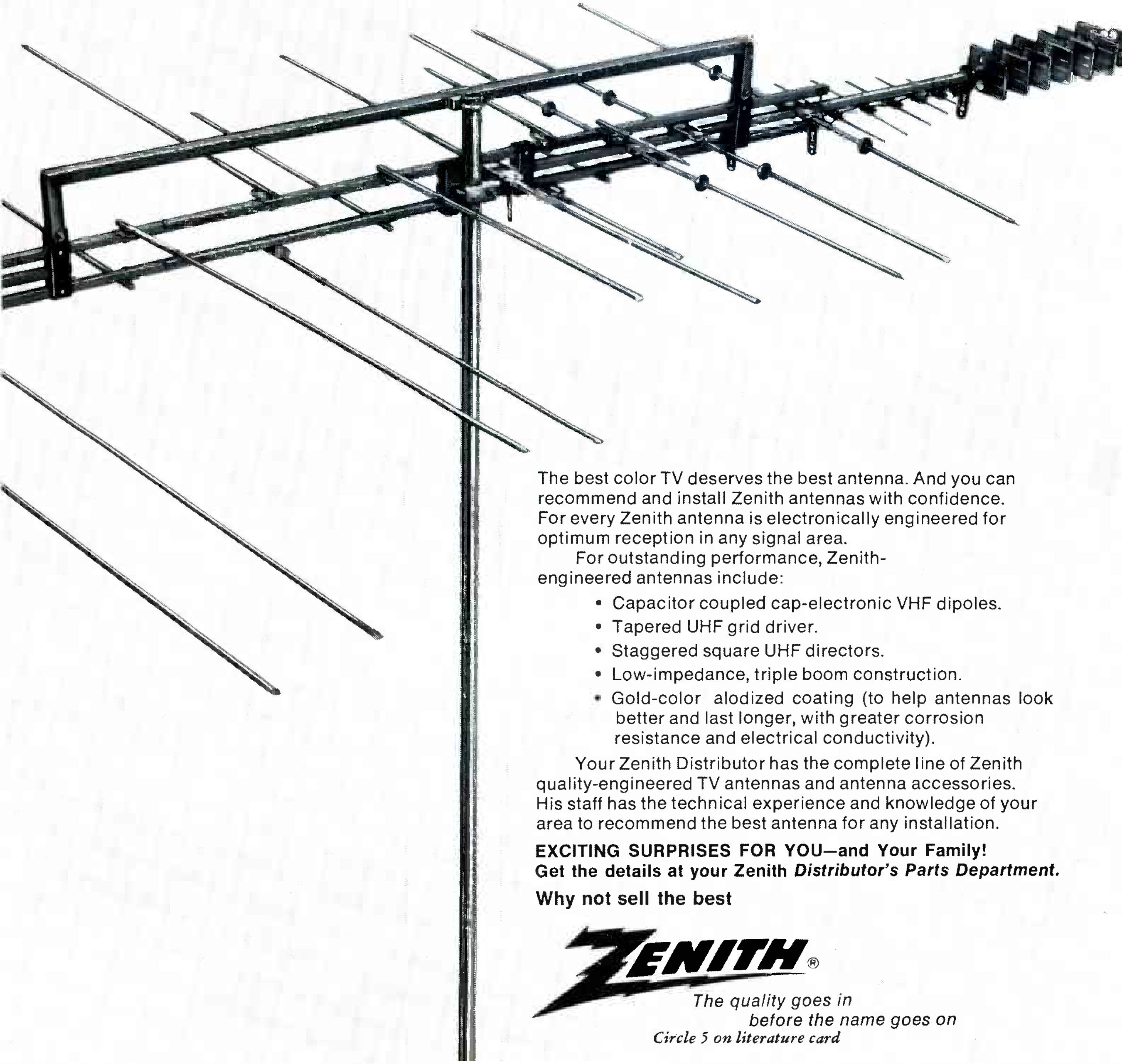

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Circle 5 on literature card

letters to the editor

Questions About Antenna System Components

(The following letter was directed to one of our contributing authors, Bruce Anderson. I think Mr. Anderson's reply will be of interest to all readers—the Editor)

I have some questions regarding the article titled "TV Antenna System or Receiver Defect?" which appeared in the June 1969 issue of ELECTRONIC SERVICING.

First, what is a UHF standoff (what does it look like)? Second, what type of VHF antenna is needed for deep fringe areas of 100 miles? And, what type of UHF antenna is needed for deep fringe areas of 50 miles?

I have done antenna work for 18 years and still found some things in the article which were new to me.

Charles E. Hunter
West Middlesex, Pa.

A UHF standoff has a pliable plastic tab which extends outward from the metal screw so that the lead-in is not encircled by the wire of which standoffs are made.

Your second question is a tough one. I am sure that I don't know the answer in its entirety, although I can perhaps shed some light on the subject. For single-channel reception, I would suggest a stacked pair of 10-element Yagi's as the best buy in microvolts per dollar. I once installed four of these in an array (two stacked pairs harnessed with 300-ohm line, trimmed for maximum signal using a signal-strength meter) and received a constant 125 microvolts from a station 145 miles away and behind a mountain.

If you are in the clear, a hundred-mile pull should be possible with most any good fringe-area antenna. The built-in preamplifier type antennas as well as the log-periodic types give good results.

In my experience, the parabolic UHF antenna works best in deep fringe. A 16-element Yagi with corner reflector also works well. It doesn't have quite as much sensitivity, but it is much easier to install. I have worked on a 20-watt translator satisfactorily at 20 miles with the Yagi and out to 40 miles with the parabolic antenna by using a mast-head booster.—Bruce Anderson.

Back Issues

Is there any demand for PF REPORTER magazines in A-1 condition? I have all the issues from August 1957 to February 1968. I am retired now, and it seems a shame to throw away all this valuable information.

Mr. Virgil V. Bowlin
Route #1
Hermitage, Mo.

Help Needed

I would like to obtain an operator's handbook on the Meissner Analyst, Model 9-1040. I have written letters to Meissner CR Co., New York, and to Meissner

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Circle 7 on literature card

& Landaver, Inc., Westfield, Mass., but received no answer. Could you or any of your readers help me find a manual? Any help would be greatly appreciated.

John L. Delaney
7527 Brous Avenue
Philadelphia, Pa. 19152

I am interested in obtaining resistor cord like the type used in the 1930's and 1940's on AC and DC radios. These cords were used to reduce filament voltage.

I would like to obtain a large quantity—at least a few hundred feet. Any information will be greatly appreciated.

Nilo A. Michelin
P. O. Box 6743
Los Angeles, Calif. 90022

I would like to buy an established one-man TV servicing business that has growth potential. The preferred area is in southeastern Florida, but I will consider the Gulf Coast. I would appreciate a snapshot with the first letter.

D. Mihychuk
755 Giasson St.
Seven Islands, Quebec, Canada

I need a schematic for a Model M345 VTVM made by Radio City Products Co. They seem to be out of business. I will be glad to pay any expenses for the schematic.

P. S. Raju
493 Wickham
St. Lambert, Quebec, Canada

I have a Philco Universal Color Bar and Dot Generator Model 7100 which I purchased used and which is giving me some trouble. I have been unable to find any circuit diagrams or technical information which tells what it is supposed to put out or exactly how it is hooked up. I have written to Philco and to Philco-Ford but to no avail.

I would appreciate it if one of your readers could help me find this information.

Donald W. Graf
2949 S.E. Boyd St.
Milwaukie, Ore. 97202

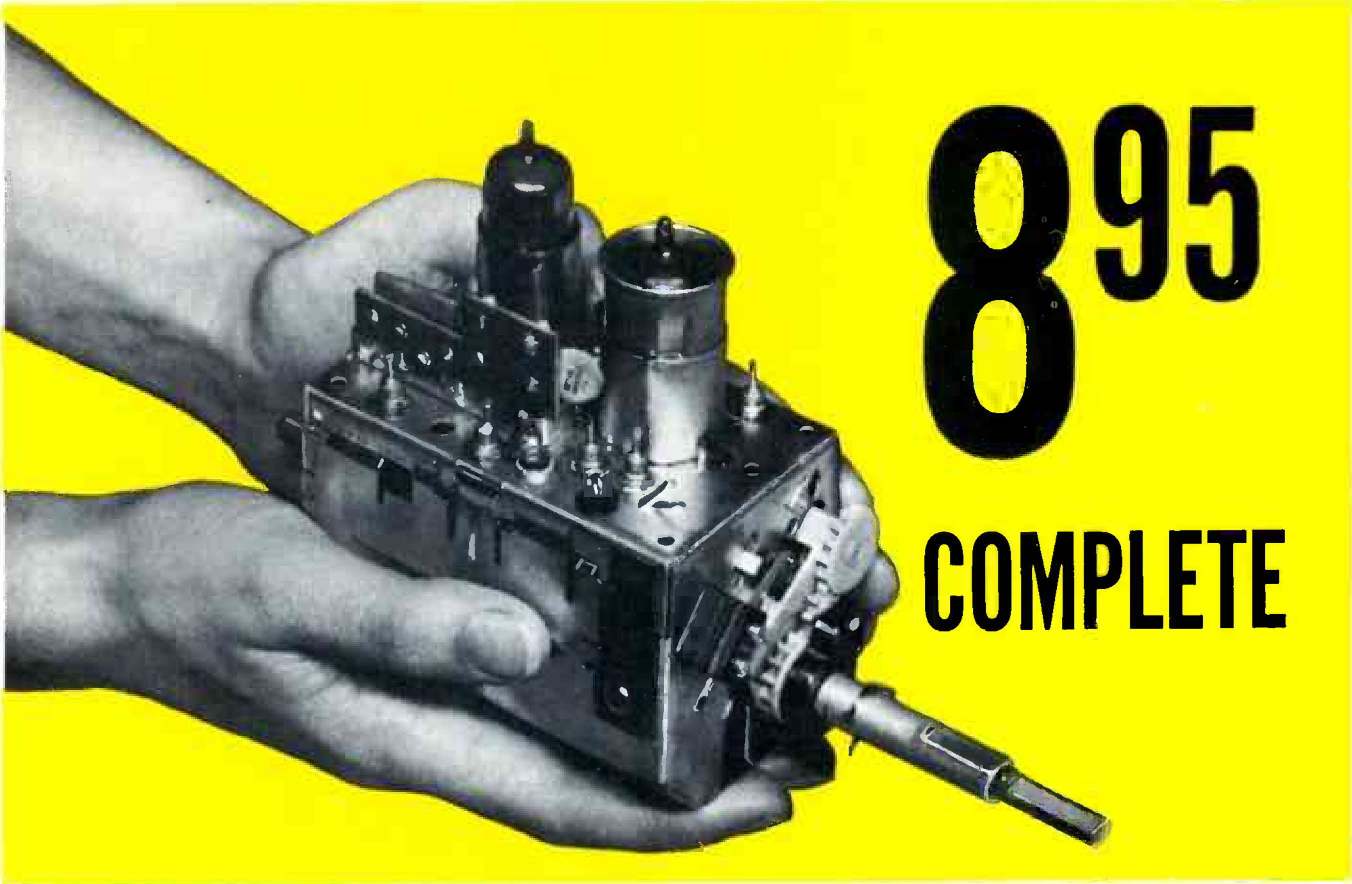
Dial-Stringing

I would like information on stringing the dial on an 8-transistor radio. It is a Sirasuna-Den Model 8TS-290. I don't know what the "Den" is, as the rest is gone. I have been unable to find a schematic on this radio. I would appreciate any help you or your readers could give me.

I am a subscriber to ELECTRONIC SERVICING and like it very much. I get a world of knowledge from it.

William B. Leake
2830 Redwood St.
San Diego, Calif. 92104

(Continued on page 8)



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CR9S	Series 450mA	1¾″	3″	41.25	45.75	9.50
CR6XL	Parallel 6.3v	2½″	12″	41.25	45.75	10.45
CR7XL	Series 600mA	2½″	12″	41.25	45.75	11.00
CR9XL	Series 450mA	2½″	12″	41.25	45.75	11.00

*Selector shaft length measured from tuner front apron to extreme tip of shaft.

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Circle 9 on literature card

A Reader Speaks Out Against Licensing

The article titled "Consumer Electronic Servicing—Licensing, A Special Report" in the July issue of ELECTRONIC SERVICING impels this reply.

I would suggest that our business environment is in the grip of a disease, fondly referred to as "Consumerism," which has made its impact these past few years, fostered by the press, radio and television. It got its start with Mrs. Peterson as a consumer-affairs overseer, followed by that female huckster, Betty Furness, and since fostered by bleeding hearts, hand wringers, band-wagon followers and coat tail riders, with a few conscientious, concerned people who are caught up in the hot winds of demogogery. This ailment has become a bonanza vote-getter for politicians at all levels who find it is the gravy train into public office.

If we were to probe deep into the motivation of the consumer-oriented politician, we would find lurking in the recesses of that astute mind a concern more for himself and his public image than for any good which might attach to the recipients of his tender regard.

All business has its buccaneers—looters of the public purse, pursuers of the fast buck. The dealers and the service people of electronic home devices are no exception. Through the years, organized society evolved laws to seek out and punish willful characters guilty of fraud and deceptive practices of one kind or another. For some obscure reason, radio and television service people have been singled out for special vigilance and stringent punitive legislation not asked for nor sought against other lines of business, service or whatever the type.

What better way to endear oneself to the public—to inflame the public mind: Besmirch the character of the serviceman and, with the help of newspaper and magazine hack writers and radio and television commentators, distort and spread misinformation to the set-owning public, creating resentment and illwill against servicemen out of all proportion to actual fact and honesty, thereby creating a clamor from the "there-oughta-be-a-law" claque which political demogogs are quick to act on.

Serenely overlooked by these biased and hypocritical mudslingers are the sickening, unethical activities of lawyers, doctors, judges and run-of-the-mill public officials, whose chicanery and misdeeds in public office and professionally makes the chiseling of television servicemen look like peanuts in comparison.

When highly-placed professional and political people are found out, separating them from their income sources is a job defying imagination. Unashamed judges, unethical lawyers, doctors and other licensed professional and political people continue on for years, engaging in highly questionable and unprofessional conduct for big money, challenging their removal. BUT, let some little TV shop operator be accused and charged with some minor fraud practice under stringent license laws now in effect or proposed and he will be lucky if he can stay out of jail, prevent the revoking or cancellation of his license to make a living and keep from having his little business shut down overnight and his earnings cut off.

This is the evil of evils with respect to license laws seeking to control and regiment radio and television servicemen, which are now in effect or sought in other states. These laws could, would and are manipulated to the detriment of the small shop owner—the "Mom and Pop" operation—by disgruntled and resentful customers, jealous competitors and, in extreme cases, by the eventual political appointees to a license board, who would want to look "good" for the record. No amount of denials and protestations on the part of license proponents can wave away this ever-present danger. There are other important reasons too numerous to mention here, but the little man would be absolutely defenseless against the multiplied attrition of numerous phony complaints that could be brought to bear against him and which would, in time, put him out of business with no one the wiser.

Much can be said about the license laws mentioned in your article. I will make but one reference —the Berder regulation of California. As stated, it has been in effect 5½ years; in that time, 12,000 complaints have been made, 12,000 investigations followed, 143 criminal actions brought and, finally, 52 licenses revoked—in 5½ years! With all that elaborate legal machinery, uncounted wads of taxpayers' money, unnumbered political payrollers, investigating, unknown informers and entrapment methods—what a record?

I have spent 16 years opposing licensing in Illinois—the more I have seen and read of it, the less that can be said for it.

Howard Wolfson
Tape Recorder Sales Co.
Chicago, Ill.

Help Needed

I need a schematic and service literature for a Mety Model 1506/7/8 AM/FM S. Wand phono combination. I have been unable to locate any information on it.

Edward J. Weimer
75-23 67th Rd.
Middle Village,
L.I., N.Y. 11379

I have a battery-operated Airline radio designated Models 62-169 and 62-172. I need the size and/or voltages on the tubes and batteries. I would appreciate it if anyone could help.

Lewis J. Clark
Box 14
Colton, N.Y. 13625

Perhaps ELECTRONIC SERVICING's readers could help me locate Volumes AR-1, AR-9, AR-10, AR-12, AR-13 and AR-15 of Sams' auto radio series. I would pay premium prices for these issues. I am also interested in buying complete libraries of car radio technical publications.

Clifford M. Gazaway
P.O. Box 46156
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news of the industry

RCA to Market Home Video Tape Player in '72

The laboratory model of a cartridge video tape player system for use with home color and b-w TV sets has been demonstrated by RCA.

Called SelectaVision, the unit reportedly will be priced at less than $400. Production will begin in 1972, and the unit will be available to the public shortly thereafter, according to a company spokesman.

Basics of the SelectaVision system, which is attached to the antenna terminals of the TV set, include a 2-mW laser whose beam passes through clear plastic tape on which appear video and color information in the form of holographic reliefs. The images and color coding illuminated by the laser are picked up by a low-cost TV camera.

The 30-minute, pre-recorded SelectaVision tapes reportedly will be scratch-proof, dust-proof and virtually indestructible under normal use. Cost of the pre-recorded tapes will be about $10.00, according to an RCA spokesman. Speed of the ½-inch tape will be 7½ ips; reel diameter will be 6 inches.

FCC Says CATV Can Use Microwave To Carry Own Programming

Programming originated by community antenna television systems (CATV) can be transmitted over CATV microwave relay facilities.

This recent ruling by the Federal Communications Commission (FCC) removes one major obstacle that, in the opinion of many observers, had prevented the emergence of a CATV network.

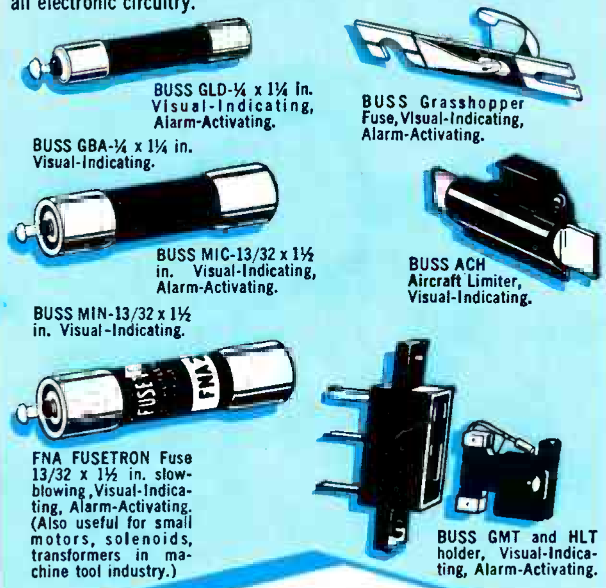
The new rule, which permits use of frequencies between 12,700 and 12,950 MHz for CATV systems, also makes available such microwave relay facilities for remote pickups.

Japanese Home Cassette VTR Systems Will Be Available in Early '70's

Sony, Matsushita and Victor, Japanese manufacturers of home entertainment products, have announced the availability in the early '70's of low-cost home video cassette systems, according to recent reports in **Home Furnishings Daily.**

A Victor video cartridge recorder for use with color and monochrome TV sets reportedly will be available early this year. Victor's video cartridge is 5.5 x 5.5 inches and is 1 inch thick. The Victor tape recorder is 17.5 x 16.6 x 7.8 inches and weighs 33 pounds. The cartridge runs for 30 minutes with ½-inch tape at a speed of 7.5 ips. Price of the cartridge is $25.00, according to the report, while the entire Victor recorder package will sell for about $500.

The Sony system, to be available late this year, is designed primarily for playback, but, according to the company, a simple adapter will enable the home user to record either color or monochrome on a video cassette. Price of the playback unit reportedly is about



$350; the recording adapter will cost an additional $100.

The Sony color video player utilizes a magnetic video tape cassette, can be used with any standard color TV set without modification and is fully compatible with any b-w set, according to the report. The unit measures 8 x 5 x 1¼ inches and weighs 1 pound. Tape width is ¾ inch and speed is 8 cm/sec.

Matsushita reportedly will have a home video cassette player available in 1972. The Japanese company, which markets products in the country under the Panasonic brand name, will have an open-reel color VTR home unit ready this year.

Precision Tuner Adds Florida Branch

Precision Tuner Service, Bloomington, Indiana based servicer of TV tuners, has announced the opening of a new facility in Miami, Florida. The address of the new tuner servicing center is Box 91, Miami, Florida 33156.

Earlier this year Precision Tuner opened other new facilities in Turlock, California and Longview, Texas.

Reversible Auto Cassette Player Developed By TEAC

A cassette player for automobiles incorporating automatic reverse has been developed by TEAC Corporation of Japan.

The cassette player has a fixed drive mechanism, which allows the user to install the system in a space-saving vertical position. Easy insertion of cassettes is permitted through the use of a spring-supported guide structure.

Two-way tape drive and stable performance under rough road conditions reportedly are made possible by two independent flywheels. "Soft-touch" push buttons are provided for stop and reverse operations, and the player can be operated by remote control.

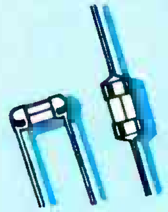
Admiral Film Available To Interested Groups

Admiral Corporation has completed and is making available free of charge to interested groups and organizations a new 25-minute color film, titled "Admiral Creative Excellence," which portrays the production of color TV tubes and the manufacture of color sets.

The film covers the production of color picture tubes in the company's plant in Chicago; the manufacture of tuners and yokes at McHenry, Illinois; the crafting of wood cabinets for color television sets at the Shelbyville, Indiana, division; and the assembly of color receivers at the giant Harvard, Illinois, consumer electronics facility.

Morse Name Added to List of TV Marketers

Morse Electric Products, marketers of stereo consoles under the name "Morse" and compact stereos under the name of "Electrophonic," reportedly will market, either late this year or early next, a large-screen



color TV home entertainment center and one smaller-screen color and one personal-size b-w TV.

Solid-State Device Reportedly Eliminates Color TV X-radiation

Scientific Components Inc. has developed a solid-state device which is reported to virtually eliminate the alledged harmful X-radiation in color television sets. The device is being shipped to a major TV manufacturer, whose name is being withheld.

The device, called a triplet, reportedly replaces the high-voltage rectifier, the focus diode and associated components.

FCC Proposes Reduction of Allowable TV Receiver Radiation

A rule to reduce the allowable amount of electromagnetic energy (radiation) emitted by TV receivers has been proposed by the Federal Communications Commission.

The rule would reduce the field-strength limit of electromagnetic energy from the present allowable level of 500 μV/m at 100 feet in the 470-1000 MHz band to 350 μV/m at 100 feet in the same frequency band.

Ten field-strength measurements taken on ten specified frequencies—520, 550, 600, 650, 700, 750, 800 and 931 MHz—also would be required by the rule.

The present allowable level of 500 μV/m at 100 feet was established by the Commission in December, 1955 and went into effect February, 1956. However, requests by TV manufacturers for delays in implementation of these limits have been granted by the Commission and, as a result, a limit of 1000 μV/m at 100 feet has been allowed up to the present time.

Customer Can Choose Own Servicer Under New Midland Warranty Program

The in-warranty servicing of Midland International Corporation's TV receivers can be performed by any reputable service facility the customer chooses.

Midland International Corporation, Kansas City based importer of home entertainment products, has adopted a new television warranty policy that gives the customer the priviledge of choosing the servicer who will perform the in-warranty servicing of his Midland TV.

Under the terms of the new program, which Midland calls "Customer's Choice Television Service Policy," Midland will supply the necessary replacement parts and will re-imburse the service center for labor. The warranty covers TV sets for 90 days. B-W picture tubes are warranted for one year and color picture tubes are warranted for two years. ▲

testequipment

notes on analysis of test instruments, their operation and applications

Color-Bar Generator

Sencore announces the availability of an updated version of their "Color King" color-bar generator. The new generator, Model CG153, will supersede the company's earlier Color King Model CG141.

New features include increased circuit stability through doubling of the timing ranges, decreased current drainage and an all-new panel and case, according to the manufacturer. The new two-toned case uses vinyl-clad steel against a brushed steel divider.

Two additional patterns, not present on the company's lower-priced models, are a moveable cross and a moveable dot. Sencore states that both can be set at center for centering the color TV raster. The CG-153 Color King features "temp control", which preheats all of the circuits so that a service technician does not have to wait for the generator to warm up and stabilize on very cold days. It is also reported that all circuits now have been voltage-regulated.

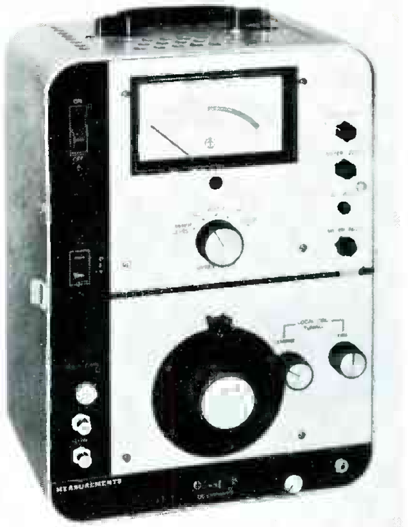
The price of the Model CG153 color-bar generator is $169.95.

Circle 55 on literature card

Standard FM Deviation Meter

Measurements announces the availability of their new Model 140A standard deviation meter and standard test receiver.

The new instrument, completely portable and designed to measure accurately the peak frequency deviation of FM communications transmitters, is specially suited for lab use and mobile radio servicing,



according to the manufacturer. The deviation meter contains accurate, linear, counter-type discriminator and degenerative voltmeter. A stable conversion oscillator reportedly permits measurements to 1000 MHz with 3% deviation accuracy. The unit is said to be easily standardized without an accurate FM source or requirement for Bessel-null techniques.

The output system includes a 750 micro-second de-emphasis network to permit use as a standard test receiver meeting EIA Standard RS-152-A, enabling simple measurements of noise, distortion and audio frequency response of transmitters. The network may be switched out of the circuit when not required. It has a front panel phone jack for monitoring. The meter has direct reading ranges of 0-5 KHz and 0-20 KHz.

The price of Model 140A is $550.00.

Circle 56 on literature card

In- or Out-of-Circuit Transistor Tester

Commander Electronics has developed a low-cost tester for all semiconductors, including the new FET's, it is reported.

Designated the Model 830, the

Circle 14 on literature card

unit reportedly is efficient and versatile, checking transistors, FET's, etc., for all critical parameters, in or out of circuit, giving calibrated readings for G_m, AC and DC Beta and leakage.

The tester utilizes a large, sensitive (200 μa) taut band meter and full-size control knobs for easy setting of function or bias levels, according to the manufacturer. A big, easy-to-read meter is color-coded to match switch positions and there is also an integral voltmeter with expanded scale. A luggage-type carrying case with handle is standard equipment.

