

# PF Reporter®

PHOTOFACT

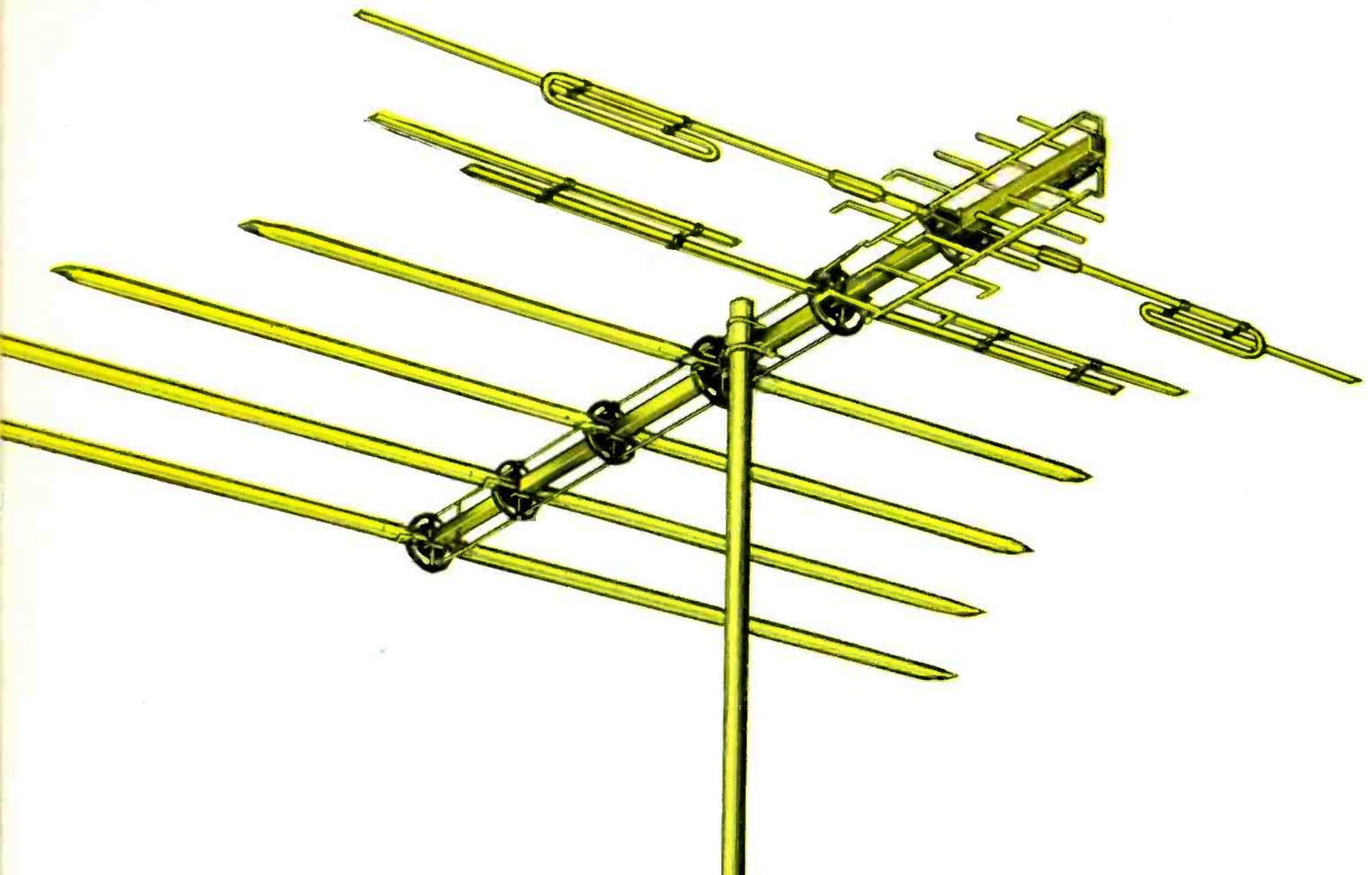
*the magazine of electronic servicing*



1A 6K 1061 568  
 R. A. FAARPTON  
 FRAMPTON HADJO SERV.  
 BOX 144  
 FIDREDS PA. 16781

- Notes on Test Equipment
- Transistor Testers
- Audio Equipment
- Scope Probes

**NEW!** beginning in the APRIL issue  
**TUBE SUBSTITUTION**  
 Supplement  
 (SEE PAGE 1 FOR DETAILS ON THIS NEW FEATURE!)



Fill the "profit gap"  
with the new Jerrold  
**VU FINDER** <sup>T. M.</sup>  
82-channel antenna

Now—the economical new Jerrold VUfinder 82-channel antenna provides the best possible 300-ohm all-channel color TV and FM reception. The VUfinder joins Jerrold's Coloraxial Pathfinder and Paralog-Plus antennas to give you another chance to profit on Jerrold reception quality:

- Sharp directivity eliminates color ghosts
- Flatness of  $\pm 1$  db per channel assures greater color fidelity
- Color-distorting phase shifts are eliminated

The Jerrold VUfinder Antenna actually works on both high and low band channels simultaneously—making each element serve double duty. The models are short, easier to install, and offer less wind loading than ordinary antennas of comparable gain. And each antenna comes complete with a UHF/VHF frequency splitter for the back of the set.

Focus on Jerrold. First with the finest products and profits. For details on the Jerrold VUfinder 82-channel antenna, see your Jerrold distributor.



DISTRIBUTOR SALES DIVISION  
401 Walnut Street, Phila., Pa. 19105

*Circle 1 on literature card*



**NEW!** from **SECO**

## "IN - CIRCUIT" CURRENT CHECKER

Eliminates most common cause of "callbacks" (unstable focus, shrinking pictures, etc.)! Should pay for itself on next months' calls alone!



Nothing else like the HC-8 available! Tune horizontal drive and linearity for "dip"—and in seconds—you've got best possible focus, width and stability at minimum cathode current. Makes convergence adjustments faster, easier—longer lasting!

Especially useful on color TV where a slight misadjustment of horizontal linearity or efficiency coils drives cathode currents sky high! 5 pre-wired sockets for all popular horizontal output tubes lets you plug into circuit fast—no clipping or unsoldering of leads!

Model HC-8  
**\$34<sup>50</sup>**  
Net

**ASK YOUR DISTRIBUTOR**  
or write for full details.

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**SECO**  
**ELECTRONICS CORP.**  
1001 Second St. So. • Hopkins, Minn. 55343

Circle 2 on literature card



## LETTERS TO the EDITOR

Dear Editor:

I've been a reader of your magazine since its inception. I think it's the best in the field. For electronic technicians it's a must.

I would like to see some articles on the European color systems, such as West Germany's PAL and France's SECAM. Also, what is Japan doing?

A. SKVARECK

Orange City, Fla.

*We have outguessed you on this one. Negotiations are already under way to have an author in Great Britain write an article on European color systems.—Ed.*

Dear Editor:

Just a line to let you know how much I enjoy your magazine. I generally read them from cover to cover. I have been most interested in your series of articles on square wave testing. However, it seems to me that there might be a simpler approach to the problem of integrated circuits that might be handled with less expensive and less complex equipment. Basically, there is nothing that the technician can do to these solid integrated circuits except replace them when they are found to be defective.

To me, it looks as if the introduction of integrated circuits will speed and simplify the servicing of electronic equipment provided that replacement parts are readily available. However, information about the input and output voltages and waveforms must be available to the technician. In any event, integrated circuits are going to be more and more frequently used, so anything that can be done to familiarize the technician with them will be most helpful.

W. WILSON

Pittsburgh, Pa.

*Our intention in publishing the Advanced Servicing Techniques series was to instruct the technician in troubleshooting integrated circuits. If the function of the IC is known, the actual circuit configuration of the IC need not be known. Either the device works or it*

*doesn't. If not, it must be replaced. You can be assured that PHOTOFACT Folders will present the maximum amount of servicing information for integrated circuits.—Ed.*

Dear Editor:

I enjoy your PF REPORTER very much—keep up the good work. Follow up articles similar to the one you had on electronics in medicine would be appreciated. Any info you can send me on servicing such medical equipment would be very much appreciated.

J. ZALESKI

Titusville, Fla.

*The results of a reader survey we conducted approximately two years ago indicated that very few of our readers actually service medical equipment. If enough readers are interested in articles on medical equipment, we will do our best to provide them.—Ed.*

Dear Editor:

Recently we had trouble with a TV using the multivibrator vertical oscillator-vertical output circuit. After much trouble and time, we fixed the set.

Since there is so much inherent interdependence in this type of circuitry and pulsed voltages preclude live-voltage testing, may we propose a Symfact or a series of articles on this circuit. We truly believe this could be a time-saving article for those technicians who will, I am sure, encounter defects in this type of circuit at one time or another.

Many thanks for PF REPORTER, which we have found to be an excellent tool. Whenever we "run out of gas" on a dog, we return to the old copies for renewed inspiration and leads.

O. KINBACHER

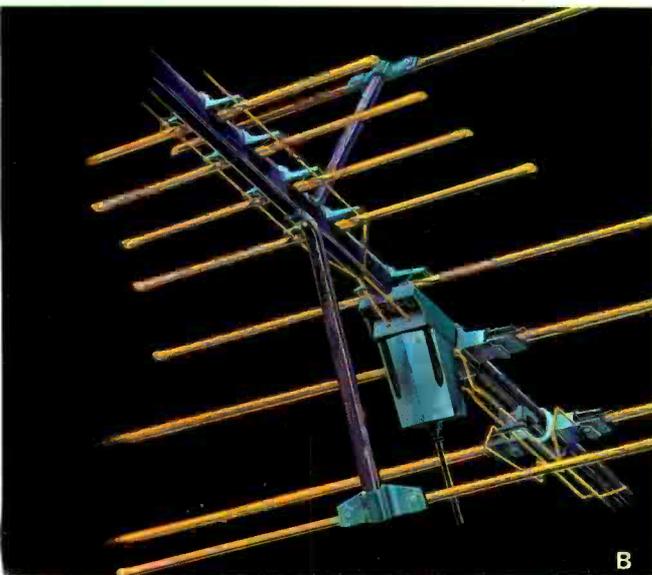
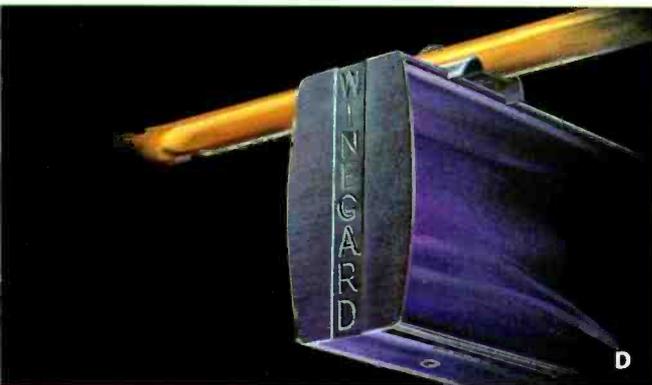
Babylon, New York

*Suggestions from our readers are always welcome. How else can we know what our readers want and need. However, a very similar circuit was covered in the December, 1962 Symfact. We will continue to investigate the possibilities of another Symfact on this type of circuit.—Ed.*

# Winegard Introduces Super Compact Total Design Electronic SUPER COLORTRONS

Five 82-Channel Models  
Four VHF/FM Models  
Three UHF Models  
...so revolutionary in design and concept,  
they have 7 patents and patents pending

82-Channel Super Colortron  
Model SC-82; \$54.95



## The World's First Total Design Antennas

New antennas come and go. But there's never been an antenna like the amazing Winegard Super Colortron. 12 models in all—totally designed with more exclusive electronic, construction and performance features than all other antennas combined. It's taken us a while to create and develop and perfect the Super Colortron. But it was worth the time. See for yourself. Read about the Super Colortron's exclusive features. Then call your Winegard distributor. Or write for full color, 8-page brochure.