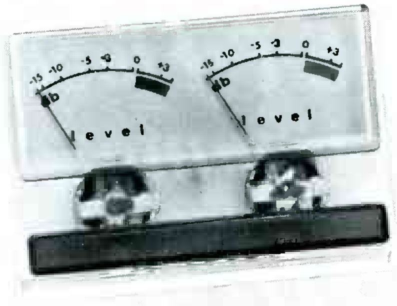
Commander is offering a free modification kit to all owners of earlier 830 models to update their equipment for testing FET's. The cost of the new Model 830 is under $80.

Circle 57 on literature card

Dual dB Meters

Cyclotronics Corp. has made available a line of dual dB meters for monitoring stereo recorders or speaker output levels.

It is reported that the meters indicate any simultaneously occuring functions which can be reduced to electrical characteristics. The units primarily are used in balancing signal levels in stereo record or playback systems. They also can be used in monaural multi-channel monitors.



The price of Model UF-3D ranges from $6.96 each for quantities of less than 50 to $2.91 each for quantities of 20,000 to 49,999.

Circle 58 on literature card

Digital Frequency Meter

Lampkin Laboratories, Inc., has introduced the Lampkin Type 107 Digital Frequency Meter (DFM) for mobile-radio servicing.

It is both a solid-state, heterodyne-type frequency meter and a signal generator, according to the manufacturer. A power supply of either a 12-volt battery or a 117-volt, 50- to 400-Hz AC source, 8-watts nominal, is needed. A three-wire AC plug and cord and a plug and cord to fit an automobile cigarette lighter are furnished with the instrument.

Characteristics

- Frequency range: 10 KHz to 500 MHz, for both measurement and generation.
- Accuracy: 0.0001%. Internal crystal secondary standard with proportional oven temperature control—3.0 MHz nominal. Aging rate—3 in 10^9 per day; stability—1 in 10^8.
- Variable-frequency Crystal Oscillator: 1 MHz, proportional oven temperature-controlled; calibrated dial ±0.005.
- Output: 1.0 volt rms, 10 KHz to 10 MHz, controlled by a step attenuator, 0 to –60 dB in 10-dB steps and by a variable panel control –8 to +2 dB. Attenuator accuracy—±2dB; output impedance—less than 20 ohms.
- Modulation: AM—approximately 1000 Hz. No FM modulation.
- Temperature range: 32°F to 122° F.

The DFM weighs 22.3 lbs. and measures 7⅜" x 17⅜" x 11". Without the handles, the height is 6 15/16", compact enough to mount in a standard relay-rack.

The price is $2,390.00.

Circle 59 on literature card ▲

Moving?

Send your new address to:

ELECTRONIC SERVICING
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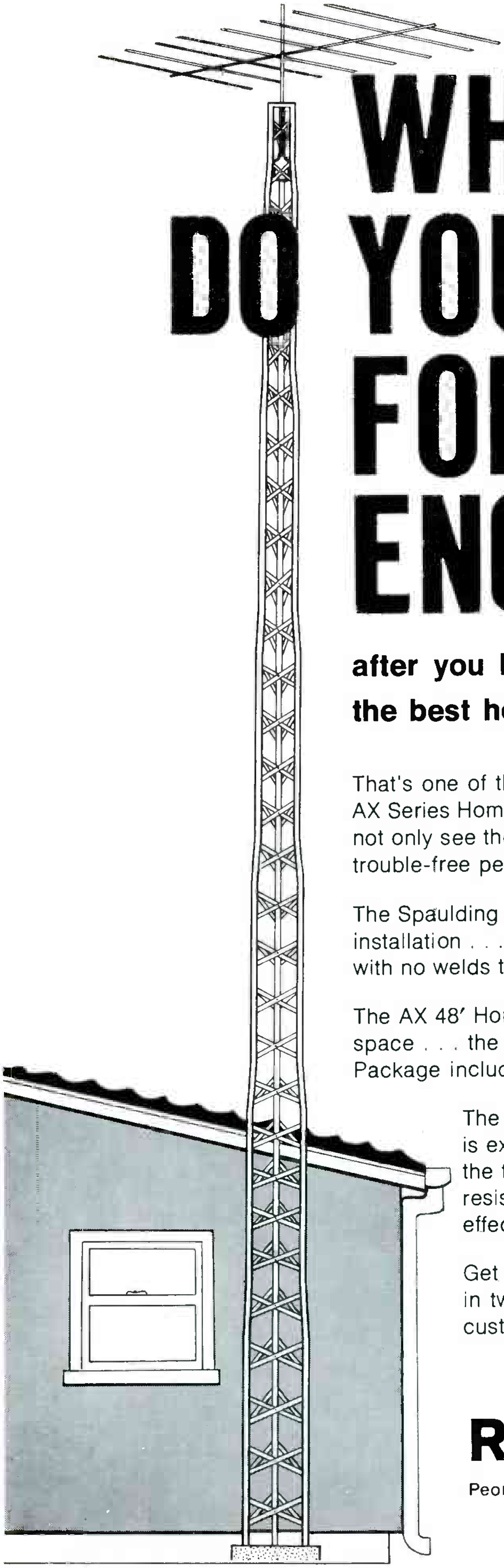

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The Spaulding AX Home TV Tower is designed for quick economical installation . . . and is all-steel, galvanized and all riveted construction with no welds to rust.

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Get specifications on this complete tower package, and profit in two ways—bigger sales and greater goodwill from your customers.

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Circle 15 on literature card

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So is this.

It used to be if you wanted to satisfy everyone, you had to stock over 30,000 different solid state replacement parts.

Well, everyone realized that was ridiculous. So some enterprising people came up with a bunch of universal replacements.

Then you only had to stock about eleven or twelve hundred.

That was a lot better, but we still thought it was a little ridiculous.

So two years ago (when we went into this business), we figured out how to replace all 30,000 with only 60.

Now all you have to do is stock 60 of our diodes, transistors, integrated circuits, etc., and you can replace any of the 30,000 parts now in use. Including all JEDEC types, manufacturers' part numbers, and foreign designs.

That means you invest less money.

You don't tie up valuable space.

You do away with complicated inventory control.

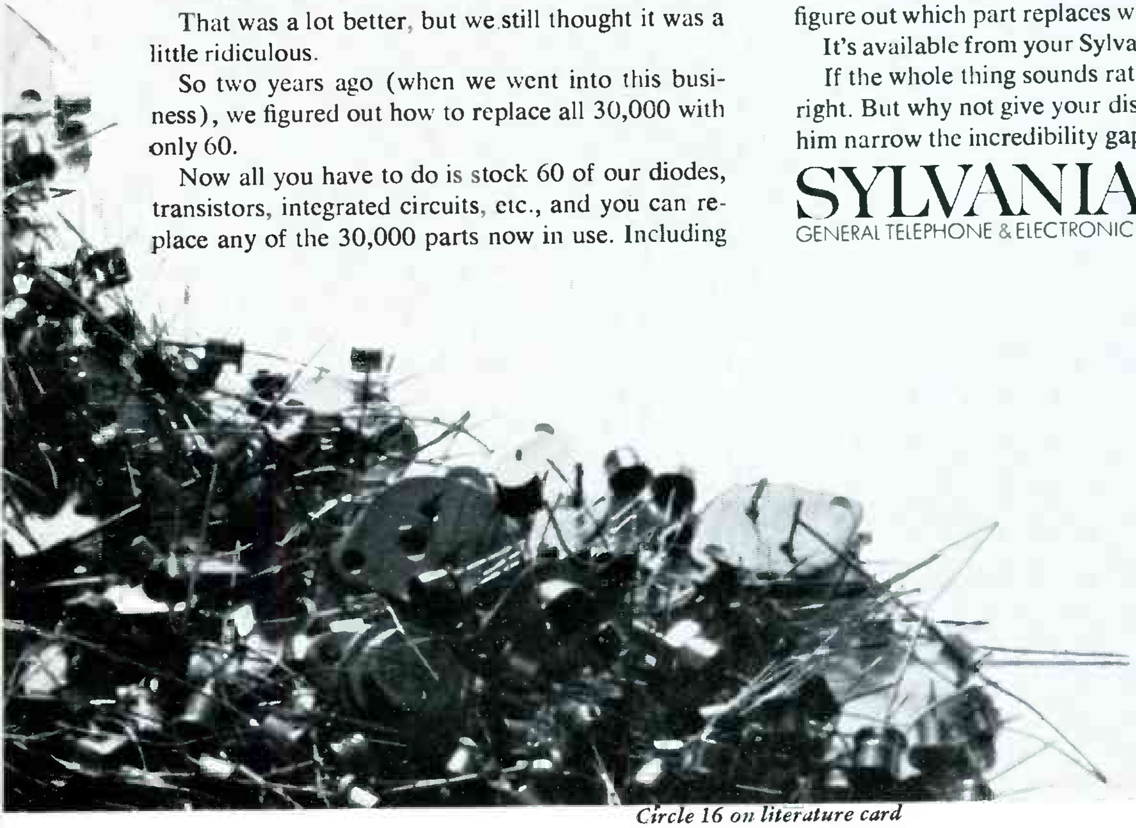
And you operate more efficiently.

To make life even easier, we've got a new book that gives you all the cross references you need to figure out which part replaces which.

It's available from your Sylvania distributor.

If the whole thing sounds rather incredible, you're right. But why not give your distributor a call and let him narrow the incredibility gap.

SYLVANIA
GENERAL TELEPHONE & ELECTRONICS



Circle 16 on literature card

www.americanradiohistory.com

Dale's service bench

by Allan Dale

How to make adjustments in FM multiplex systems

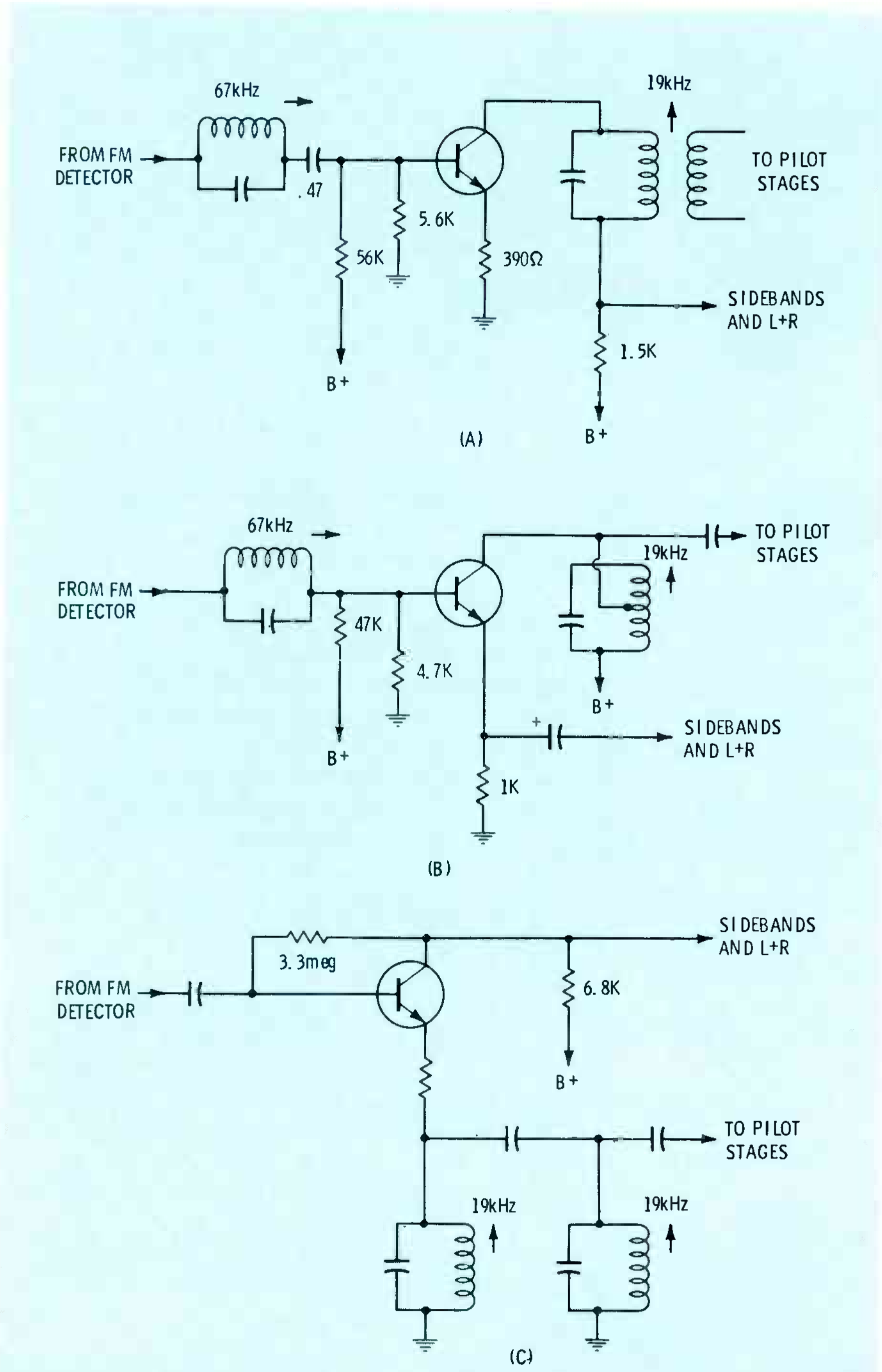


Fig. 1 Preamplifiers in many multiplex receivers have the 67-KHz SCA traps preceding them, as in A and B. In others such as C, they are further along, in the branch of the section that handles the L — R sidebands and the L + R signal.

Not long ago I described how to simplify sweep alignment (August 1969, page 12). From what I hear, a natural followup is a story about easy alignment for FM-stereo multiplex receivers.

Stereo FM sets still baffle a good many technicians. Mostly, I think it's because no one has explained to them just what goes on inside the multiplex section and what it takes to decode a stereo broadcast. So that's where I'll start.

The signal from a stereo FM station has three components. They are: 1) the pilot carrier, a steady 19-KHz tone that is used for synchronizing the stereo; 2) the L + R signal, which is a combination of the audio signals from the left and right microphones; and 3) a complex signal made by subtracting the right microphone signal from the left, amplitude-modulating the result on a 38-KHz carrier and then eliminating the carrier, leaving a pair of L – R sidebands. All of these are put together and frequency-modulated on the station carrier.

At the receiver, the FM carrier, with its modulation, is converted to an IF signal and amplified in regular 10.7-MHz tuned amplifiers. Bandwidth is designed into the IF amplifiers; for alignment you need only peak them at 10.7 MHz.

The FM detector that follows the IF strip recovers the composite stereo signal just described, with its three components. The multiplex section, then, has the task of handling these three components. The object is to recover the left and right audio channels.

Separating Sync from Sidebands

The first stage of a multiplex section is almost always a preamplifier. It's not always for amplifying. More often, it's a coupling device and a splitter. As a coupler, it matches detector-to-multiplex impedances. As a splitter, it separates the 19-KHz pilot signal from the L − R sidebands and the L + R signal. Sometimes, it amplifies one or the other.

Some popular preamplifiers are shown in Fig. 1. The first one, in Fig. 1A, is common in home stereo receivers. The composite stereo signal comes through a trap that's tuned to 67 KHz (I'll explain that later) and a coupling capacitor.

This stage does amplify. The L − R sidebands and L + R signals find very little impedance in the 19-KHz tuned circuit. The 1.5K-ohm resistor is the load for them.

The 19-KHz pilot signal is developed across the tuned circuit. This load does two jobs: Its impedance to 19 KHz, in series with the collector load resistor, effectively blocks 19 KHz from the sideband/L + R portion of the multiplex section. Its main job is to couple the 19-KHz pilot signal to stages that prepare it for synchronizing the stereo detector.

About that 67-KHz tuned circuit. Some FM stations broadcast a special store music channel. Sound for it is amplitude-modulated on a 67-KHz subcarrier. It's often called an SCA (Subsidiary Communications Authorization) subcarrier. The modulated 67-KHz subcarrier becomes a fourth signal multiplexed on the FM carrier. If broadcast simultaneously with regular stereo, the SCA subcarrier might cause interference noises in a receiver. A 67-KHz trap blocks the SCA signal out of the sideband/L + R stages.

During alignment, you feed a plain 67-KHz signal into the multiplex section and tune the trap for minimum response to it. The tuning dip will be sharp if the coil is okay.

The stages in Figs. 1B and 1C are common to FM stereo receivers in automobiles. However, they may show up anywhere. In Fig. 1B, the preamplifier stage amplifies the 19-KHz pilot. It feeds out the sidebands and L + R signals from the emitter, without gain. The stage in Fig. 1C is just the opposite. The tuned 19-KHz load is in the emitter circuit; the sidebands and L + R are taken from the collector load.

Adjusting Pilot Stages

The stages in the pilot-handling portion of a multiplex section have two things to accomplish: 1) They must amplify the 19-KHz signal, and 2) one of them must convert the 19-KHz signal to a precisely phase-accurate 38-KHz signal. These steps are necessary for converting the L − R sidebands back into an accurate reproduction of the original L − R signal. Fig. 2 shows in semi-block form how this is done in various receivers.

The most popular way to produce a 38-KHz signal for subcar-

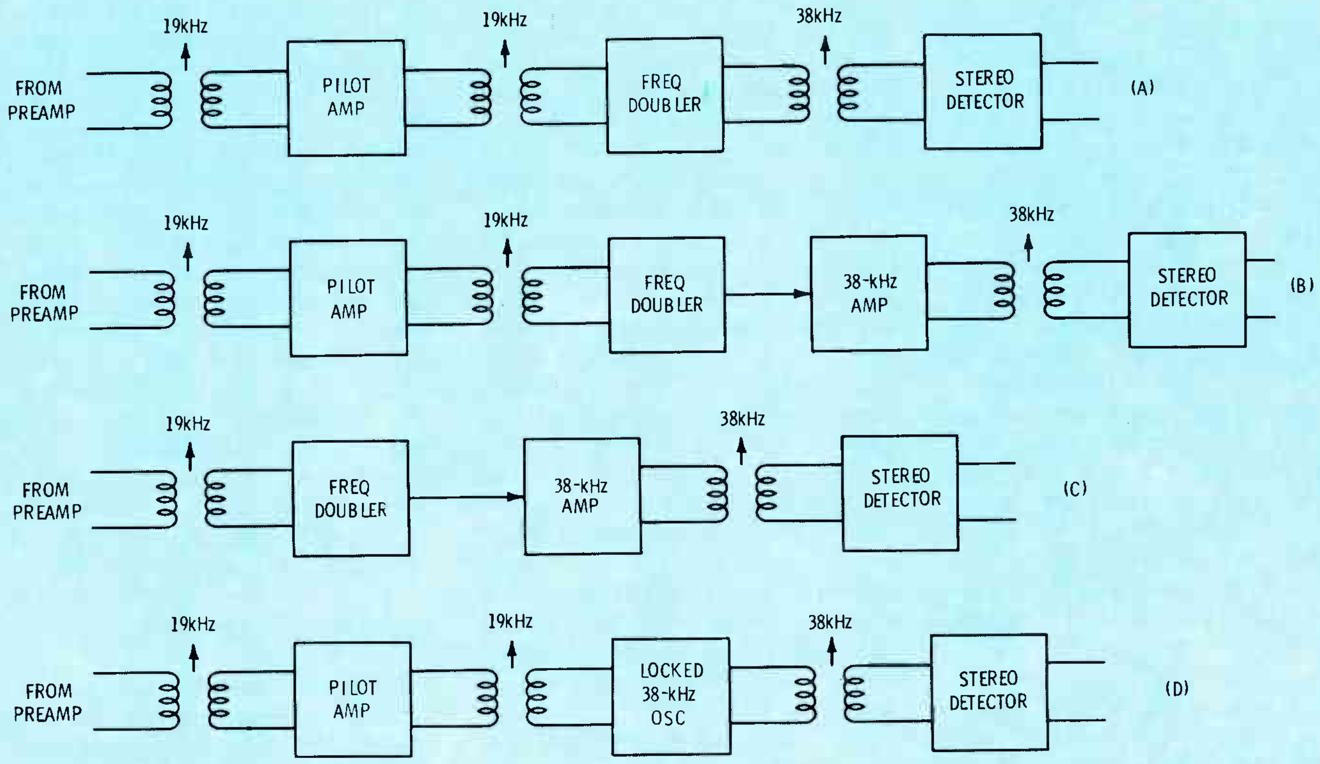


Fig. 2 Typical arrangements for handling the 19-KHz pilot carrier and generating the 38-KHz reinsertion carrier. This is also called the "stereo sync" section by some hi-fi technicians.

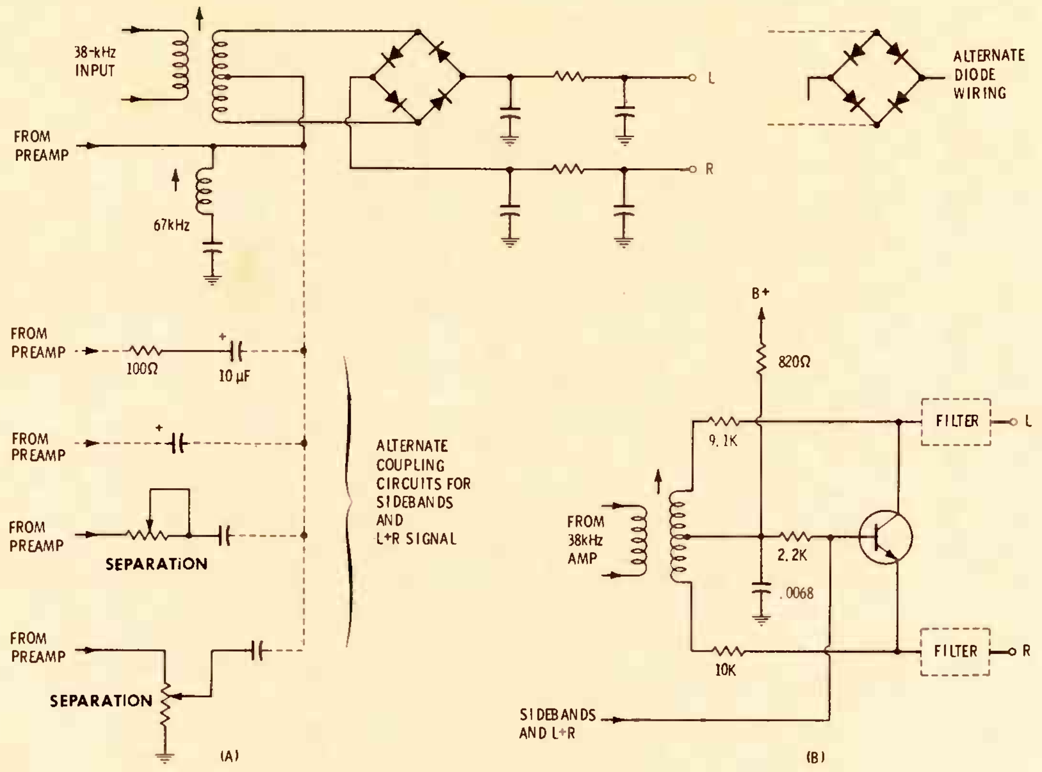


Fig. 3 Stereo detectors, shown with some of the feed paths that bring the sidebands and the L + R signals to the detector from the preamplifier. A) The alternate set of diodes is a regular bridge, which is used more often than the "ring" connection shown in the main diagram. B) This detector is used in certain Zenith chassis.

rier reinsertion at the stereo detector is by frequency-doubling the 19-KHz pilot itself. That certainly takes care of phase-locking. The primary differences among the systems illustrated in Fig. 2 are where and how much amplification occurs. There are two 19-KHz and one 38-KHz adjustments in Figs. 2A and 2B. There's only one of each in Fig. 2C.

The unit in Fig. 2D has an oscillator to produce the 38-KHz signal. However, it is phase-locked by the pilot carrier. Otherwise the stereo signals recaptured by the stereo detector would not be faithful reproductions of the originals.

Some of the frequency doublers are class-C transistor stages. Most often, though, a full-wave twin-diode setup is used, fed by the center-tapped secondary winding of a 19-KHz transformer. However, alignment is the same no matter what kind of stage is used for doubling.

The best thing about all these pilot sync systems is how simple they are to adjust. You just peak all the transformers. The main requirement is that the test signal you feed to the stages be extremely accurate. Either use a stable stereo generator or the signal from an FM station that's broadcasting stereo.

The Sidebands and L + R Signal

The branch of the multiplex section that connects the preamplifier to the detector is the simplest (Fig. 3A). In many receivers it is nothing but a capacitor that couples the L − R sidebands and the L + R signals from the preamplifier to the stereo detector. In some, a resistor and a capacitor are wired in series, for frequency compensation. Only in a few models is an active stage used, and then it's an emitter follower, which is used to match a high-impedance circuit to a low-impedance one, but which doesn't add gain.

When the multiplex section has a **Separation** control, it is usually in this branch. Proper operation of the stereo detector depends on how much L − R sideband and L + R signal it mixes with the 38-KHz reinsertion subcarrier. So, a control that affects this ratio makes a good separation adjustment.

The stereo detector in Fig. 3A is drawn with some typical sideband/ L + R paths, and a couple of separation controls are included. As you can see, they merely determine how much sideband and L + R signal is fed to the detector.

You adjust a **Separation** control with only one channel of stereo modulation, usually the left. For an indicator, you connect an audio VTVM to the output of the right channel. Your regular VTVM, set for AC, is okay. Feed into the receiver a stereo signal that contains only left-channel audio information; be sure there is no right-channel audio present in the input signal. Adjust the separation for **minimum** left signal in the right-hand channel.

An unusual stereo detector, which uses a transistor, is shown in Fig. 3B. Its base is the input coupling device for the sideband/L + R signals. This is a balanced mixer. The sideband and L + R signals are applied in parallel with the two "branches" (emitter and collector circuits), and the 38-KHz signal is fed to them in push-pull.

Stereo Indicator Lamps

Some of these may need adjustments. The idea is to make sure they light during stereo programs and go out during mono programs. The adjustment is a sensitivity control.

You first make sure the lamp is out when the receiver is not tuned to any station. If it stays on, there's a defect that must be corrected before adjustment.

Then, tune in a strong station with a stereo program. Turn the adjustment, usually a potentiometer shaft, slowly until the lamp comes on. Then tune in a strong station with a monophonic program. If the lamp doesn't go out, reduce sensitivity slightly.

This is an easy adjustment, and you'll have no trouble getting it set.

Making It Quick and Easy

Aligning a stereo FM multiplex section can be reduced to a group of simple steps. The only problem then is to find the right coils.

The number of each coil often is marked beside it on the printed board. That and the schematic should be enough to keep you from turning the wrong cores.

Here, to help you take care of any multiplex alignment, is a procedure you can use for any of them:

(1) Connect your DC VTVM to any point in the stereo detector that produces an increase in the meter reading as you increase the level of signal fed into the preamplifier. (Try it first with a 10-KHz audio tone.)