### (A) Total Design

#### Cartridge Pre-Amps:

Exclusive solid state, instant-loading cartridge pre-amps drop into totally enclosed, weatherproof cartridge housing at point of signal interception. Models for 82-channel (VHF-UHF) antennas, VHF only, UHF only—plus a color spectrum filter. Custom-match the Super Colortron to any reception requirements.

#### Total Design

#### Impedance Correlators:

Exclusive impedance correlators (2 patents pending) automatically increase 75 ohm driven elements to 300 ohms to provide 100% signal transfer from antenna to set. Enables antenna to be 20% more compact!

### (B) Total Design

#### Vertical Resonant Reflectors:

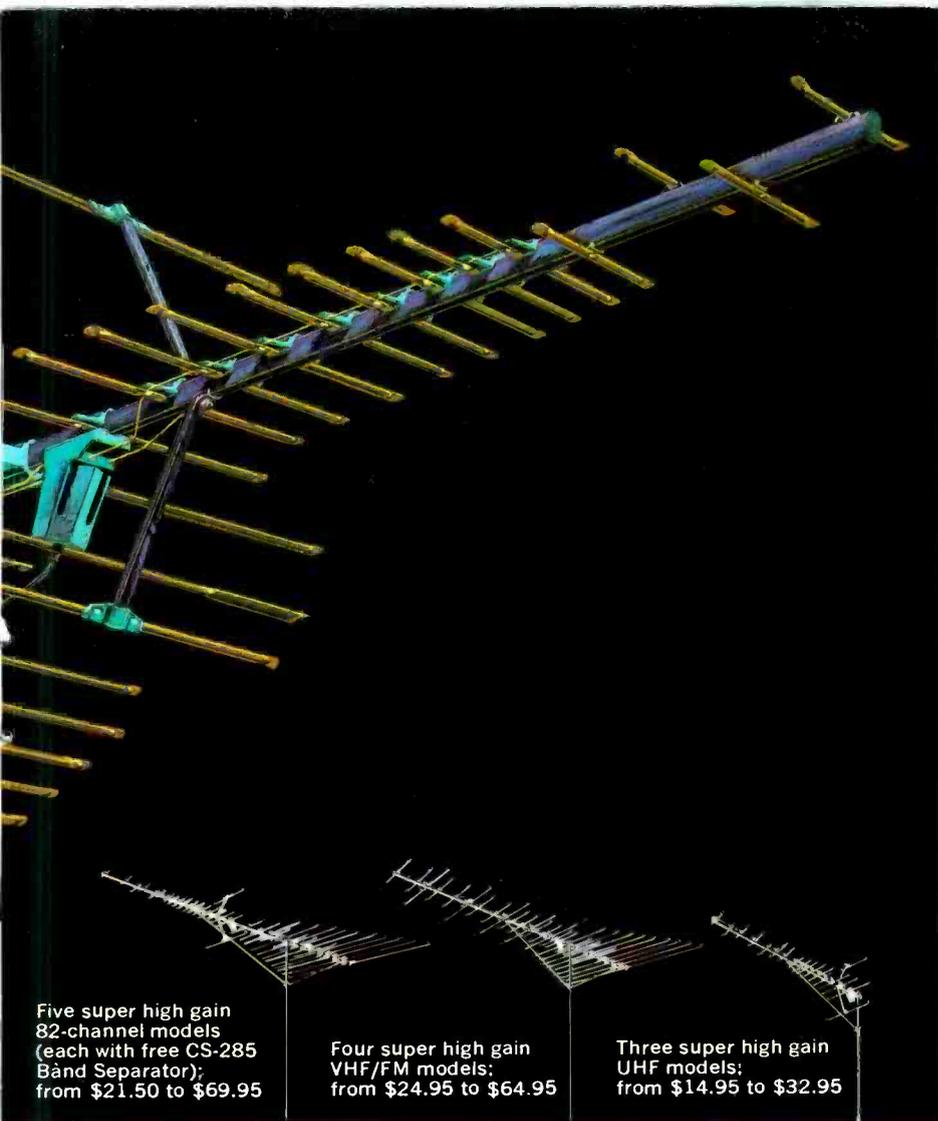
Exclusive UHF vertical resonant reflectors achieve highest realizable gain on channels 14-83 because of exceptionally large vertical capture area. More UHF gain than any other 82-channel antenna design.

#### Total Design

#### Electro-Lens Director System:

Exclusive patented Electro-Lens system (U.S. Patent 2,700,105; Canada 511,984) absorbs entire signal and focuses it directly onto the driven elements to give Super Colortrons pinpoint directivity.

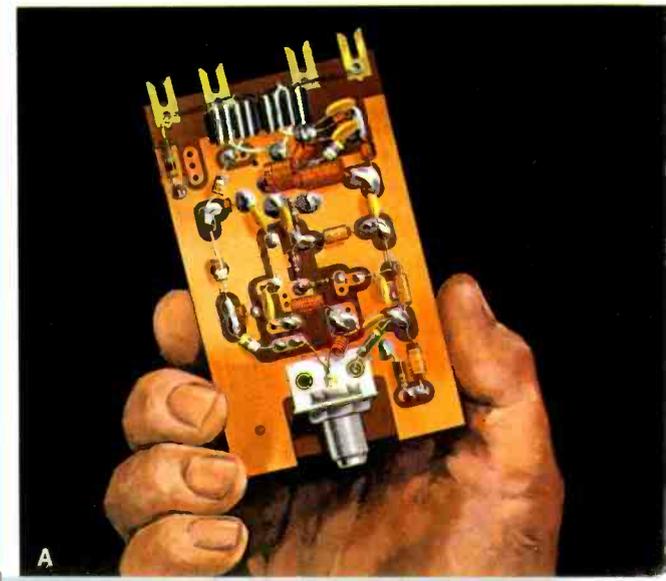
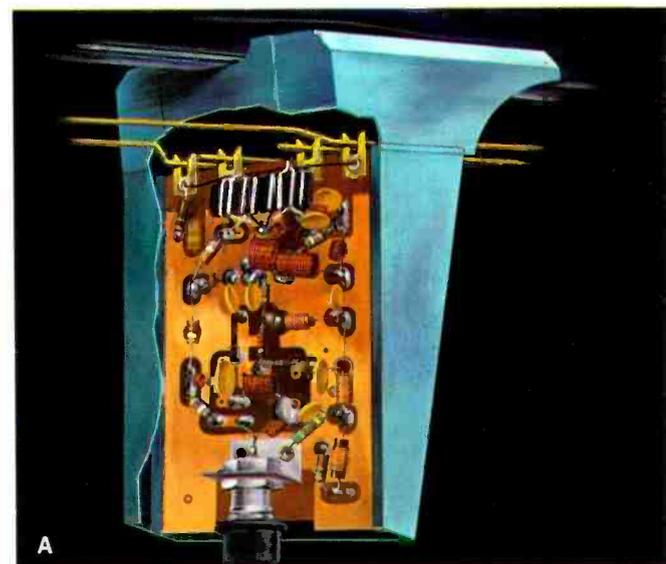
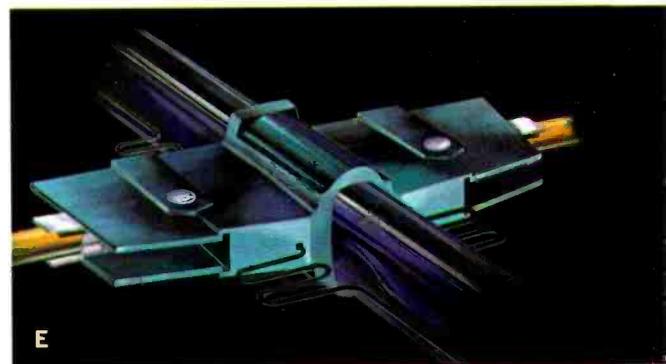
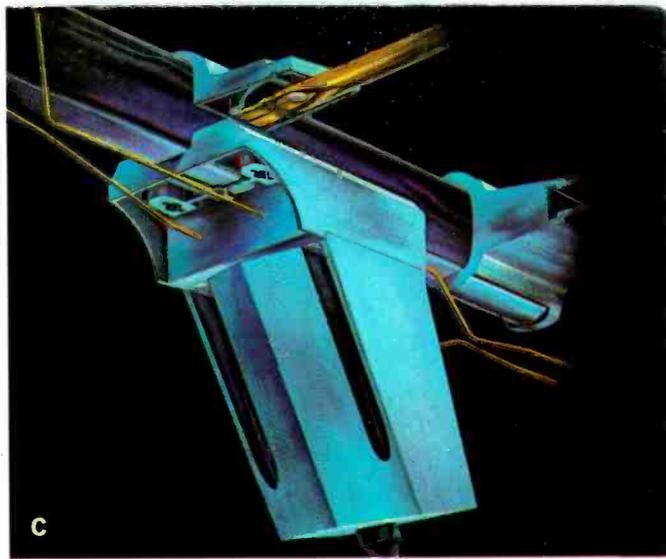
Circle 3 on literature card



Five super high gain 82-channel models (each with free CS-285 Band Separator); from \$21.50 to \$69.95

Four super high gain VHF/FM models; from \$24.95 to \$64.95

Three super high gain UHF models; from \$14.95 to \$32.95



**Total Design FM Control Element:**

Exclusive FM element provides high gain on FM bands—and enables you to attenuate FM bands in areas where strong FM signals interfere with TV reception.

**(C) Total Design Cartridge Housing:**

Exclusive housing is an integral part of Super Colortron—built-in and permanent. Completely weatherproofed to protect solid state cartridge pre-amps and connections.

**(D) Total Design Ellipsoidal Boom:**

Exclusive boom is the first aluminum tubing shape engineered especially for antenna use. Proved far stronger than any other existing boom design.

**(E) Total Design Wrap-Around Insulators:**

Exclusive low loss dielectric insulators completely encapsulate and weatherproof elements and correlators at point of electrical contact. Hi-impact polystyrene. Provide perfect alignment of elements and eliminate sagging and loosening.

**Total Design High Tensile Aluminum Elements:**

Exclusive aluminum alloy has PSI rating of 38,000 as compared to 27,000 PSI for alloys used in other antennas. More than 49% stronger—and 29% more resistant to bend and wind distortion.

**Total Design Wrap-Around Mast Clamp:**

Exclusive mast clamp has 4 pair of locking jaws (not just 2) to automatically align antenna on mast and for greater strength and durability. Requires only one U bolt.