(2) Feed an unmodulated 67-KHz (or other trap frequency) signal into the multiplex section input. A handy injection point, usually, is at the output of the FM detector of the receiver.

(3) Adjust each trap for minimum reading on the VTVM. Be sure to feed in enough signal at each trap frequency to make a noticeable reading on the VTVM.

(4) Feed in a precise 19-KHz pilot signal. An FM station with a stereo program in progress is the most accurate source you're likely to find.

(5) Adjust all the 19- and 38-KHz transformers for maximum reading on the VTVM. Use as weak an input signal as you can while still getting a healthy VTVM reading.

(6) Feed in a stereo signal that has only the **left** channel modulated. You'll need a stereo generator for this, or a station that makes regular announcements on left channel only.

(7) Connect an AC VTVM to the output of the **right** channel.

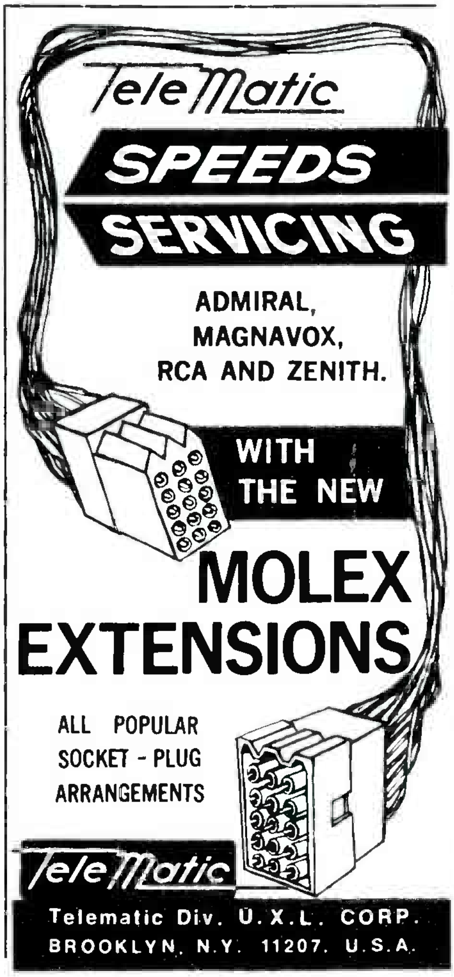
(8) Adjust the separation control for minimum meter reading.

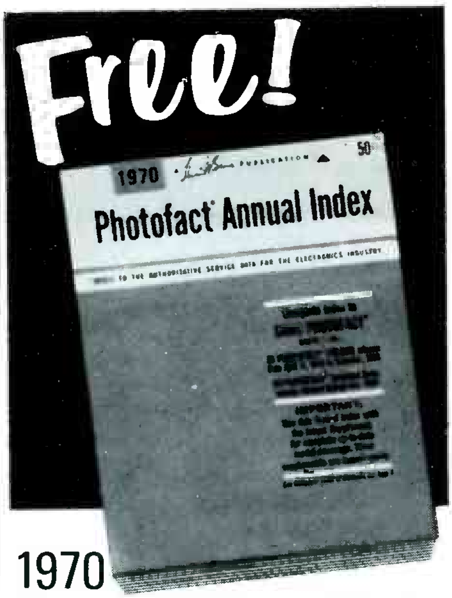
(9) With a stereo program tuned in, back the stereo-lamp sensitivity control off till the lamp goes out. Then turn the control up just enough to light it again.

Coming Next Month

I have received many requests for help with solid-state troubleshooting. One circuit that seems to demand a lot of explanation is forward AGC, the type used most often in transistor IF stages. You find it in tiny transistor radios and in transistor TV sets.

In my next column I'll explain more carefully what forward AGC is, how it is developed and how it is applied. More important, I'll tell you how to find and eliminate the troubles that sometimes crop up in these circuits. ▲

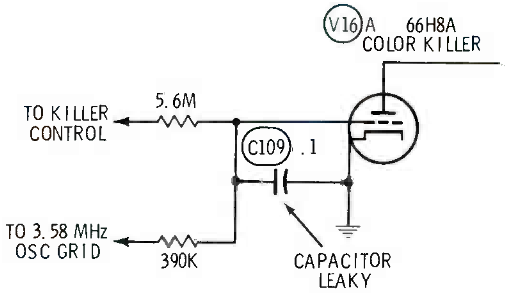




symcure

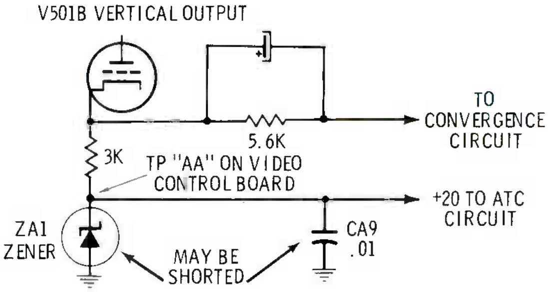
Symptoms and cures compiled from field reports of recurring troubles

Chassis—Admiral H12
PHOTOFACT—876-1



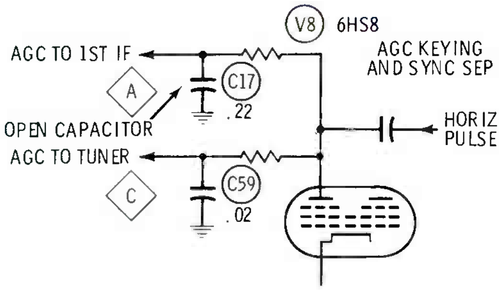
Symptom—No color
Cure—Check and replace leaky capacitor C109

Chassis—Magnavox T940
PHOTOFACT—none



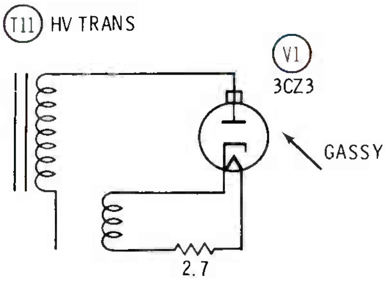
Symptom—No color
Cure—Check for +20 volts at TPAA on video control board; zener ZA1 or capacitor CA9 may be shorted if voltage is missing.

Chassis—Admiral 6H10
PHOTOFACT—949-1



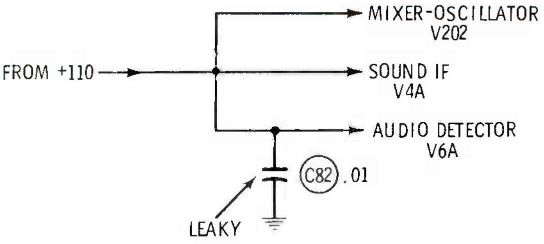
Symptom—Bad horizontal locking, picture dark on left side
Cure—Resolder or replace open capacitor C17

Chassis—RCA CTC40
PHOTOFACT—1030-2



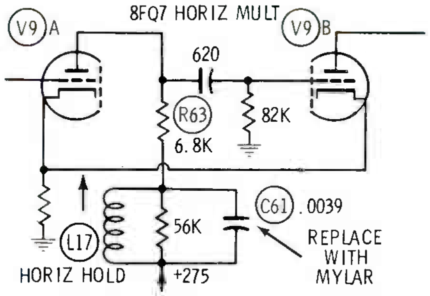
Symptom—Circuit breaker opens each time it is reset
Cure—Replace 3CZ3 high-voltage rectifier tube

Chassis—Admiral 4H12
PHOTOFACT—1049-1



Symptom—All high-band channels dead
Cure—Check and replace leaky capacitor C82

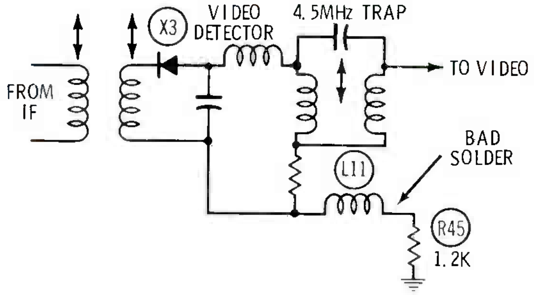
Chassis—Magnavox T927
PHOTOFACT—963-1



Symptom—Horizontal frequency drift
Cure—Replace C61 with a Mylar-dielectric type

symcure

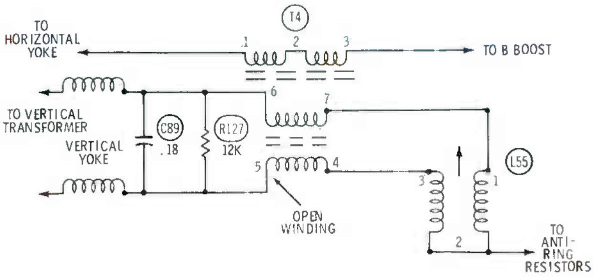
Chassis—RCA CTC36
PHOTOFACT—1012-2



Symptom—Low sensitivity and overload on strong signals

Cure—Check and resolder connection on peaking coil L11

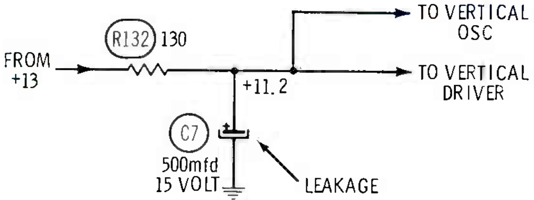
Chassis—Sylvania D12
PHOTOFACT—1045-2



Symptom—Very little vertical deflection

Cure—Check the windings of T4 and L55 for open circuits

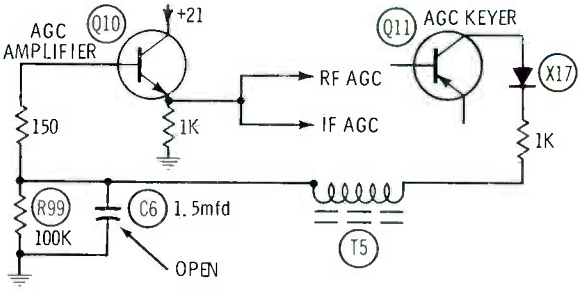
Chassis—Sony TV710U and 720U
PHOTOFACT—1019-2



Symptom—Lack of height when first turned on

Cure—Replace leaky capacitor C7

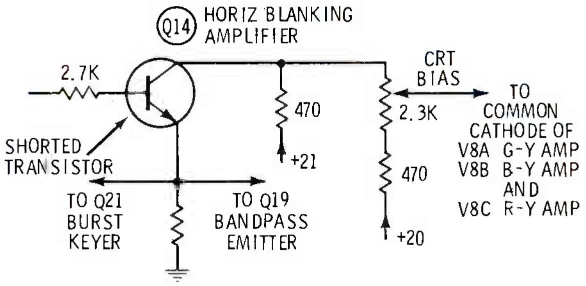
Chassis—Sylvania D12
PHOTOFACT—1045-2



Symptom—Right half of picture black, left half washed out; sync missing

Cure—Check and replace open electrolytic capacitor C6

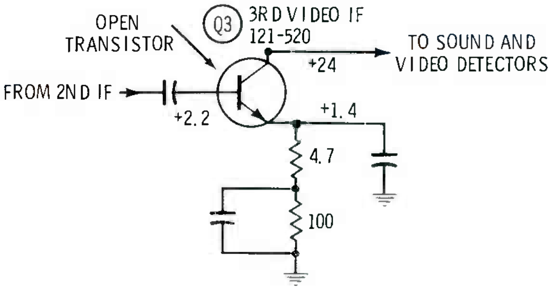
Chassis—Sylvania D12
PHOTOFACT—1045-2



Symptom—Dark vertical bars; dark picture

Cure—Check and replace shorted blanker transistor Q14

Chassis—Zenith 16Z7C17
PHOTOFACT—1014-3



Symptom—Very low sensitivity and no snow off channel

Cure—If the emitter voltage is zero, replace 3rd IF transistor Q3 ▲

Test Equipment Input Impedance and Its Effects

The effects of resistive and reactive components combine vectorially to produce impedance, which varies with frequency. This article explains what impedance is, how much of it typical test instruments have, what its effects are, and how these effects can be reduced or eliminated.

by Robert G. Middleton

The effects of test-equipment input impedance must be taken into account if you are to avoid incorrect measurements and resultant false conclusions. Apprentice technicians are particularly apt to be misled, because the beginner does not always have a clear understanding of impedance.

From a very general point of view, impedance is merely an opposition to current flow. On the other hand, when the characteristics of impedance are detailed, we find that an impedance is considerably more complex than pure resistance. In the first place, resistance is a measure of opposition to DC current flow. The effects of test-equipment input resistance in DC voltage and current measurements will be discussed first.

Resistance-Loading Errors

More volt-ohm-milliammeters (VOM's) are used to measure DC voltage and current than any other type of electronic instrument. Accordingly, we will begin with an analysis of resistance-loading errors in DC voltage measurements with a VOM.

Various types of VOM's differ greatly in sensitivity; however, the 20,000 ohms-per-volt type is most common. As we know, the input resistance of a 20K ohm/volt meter is equal to the full-scale indication multiplied by 20,000 ohms. For example, if we are operating on the 2.5-volt range, its input resistance will be 50,000 ohms; if we are operating on the 10-volt range, its input resistance will be 200,000 ohms.

When a voltmeter is connected across a circuit, it diverts current from the circuit. If the voltmeter has a low resistance, it will draw an appreciable amount of current. This current produces an abnormal voltage drop across the internal resistance of the circuit, which subtracts from the normal voltage value across the test points. Consequently, the voltage reading is lowered. For example, some AGC circuits have a high internal resistance; in turn, a 20K ohm/volt VOM gives subnormal voltage readings, and these readings are different on each range, as shown in Table 1.

The equivalent circuit for testing an AGC circuit having an internal resistance of 180K ohms is shown in Fig. 1. Because the internal resistance of a series-parallel circuit is different between various pairs of test points in a circuit that has high internal resistance, the voltmeter reading will change when the various test points are checked. For example, in Fig. 2 a higher value of voltage will be measured between test point X and ground, compared with the value measured between test point Y and ground.

If we use a VOM that has comparatively higher sensitivity, such as 100,000 ohms-per-volt, the circuit disturbance due to instrument loading is much less, and the voltage readings will be more accurate. Older technicians will remember how the sensitivity of DC voltmeters has been increased over the years. Table 2 shows the input resistance values on the 150-volt range and the full-scale current demand for typical voltmeters used in the past 50 years. The large increase in voltmeter sensitivity after 1924 was due to the advent of electron tubes. For obvious reasons, the vacuum-tube voltmeter (VTVM) gained increased acceptance in the 1930's.

Measurement of Input Resistance

If the input resistance of a DC voltmeter is not known, a simple test can be made to measure it. Connect the voltmeter across a battery or a power supply and note the scale reading. Then connect sufficient resistance in series with the voltmeter to reduce the scale reading to one-half of the former value. The input resistance of the voltmeter is equal to the value of series resistance that was inserted. This is called the "half-scale method" for measuring the internal resistance of a meter; the internal resistance of an instrument, as "seen" from its input terminals, is called the input resistance.

Next, let us consider the effects of the input resistance of a VOM when it is operated on its current ranges. A typical 20,000 ohms-per-volt instrument has the following input resistances on its various current ranges:

50 μa	2,000 ohms
10 ma	25 ohms
100 ma	2.5 ohms
500 ma	0.5 ohm.

Observe that the input resistance is substantial on the first current range. If the circuit under test has an internal resistance of about 2,000 ohms or more, the indicated value of current will be less than the actual value. For example, the load resistor in Fig. 3A normally draws 66 μa. However, if we insert the VOM in the circuit as shown in Fig. 3B the indicated value of current will be 38 μa. Therefore, a direct measurement of current is impractical in this example. It is better practice to check the value of the load resistance with an ohmmeter; then, the voltage drop can be measured across the load resistor and the actual current flow calculated using Ohm's law (I=E/R).

In most cases, the input resistance of a VOM on its various current ranges is unknown. However, it is easy to measure input-resistance values with the aid of a small battery and a pair of precision (±1%) resistors. Connect one of the resistors into the test circuit as shown in Fig. 4, and note the current reading. Then, connect the second resistor in place of the first, and again note the current reading. (Resistance values should be chosen so that both readings can be taken on the same current range. For example, the first reading might be about ⅓ of full scale, and the second reading might be ⅔ or ¾ of full scale.) Calculate the input re-

TABLE 1

Typical AGC Voltage Indications with a 20,000 Ohms-Per-Volt VOM

(True AGC voltage is −7.8 volts)

Range (Volts)	**Indication** (Volts)	**Actual Error** (%)
2.5	−1.7	78
10	−4.1	47
50	−6.6	15

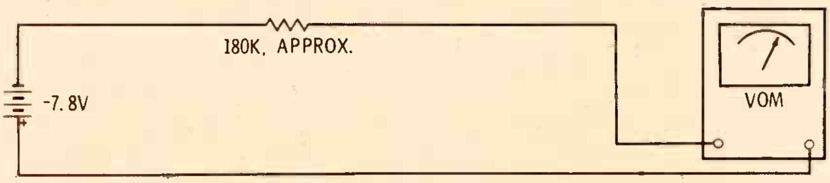


Fig. 1 Equivalent circuit of AGC circuit and values listed in Table 1.

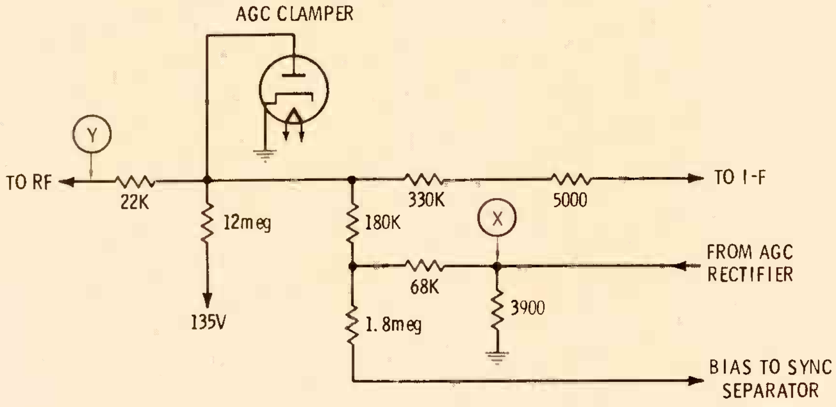
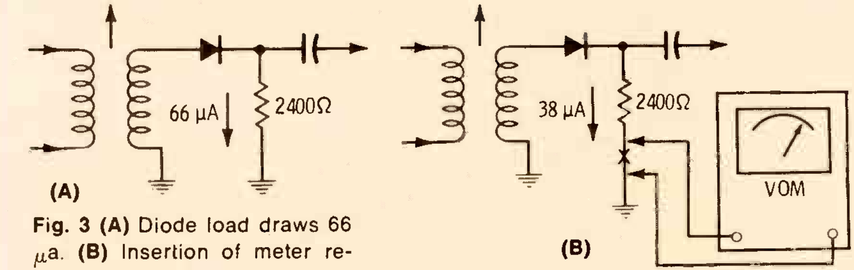


Fig. 2 A typical simple AGC circuit.

TABLE 2

Increase in sensitivity of voltmeters

Time of manufacture	**Sensitivity**	**Resistance**	**Current to deflect full scale**
Before 1924	10 ohms per volt	1.5 k-ohms	100 ma
After 1924	100 ohms per volt	15 k-ohms	10 ma
Today	1,000 ohms per volt	150 k-ohms	1 ma
	20,000 ohms per volt	3 megohms	50 μa
	200,000 ohms per volt	30 megohms	5 μa



(A)

(B)

Fig. 3 (A) Diode load draws 66 μa. **(B)** Insertion of meter reduces current to 38 μa.

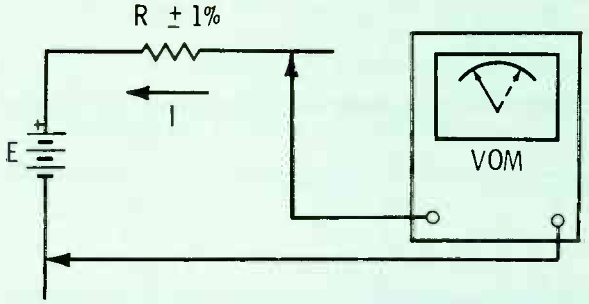


Fig. 4 Test setup.

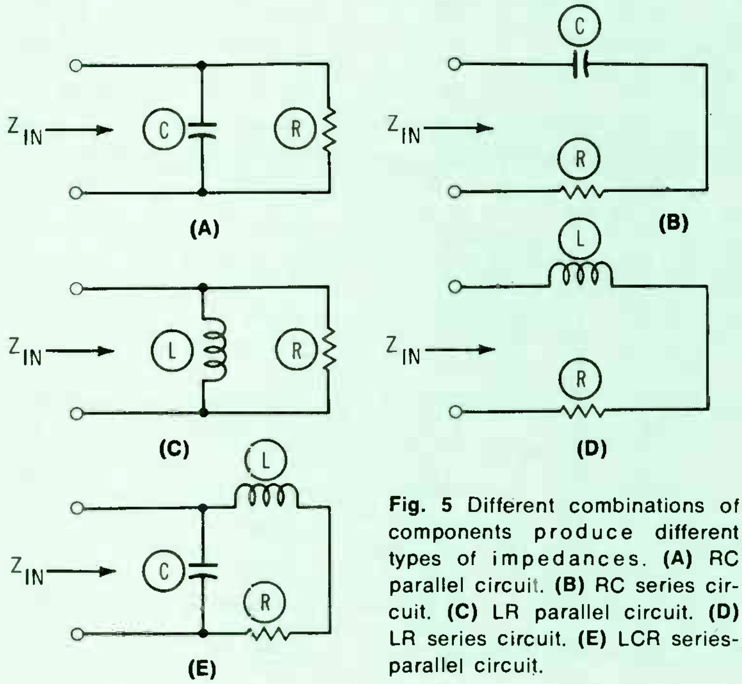


Fig. 5 Different combinations of components produce different types of impedances. **(A)** RC parallel circuit. **(B)** RC series circuit. **(C)** LR parallel circuit. **(D)** LR series circuit. **(E)** LCR series-parallel circuit.

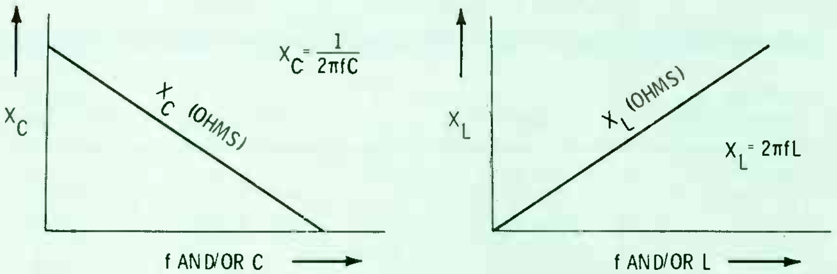


Fig. 6 Capacitive reactance varies inversely to frequency, while inductive reactance varies directly. **(A)** Capacitive reactance. **(B)** Inductive reactance.

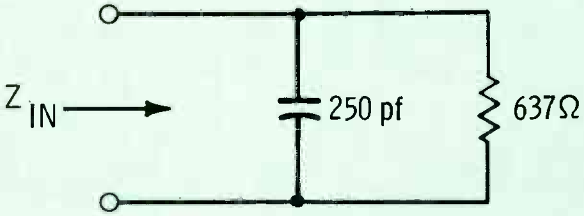


Fig. 7 637-ohm resistor in parallel with a 250-pf capacitor.

sistance on the given current range as follows:

$$Rin = \frac{I2R2 - I1R1}{I1 - I2}$$

where Rin is the input resistance, I1 is the current measured with R1 in the test circuit, and I2 is the current measured with R2 in the test circuit.

Impedance Characteristics

Impedance is measured in ohms; however, as stated earlier, impedance is more complex than pure resistance, because an impedance is a combination of resistance and reactance. A capacitor develops capacitive reactance, and an inductor develops inductive reactance. Reactance values are measured in ohms, although "reactive" ohms cannot be measured with an ohmmeter. Similarly, the number of ohms in an impedance cannot be measured with an ohmmeter. Fig. 5 shows some basic impedance configurations. Insofar as test-equipment input impedance is concerned, the arrangement in Fig. 5A is the most common.

The value of a reactance, whether it be capitive or inductive, depends on two factors. As shown in Fig. 6A, the amount of capacitive reactance (X_C) varies **inversely** with frequency and/or capacitance; as frequency and/or capacitance increase, capacitive reactance decreases. The amount of inductive reactance (X_L) varies **proportionally** with frequency and inductance; as frequency and/or inductance increase, inductive reactance increases (Fig. 6B).

Since the value of a reactance changes with frequency, impedance also varies with frequency. For example, a 250-pf capacitor has a reactance of 636 ohms at 1 MHz, and a reactance of only 6.36 ohms at 100 MHz. Or, consider the parallel arrangement in Fig. 7; at a frequency of 1 MHz, the input impedance of the configuration is 450 ohms, approximately; however, at a frequency of 100 MHz the input impedance will be about 6.36 ohms.

Because impedance is a function of frequency, we must state either the chosen frequency or the resistance and capacitance values when specifying the input impedance of a test instrument. It is common prac-

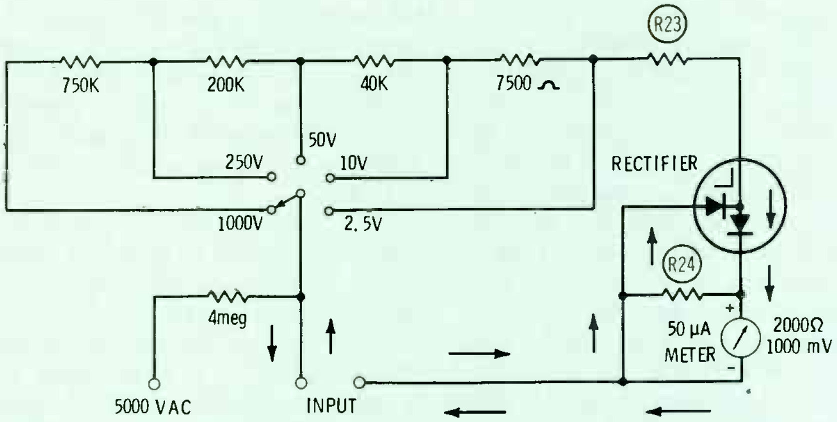


Fig. 8 Configuration of a typical AC voltmeter. (Courtesy, Simpson Electric Co.)