**Total Design Gold Anodizing:**

Exclusive Gold Anodizing is the only permanent gold finish used on any antenna—the only positive protection against corrosion and fading.

**Total Design Assembly:**

Exclusive construction makes the Super Colortron truly easy-to-install—unfolds in seconds—completely factory pre-assembled.



**Winegard**  
ANTENNA SYSTEMS

WINEGARD COMPANY, 3000 KIRKWOOD STREET, BURLINGTON, IOWA 52601

# PF Reporter<sup>®</sup>

PHOTOFACT

*the magazine of electronic servicing*

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## ABOUT THE COVER

Selecting the proper test equipment can spell the difference between success and near success in solving a particularly difficult servicing problem. Equally as important is the choice of probe. All too often the effectiveness of a test instrument is nullified by the choice of probe. Our cover this month symbolizes this interdependence of test instruments and probes. Further information on this subject is provided in an article beginning on page 28 of this annual test equipment issue.



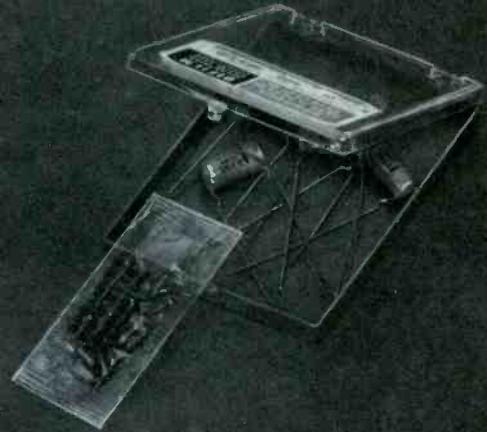
# KWIKETTE<sup>+</sup> Soldering Aids available these NEW ways...



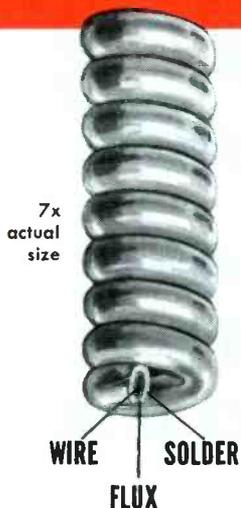
Packet of 10  
for 29¢



Package of 100  
for \$2.79



With all Sprague pre-packaged  
wire-lead service-type capacitors  
at no extra cost to you!



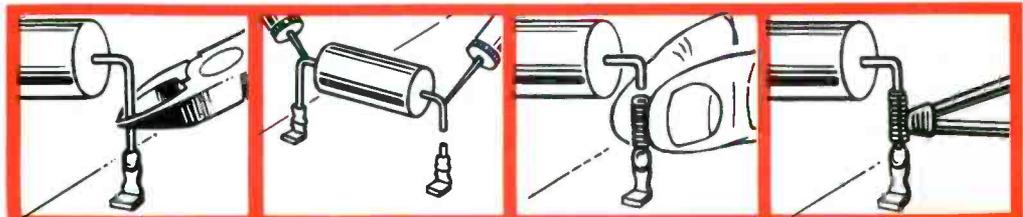
## NOW...YOU CAN SAVE TIME, TROUBLE, AND \$\$\$\$ ON MORE SOLDERING JOBS

*This is it:* the revolutionary KWIKETTE that speeds component replacement . . . and practically lets you do "in-circuit" parts testing. This unique soldering aid is not just another wire spring connector. It features a Copperweld wire inner core, an intermediate layer of flux, and an outer jacket of solder . . . all you need is heat!

You can now buy KWIKETTES from your Sprague distributor in packages of 10 and 100. You'll also find them included with all Sprague pre-packaged wire-lead service-type capacitors . . . at no extra cost to you.

★Trademark

If you haven't tried KWIKETTES yet, do it now. They're the biggest boon to the service technician since the soldering gun!



SNIP LEAD...

TEST...

SLIP ON KWIKETTE...

APPLY HEAT!

**FREE TRIAL PACKAGE:** A postcard request will bring you ten KWIKETTES for testing. Write to Sprague Products Co., 105 Marshall Street, North Adams, Massachusetts 01247. (Please include the name of your Sprague distributor.)

**DON'T FORGET TO ASK YOUR CUSTOMERS  
"WHAT ELSE NEEDS FIXING?"**



For window-size blow-ups of this message, send 10¢ to Sprague Products Co., 105 Marshall St., North Adams, Mass., to cover handling and mailing costs.



## **YOUR TV TECHNICIAN GUARANTEES YOU THE BEST SEAT IN THE HOUSE!**

Did you ever stop to think how many millions of dollars in entertainment your TV set brings you? A national half-hour show once each week costs its sponsor about \$7,000,000 a year. And you can watch it all for free . . . from the best seat in the house!

When something goes wrong, you can thank your local *independent technician* that it won't stay that way for long. Before you even got your set, he spent years of study in television techniques . . . repaired hundreds of sets . . . bought all kinds of necessary expensive test equipment to do the job right. That's why, when you

call him you'll find he already knows your set and has the knowledge and equipment to fix it promptly. Call him at the first sign of trouble, and you won't have to spend a single night without TV.

As a responsible member of your community, your service technician stakes his reputation on your satisfaction. He'll charge a fair price for his work, based upon his time and the quality of replacement parts he uses. But you'll be able to go back to enjoying millions in entertainment—all for free!

**THIS MESSAGE WAS PREPARED BY SPRAGUE PRODUCTS COMPANY,**

DISTRIBUTORS' SUPPLY SUBSIDIARY OF SPRAGUE ELECTRIC COMPANY, NORTH ADAMS, MASSACHUSETTS FOR . . .