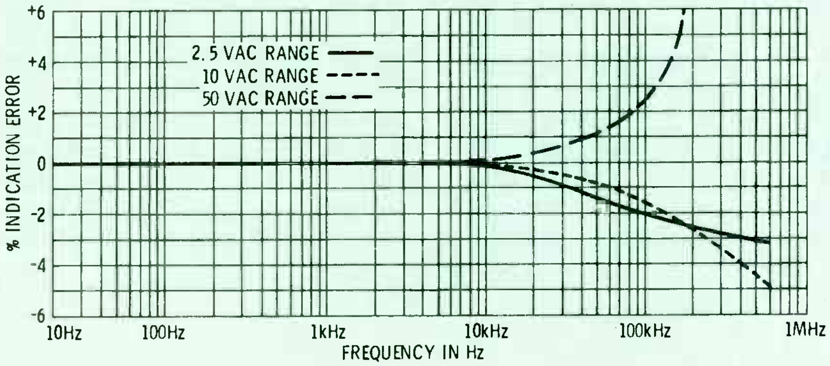


Fig. 9 Percentage of error versus frequency. (Courtesy, Simpson Electric Co.)

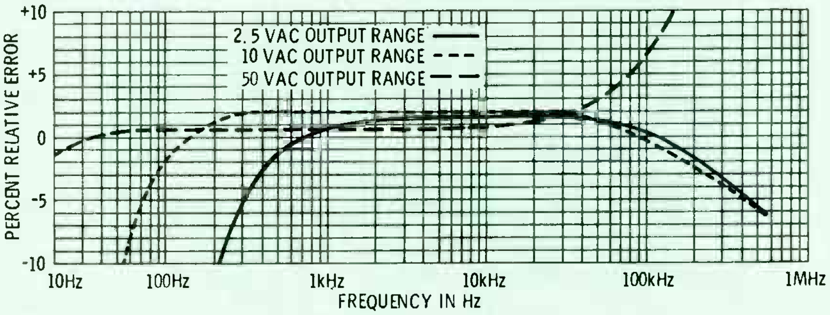


Fig. 10 Accuracy for output measurements with a typical VOM. (Courtesy, Simpson Electric Co.)

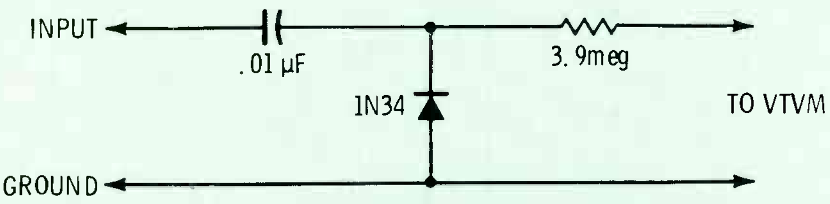


Fig. 11 Typical accessory RF probe for a VTVM.

tice to state the resistance and capacitance values. For example, the input impedance of a test instrument may be listed in a manufacturer's manual as 3 megohms shunted by 90 pf.

The input impedance of a test instrument can determine the useful frequency range of the instrument. For example, consider the AC voltmeter circuit shown in Fig. 8. It is evident that the configuration has input resistance. Although the diagram does not show it, input capacitance is also present in the form of stray capacitance between the test leads and between the various components and their connecting wires, and there is distributed capacitance in the moving coil of the meter movement. Also, although the diagram does not show it, there is inductance in the moving coil. The input impedance of the AC voltmeter can be represented by the LCR series-parallel circuit depicted in Fig. 5E. (Note, however, that the equivalent circuit changes on each position of the range switch.)

Any LCR circuit has a resonant frequency, at which the impedance value of the circuit is maximum. In a parallel LC circuit, there is an increase of current in the coil and in the capacitor at resonance; this is usually referred to as the "current magnification of a parallel-resonant circuit," and it is equal to Z (impedance) multiplied by the input current of the circuit. It causes an error in the reading at frequencies higher than the rated range of the VOM, as shown in Fig. 9. Note that the amount of error and the sign of the error depend on the meter range that is used. The change in sign occurs because the AC voltmeter circuit is actually a highly complex network when all of the stray capacitances are taken into account.

When a VOM is operated on its "output" function, a series capacitor is employed in the input lead to the AC voltmeter circuit. This is a blocking capacitor that has a value in the range of 0.1 or 0.25 mfd. With this series capacitance present in the input circuit of the instrument, the input impedance is changed, and the frequency characteristic of the VOM is shown in Fig. 10. As would be expected, the input impedance increases rapidly at low frequencies, with the result that the meter reads low at frequencies below 30 Hz.

Input Impedance of VTVM

A VTVM has higher input resistance than a VOM on the lower DC voltage ranges. For example, a typical VTVM has an input resistance of 11 megohms on all DC voltage ranges, whereas a 20,000 ohms-per-volt VOM has an input resistance of 50,000 ohms on its 2.5-volt range, and an input resistance of 10 megohms on its 500-volt range. However, the VOM has higher input resistance on the higher DC voltage ranges than does the VTVM. Thus, the VOM has an input resistance of 30 megohms on its 1500-volt range. In other words, the chief advantage of a VTVM is its comparatively high value of input resistance on its lower DC voltage ranges.

The capacitive component of the input impedance of a VTVM also must be considered. The capacitance between a pair of test leads used with a VOM is typically 25 pf. This is an objectionable amount of capacitance when measuring the DC voltage at the plate of a local oscillator, for example. That is, the input capacitance of the VOM detunes the oscillator considerably, and may "kill" the oscillator. In turn, an incorrect value of DC voltage is measured, because the circuit is not operating normally. On the other hand, a VTVM has a 1-megohm isolating resistor in its DC probe, which reduces the input capacitance to 1 or 2 pf. This is sufficiently low enough to permit accurate measurement of DC voltages in high-frequency circuits.

The input impedance of the AC voltage ranges of a VTVM often must be taken into account in routine service tests. A typical VTVM has an input resistance of 830K ohms and an input capacitance of 70 pf. The input resistance is sufficiently high so that it usually can be ignored. On the other hand, the shunt capacitance (70 pf) of a VTVM has a greater detuning effect than that imposed by a VOM. In general, applications of the AC voltage function of a service-type VTVM should be restricted to vertical and horizontal-frequency waveform amplitude tests. However, there is one exception: The AGC keying pulse is so narrow that it cannot be measured with reasonable accuracy in most receivers by a VTVM.

For measurement of voltages in the range from 20 KHz to 100 MHz with a VTVM, it is advantageous to use an accessory RF probe. The circuitry for a typical probe is shown in Fig. 11. Its advantage is a high input impedance, which minimizes circuit loading and detuning. This type of probe has an input capacitance of 2.5 pf, which is about the same as the input capacitance of a DC probe for a VTVM. The probe shown in Fig. 11 rectifies an applied RF voltage; the VTVM is operated on its DC voltage function. The chief limitation of a probe that employs a semi-conductor diode is its maximum input voltage rating, which usually is approximately 20 volts peak. Note that

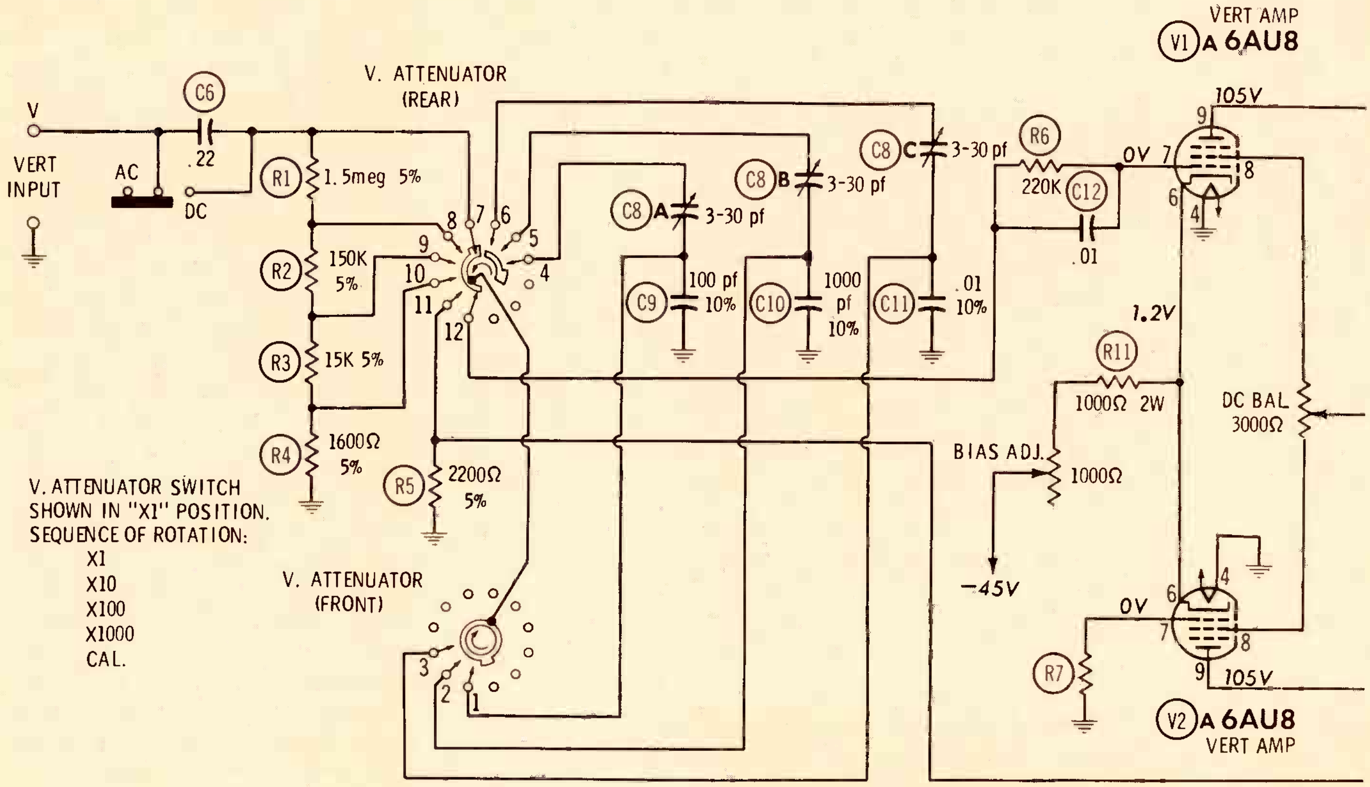


Fig. 12 Step-attenuator circuitry of vertical input of typical service-type scope.

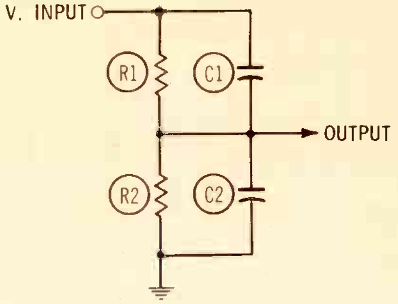


Fig. 13 Time constants R1C1 and R2C2 are equalized to provide constant value of input impedance at all settings of step attenuator.

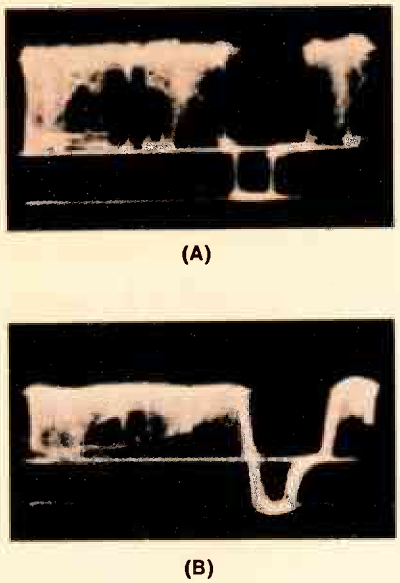


Fig. 14 (A) Fast-rise waveform in a video amplifier. **(B)** Distorted waveform caused by input capacitance of scope.

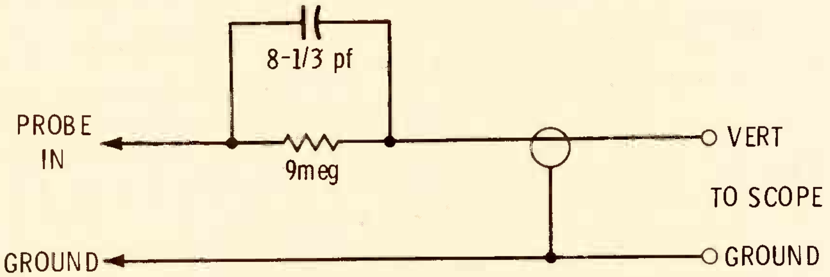


Fig. 15 Compensated low-capacitance probe.

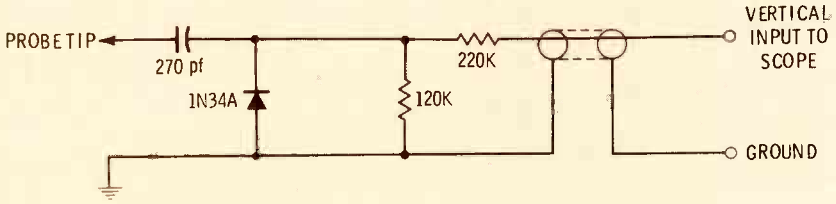


Fig. 16 Typical demodulator probe and specifications.

FREQUENCY RESPONSE CHARACTERISTICS:	
RF CARRIER RANGE	500 kHz to 250 MHz
MODULATED-SIGNAL RANGE	30 to 5000 Hz
INPUT CAPACITANCE (APPROX.)	2.25 pf
EQUIVALENT INPUT RESISTANCE (APPROX.):	
AT 500 kHz	25,000 OHMS
1 MHz	23,000 OHMS
5 MHz	21,000 OHMS
10 MHz	18,000 OHMS
50 MHz	10,000 OHMS
100 MHz	5000 OHMS
150 MHz	4500 OHMS
200 MHz	2500 OHMS
MAXIMUM INPUT:	
AC VOLTAGE	20 RMS VOLTS 28 PEAK VOLTS

this type of probe cannot be used at frequencies below 20 KHz because of the increasing reactance of the 0.01-mfd. input capacitor at lower frequencies.

Oscilloscope Input Impedance

All wide-band scopes have compensated step attenuators in the vertical channel, as shown in Fig. 12. Individual attenuator sections are arranged as shown in Fig. 13 to provide decimal voltage division, and with equal time constants: R1C1=R2C2. The sum of R1 and R2 is made equal on each step; hence, the scope has the same value of input resistance and capacitance on each step. For example, a typical service-type scope has an input resistance of 1 megohm and an input capacitance of 40 pf on each step. In practical applications a shielded input cable must be utilized, which adds another 35 pf to the value of input capacitance. In other words, when the scope is used with a shielded direct cable, it has an input impedance consisting of 1 megohm of resistance and 75 pf of capacitance.

A shunt capacitance of 75 pf can detune peaking coils and seriously disturb a high-impedance video-amplifier circuit. For example, the fast-rise sync pulse illustrated in Fig. 14A is seriously distorted when checked with a scope that employs a direct vertical-input cable (Fig. 14B). Observe that high-frequency components also are removed from the camera signal. In such a situation, the distortion caused by the value of scope input impedance might falsely be charged to the video amplifier. To avoid this type of circuit disturbance, technicians generally use a low-capacitance (L-C) probe. This is a form of accessory probe that makes a useful trade-off by exchanging signal voltage for a step-up in input impedance.

Fig. 15 shows a low-capacitance probe designed for use with a scope and input cable that presents an input impedance of 1 megohn shunted by 75 pf. Circuit analysis will show that the probe attenuates an applied signal to 0.1 of its original amplitude, while presenting an input impedance of 10 megohms and 8 pf, approximately. In other words, we lose 0.9 of the signal voltage through the probe, but obtain in return a

10-times step-up of input impedance. This increased input impedance permits most of the circuitry in both black-and-white and color TV receivers to be checked without noticeable circuit loading. Most low-capacitance probes are rated for a maximum applied peak potential of 600 volts.

Demodulator Probe Impedance

A demodulator probe, such as the one shown in Fig. 16, is a familiar item in TV service shops. It primarily is used for signal-tracing in IF amplifiers, and sometimes in intercarrier-sound circuits. Demodulator probes also are used in certain color-TV visual-alignment procedures. As seen in the tabulation of Fig. 16, a demodulator probe has a rather low input capacitance—2.25 pf in this example. This input capacitance remains practically constant regardless of frequency; on the other hand, the input resistance of the probe decreases from 25,000 ohms at 500 KHz to 2,500 ohms at 200 MHz. This is a reasonably high input impedance, although it is not sufficiently high to avoid the possibility of problems when testing 40-MHz IF amplifiers. In a 40-MHz IF amplifier, a capacitance of 2 or 3 pf can detune appreciably the plate-load circuit. If the circuit is detuned away from the frequency of the associated grid circuit, the only practical effect is a weakening of the IF signal. On the other hand, if the circuit happens to be detuned toward the frequency of the associated grid circuit, the IF stage will become regenerative, or may break into oscillation. Regeneration results in serious waveform distortion; oscillation causes the stage to block and, therefore, to kill the IF signal. Consequently, any trouble symptom indicated when a demodulator probe is employed should be confirmed by supplementary tests.

A demodulator probe badly distorts horizontal-frequency waveforms because of limited envelope response. Therefore, it is advisable to operate the scope on 30-Hz horizontal deflection when signal-tracing in IF amplifiers. This deflection rate provides display of the vertical sync pulse in the video signal. Since the vertical sync pulse is much wider than the horizontal sync pulse, the resulting pattern is reproduced with greater fidelity. Because of the detuning and loading effects produced by the input impedance of a demodulator probe, its usefulness is largely restricted to determining whether a signal is present or absent in the IF channel.

The input impedance of a demodulator probe is of less concern when it is used in many transistor IF circuits, because the collector-circuit capacitance is comparatively higher. A transistor also has a low input resistance, whereas a vacuum tube has an extremely high input resistance. The practical result is that a transistor IF stage is less likely to be thrown into oscillation by the input impedance of a demodulator probe. Moreover, the comparative waveform amplitudes at the input and output of a transistor IF stage will usually give at least a rough indication of stage gain. ▲

photofact™ bulletin

Photofact Bulletin lists new Photofact coverage issued during the last month for new TV chassis. This is another way Electronic Servicing brings you the very latest facts you need to keep fully informed between regular issues of Photofact Index Supplements issued in March, June, and September. Photofact folders are available through local parts distributors.

ADMIRAL	Chassis T2H3-1A, T3/T11/T12/T13/T16H4-1A, TH3/TH4-1A	1068-1
	Chassis 4K10-1A	1071-1
CURTIS MATHES	53M023/033/043/053/063 (Ch. CMC-33)	1070-1
	10M100	1074-1
OLYMPIC	9P90, 9P91 (Ch. 30720)	1072-1
PANASONIC	AN-189D (Ch. N-919B)	1074-2
	AN-169, AN-179 (Ch. N-919A)	1076-1
PENNCREST	2883	1073-1
RCA	Chassis KCS176A, KCS176B	1075-1
SEARS SILVERTONE	Chassis 528/529.72840 thru 528/529.72849, 529/529.72860 thru 528/529.72868	1073-2
SHARP	CN-52T	1076-2
SYLVANIA	Chassis D06-3, D06-4	1072-2
TRUETONE	EIS1015A-96, EIS1017A-96	1071-2
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	GHJ-15829A, GHJ-15849A, GHJ-15859A	1075-2
	AM-FM Radio used in Models GHJ-15829A/49A/59A	1075-2-A
ZENITH	Chassis 16Z8C50	1074-3
	Chassis 13A16, 13A16M, 13A16S	1076-3

PRODUCTION CHANGE BULLETIN

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SYLVANIA	Chassis B10-1, B10-2 (Codes 01, 02)	1075-3

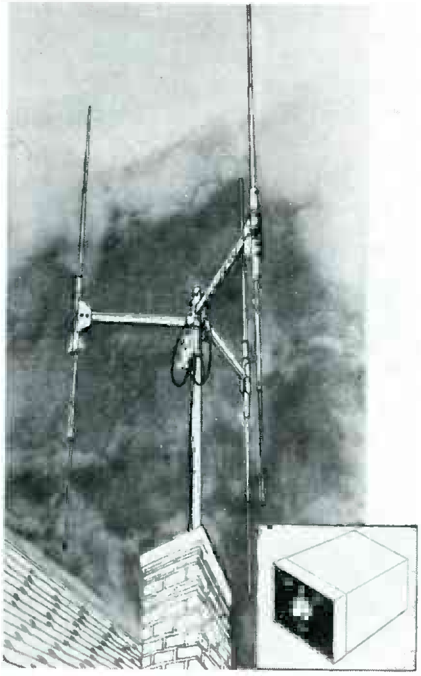
antenna systems report

Omni-Directional Antenna

Antenna Specialists' sector-phased electronic beam CB antenna, "The Scanner", has incorporated new control circuitry which permits omni-directional, instantaneous 360° scanning.

The effect is achieved through an aditional switch position on the control box, located at the transceiver. In this position, the antenna works omni-directionally with a 2.5-dB gain in all directions. The operator may search and identify desired mobile or base stations and then switch electronically to the appropriate directional sector, in which the "Scanner" operates as an electronic beam.

In the beam mode, the antenna, identified as Model MR119 "Super Scanner," delivers 7.75 dB forward gain with a front-to-back ratio of 23 dB, thus substantially eliminating interference and extraneous signals from the back side and greatly increasing directional range, according to the manufacturer. The beam effect is achieved electronically and, therefore, no mechanical rotor is needed.



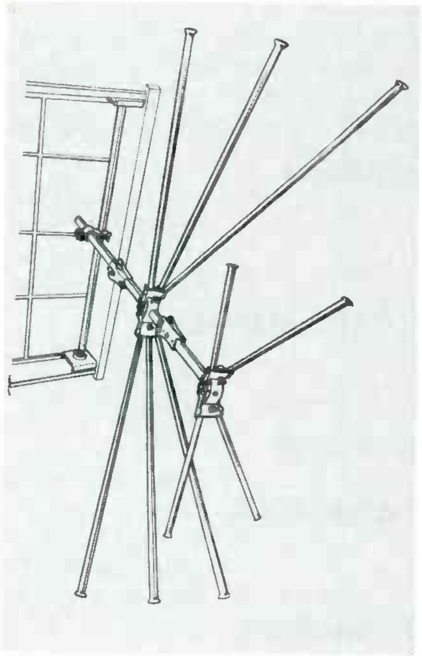
Model MR119 weighs 17 lbs. and is designed to withstand wind forces of up to 100 miles per hour. The suggested price is $79.95.

Circle 60 on literature card

Window TV Antenna

A new 82-channel, swiveling window antenna for VHF, UHF and FM has been introduced by JFD Electronics, Consumer Division.

The new antenna features separate swivels for UHF and VHF antenna elements. This reportedly permits orientation for best reception, even if UHF and VHF channels are not located in the same direction. The Model C119-82 window antenna is designed for apartment buildings, hotels, institutions and wherever it is impractical to install a rooftop antenna.



JFD states that the antenna can be mounted in less than a minute through the use of a spring-loaded bracket that expands to fit any window frame up to 42 in. wide, and is locked into place by means of a single bolt. Extension bars are available to accommodate windows up to either a 5-ft. or 6-ft. width. To further simplify installation, UHF and VHF signals are carried into the room over a single twinlead, it is reported.

The C119-82 antenna is constructed of a golden-colored, heavy-duty aluminum alloy. All elements are held securely in place with snap-out spring contacts, assuring excellent electrical and mechanical contact, according to the manufacturer. This feature reportedly enables the new antenna to deliver steady, top-quality pictures, even when vibrated by high winds. High gain is provided by six VHF elements and four UHF elements.

The C119-82 window antenna lists for $14.95. A VFH-only version, Model C119, lists for $12.35.

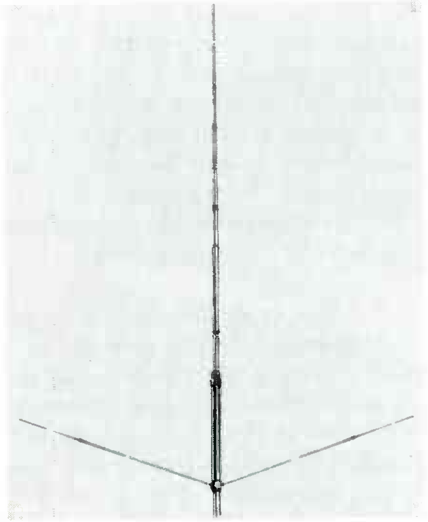
Circle 61 on literature card

Omni-Directional Base Station Antenna

A new series of rugged professional base station antennas for the 25- to 50-MHz frequency range has been announced by the Antenna Specialists Company.

Designed to meet or exceed all EIA Standards for base station antennas (RS-329), the ASP-600 series reportedly will handle 500 watts of input power with reserve. A true 3 dB omni-directional gain provides more reliable total system operation.

For rugged wind-loading capabilities, a new high-strength aluminum alloy is used in the radial and support tubes. This new material, combined with the fiberglass reinforced coil jacket, which shares the flexural load of the wind, provides a 100-MPH load rating with a 1.65 safety factor, Antenna Specialists states. A molded neoprene suspension gasket separates the base tube of the radiator and the transformer to seal out moisture. The braided transformer jacket design also provides ultraviolet stabilization characteristics.



Antenna Specialists reports that the ASP-600 series antennas are DC grounded to minimize precipitation static and reduce receiver noise interference, and that tuneable radials provide for maximum decoupling of RF. Three models in the series cover 25-28, 30-40 and 40-50 MHz. The list price of each is $149.00.

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How Defects Affect the Operating Voltages and Parameters of Tube Circuits

by Bruce Anderson

Many of the servicing procedures we find in servicing literature direct the technician to the general area of the problem and end by suggesting that he measure a few voltages to isolate the trouble to a specific component. In this article, we shall examine just how the voltages on tube elements can become abnormal, and also the effects on circuit performance which may result from off-tolerance components.

The Filament Circuit

When TV receivers with series filaments first appeared on the market, a lot of discussion centered around improper filament voltage. When these receivers first were designed, tube technology simply had not advanced to the point where 13 to 18 tube filaments could be connected in series and each drop its exact specified voltage. True, at the time of manufacture the hot-filament resistance of the tubes could be expected to be within fairly close tolerance limits, but after a few months of use, a horizontal-output tube, for instance, might drop more or less than the specified 25 volts when the filament current was 300 milliamperes.

If its filament resistance increased by, perhaps, 25%, the tube would drop in the neighborhood of 31 volts, thereby reducing the filament voltage available for the remaining filaments in the string. Whichever of the other tubes happened to be in the most critical circuit then would no longer perform properly and often were replaced, while the real culprit remained precisely where it was, to cause a callback in a month or so.

Of course, better design of tube filaments makes this type of trouble relatively rare nowadays, but other failures which result in reduced filament voltage still do happen.

Referring to Fig. 1, suppose that the bypass capacitor becomes leaky. The result is that the resistance of the complete filament circuit is reduced, increasing the current through the filaments of V1 through V9. (For simplicity, V3 through V8 are omitted.) Accordingly, the voltage drop across each of these filaments will be increased, shortening their lives, but possibly not leading to any immediate reception problems. However, the voltage drops across the filaments of V10 and V11 will be decreased, reducing their temperatures and ultimately reducing the cathode emission. This, of course, has about the same result as if the tube were weak and, unfortunately, installing a new tube normally will remove the symptoms —for a month or so.

How, then, should this type of problem be avoided? Since the object of being in the TV servicing business is to make money, it is impractical to make exhaustive tests every time a tube is replaced. Even testing those tubes which are replaced is not particularly satisfactory, because a tube tester often will indicate that a tube is good when it is not, thereby starting you on a wild-goose chase. Because of this, callbacks for this type of problem must be expected; however, when replacing a specific tube for the second time, it is worth the effort to do a bit of investigating. After all, the second callback is going to cost just as much money as the first one—plus, it probably will drive away the customer.

If a set of tube socket extenders and some sort of inexpensive voltmeter are kept in the service truck, it will take but a few minutes to check the filament voltage of the tube in question. If it is less than 95% of the rated value, assuming the line voltage is correct, a filament-voltage problem should be suspected. Since meters which regularly ride about in the service truck are likely to have inaccuracies greater than ±5%, several filament voltages in the string will have to be checked to obtain any useful information. Referring again to Fig. 1, if the filament voltage of V10 (the tube which is causing the trouble in this example) is low, also check the filament voltage of V11 and a couple of the other tubes. If the filament voltage of V11 is low and all of the others are slightly high, it is almost certain that there truly is a filament-voltage problem. Most meters, even though inaccurate, will read consistently in the same direction on one particular range.

The Cathode Circuit

Abnormal cathode voltage on a tube can be either the cause or the result of abnormal tube operation. Referring to Fig. 2, all of the bias supplied to the tube is cathode bias, since the control grid is at DC ground potential by virtue of the low resistance of the input transformer. Therefore, if the cathode voltage is out of tolerance, it is reasonable to assume that the fault it located in the cathode circuit. Since the design cathode voltage is 1.5 volt and the cathode resistance is 150 ohms, a simple calculation $(I = \frac{E}{R})$ indicates that the normal cathode current is 10 ma.

If the cathode voltage is greater than 1.5 volt, either there is additional cathode current or the value of the cathode resistor has increased. A large increase in screen voltage would increase the cathode voltage slightly, but the most likely fault is an above-tolerance cathode resistor.

In the same fashion, a decrease in cathode voltage also is likely to be caused by a change in cathode resistance; but in this case, the resistance would be decreased. (A less likely cause is an increase in the value of the screen resistor, causing a net decrease in cathode current.) A failure which causes the same effect as a decreased cathode resistor is a leaky cathode-bypass capacitor. By disconnecting the capacitor from the resistor and checking the resistance of each, it is possible to determine which is at fault.

The Control-Grid Circuit

The bias voltage present on the control grid of a vacuum tube can be developed in one of two fashions, or by a combination of them. If it is derived from some source external to the tube, this source should be suspected if the bias is abnormal. On the other hand, grid bias may be developed by the grid current of the tube itself; in which case improper drive may be the result of a change in this resistance, or from the introduction of an unwanted voltage.

The circuit shown in Fig. 3 is typical of the horizontal-output circuit used in many color receivers. An analysis of how the grid bias is developed and the types of failures that can change this bias will help you understand the bias systems of nearly all the circuits in a television receiver.

Grid-leak is the principal method of obtaining bias for the horizontal-output stage. So, for the moment, assume that the small amount of fixed bias obtained from the 140-volt supply through R1 is not present, and the high end of R1 is returned to ground, rather than to B+. Each time the grid is driven positive by the signal, it draws some grid current, which charges C1 to a negative potential. Since the time constant of R1 and C1 is long compared to the pulse rate, a constant level of DC bias is developed. If the amplitude of the driving pulses is decreased, less grid current flows and the bias decreases. This is desirable up to a point. But if the drive is reduced radically, the bias will decrease to a point where the cathode current of the tube will exceed the maximum rating for the tube, and the tube will be damaged. In an extreme case, such as oscillator failure and complete loss of drive, the bias will fall to zero and the tube will be damaged in a matter of seconds, unless overload protection is provided.

Although loss of drive is the most frequent cause of loss of bias in grid-leak-biased circuits, leakage of the coupling capacitor (C1 in Fig. 3) is another possibility. In effect, this connects the plate supply of the preceding stage to the control grid via the leakage resistance of the capacitor. If this leakage resistance is quite high, the bias may shift only slightly, causing excessive current and shortened tube life, and also can cause distortion of the signal. Of course, a leaking coupling capacitor will cause a bias shift in any grid circuit that has fairly high DC resistance to ground.

Excessive bias in a grid circuit employing grid-leak bias is not apt to be caused by excessive drive, because few malfunctions can occur which will allow excessive drive. The most likely cause of excessive bias is an increase in the value of the grid resistor. When the grid resistance becomes excessive, a condition known as grid blocking results, which causes the tube to become biased near cutoff. If a meter is connected from grid to ground, the shunting effect of the meter often will be sufficient to restore nearly normal operation—a handy point to remember. Naturally, grid blocking can occur in circuits that are not grid-leak biased.

R1 in Fig. 3 is connected to the 140-volt supply, instead of ground, to slightly reduce the grid bias and increase the output power from the tube. This, in turn, increases the scanning width and the high-voltage power. Since R1 is quite large, nearly all the supply voltage is dropped across it, and the actual grid voltage is only a little less negative than it would be if R1 were grounded. However, the circuit is there for a purpose, and if R1 changes value, the bias will be upset and width will be affected.

In various color receivers, a negative supply voltage is required for some circuits, such as the ACC or chroma-blanking circuit. Rather

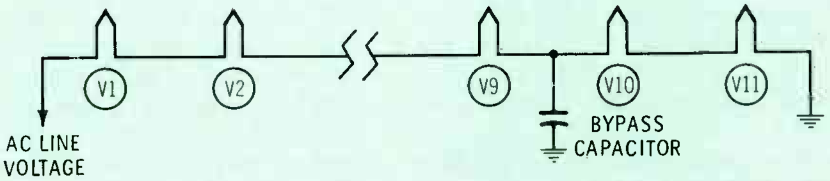

Fig. 1 Typical series filament string.

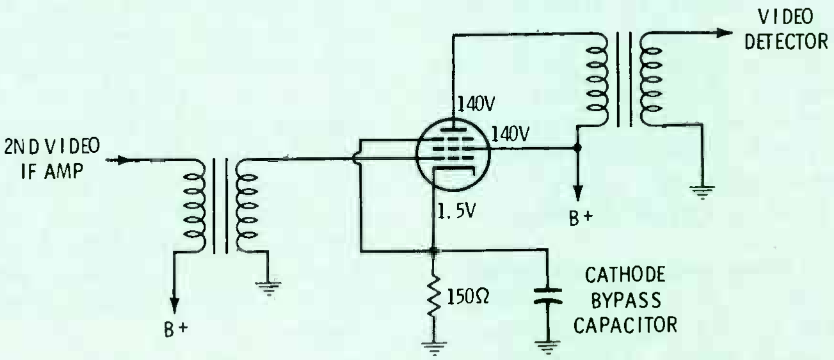

Fig. 2 A transformer-coupled amplifier.

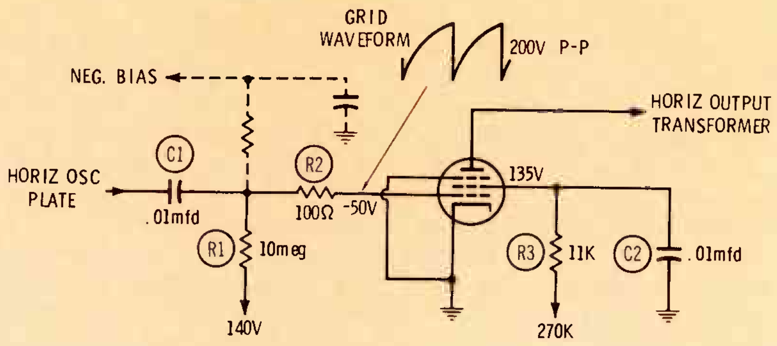

Fig. 3 Typical horizontal-output amplifier.

than construct a negative power supply, it is customary for some of the manufacturers to obtain this negative voltage from the horizontal-output grid circuit. By “tapping” the grid circuit, as shown by the dotted-line connections in Fig. 3, an unloaded negative supply of about 50 volts may be obtained for these purposes. This is a frequently overlooked source of problems, because the circuit which uses this negative voltage may be more critical than the horizontal deflection system. In this case, insufficient drive to the horizontal output stage might produce trouble symptoms in the ACC circuit rather than in the deflection system.

The horizontal-output circuit has been discussed in detail because it demonstrates both methods of obtaining grid bias, and because it is subject to nearly all the bias failures that can occur in any of the other circuits in a TV receiver. Other stages which use some form of grid-leak bias are the various oscillators—horizontal, local, color reference and vertical—and the sync separator. The RF amplifier of the tuner, usually two of the IF amplifiers, the chroma amplifier and the color-killer circuit normally obtain bias from sources external to themselves, but dependent on signal level. Most other stages are fixed-biased, or cathode-biased.

Plate and Screen Circuits

If the control-grid-to-cathode voltage of a tube is abnormal, the cathode current will be abnormal, and the plate and screen voltages will be incorrect. Because of this, it is unwise to assume that the cause of a trouble symptom is in either of these latter circuits until it has been determined that the bias is within specifications. If the bias is correct, reduced plate or screen voltage may be caused by an increase in the value of a plate-load resistor or a screen-dropping resistor. Conversely, an increase in voltage on one of these elements indicates a decrease in the value of the associated resistor. It is assumed, of course, that the power-supply outputs are normal.

It should be remembered that in some types of tubes if either the plate or screen voltage is very far off value it will affect the voltage on the other element. For example, a plate-load resistor greatly increased in value will cause the plate voltage to be reduced. This, in turn, will result in decreased plate current, although not in proportion to the reduction in plate voltage. The cathode current of a pentode tube is relatively independent of plate voltage, and some of the normal plate current now will flow to the screen grid, reducing the screen voltage.

On the other hand, a decrease in the value of a screen-dropping resistor will tend to increase the cathode current, probably increasing both the plate and screen currents. The increased plate current will cause the plate voltage to be lower than normal, but the screen voltage may be only slightly high, since the increased current partially offsets the effect of the reduced dropping resistor.

Dynamic Considerations

Thus far, the static conditions of a stage which is operating with off-tolerance circuit components have been discussed, since these are the symptoms most likely to be discovered in routine troubleshooting with a meter. Nevertheless, it is useful to have some knowledge of how these component failures will affect the ability of the stage to perform its normal function.

We already have considered the effect of a shorted or leaking capacitor on a circuit. It also is possible that a capacitor may lose some of its capacitance or become completely open. If it is a coupling capacitor, the result is attenuation of the signal, particularly the low-frequency components; this will affect the bias if grid-leak bias is employed (as in a horizontal-output state).

If a cathode-bypass capacitor loses its capacitance, the voltage measured at the cathode may not change noticeably. With proper bypassing, the cathode voltage is essentially DC; in the absence of the capacitor, the voltage is the sum of the DC voltage dropped across the resistor and the AC signal developed across this same resistor. But since a meter will average the signal voltage to zero, this “ripple” may go undetected. However, the stage will not amplify as it should because of the severe degeneration of the unbypassed cathode. If the cathode is only partially bypassed (some capacitance lost), low-frequency response will deteriorate noticeably.

One method of detecting improper bypassing is to use a DC scope for all voltage measurements, since it will indicate signal voltage (AC) if any is present. If such a scope is not available, a large-value blocking capacitor in series with the leads of an AC meter will allow signal to be measured. A properly bypassed cathode seldom will have a ripple voltage (signal voltage) in excess of 10% of the specified DC voltage. It is assumed, of course, that signal is present when the measurements are being made.

Insufficient or no bypassing of a screen grid also can result in reduced gain, although the reasons are less obvious. Referring to Fig. 3 once more, if C2 were removed from the circuit, the voltages measured on the tube elements would not be greatly affected, but reduced high voltage and insufficient width might be observed. As the control grid is driven positive, the screen current normally increases; but, without the bypass capacitor, this causes the screen voltage to decrease, tending to decrease the cathode current and also the plate current. Accordingly, there is less energy in the output circuit. Conversely, on the negative-going excursion of the input signal, the decrease in cathode current causes the screen voltage to increase if it is unbypassed, and this has the tendency of increasing the cathode current. Therefore, the effect of an unbypassed screen grid is always to oppose the signal at the control grid and, hence, to reduce the effective gain of the stage.

Another effect of an unbypassed screen results from the fact that considerable signal is present across the screen-dropping resistor (which now is actually a **screen-load** resistor). This signal may be radiated around the chassis, producing various types of interference, and sometimes causing the stage to break into oscillation.

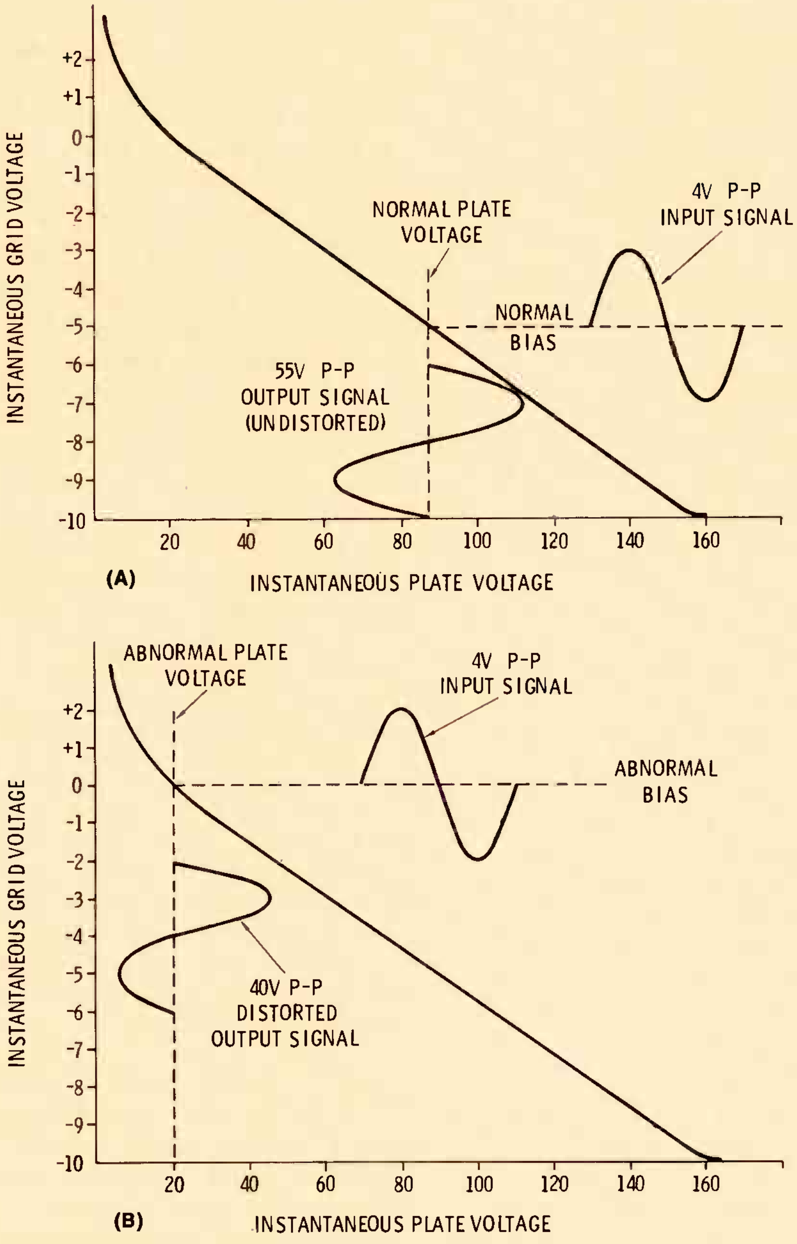

Fig. 4 The effects of bias on gain and distortion. **(A)** Operating point at −5 volts. **(B)** Operating point at 0 volts.

The dynamic effects of a change in bias may be slight or rather drastic, depending on the amount of shift, the characteristics of the tube and the particular circuit involved. If the tube is of the sharp-cutoff variety, the amount which it amplifies remains fairly constant between the points of cutoff and saturation, and gain is not seriously affected so long as operation remains within these limits. However, if the bias is shifted so that the tube is cut off or saturated during part of the input cycle, serious distortion will follow.

Suppose that a certain tube cuts off with 10 volts of bias. If it is operated at a bias level of 5 volts, a 4-volt peak-to-peak signal will cause the instantaneous grid voltage to vary from −7 volts to −3 volts (Fig. 4A). Amplification remains fairly constant throughout this range of grid voltages and the signal will be amplified with little or no distortion. If the bias, or operating point, were shifted to either −7 volts or −3 volts, the operation would not be seriously affected, although the voltage measured at the plate would change.

If the bias, or operating point, were shifted to zero volts, as shown in Fig. 4B, the instantaneous grid voltage would vary from −2 volts to +2 volts, and the tube would be in saturation during the positive half-cycle. This would cause the negative half-cycle of the output to be amplified very little, causing lowered gain and severe distortion. Obviously, a shift in bias to −9 volts would clip the positive half-cycles of the output.

If the tube just discussed had been a remote-cutoff tube, distortion would result in the same manner as cutoff and saturation were reached. Even if these extremes are not reached, the amplification of the stage would depend on the bias. For example, in an AGC-controlled IF amplifier, insufficient bias will increase the gain, causing the picture to have excessive contrast. If the bias is reduced to the point where the tube saturates on peak-

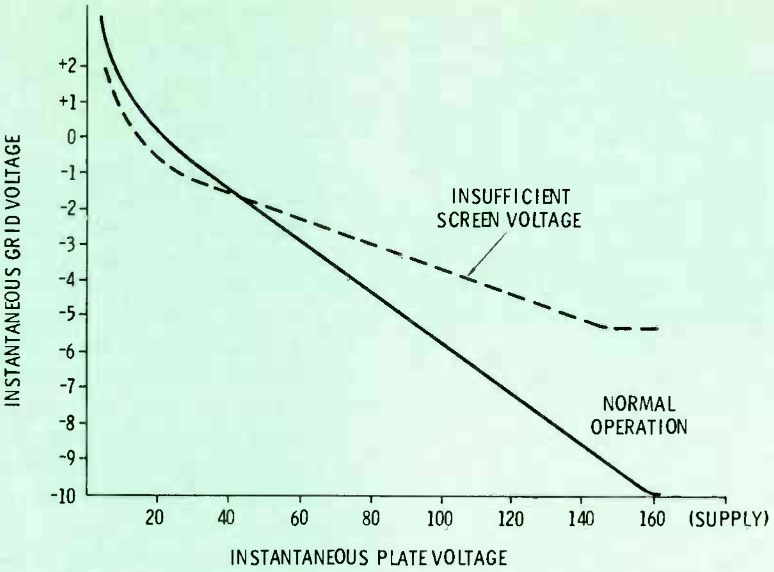

Fig. 5 The effect of insufficient screen voltage on amplification in a pentode.

amplitude signals, the sync pulses will be amplified less than the lower-amplitude video signals, and sync compression will result.

Increasing the value of the screen-dropping resistor of a pentode will reduce the screen voltage, thereby decreasing the dynamic operating range of the tube; it will cut off with less bias and saturate more quickly, as shown in Fig. 5. The effect of an excessively large plate-load resistor in a triode circuit is much the same, with one additional complication: As the plate load resistance is increased, the effect of the stray shunt capacitance becomes more pronounced and high-frequency response is reduced.

If the plate-load resistance of a pentode is increased, gain will tend to increase to a point, but the voltage at the plate will be reduced because of the additional drop across the resistor. Obviously, if the quiescent plate voltage is reduced from, say, 75 volts to 25 volts, the possible maximum amplitude of the negative half-cycles of signal is reduced from slightly less than 75 volts to slightly less than 25 volts; the plate cannot swing negative with respect to the cathode if a resistive load is used. In certain RF power-amplifier applications, it is possible for the plate to actually swing negative with respect to the cathode, but this is beyond the scope of this article.

Summary

Some of the effects of changes in value of the components associated with tube circuits have been discussed in this article. These component changes will affect both the voltage present at the various tube elements and the amplifying ability of the circuit.

The changes in tube-element voltages are probably of greater concern and of more practical interest to the servicing technician, since these are more readily utilized in actually troubleshooting the instrument.

It should be remembered that the effects described here are general in nature; how much circuit voltages deviate from normal depends on such factors as the degree of failure of a component; how much the value of the component changes, and in which direction; the normal operating potentials; the presence or absence of feedback loops; the purpose of the circuit; etc. For example, a 5-megohm grid resistor is normal for a sync separator, because this high resistance causes a large amount of self-bias to be developed; but this much resistance in the grid circuit of a video amplifier would be highly abnormal, and the bias developed would cause severe distortion.

In spite of the vast differences in the ways tubes may be used, there are some patterns of behavior which are consistent. If the grid voltage, or bias, of a particular tube is incorrect, it is reasonable to assume that the trouble lies before the circuit of the tube itself. It may be because of improper bias supply, as in the case of AGC bias supplied to an IF amplifier, or it may be the result of insufficient drive, as in the case of a horizontal-output tube. In any circuit using a coupling capacitor, this component should be checked for leakage if the bias is more positive than specified. It is unlikely that faulty components in the plate, screen or cathode circuits of a tube will affect the grid voltage, but the opposite is not true. In fact, if the control-grid voltage is wrong, it is probable that all the other element voltages also will be affected.

Since the voltage applied to the plate of a pentode has but slight effect on the cathode current, a failure in the plate circuit may not change the cathode voltage very much. The cathode current of a pentode is affected by the screen voltage in much the same manner as the cathode current of a triode is affected by the plate voltage, and it may affect the cathode voltage. Radical changes in cathode voltage are likely to be the result of a change in the cathode resistance.

Changes in plate and screen voltages often affect the division of the cathode current between these two elements, so that the voltages on both may be affected. Also, it should be remembered that decoupling circuits often are common to both the plate and screen supplies. If the resistance of a decoupling resistor should change, or the capacitor become leaky, it will change the voltage on both elements. The power supply voltage should be checked before attempting to check voltages in the various amplifying stages of the instrument.

Coming Up

The effects of component changes in solid-state circuits will be considered in a following article. These often are complicated by the effects of forward biasing, constant emitter-base potentials, the low-impedance characteristics of many transistor circuits, direct coupling between stages and the use of numerous feedback loops. ▲

11CF11

Compactron
Double Triode Pentode
Used in color TV Video
Filament—10.7V @ .6A

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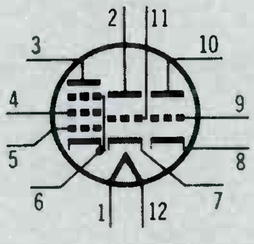
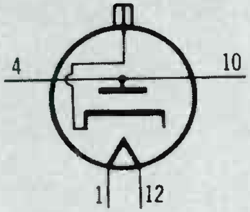
E_{SG}	=	----	----	120
E_G	=	−5.5	−6.3	−5.0
I_P	=	7.1	7.6	27.5
I_{SG}	=	----	----	4.9
G_m	=	5500	6300	21200



12HW

19DE3

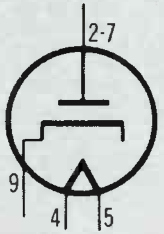
Compactron diode (Damper)
Filament—19V @ 0.6A—11 sec warmup
PIV—5000V @ 350mA



12HX

25CK3

Filament—25.2V @ .3A—11 sec
PIV—5200V @ 250mA



9HP

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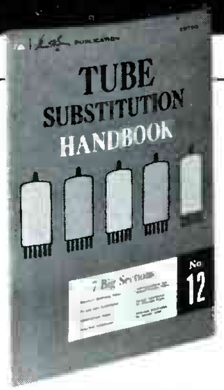
This Supplement has been designed to provide you with the latest up-to-date information on new tubes. The format allows maximum use during a house call or at the bench.



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TUBE
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HANDBOOK

direct substitutes

Included are the older tubes that will substitute directly for the new tubes. This information supplements the sections in the Tube Substitution Handbook for American Receiving Tubes and Picture Tubes.

basing diagrams

The basing diagram for each new tube will help you in the servicing of new receivers when service literature is not available.

typical characteristics

The typical, or average, characteristics of each new tube can be of great help when troubleshooting new circuits.

easy reference

The direct substitution list will be cumulative each month. Thus, only the latest edition need be carried in the Tube Substitution Handbook.

Direct Substitutions

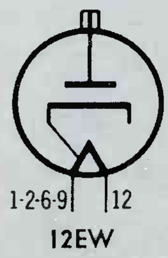
To Replace	Use	To Replace	Use
2AS2A	*	16DCP4	*
3BN2A	*	16LU8	16LU8A
4LU6	*	16LU8A	16LU8
5MQ8	*	17FCP4	*
6AG9	6AL9	18AJ10	*
6AK10	*	19DE3	*
6AL9	6AG9	20AHP4	*
6BW3	*	22AHP22	*
6KV6A	*	25CK3	*
6MQ8	*	25GP22A	*
8AL9	*	31AL10	*
8KR8	*	32HQ7	*
8LS6	*	33HE7	*
9AK10	*	12DEP4	*
10ASP4	*	12DHP4	*
10LY8	*	19GEP4	*
11CF11	*	19HNP22	*
12DKP4	*	22TP4	*
15ACP22	*	22ZP4	*
16BX11	*	25ALP22	*

*No substitution at present time.
Twelfth edition of Tube Substitution Handbook now available at your distributor.

General Specifications

Diode—H.V. Rect.
Filament—2.5V @ 0.33A
PIV—30KV @ 1.7mA

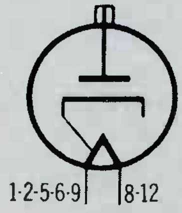
2AS2A



12EW

Diode—H.V. Rect.
Filament—3.15V @ 0.30A
PIV—30KV @ 1.7mA

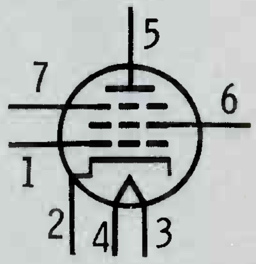
3BN2A



12FV

Filament—4.2V @ 0.6A
E_P = 200V
E_{SG} = 125V
E_G = −8.6
I_P = 20mA
I_{SG} = 4.4mA
G_m = 8000

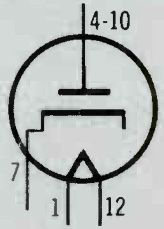
4LU6



7CM

Damper Diode
Filament—6.3 Volts @ 1.6A
PIV—5KV @ 175mA

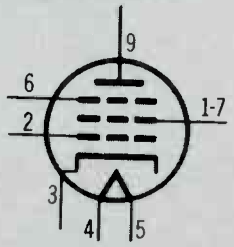
6BW3



12FX

Filament—6.3V @ 1.6A
E_P = 140
E_{SG} = 140
E_G = −24.5
I_P = 40
I_{SG} = 2.4
G_m = 6000

6KV6A



9QU

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Servicing AGC—Tube, Hybrid and

Analysis of the circuit operation and troubleshooting of old and new system designs, plus lists of common trouble symptoms and their probable causes.