**YOUR INDEPENDENT TV-RADIO SERVICE DEALER**

6S-205 R3



# THE ELECTRONIC SCANNER

*news of the servicing industry*

### Radio Most Popular

Radio is America's most popular entertainment, according to the **National Association of Music Merchants**. In fact, America has 25% more radios than people—242 million radios compared to a population of 195 million. The average U.S. family has four radios in its house.

Seven out of ten Americans listen to the radio every day and the most-listened-to programs on radio are music, according to the NAMM. Music is the most common interest of the entire family in terms of home entertainment and radio is the electronic device that delivers this to the home at the lowest cost.

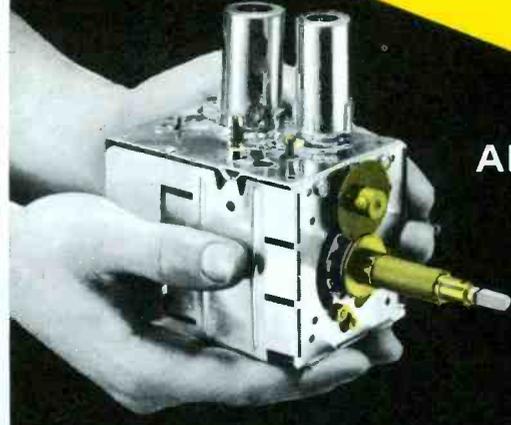
Price has been a key element in making radios so common with total sales reaching 34 million annually. A typical U.S.-made transistor set costs just 25% of what it did seven years ago and imports, which account for half of all radios sold in the U.S., have dropped to an average wholesale price of \$5.95 with sets from Hong Kong wholesaling at an average price of \$2.57.

In the first nine months of 1966, Hong Kong alone sent 5,500,000 radios to the U.S., while Japanese exports of radios to the U.S. for the first nine months added up to 9,600,000.

Radio's penetration of the American home has been recognized by marketing experts and last year network radio had the biggest growth in advertising sales volume of all media, its 18% gain doubling even the percentage gain of television.

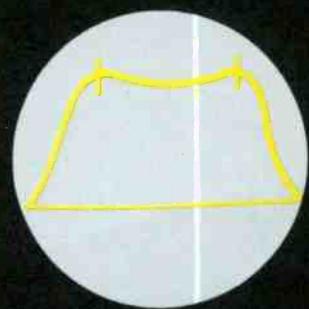
Americans are far ahead of the rest of the world in use of radios although half of our U.S. sets are foreign-made, mostly in the Far East. Compared to more than one set per person in the U.S., there's a set for every three persons in western Europe, one for every six people in Russia and one for every 40 in south-east Asia.

## COMPLETE TUNER OVERHAUL



ALL MAKES — ONE PRICE

# 9.95

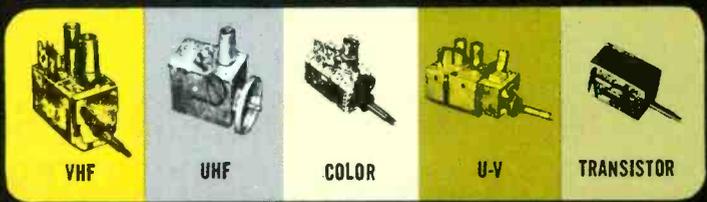


3.58

ALL LABOR AND PARTS (EXCEPT TUBES & TRANSISTORS)\*

## COLOR TUNERS

GUARANTEED ALIGNMENT — NO ADDITIONAL COLOR CHARGE



Simply send us the defective tuner complete; include tubes, shield cover and any damaged parts with model number and complaint. Your tuner will be expertly overhauled and returned promptly, performance restored, aligned to original standards and warranted for 90 days.

UV combination tuner must be single chassis type; dismantle tandem UHF and VHF tuners and send in the defective unit only.

Exact Replacements are available for tuners unfit for overhaul. As low as \$12.95 exchange. (Replacements are new or rebuilt.)

And remember—for over a decade Castle has been the leader in this specialized field . . . your assurance of the best in TV tuner overhauling.

Pioneers of TV  Tuner Overhauling

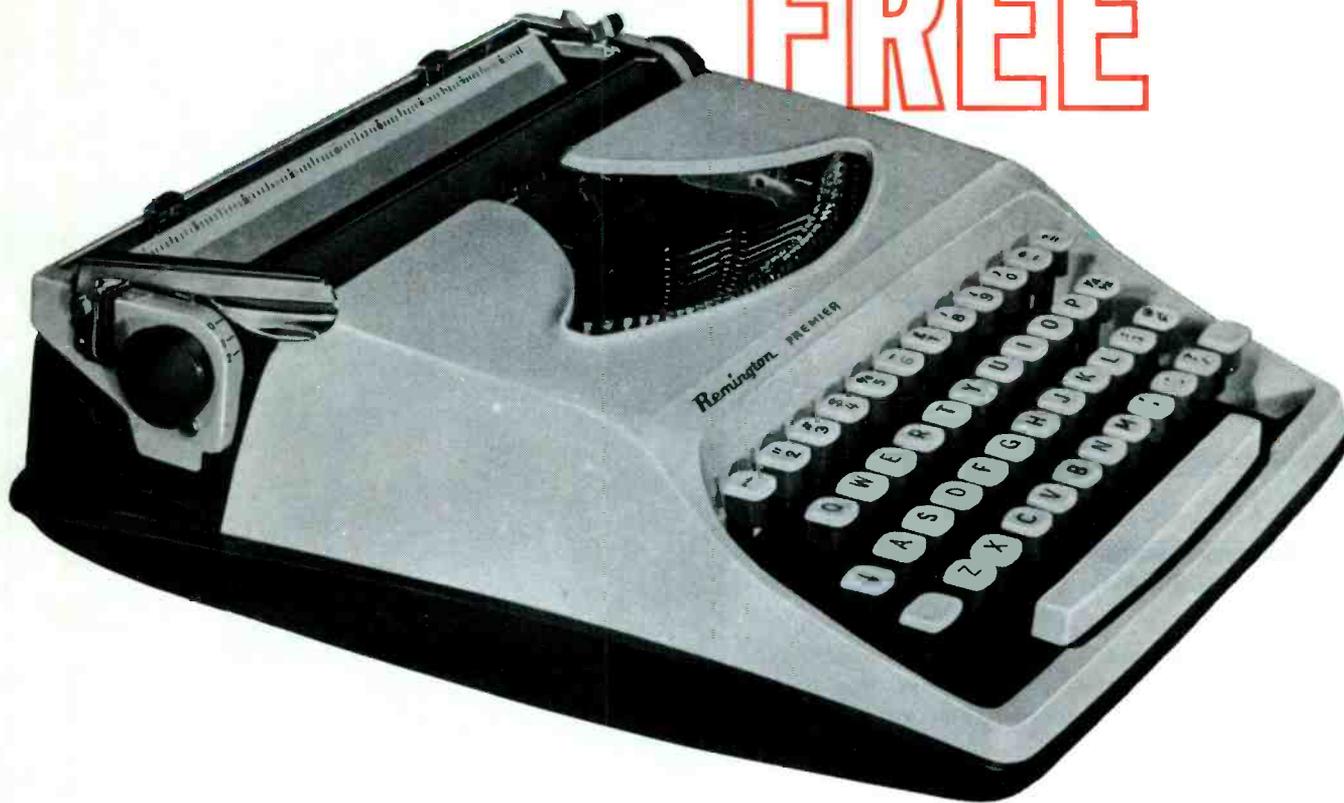
# CASTLE TV TUNER SERVICE, INC.

MAIN PLANT: 5701 N. Western Ave., Chicago 45, Illinois  
EAST: 41-90 Vernon Blvd., Long Island City 1, N.Y.

Circle 6 on literature card

This **Remington** PREMIER PORTABLE TYPEWRITER

FREE



**WHEN YOU BUY THIS RCA WR-64B  
COLOR BAR/DOT/CROSSHATCH  
GENERATOR...THE ESSENTIAL  
COLOR TV TEST INSTRUMENT**

Here's a deal you can't afford to miss! A FREE Remington portable typewriter—yours when you purchase the most essential color-TV test instrument—the RCA WR-64B!

Just imagine how handy your new typewriter will be—in the shop or at home. You'll use it almost as much as you use the RCA WR-64B—standard of the color TV servicing industry.

Here's how to get your FREE Remington Typewriter. Mail in the warranty card plus the gold label from the shipping carton of your new RCA color bar generator to RCA Test Equipment Headquarters, Bldg. 17-2, Harrison, N.J. We will ship your new Remington portable typewriter to you direct, freight prepaid. But remember—this offer covers only equipment purchased between February 1, 1967 and May 15th, 1967. To allow for postal delay, we will honor cards postmarked up to May 31st.

Plan NOW to take advantage of this BIG offer—a FREE Remington portable typewriter with your purchase of an RCA WR-64B color bar/dot/crosshatch generator.



The standard of the Color-TV Servicing Industry. Generates all necessary test patterns—color bars, crosshatch, dots plus sound-carrier. Only \$189.50\*

\*Optional Distributor resale price. All prices subject to change without notice. Price may be slightly higher in Alaska, Hawaii, and the West.

Ask to see it at Your Authorized  
RCA Test Equipment Distributor

RCA Electronic Components and Devices, Harrison, N. J.



The Most Trusted Name in Electronics

Finally somebody is helping...  
helping you prepare for

# The growing crisis in service

Motorola takes the bull by the horns . . . introduces  
“on-the-job” technical training  
for your men—with a greatly expanded  
staff of technical personnel.

Home entertainment products are changing—fast. There’s more transistorization . . . and of course more color every year. This means great opportunity for service organizations that keep abreast. Well-informed technicians will be in even greater demand than they are now.

Motorola can help your service department be well prepared.

We have recently increased our staff of field technical personnel. It is their job to help provide you with Technical information for your men and to give some of the training your men will need to cope with this rapidly changing industry.



Each of our technicians has had extensive, practical consumer experience. They know their business—from your side of the fence. The training will be done *right in your place of business*. It will provide a valuable adjunct to the large-scale training meetings held by Motorola Regional Managers & Distributors.

Two hours will be spent in formal training. The remainder of the day will be spent working with your men *on your work* to give information—and to help find ways to make more profitable and productive use of service time. Get full information on availability of this training for your shop. Just call your Motorola Distributor.



**MOTOROLA®**



# BLOCKS for BUSS FUSES

TYPES AVAILABLE  
FOR ALL  
APPLICATIONS

Single pole, multiple pole, small base, full base, molded base, laminated base, porcelain base for fuses from  $\frac{1}{4}$  x  $\frac{3}{8}$  inches up. Also signal type fuse blocks and special blocks of all types.

Tell us what you need or . . .

Write for BUSS Bulletin SFB

INSIST ON **BUSS**  
**QUALITY**

BUSSMANN MFG. DIVISION McGraw-Edison Co., St. Louis, Mo. 63107

signals directly on motion picture film has been announced by the Revere-Mincom Division of **3M Company**.

Called the Electron Beam Recorder, the new device combines the speed and economy of film duplication with the image quality of magnetic video tape or live TV, 3M said.

"Under present systems, television images are photographed from the television screen itself," said Robert Herr, Revere-Mincom general manager. "The resultant product or kinescope contains much of the inherent noise disturbances and imperfections present on the tube's phosphor surface. Image quality of this film, when rebroadcast, is far below that of the original telecast."