By Carl Babcoke

Keyed AGC is a closed-loop system in which the control signal is taken from amplifier stages that are being controlled. One of the inherent characteristics is that a defect will usually change the voltages in all parts of the closed-loop. An analysis of the DC voltages is recommended as the fastest and most accurate method of finding the malfunctioning stage.

Three types of AGC circuits are discussed here: Those with tubes only, hybrids with tubes and transistors intermixed, and all-transistor designs.

A typical AGC system employed in the older and simpler tube-powered television receivers, such as the RCA KCS92 chassis, is shown in the partial schematic of Fig. 1. Operation of this system is as follows: DC and video voltages from the detector (testpoint C) are applied to the grid of the first video amplifier tube, V6A. The detector polarity is negative-going, so an increase in signal strength makes the grid more negative, which in turn makes the plate more positive. Part of this plate voltage is connected to the grid of the AGC keyer tube, V7B, where it is compared to a fixed voltage on the cathode of that tube.

The keyer tube is a grid-controlled rectifier that converts the horizontal pulses applied to the plate to negative DC voltage. The less negative the grid is during the time the horizontal sync pulse is applied to it, compared to the cathode, the more rectification takes place and the larger the DC voltage at the plate.

To minimize snow, AGC is not applied to the tuner RF stage until the input signal is quite strong. This is done by applying B+ through R51 to the tuner AGC line. A diode (part of the 6AV6 audio tube) prevents the AGC voltage from going positive when weak signals are being received.

The large amount of negative voltage necessary to make the tuner AGC operate correctly is too high for the IF's, so a simple voltage divider, consisting of R22 and R24, reduces it. It may surprise you that the second IF tube, V4, also has some AGC indirectly applied to it. Referring to Fig. 1, the first and second IF tubes are DC coupled (some of the filtering components have been omitted for better clarity). When a negative AGC voltage is applied to the grid of V3, its plate voltage rises. Since the cathode of V4 is DC coupled to this plate circuit, the cathode of V4 also becomes more positive. This increases the bias on V4 because the grid is clamped, by the voltage divider R29 and R30, to a fixed positive voltage.

Troubleshooting All-tube AGC Circuits

Three voltages should be checked in each tube set that has, or is suspected of having, AGC trouble. These three voltages are: Tuner AGC voltage, IF AGC voltage and the DC video detector voltage. When these have been checked in a number of sets, and the results analyzed, several conclusions can be made:

1. If the set has normal gain, as evidenced by normal snow off channel, loss of **both** RF and IF AGC voltages will cause excessively high detector voltage, a blank raster on b-w sets or a black raster on a color receiver.
2. If a set has normal gain, **low** RF and IF AGC voltages will cause high detector voltage, overload or locking instability, and a darker picture on color sets.
3. A weak tuner or IF stage makes all three readings low.
4. Too much RF and IF AGC voltage (on or off channel) causes a blank raster on all channels.
5. Low IF AGC and high RF AGC voltages cause snow in the picture. This is true whether the defect is in the IF or RF AGC.
6. High IF AGC and low RF AGC voltages can cause mixer overload with "windshield wiper" or sync instability on strong signals.

In all keyed AGC circuits, the AGC voltage is divided, with part of the grain-reduction voltage going to the RF stage and part to the IF's. If a defect reduces one of these two voltages, the AGC will attempt correction by increasing the remaining one. This may not give perfect reception, but it does make the voltage analysis easier.

Several visual symptoms from the picture, the three measured AGC voltages, a description of the conditions under which the receiver was operated and a few suggestions about what components could cause each symptom are listed in Table 1. The most important thing about these voltages is not their exact value (because they will vary according to signal strength and AGC control adjustment) but their relative value compared to normal AGC voltages for that model and location. The symbols indicate whether the readings are higher or lower than normal.

Case Histories—Tube Circuits

Case #1: An RCA KCS92 chassis had snow off channel, but a clear white raster on any strong channel. The AGC voltages were:

RF	+1	(normal: –2)
IF	+5	(normal: –6)
detector	–14	(normal: –1.5).

The video amplifier was biased to cutoff, thus no picture. High detector voltage and low AGC voltages indicated a defect in the AGC circuit at a point before the RF and IF voltages separate. The positive AGC voltage to the IF's indicated a defect other than a mere loss of AGC voltages. The symptoms were similar to those listed in item #6 in Table 1, except for a positive IF voltage.

Referring to Fig. 1, the voltage at the plate of the AGC keyer was

Solid State

+115 instead of the normal negative voltage. Capacitor C82 was suspected of being leaky; however, before clipping it loose for a voltage-leakage test, a voltage reading at the junction of R48, R50 and C54 made that step unnecessary—the +290 volts measured at that point indicated that C54 was shorted. With a new capacitor soldered in place and the AGC control properly adjusted, two more voltages were added to the three already penciled on the PHOTOFACT schematic: –38 at the plate (pin 1) of V7B, the AGC keyer, and –23 at the junction of R48, R50 and C54, with normal signal.

Here is a helpful, fast test: Short the grid of the AGC keyer tube to the cathode, and measure the negative voltage at the plate. In this set it was –215 volts. This test will help you determine that the keying pulse is present at the plate, the cathode circuit has continuity (ever have an open socket pin?) and all conditions are good except for the grid or cathode voltages.

Case 2: Very snowy picture. At first, the tuner was suspected, but voltage analysis, similar to item 5 in Table 1, eliminated the tuner as the source of trouble. The trouble was found to be a gassy first IF tube that was reducing the IF AGC; replacement cured the snow.

Circuit Changes In Later Designs

The first basic circuit variation that might seem to defeat the usefulness of Table 1 is shown in Fig. 2, the schematic of the AGC circuit in the Zenith 23XC36 chassis. The function of R46, the 1.2K resistor in the cathode return of the first IF amplifier, is to provide smoother AGC action. The voltage drop across R46 is so high that the grid-to-ground voltage will measure positive until the station signal reaches extremely high amplitudes. If the true IF bias is measured from cathode to testpoint A in the grid return circuit, the analysis in Table 1 is still valid.

In the absence of any signal, the plate of the AGC keyer tube, V6A, is slightly positive because of R40.

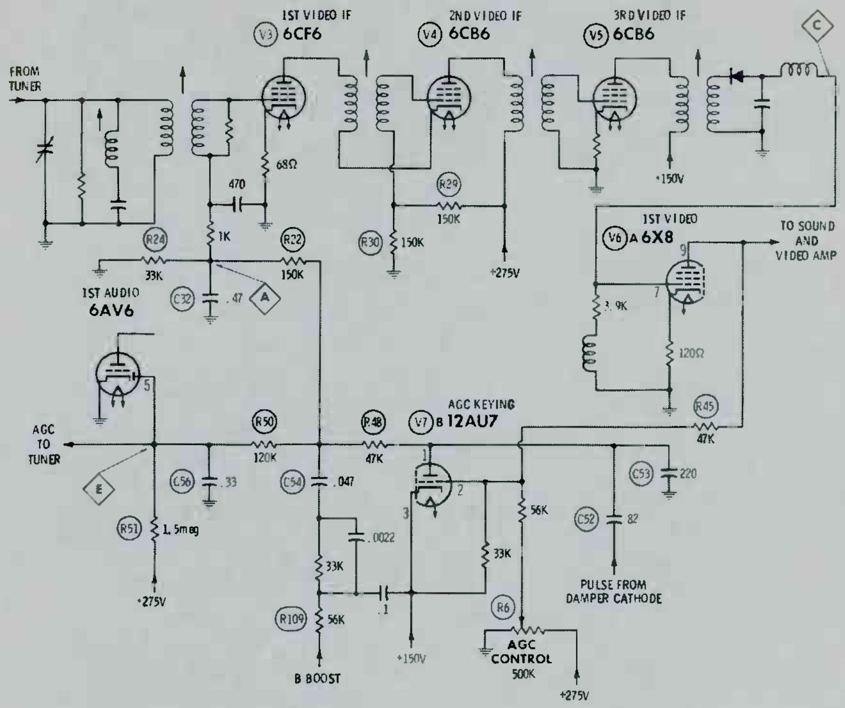


Fig. 1 RCA KCS92 chassis AGC schematic.

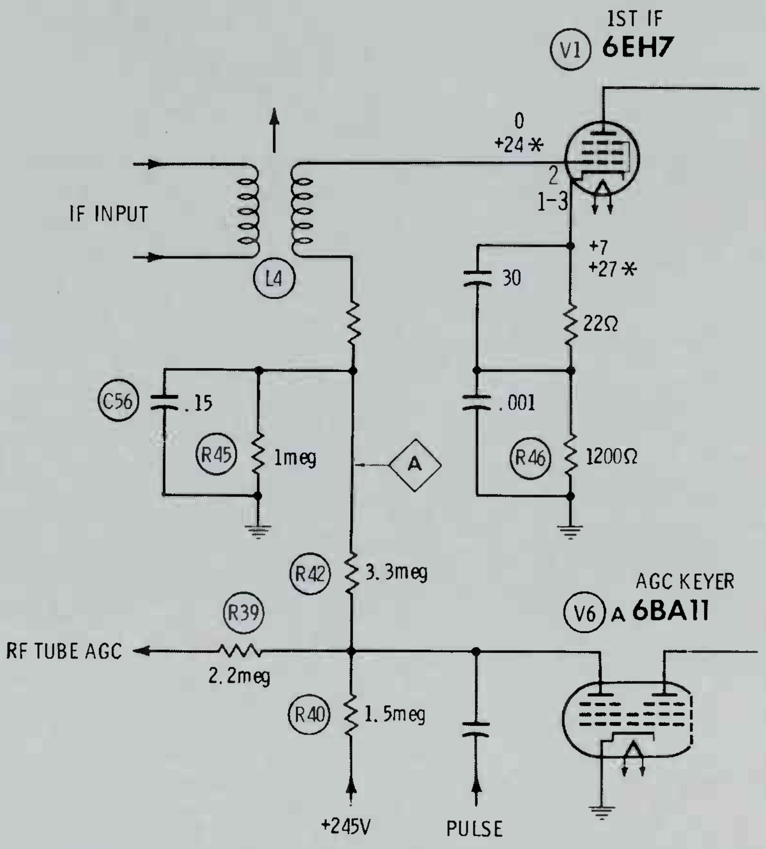


Fig. 2 High-value cathode resistor used in the Zenith 23XC36 chassis makes most of the AGC voltages at TP1 (A) measure positive.

TABLE 1

AGC Voltages for Analysis of Trouble in RCA KCS92 Chassis

Visual Symptoms	Detector Voltage	IF AGC	Tuner AGC	Receiver Condition or Probable Sources of Trouble
1. Stable picture, normal contrast and snow	−1.5	−6	−2	Normal for moderate signal
2. Stable picture, slight snow	−1.4	−5	0	Normal for weak signal
3. Grainy picture with "windshield wiper"	−1.7	−7	−8	Normal for very strong signal
4. Overload, little sync	−2†	−9‡	0†	Tuner AGC too low, C56 leaky, R50 raised, RF tube gassy.
5. Snow on medium strength signal, normal on weak signal	−1.5	−2†	−10‡	Tuner AGC too high, R51 open, IF AGC too low, C32 leaky, 1st IF gassy, R22 too high
6. Blank raster on channel, normal snow off channel	−12‡	−3†	0†	AGC keyer stage dead, C52 open, C53 shorted, R48 open, V7 dead
7. Blank raster	0†	−12‡	−20‡	V7 conducting too much, tube shorted, open R6, low 150 volts, video tube open
8. Low contrast. no snow	−1†	−3†	0†	Weak IF stage
9. Low contrast, some snow	−1†	−3†	0†	Weak mixer stage
10. Normal contrast, heavy snow	−1.3†	−4†	0†	RF stage dead
11. Low contrast, poor locking	−.4†	−3†	0†	Defective detector diode
12. Overload, no sync	+2	−3†	0†	Detector diode reversed

†Voltage is low ‡Voltage is high

TABLE 2

AGC Voltages for Analysis of Trouble in Zenith 14A9C51 Chassis

Visual Symptoms	Detector Voltage	IF AGC	Tuner AGC	Receiver Condition or Probable Sources of Trouble
1. Raster with normal snow	+.6	+4.9	+1	Normal for no signal
2. Normal, stable picture	+3	+7.4	−5	Normal for strong station
3. Dark, snowy, overloaded picture	+8‡	+4.9†	−15‡	Loss of IF AGC, C to E short in Q202, defective Q202
4. No snow off channel, no weak signal received	+.1†	+7.4‡	0	Q202 not conducting on weak signals, R1 open, Q202 open, R3 open, C218 shorted.
5. Overload on strong channel	+5‡	+7.4	0†	Loss of AGC to RF stage, R4 open, C1 shorted, gassy RF tube, shorted feedthru capacitor on tuner
6. Dark, overloaded picture	+8‡	+4.9†	+1†	Loss of negative voltage at 6BA11 plate, bad tube, shorted or open C5, no video at pin 5, open AGC control
7. Normal picture of very low contrast	+1†	+7.4	−5	Might be misadjusted AGC level control, or CR102 may be defective (control of AGC comes from sound detector—not picture detector)
8. Snowy, low contrast picture—no weak stations	+2†	+7.4	−35‡	Excessive conduction in 6BA11, shorted tube, open R5, shorted C228, shorted C6

†Voltage is low ‡Voltage is high

This is necessary to make the grid of V1 nearly as positive as its cathode, and to delay application of the AGC voltage to the RF tube. Yet, the voltage at the AGC terminal on the tuner is only a few tenths of a volt, because the value of R39 is so high (2.2 megohms) that the current drawn by the positive grid reduces the voltage to a low value that will not cause damage to the tube. When using Table 1, consider any positive tuner AGC voltage as being zero.

Hybrid AGC Circuits

A partial schematic of the Zenith 14A9C51 hybrid chassis is shown in Fig. 3. Note that the video detector is positive-going. The output from the plate of V201A, the first video amplifier, supplies a negative-going signal to the common control grid (pin 4) of the 6BA11 sync/AGC tube for the purpose of noise inversion. Another signal from the negative-going sound detector at testpoint C2 is fed to the grid (pin 7) of V203A, the 6KT8 sound/sync/AGC amplifier. The positive-going output at the plate (pin 9) of V203A supplies the sound IF and sync separator circuits and also the suppressor grid (pin 5) of V204A, the 6BA11 sync/AGC tube. This is the signal that controls the amount of rectified negative voltage developed at the plate of V204A.

AGC voltage for the RF tube in the tuner is developed and delayed in exactly the same way as was described for the all-tube circuit in Fig. 2.

Most transistor IF stages require a transistor AGC amplifier to supply the power required by the base circuit of the stage that is being controlled. In this case, phase inversion is also needed, since the AGC plate becomes less positive with increases in signal level, and even reaches a few volts negative on very strong signals. Two resistive networks limit the action of the IF AGC amplifier, Q202. If the base voltage becomes near zero, or slightly negative, the base will be biased insufficiently or reversed biased, respectively, and will be cut off. With such bias conditions, maximum collector voltage is limited by the 470-ohm resistor and the 400-ohm AGC delay control to about +7.5. The function of the AGC delay control is to set the maximum amount of AGC that ever can be applied to Q101, and this indirectly sets the bias on the RF tube to produce the minimum amount of snow. With no signal being received, Q202 transistor is heavily forward biased so that the emitter and collector effectively are nearly shorted together. The 820-ohm emitter resistor prevents the AGC from being reduced too much (minimum bias for weak signals). A non-polarized capacitor (needed because the voltage varies between +5 and −1) bypasses the base to ground for AC signals.

The 1K emitter resistor stabilizes Q101 against drift caused by thermal changes. Because of the emitter-follower action to DC, a change of 2.5 volts (measured to ground) is required to produce a true change of forward bias of only .04 volt (measured from base to emitter). Saturation biasing is used in this chassis; the forward bias on the 1st IF amplifier is +.78 volt with no signal applied and +.82 volt with a strong local signal.

If transistor Q101 is not excessively leaky and the 1K emitter resistor is not out of tolerance, the AGC voltage at testpoint E is usually the only IF voltage measured in analyzing overload or AGC problems. It is not necessary to actually measure directly the base-emitter voltage.

Table 2 gives some clues for analyzing the visual symptoms and AGC voltages in the Zenith hybrid chassis. A "†" after a voltage reading indicates the voltage is too low and a "‡" indicates that it is too high.

The AGC delay control actually delays application of the AGC voltage to the RF stage by limiting the maximum amount of gain-reduction voltage applied to the 1st IF stage. Variations in positive voltage at the plate of the AGC keyer change the IF but not the RF AGC voltage. When the voltage at the keyer plate goes negative because a very strong signal is being received, the IF AGC transistor is reverse biased and cut off (the AGC delay control sets the minimum amount of IF gain), but the negative voltage applied to the RF tube continues to increase as the received signal becomes stronger, and gradually reduces the gain of the RF stage.

Case Histories—Hybrid Circuits

Case #1: Slight pressure on the IF compartment caused the picture to become very weak and the follow-

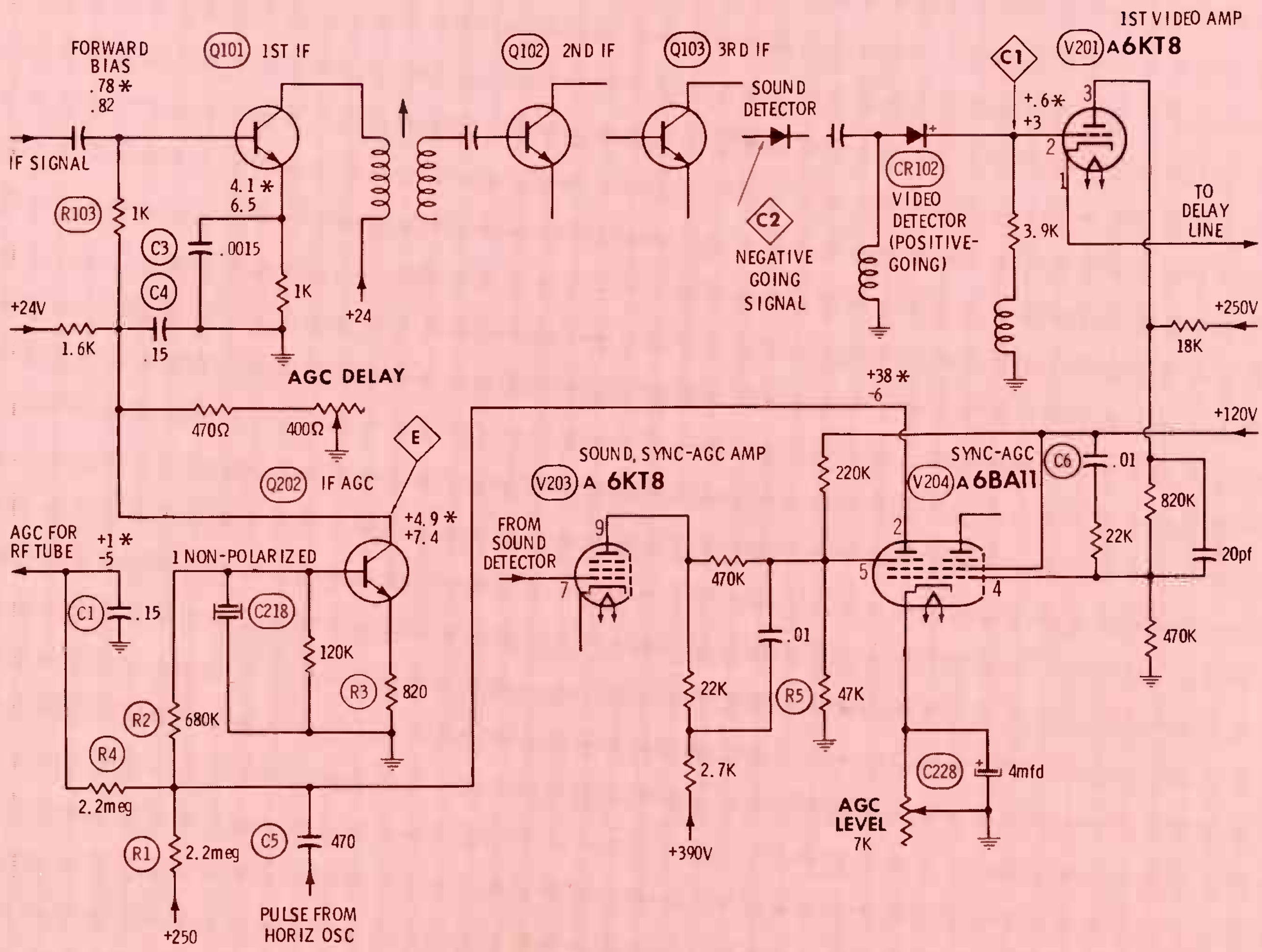


Fig. 3 Zenith 14A9C51 chassis has an AGC circuit with a positive-going video detector, sound/sync/AGC amplifier, keyed AGC and an IF AGC transistor. (*Indicates voltage with no signal applied.)

ing voltages to read:

RF	+1
IF	+3.1
detector	+1.0.

Analysis of these voltages indicated a loss of tuner or IF gain, plus an abnormally low IF AGC voltage. This latter clue pointed to the IF's.

After the IF top shield was removed, the emitter voltage of Q101 was monitored as the defect was cycled on and off. When the gain was low, the emitter voltage was zero.

Repositioning the emitter lead so that it could not touch a grounded point solved the problem. With the emitter voltage grounded, the base was highly forward biased even though the AGC supply voltage decreased because of the added load, and the gain of that stage went to zero and the collector current increased greatly. Only the B+ decoupling resistors prevented the transistor from being destroyed.

Case #2: The receiver operated normally for about 15 minutes, then lost contrast and sensitivity. Analysis of the AGC voltages indicated a loss of signal in an IF stage (see item 1 in Table 2). After the set had heated enough to lose sensitivity, each IF transistor was sprayed with circuit cooler. The 3rd IF transistor was found to be heat sensitive, and was replaced.

All-Solid-State AGC Circuits

Fig. 4 is the simplified schematic of the AGC system in the RCA CTC40 chassis. The video detector is similar to that used in many older RCA chassis designs, except it produces a positive-going signal, and +2.3 volts is applied to its cathode, which normally is

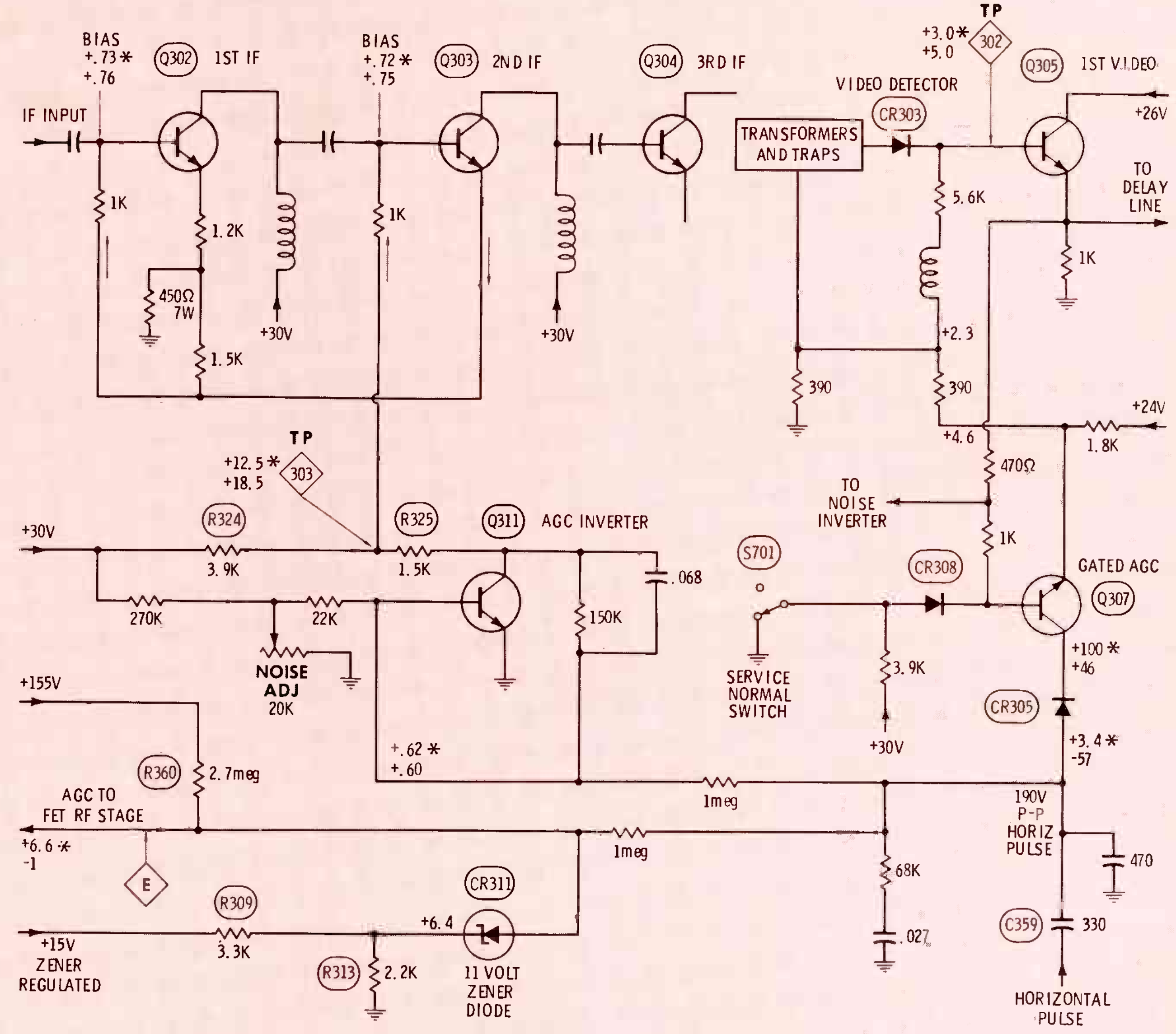


Fig. 4 RCA CTC40 chassis is all-transistor, limits the AGC voltage applied to the RF FET and has no AGC level control. (*Indicates voltage with no signal applied.)

grounded. The purpose of this voltage is to forward bias the first video amplifier, Q305.

DC and AC signals from the emitter of Q305 are applied to the base of Q307, the AGC keyer, where they are compared to a fixed voltage at the emitter. The more forward bias applied to the base of Q307, the more it conducts, which increases the negative DC voltage at the anode of CR305. Without CR305, the horizontal pulses would be rectified by the collector of Q307, and the negative voltage thus produced would find the collector-emitter path a virtual short circuit. Much of this negative voltage would leak off between horizontal cycles. CR305 effectively is a short circuit when the horizontal pulse is present on its anode, but is an open until the next pulse arrives. This is important information for servicing, because either an open or shorted diode or open keying transistor will cause AGC overload.

RF amplification in the tuner is accomplished by a field-effect-transistor (FET), which reportedly is protected from damage from external voltages by zeners at each gate input. As added protection, the variation of AGC voltage to this stage is limited by a circuit consisting mainly of R309, R313 and zener diode CR311. If the voltage at testpoint E (RF AGC) starts to become more positive than +6.6, zener diode CR311 operates in the normal diode mode, and since its anode is positive compared to the +6.4 at the cathode, it conducts and clamps the AGC to the fixed +6.4-volt supply (plus the drop across the diode). If the voltage at testpoint E attempts to become more than –5 volts negative, the 11-volt rating of the zener is exceeded, zener action takes place, and the AGC is clamped to a level that is 11 volts more negative than the +6.4 volts on its cathode, or slightly less than –5 volts.

AGC control of the IF transistor requires a power gain and a polarity inversion that is accomplished by Q311. The noise control varies the bias on the AGC inverter to change the amount of AGC action applied to the IF stages. This indirectly changes the AGC applied to the RF stage, and has the most effect on the visible snow in the picture. Experience has shown that RF AGC voltages in excess of –1 will noticeably increase the snow. Adjust the noise control for minimum snow on a medium-strength station. There is no AGC level control on this model.

The AGC inverter actually controls the voltage supplied to the base of the 2nd IF stage (forward bias is increased to decrease gain). Because of the large emitter resistor in the 2nd IF stage, the emitter voltage changes almost as much as the base voltage; part of this emitter voltage is applied to the base of the 1st IF amplifier to function as AGC voltage.

TABLE 3

AGC Voltages for Analysis of Trouble in RCA CTC40 Chassis

Visual Symptoms	Detector Voltage	IF AGC	Tuner AGC	Receiver Condition or Probable Sources of Trouble
1. Raster with normal heavy snow	+3.0	+12.5	+6.6	Normal for no signal
2. Normal, stable picture	+5.0	+18.5	–1	Normal for a strong station
3. Bright, snow-free raster	+2.3†	+20‡	–5‡	Overactive AGC, S701 open, Q307 shorted
4. Unstable, overloaded picture	+7‡	+14†	+6.6†	Very low negative voltage at CR305, Q307 open **or** shorted, open Q305, C359 open
5. Very snowy picture	+4.4†	+17†	–5‡	Too much AGC at RF FET, R360 raised in value, noise control misadjusted, Q311 leaky, AGC to IF too low
6. No picture	+2.3†	+24‡	+6.6†	Q311 not conducting, R325 open, no forward bias, Q311 open

†Voltage is low ‡Voltage is high

Case Histories—Solid-State Circuits

Case #1: Visual symptoms were typical of those caused by insufficient AGC. The voltage at the three AGC testpoints read:

RF	+6.6
IF	+9
detector	+6.

The voltage readings in item 4 of Table 3 are the most similar to these readings, but the IF AGC voltage reading is lower, and probably significant.

Further voltage tests revealed about +60 volts on the anode of CR305, with less on the other ends of the 1-megohm resistors connected there. C359 was disconnected and found to be leaking. Replacing this capacitor eliminated the trouble symptoms.

Case #2: On channel, the picture was blacked out; off channel, the snow was normal. The three AGC voltages on channel were:

RF	+6.6
IF	+12.5
detector	+9.0.

Total loss of AGC and a very high detector voltage were indicated. A normal horizontal pulse was measured on the collector of Q307, and the base was very forward biased, but there was no rectification. Replacing transistor Q307 cured the AGC problem.

Conclusion

Almost all new circuitry is more complex than it has been in the past, particularly when it uses solid-state components. Also, transistors often are soldered into circuit boards, and the boards can be damaged if components are removed and reinstalled too often. For all of these reasons, it is becoming even more imperative that most of our servicing be done with a minimum of component removal.

Good test equipment helps, of course. Every test used or recommended in this article can be accomplished with a scope and a VTVM (or FET meter). We need to **measure more** and **analyze more.**

One last word on AGC servicing: Remember that the desired end-product is an undistorted, constant-amplitude signal at the video detector. Make certain this consideration is included in your analysis because all parts of the circuit are merely means to this end. ▲

troubleshooter

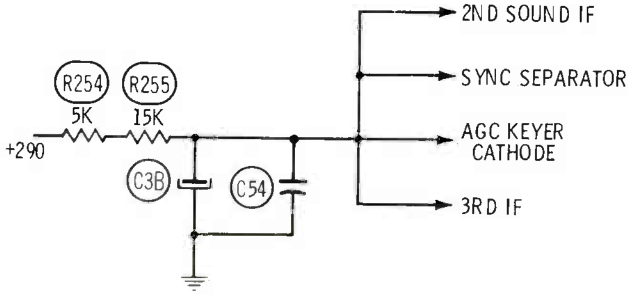
I am working on a Sears Model 6165 color TV that is covered by PHOTOFACT folder 861-2. Here are the symptoms: When it first is turned on, sound is heard in about 20 seconds, stays on about 10 seconds and then disappears as the high voltage comes on. There is a raster without sound or picture.

The trouble seems to be in the AGC. According to the schematic, the plate of the 6AU6 AGC keyer should be +15 volts, but it measures –150 volts. Other readings are: 88 volts on the 6AU6 grid (pin 1), 88 volts on the cathode (pins 2 and 7) and 160 volts on the screen (pin 6). When I clip out C69, the sound returns and the picture is overloaded. With the antenna removed, the picture is weak and snowy.

What other checks do you suggest?

David B. Kaufman
Inglewood, Calif.

Yes, this is an AGC problem concerned with the bias on the AGC keyer tube. Both grid and cathode are the same voltage so the bias is zero. Under that condition, the plate should be *very* negative. The wrong voltage is the cathode voltage. PHOTOFACT specifies +130 volts while it measures about +90 volts. Refer to the schematic. R254 or R255 may have increased in value, C3B or C54 may be leaky, or one of the stages may be drawing too much current. Find the source of the low supply voltage, repair it, and the AGC problem should be cured. You might want to refer to the AGC article in this issue for more information.

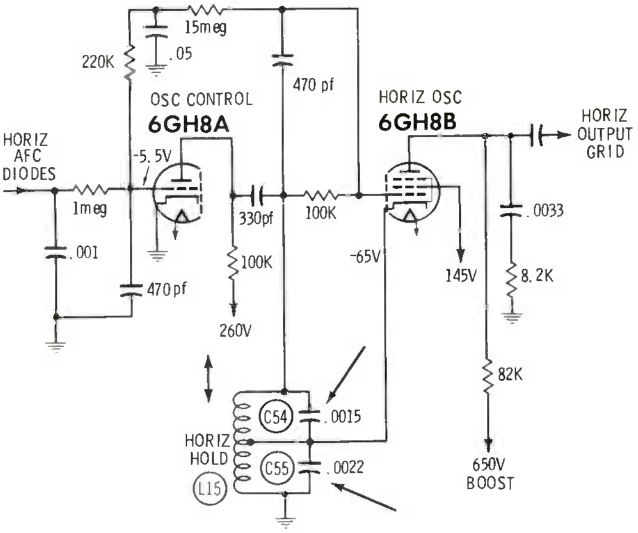


Horizontal Oscillator Off Frequency

Can you please give me some help with regard to a Zenith chassis 14M29 (PHOTOFACT 743-4)? There is a high-pitched whine from the horizontal circuit, no light on the screen and the horizontal frequency is too high. The horizontal output transformer has been replaced because it was shorted, and the oscillator coil was replaced because it was open. All voltages in the horizontal circuit are good except the 650-volt boost voltage, which is only 325 volts. Sometimes I get a dim light on the screen, but it is only about one inch high. Why?

Harold Braden
Riverdale, Illinois

Harold, the number one priority is to get the oscillator back on 15,750 Hz. The boost voltage indicates it is



running 30 to 40 KHz. This horizontal oscillator is a sine-wave type with a coil and capacitor tuned circuit. A blocked oscillator or a multivibrator might deviate that far off frequency from a large change in positive feedback or from a RC time-constant change, but a sine-wave oscillator must have a defect in the oscillator coil or one of the tuning capacitors (L15, .0015 and .0022) for the frequency to have changed that much. Is the oscillator coil an exact duplicate? Are C54 and C55 on the right coil lugs, and are the solder joints all good?

Biasing of RCA CTC17X Vertical Blanking Transistor

The September '69 issue of ELECTRONIC SERVICING shows the last item of Symcure on page 25 to be an NPN transistor with .9 volt on the emitter and .6 volt on the base. The transistor is not forward biased. *Is this correct?*

B. J. Brown
Trion, Ga.

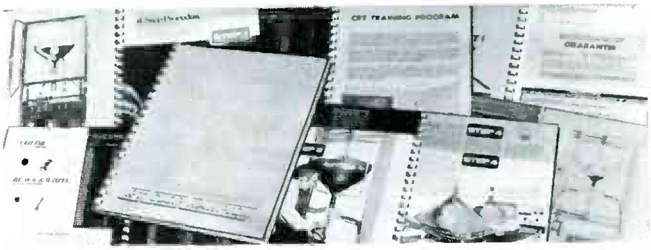
The bias indicated on the vertical blanking transistor in the CTC17X RCA chassis is incorrect. This diagram was reproduced from the PHOTOFACT for that model, so we did not cross-check for wrong values and voltages as we normally do.

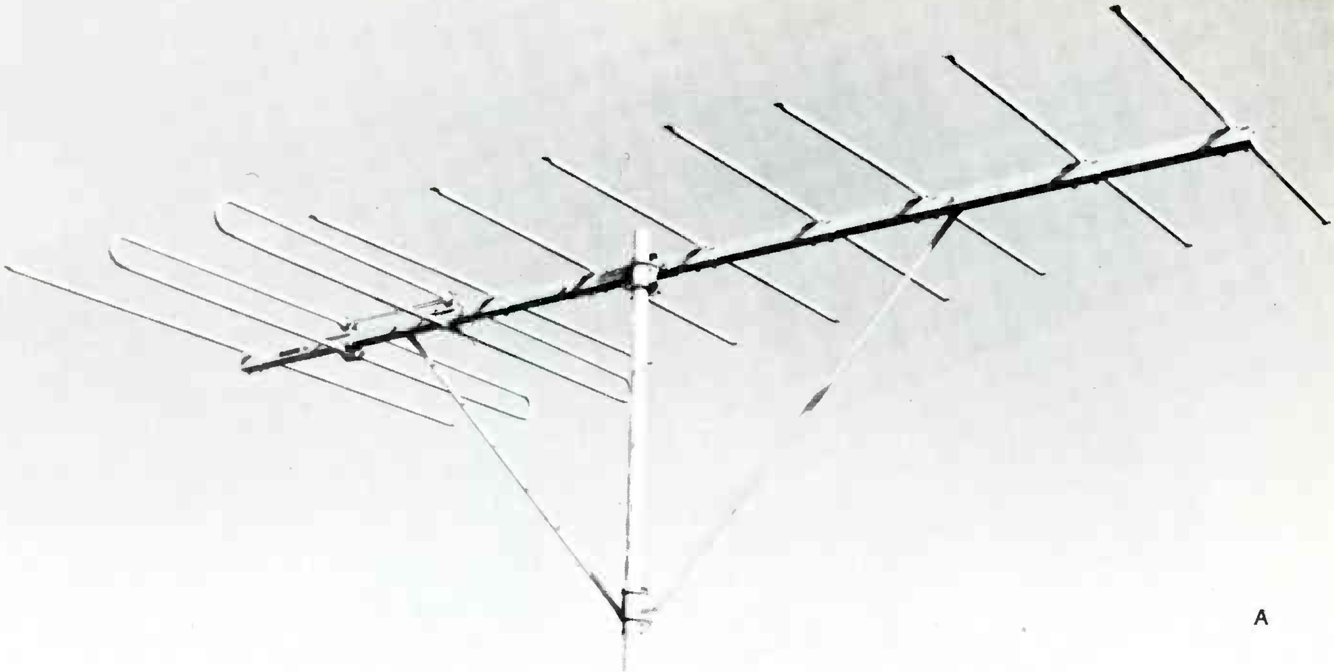
The correct voltages, according to my own tests on dozens of these circuits, are:

base—+.6
emitter—0
collector—between +.2 and +.9.

The emitter returns to ground through a winding on the vertical output transformer, and there is not enough DC resistance to cause a measureable emitter voltage. Between vertical pulses, the transistor is heavily forward biased, and the pulse reverse biases it for a short period of time during each cycle. This accounts for an output of about 10 or 11 volts p-p from a collector on which there is less than a volt of DC.

The voltage measured across the base-emitter junction of class "C" stages (oscillators, sync separators, etc.) usually indicates a reversed-bias condition; this is because of base rectification. The pulse input to such circuits is usually of the polarity that will forward bias the base at the maximum level of the input pulse. ▲





Facts about basic home TV antenna system components

Understanding the fundamental characteristics of basic designs of antenna and lead-in will help you select the correct combination of components for each installation. Knowing how to properly install the system is also important. This article discusses both aspects.

by Bruce Anderson

Characteristics of Basic Antenna Types

The Yagi

One of the earliest types of antennas used for TV reception was the familiar Yagi. Fig. 1 shows an example of this type antenna along with a sketch of its directivity pattern. Probably, if the only consideration was microvolts per dollar of antenna cost, this type would still be the most popular; however, a couple of other considerations enter into the problem. First of all, the Yagi is essentially a one-channel antenna. This means that it is a sharply tuned device which "reflects" the signals from all channels except the one for which it is tuned. This, in itself, could be desirable because it tends to reduce interference from other channels, but, because of the narrow passband, the response to the higher-order sidebands within the channel for which it is tuned may be rejected to a degree which is undesirable. Yagi antennas manufactured after the advent of color TV usually have been designed to provide adequate bandpass for color.

The other disadvantage is more obvious. Since the Yagi will receive only one channel, an array of several antennas, one for each channel, would be required in most areas. This can be done, of course, and the several antennas may be connected to a single lead-in by use of a passive mixing device (multicoupler), but the installation is cumbersome, overly expensive in some cases, and the mixing losses may exceed the advantage in sensitivity of the antennas themselves.

The Conical

One of the early antennas which was designed to receive all the VHF channels more or less equally well was the conical (or "flying V") antenna shown in Fig. 2. Two of these antennas often were stacked and connected together with matching bars to provide additional signal. While this type of antenna served well for monochrome reception, it, too, has some disadvantages. One of the problems with the "connie" is that it has fairly high sensitivity to signals which arrive at its sides. This makes it particularly susceptable to ghosts, as shown in Fig. 3. Also, because the "connie" has an output impedance which varies from channel to channel, it usually is mismatched to the lead-in, and standing waves result. This causes picture smearing, which is particularly troublesome in color reception.

Log Periodics

Ideally, an antenna should combine the good features of both the foregoing antennas while avoiding their disadvantages. The log-periodic types of antenna are broadly tuned to receive all VHF channels,

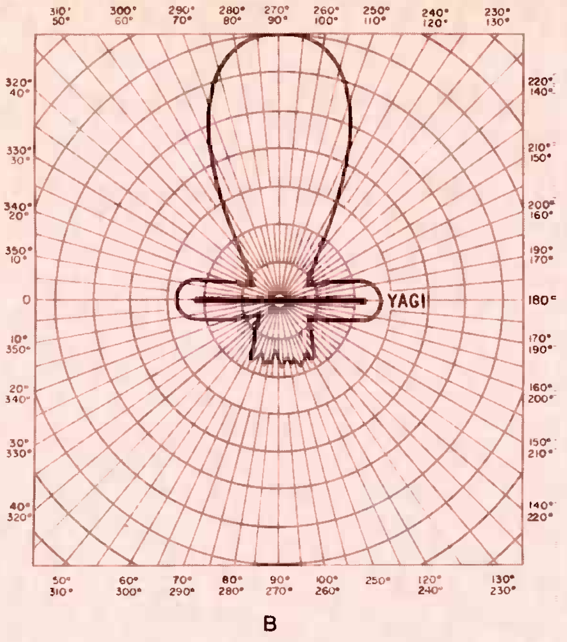


Fig. 1 A) A single-channel, heavy-duty Yagi antenna. B) The directivity pattern of a simple yagi.

maintain fairly constant impedance throughout the band and suppress the side lobes. To do this, of course, there is some sacrifice of sensitivity (microvolts per dollar), and the antenna is somewhat more complex than the conical type.

As the name implies, the log-periodic antenna has elements which are spaced logarithmically and also graduated in length, as shown in Fig. 4. By proper selection of lengths, at least one element (and usually two or three of them) is tuned to each channel. This may seem impossible at first glance, but remember that an element which is one-half wavelength at some frequency, and therefore tuned to that frequency, will act as a good receptor for a higher frequency, for which the element becomes electrically 1½ wavelengths long.

Unfortunately, the elements which are tuned to the 3/2 mode and those which are not tuned at all to the particular channel being received cause the antenna to have rather serious side lobes. Several "cures" for this problem have been devised; the two most popular ones are to incline the outer ends of the elements towards the transmitter (thus forming the V-type log-periodic antenna shown in Fig. 5), or to carefully design the element lengths and add loading devices where necessary to minimize the side lobes (resulting in the design shown in Fig. 4).

V-Yagi

The type of antenna known as a "V-Yagi" attempts to recover some of the gain lost by the log-periodic type while still maintaining flat response across the frequencies of the VHF channel. Fig. 6 shows that this type of antenna has some of the rearmost elements "V-eed" towards the station, similar to the V-type log-periodic; notice also that, unlike the Yagi, a number of the elements are connected to the lead-in. The remaining elements are passive (not driven) as are all but one element in the conventional Yagi.

In the foregoing discussion of all these antennas, it was assumed that maximum sensitivity to the signal was a desirable quality; however, this is not always the case. In many metropolitan areas, signal strengths are so high that the reception problem is one of not overloading the AGC circuits of the receiver, rather than the conventional problem of obtaining enough signal to bring the picture out of snow. For reception in this type of high-signal-level area, the ideal antenna is one having little or no gain, or perhaps some loss, but also having very little sensitivity to signals coming from the sides and the rear. An antenna such as this is shown in Fig. 7.

UHF antennas

Several types of UHF antennas

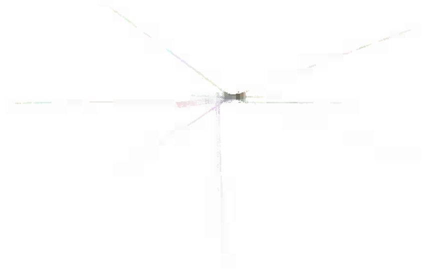


Fig. 2 Typical conical antenna.

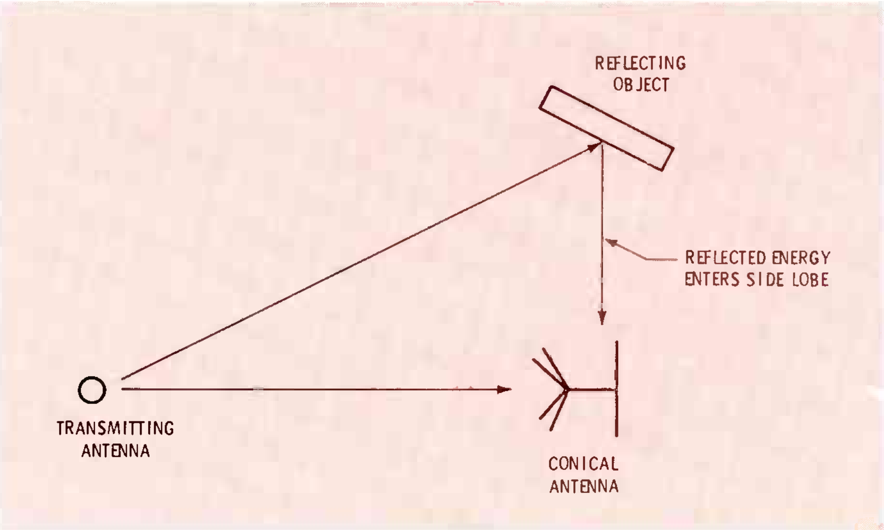


Fig. 3 How side lobes aggravate the reception of ghosts.

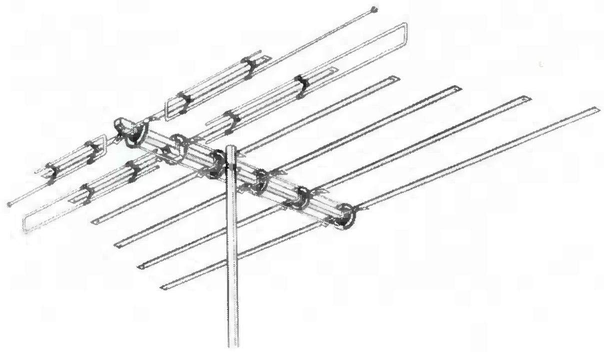


Fig. 4 Straight-element log-periodic antenna.

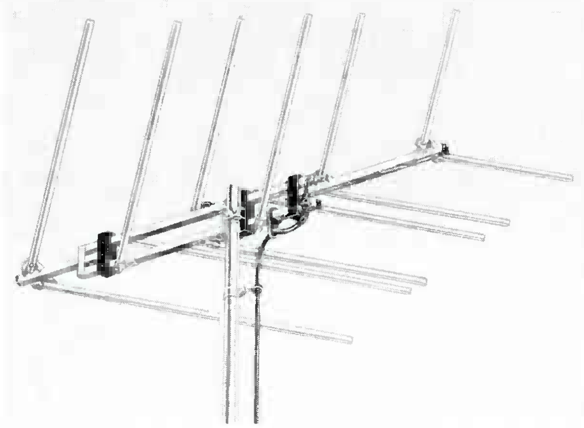


Fig. 5 V-element log-periodic antenna.

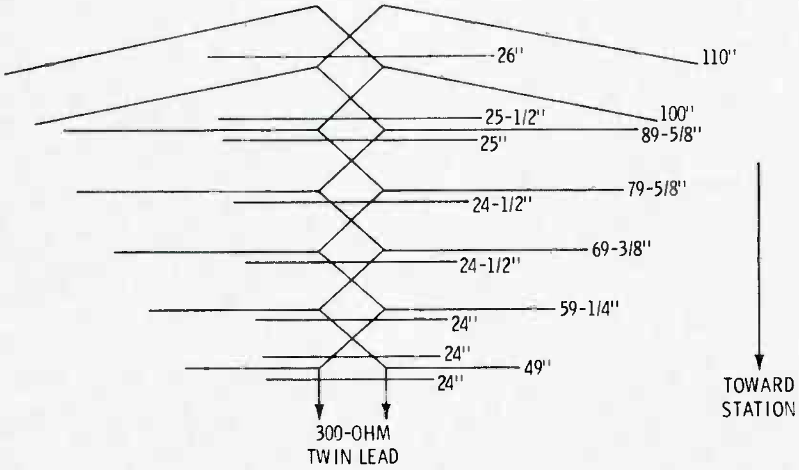


Fig. 6 Typical V-Yagi antenna.

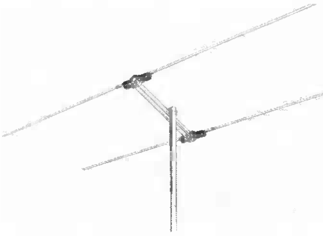


Fig. 7 Low-gain, highly directional "metropolitan" antenna.

also are available. Since the wavelengths of the UHF channels are much shorter, most of these antennas are characterized by their small size and relatively high gain.

Fig. 8 shows the always-popular bow-tie-and-corner-reflector type. (The bow-tie antenna placed in front of a flat reflector also is popular.) Such antennas can be expected to work reasonably well over a frequency range of perhaps 25 channels. Some manufacturers design this type of antenna with a variety of sizes of the bow tie (driven element); the largest element is for the lowest channels. If a new, higher-channel station should happen to go on the air, improved performance may be obtained by trimming off the edges of an existing antenna. Of course, this may result in poorer reception on a lower UHF channel.

While the Yagi antenna may be tuned too sharply for VHF reception, this is not the case with UHF. (A bandwidth of ±5% of center frequency on channel 2 is only about 5.5 MHz, but on channel 40 it is more than 60 MHz, the spectrum of 10 consecutive channels. Naturally, the response to all the sideband frequencies of a single channel is essentially constant.) UHF Yagi's have good sensitivity and they are highly directional, making them very desirable in fringe areas, or where ghosts are a problem. In many designs, the Yagi configuration is modified slightly by placing a corner reflector behind the antenna to reduce back-lobe response.

Increasing Gain

The concept of 'aperture" in antennas may perhaps be most easily understood by considering the sketch in Fig. 9. Obviously, the light **intensity** observed at each aperture will be the same, but if all the light passing through hole "A" were concentrated into a beam equal in diameter to the beam passing through hole "B" (by use of a lens), this concentrated beam would be the brighter. Therefore, it is apparent that more light **energy** can be obtained from the larger aperture. In much the same manner, an antenna having the ability to intercept the energy from a larger cross-section of a TV wave front will provide more signal strength.

To increase the aperture of a

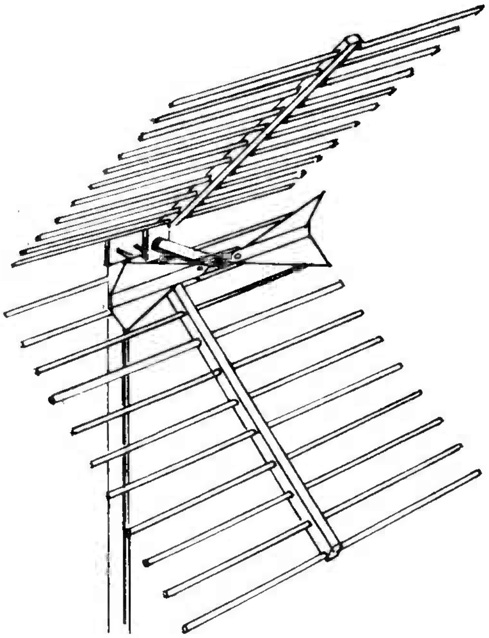


Fig. 8 UHF "bow-tie" antenna with corner reflector.

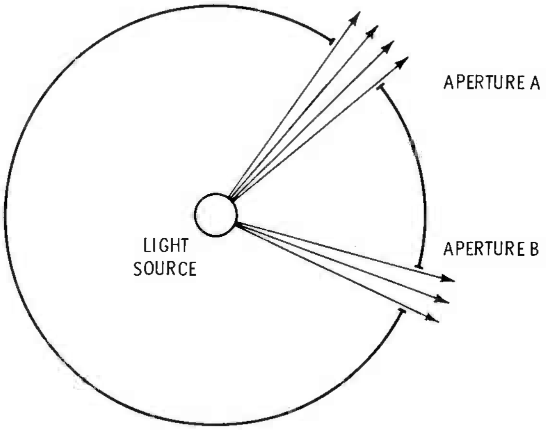


Fig. 9 Relation of aperture to energy obtained.

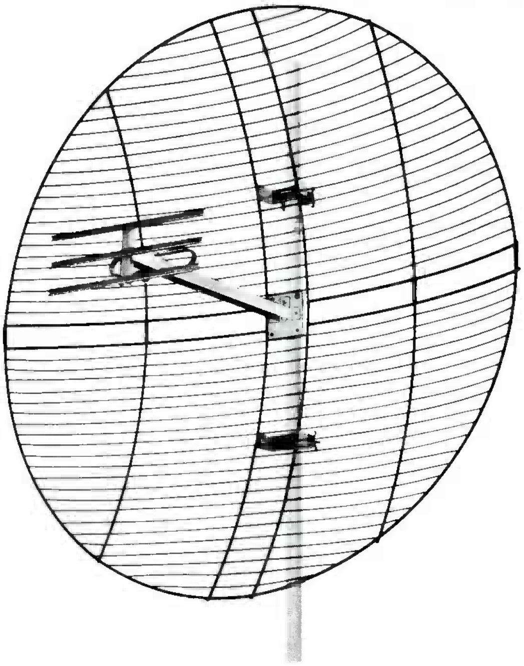


Fig. 10 A large aperture UHF antenna, the parabolic.

VHF antenna, it is common practice to stack antennas—the stacked conical or Yagi, for example. Large-aperture UHF antennas are available as a single unit. Two examples are the "cat-whisker" and the parabolic-reflector types (see Fig. 10). Of the two, the parabolic reflector is the more efficient, but its cost is proportionately greater. Also to be remembered is the fact that a large-aperture antenna intercepts additional wind energy (added wind-loading) as well as additional RF energy.

Combination Types

Today, most manufacturers sell combination UHF/VHF antennas, and also UHF/VHF/FM antennas. These are usually variations of the types described here, with all antennas mounted on one boom. A passive matching device is normally provided to allow the use of a single lead-in. In installing these, or any UHF antenna, use a good grade of UHF lead-in, such as foam-filled twin-lead.

Lead-in

The subject of lead-in has been covered at length in previous issues (see PF REPORTER, May 1968—"Facts About Antenna Lead-In"), but, for convenience, a short summary of the subject is included here.

Flat twin lead

For VHF applications, the conventional type "ribbon lead" (Fig. 11A) is still popular. It has the advantage of being cheap, but this is about all that can be said in its favor. It tends to "check" after prolonged exposure to the weather, thereby increasing its losses; it is affected most by deposits of foreign material on its surface; and its standing-wave ratio is increased by the proximity of metallic objects.

Foam-filled twin lead

Lead-in of the foam-filled variety (Fig. 11B) is much less affected by all of the conditions described above. This is of some importance in color reception, of great importance in UHF reception, and of particular importance in UHF color reception. Because of this, a good quality, foam-filled lead-in is perhaps the minimum type that should be considered for use in a modern installation.

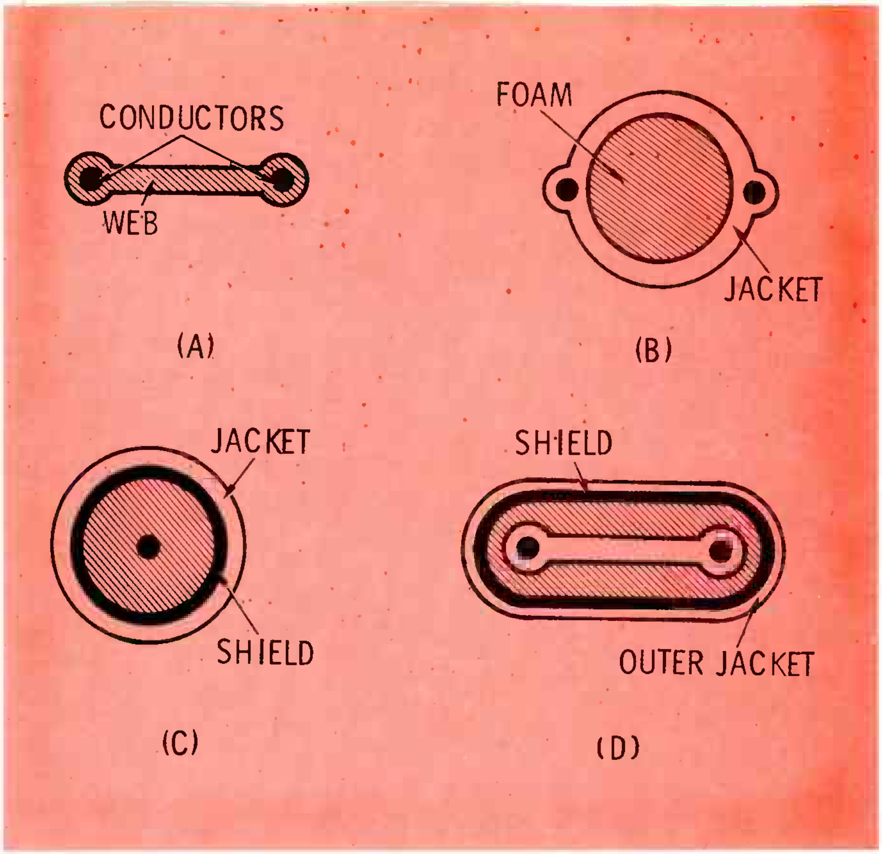


Fig. 11 Popular types of lead-in. A) 300-ohm flat or "ribbon" line. B) 300-ohm foam-filled line. C) 75-ohm coaxial cable. D) 300-ohm shielded line.

In the paragraphs above, we were careful to stipulate that the UHF lead-in under discussion was the foam-filled variety. When UHF television first appeared on the scene, it was recognized that the cross section of the lead-in should be circular so that more of the field surrounding the conductor would be in a controlled environment. The attempt to do this by means of a hollow, circular line was a rather dismal failure. Even with careful attention to sealing the ends of the line and providing drip loops with holes cut in the tubing to allow water to escape, it seemed that water always managed to fill at least a portion of the line after a short time (usually during the first rain). This, of course, resulted in very high attenuation of the signal, as well as a gross mismatch of impedance. For this reason, hollow, tubular lead-in should be used **only** if its entire length is installed inside a building where there is no possibility of moisture entering it. Even under these conditions, moisture may condense inside the line after a few years, rendering it useless.

Coaxial cable

The use of coaxial cable (Fig. 11C) for lead-in has never been very popular because it has much higher attenuation than 300-ohm lead-in, particularly at UHF frequencies, and because nearly all antennas are designed for 300-ohm operation. As an example of the increased signal loss incurred by the use of coaxial cable, 100 feet of typical 300-ohm lead-in will have a loss of about 1 dB, and coaxial cable (RG-59) will have a loss of about 2.5 dB on channel 2. On channel 13, these losses increase to 2 dB and 5 dB, respectively; but on channel 14, the losses are about 3 dB and 8 dB, again, in the same order. Assuming a 1000-microvolt input to the line, 1 dB of loss results in about 900 microvolts output, 3 dB loss results in 700 microvolts output, and for losses of 6 and 9 dB, the outputs are about 500 and 350 microvolts, respectively.

Recently, some manufacturers have made available antennas designed for direct connection to 75-ohm coaxial cable, such as RG-59. Also, some TV tuners are constructed so that they may be directly connected to 75-ohm cable. Of course, matching transformers having only moderate losses are available.

The major advantages of coaxial lead-in are that it is unaffected by the proximity of metallic objects, and dirt or water on its surface does not affect its operation. Also, since all the signal energy is contained inside the shield, it is completely immune to RF interference from automobiles, welders, medical electronics equipment, etc. When the amount of signal strength is sufficient so that the increase losses of coaxial lead-in can be tolerated, its use normally is satisfactory; however, this seldom will be the case for UHF reception..

Shielded 300 ohm lead-in

Gaining considerable popularity during the past few years is the shielded type of 300-ohm lead-in seen in Fig. 11D. This type seems to combine the best features of both foam-filled line and coaxial cable. It is unaffected by its surroundings, like "coax," and its losses are only slightly greater than conventional lead-in. At the frequencies of channels 2, 13, 14, and 83, its attenuation will be roughly .75, 2, 3, and 4 dB greater than the best foam-filled, 300-ohm lead-in. Since no standoffs are required and the shielded lead-in need not be routed away from metallic objects, the modest additional cost of the lead-in is normally offset by the savings in installation time and hardware. For these reasons, the average installation should use shielded lead-in.

Installation

After having installed antennas for more years than I care to admit, I feel confident that the best way by far to do the job is to build from the ground up. A mast or tower firmly "planted" in the ground and fastened to the edge of the roof is simple to install, sturdy, requires a minimum of lead-in, simplifies electrical grounding, and is less apt to involve you in a law suit for damages to a roof or chimney, either during installation or subsequent to a storm.

If the mast must be mounted on a chimney, be certain that it is mounted well above it and on the predominate up-wind side. Otherwise, the antenna and lead-in soon will become corroded or covered with soot, reducing their effectiveness.

A second rule to follow is to carefully inspect the chimney to determine if it is strong enough to support the antenna under all conditions. I recall installing an antenna without taking this precaution (because the building was only two or three years old and the cement-block chimney looked strong enough), only to have the chimney break off at the roof-line after the first wind storm. Then I discovered that the builder had not installed a liner in the chimney. Of course, this was a violation of the building ordinances, but I still had to re-install the antenna to avoid losing a good customer.

If an antenna is to be mounted on a roof vent, be sure that the vent pipe is cast iron or steel. Nowadays, many plumbers use copper vent pipe, which is not strong enough to support large antennas. Always be sure that the roof jack (the inverted cone through which the vent passes) is secure and well sealed against moisture. If the vibrations of the TV mast are likely to loosen the joint between the roof jack and the roof so that water can enter, some other means of mounting the antenna should be found.

Mounting a mast directly on a roof is relatively simple and completely satisfactory if a few precautions are observed. Never walk on a composition roof in cold weather, and never walk on a dry shingle or "shake" roof. Always wear "sneakers" or some other type of soft-soled shoes when working on a roof. Use liberal amounts of roofing tar at any point where you puncture the roof, and finally, use a safety rope—or buy more insurance!

All antenna installations should be securely grounded to prevent lightning damage to the television receiver and to the building. If the mast or tower extends to the ground, it may be connected to a ground rod at least six feet long by means of #6 (or larger) copper wire. Nearly all antennas are constructed so that all elements are DC connected to the boom, and thence to the mast, so that this method of grounding is satisfactory. Even if the mast does not come near the ground, this type of lightning protection is recommended, although a lightning arrestor properly attached to the lead-in normally will prevent any lightning damage, except possibly to the receiver itself. Cast-iron vent pipes may make a good ground connection, but it is possible that the joints will form reasonably good insulators—don't depend on them for lightning protection.

Summary

Some of the fundamental characteristics of various basic types of antennas have been mentioned in this article along with some observations (based on my own experiences) about the choice of lead-in and installation methods.

There are so many variables involved in antenna installation that no single antenna type or installation method can possibly be correct for all cases, even in the same locality.

Because of this, the technician should be familiar with the advantages and disadvantages of the basic types of antenna and lead-in so that he can weigh them against the requirements of each installation and recommend the best possible system design to the customer, who, in turn, must make the final decision based on economic considerations.

Once the design is agreed on, the technician must be capable of properly installing the system components so that all the advantages of the design are realized. ▲

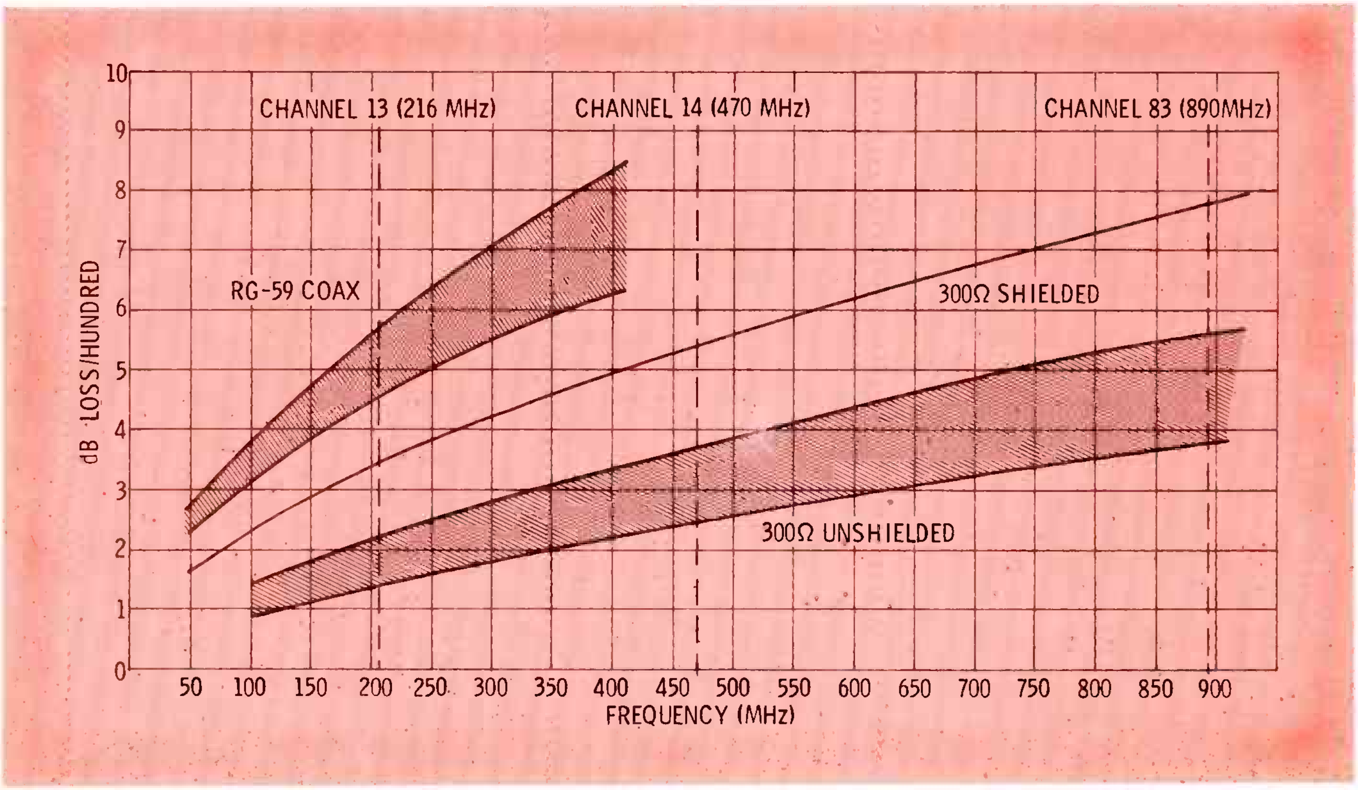


Fig. 12 Typical lead-in attenuation curves show losses of basic types of lead-in.

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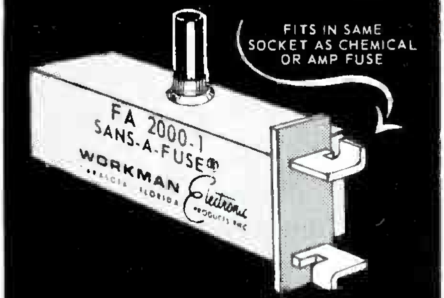

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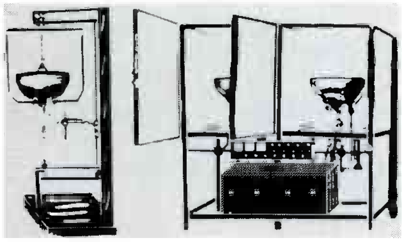

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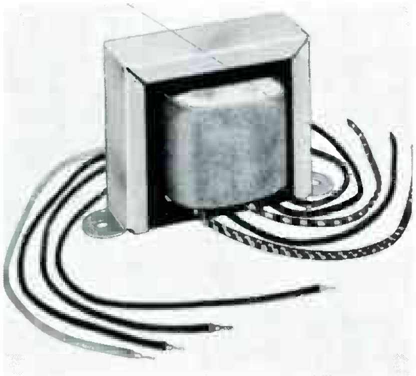
productreport

for further information on any of the following items, circle the associated number on the reader service card.

Low-voltage Power Supply Transformer

The Stancor TP-5 Rectifier Transformer, for use in low-voltage power supplies, is available from Essex International, Inc.

The Stancor TP Series (TP-2 thru TP-5) is designed for 117-volt, 60-hz input. It has multiple primary and secondary taps for output voltages ranging from 6.5 to 42 volts (center tapped). Each unit differs in the secondary current rating.



The TP-5 cost range is from $6.77 to $11.27 each in quantities of one to nine.

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TV Pole Stand

The Slip Seal Co. has introduced a new adjustable pole stand for use with either color or black-and-white television.

According to the manufacturer, the stand can be moved from location to location, without dismantleing, in a matter of several minutes. It adjusts to either a high, medium or low height without taking the unit apart. It swivels easily and takes little floor space.

The Slip Seal Co. states that the stand requires no tools for assembly and is designed for standard ceilings, ranging from 7 ft. 10 in. to 8 ft. 2 in. in height. Extensions of 6 in. and 12 in. are available for higher ceilings.

Two models of the TV pole stand are available. Model C-20 holds color televisions up to and including 20-in. screens and b-w televisions up to and including 23-in. screens. Model BW-69 holds color sets up

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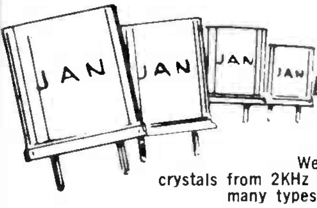

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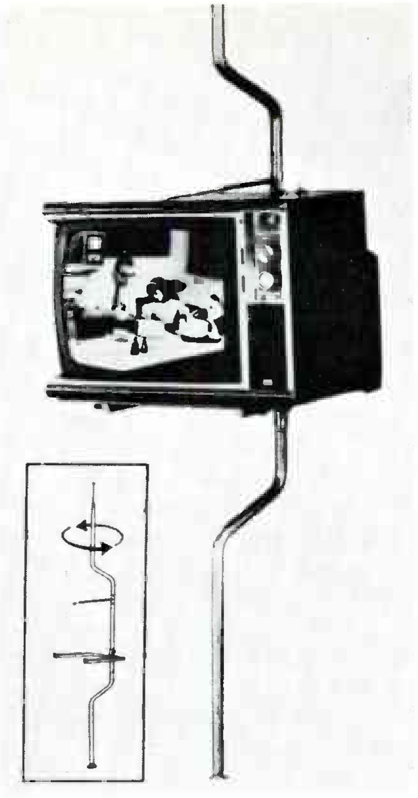


to and including 18-in. screens, providing the depth does not exceed 15 in. It will hold b-w television sets up to and including 21-in. screens.

The stands are manufactured from 1¼-in. steel tubing and are guaranteed by the manufacturer against all defects in material and workmanship. Model C-20, finished in gold, sells for $24.95. Bronze-finished Model BW-69 sells for $22.95.

Circle 71 on literature card

Miniature Welding Torch

Tescom Corp. has announced the development of the "Little Torch," designed for precision welding.

The torch is said to weld metal smaller than .002-in. wire and up to 16-gauge steel. It is applicable for heat bonding, welding and soldering. Tescom states that "Little Torch" uses oxygen and a fuel gas (acetylene, hydrogen, LP-gas or natural gas) to produce flame temperature to 6300° F. It operates at pressures of 2 to 4 psi and uses gas at the rate of .023 to 2.54 cfh.

The "Little Torch" is equipped with five different tips which swivel 360° for ease of handling. The two smallest tips (#1 and #2) have sapphire jeweled orifices for extra durability and precision performance, it is reported.

The torch is available in a variety of different kits, ranging in price from $74.65 to $294.45, depending on the accessories needed.

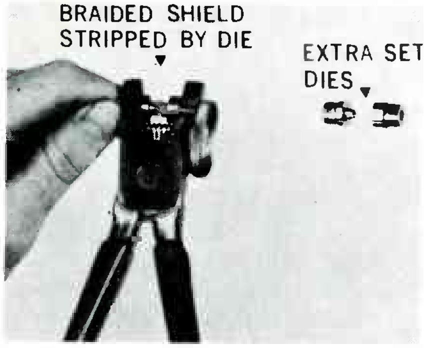
Circle 72 on literature card

Hand Stripper for Metal Braid Shielding

Availability of a hand stripping tool for metal braid shielding has been announced by the Henry Mann Co.

The tool reportedly removes shielding from metal braid 500% faster in production line applications and is fully portable, requiring no power connections. It is stated

that inner plastic insulations cannot be damaged because no heat or razor blades are employed.



Wire is inserted into the "Shield-Stripp" tool, the plier-like handles are pressed and, as the jaws close, the braided shielding bulges out and is sheared off as the punch enters the die. The manufacturer states that the shielding on the wire is cut cleanly and left slightly flared to receive the ferrule and ground connector.

The tool is available in three different models. Dies numbered 1 through 13, covering OD of shielding from sizes .055 to .248 are interchangeable on Model 8. Model 10 is designed for use with dies numbered 43 through 56, which range in sizes from .077 to .307. Model 10X is designed for stripping metal shielding in sizes of 5/16 in. to ½ in. OD.

Model 8 is priced at $31.50, Model 10 sells for $34.50 and Model 10X is listed at $59.50.

Circle 73 on literature card

VOM Teaching Aid and Demonstrator

A special jumbo-size training aid and VOM instrument demonstrator designed for classroom and industry use is being offered by the Triplett Electrical Instrument Co.

The demonstrator is a large-scale replica of Triplett's 630-APLK overload-protected VOM instrument. It can be used for demonstration purposes for the entire Triplett Series 630 product line. The 630-APLK training aid simulates DC measurements in current, voltage and ohms, and AC measurements in voltage only.

The demonstrator comes equipped with a knife-edge pointer that the instructor or student can operate manually. The overload button is triggered by full-scale deflection of the pointer, causing it to pop out, simulating an overload condition.

An ohms adjust knob is operable for simulated zeroing operation.

Circle 32 on literature card

The large polarity-reversal switch may be rotated enabling the instructor to demonstrate range selection and dial association. The use of the mirrored scale incorporated in the unit may also be utilized to teach the student or trainee the value of anti-parallax. A set of test leads is also supplied which can be plugged into the demonstrator to familiarize the student with the operation and set-up of the VOM.

The Triplett demonstrator, complete with a set of instructions and a schematic diagram of a typical basic circuit that can be used for making simulated measurements, is user net priced at $30.00. ▲

Circle 74 on literature card

Jerrold Offers Free 3-Day MATV Course

A three-day Master Antenna Television (MATV) course covering design and installation techniques will be conducted January 20-22 by Jerrold Electronics at their General Office facilities, 401 Walnut Street, Philadelphia, Pa.

The course is offered without charge, except for travel and living expenses, which are to be paid by each person attending, or their sponsor. All classroom and laboratory materials, refreshments at morning and afternoon breaks, and lunches will be provided without cost by Jerrold.

Decibels, antennas, transmission lines, amplifiers, splitters, taps, MATV system layout techniques, problems and demonstrations will be presented during the first two days. An "advanced system school" on the third day will cover strip amplifier head-ends including PMA, HPM and Modlin systems, plus all-channel J-Jacks equipment and layouts.

The starting time each day will be 9:00 a.m. Russell Gimellaro, Technical Director of Jerrold MATV Products, will conduct the course. Dealers, technicians and sales personnel are invited to attend the course.

Course reservations can be made by calling Janis Lerman at Jerrold's offices in Philadelphia (phone WA5-9870). Motel accomodations can be made at Holiday Inn, 1311 Walnut Street, Philadelphia. ▲

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Circle 34 on literature card

catalogs literature

ANTENNAS

100. *New-Tronics Corp.* — announces the publication of a 3-color, 20-page 1970 Hustler CB Catalog, which covers over 80 models of their CB antennas.

AUDIO

101. *Nortronics Co., Inc.* — has released a short form Tape Head Replacement and Conversion Guide, covering 218 manufacturers and over 2,100 tape recorder models.

SPECIAL EQUIPMENT

102. *Dazor Manufacturing Corp.* —has issued 4 new bulletins: Catalog No. 6300, covering their complete line of "floating" lights; Supplement A to Catalog No. 6300; Form 850, which illustrates the Dazor floating magnifier; and Form 821, which also covers their floating magnifier.

103. *Lucasey Manufacturing Co., Inc.*—has released a 4-color, 4-page catalog covering their line of television brackets.

TECHNICAL PUBLICATIONS

104. *Howard W. Sams*—Literature describes popular and informative publications on radio and TV servicing, communication, audio, hi-fi and industrial electronics, including 1969 catalog of technical books on every phase of electronics.*

TEST EQUIPMENT

105. *Lectrotech* — Catalog describing the complete Lectrotech line of vectorscopes, color-bar generators, oscilloscopes, picture tube analyzer, transistor TV sweep circuit analyzer, CB analyzer and frequency meter, power supplies, Lectrocell, and Metergard.*

*Check "Index to Advertisers" for additional information.

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The following code system is used to indicate department coverage of a subject: ASR, Antenna Systems Report; CCM, Color Countermeasures; ES, The Electronic Scanner; LE, Letters to the Editor; NTE, Notes on Test Equipment; PR, Product Report; SYM, Symcure; TER, Test Equipment Report; and TS, The Troubleshooter.


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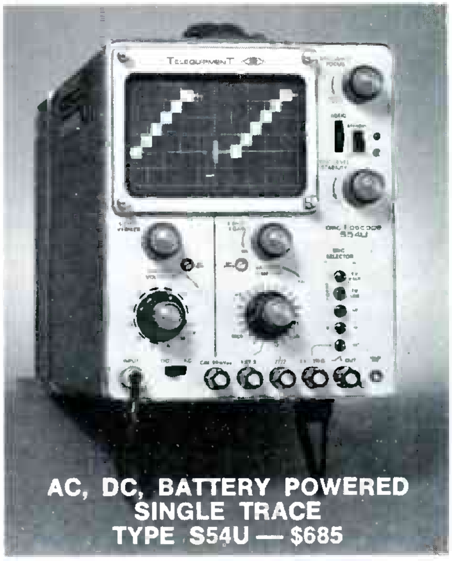
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