A prime advantage of electron beam recording is that once the image has been photographed, duplication can be accomplished by conventional film duplicators, at a rate six times that of video tape duplications," Herr said.

Herr added that video tape plays an important role in the initial production stages. Tape originals are easier to produce and are less costly than film with the added flexibility of instant replay, re-use, and elimination of processing.

Electron beam recording, in operation, eliminates the conventional camera lens, cathode ray tube phosphor screen, and glass mask and mates a photographic film directly to a vacuum chamber. Electrons which normally produce an image on the phosphor screen, paint directly on the film. The result is a bright image of high resolution with reduced graininess and electrical noise.

## BUSS: The Complete Line of Fuses and . . . . .

### All-Band MATV

In a recent press conference held in New York, **JFD Electronics** Company vice-president William Clancy stated: "We believe that the federal government, which is concerned about enhancing the growth of UHF, will soon require that multiple dwellings be equipped with master antenna systems that reproduce all television channels broadcast in the area."

Mr. Clancy further pointed out the paradox of requiring presently manufactured TV receivers to be of all-channel design, but not requiring that other receiving equipment (specifically MATV) follow this pattern.

To further bring home this point, and show what can be done, Mr. Clancy unveiled JFD's new "Smooth Line." This is a complete new line of MATV components designed for flat response and corrected tilt, so that no station—VHF or UHF—suffers distortion.

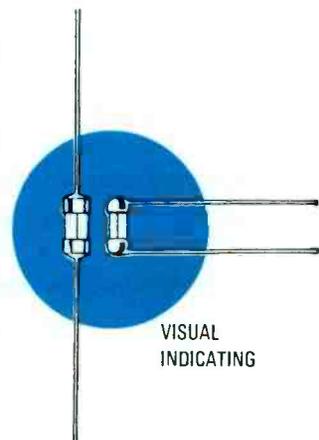
### Potpourri

**Mercury Electronics Corp.** announced a new one year guarantee policy on all their test instruments. In making the announcement, president Harry M. Rich remarked: "We know of no better way to demonstrate the confidence we have in our products than to go beyond the conventional test equipment guarantee, and offer a full one year warranty on parts and workmanship under normal usage."

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**Ray-O-Vac Division**, The Electric Storage Battery Company is in the process of completing their move of technical personnel and equipment into a recently completed Ray-O-Vac Engineering and Development Center located in a 73,000 square foot building in Madison, Wisconsin.

The new building is designed to consolidate Ray-O-Vac Division's research, development and testing operations into a well-equipped single location.

**Texas Instruments** announced that it is starting construction of a new multi-million-dollar plant to provide approximately 185,000 sq ft of additional manufacturing and office space on the company's industrial site in Attleboro, Massachusetts. The multi-purpose building will house light manufacturing, research and development activities, and several administrative offices.

This new building will bring total manufacturing and office space owned by the company in Attleboro to approximately one million square feet, and presently there are more than 5,000 TI employees in the Attleboro area.

**Vaco Products Company**, manufacturers of tools and solderless terminals, moved its general offices to 510 North Dearborn Street, Chicago. The new quarters will double the amount of floor space, and provide for additional electronic order processing equipment, plus sales promotion facilities.

## Fuseholders of Unquestioned High Quality

### Expansions

**Amphenol Corporation's** Cable Division has announced plans to build a cable-manufacturing plant on an 18-acre tract in the industrial park at Danville, Kentucky.

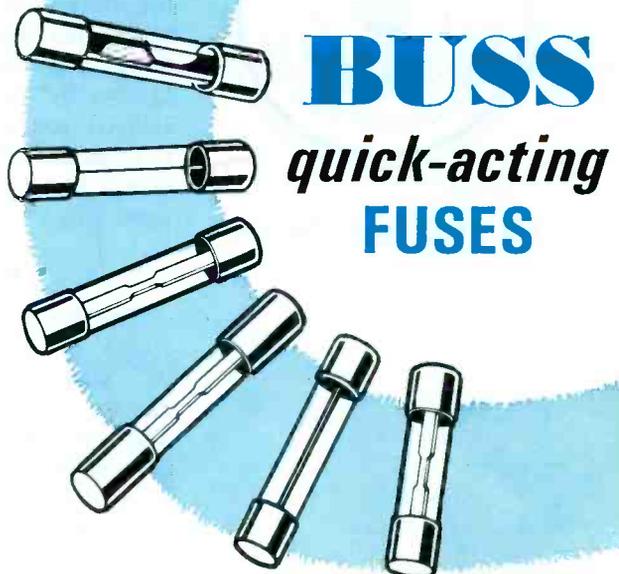
An Amphenol spokesman said the division will construct an expandable 30,000-square-foot, single-story facility as soon as contractual arrangements can be made. The plant is scheduled for completion in the early fall of 1967 and will employ about 50 persons.

Amphenol Cable already has expanded twice in the last 18 months, first with the acquisition of Liberty Copper & Wire Company, Downers Grove, Ill., and then with the purchase of additional equipment for expanded plant facilities in Chicago.

A leading producer of public address loudspeakers, microphone stands, and accessories has announced the relocation from its Brooklyn factory to its new plant in Parsippany, N. J. According to Mr. Jerome W. Heller, Division Manager, **Atlas Sound** production capacity is 3 times greater as a result of the move.

**Bogen Communications** Division of Lear Siegler, Inc., has announced the purchase of Cardion Communications Corporation's B-250-VA4 transmitter product line.

The move enables Bogen to manufacture and supply directly the powerful 250-watt transmitters that are used in Pagemaster city-wide radio paging systems made by the company.



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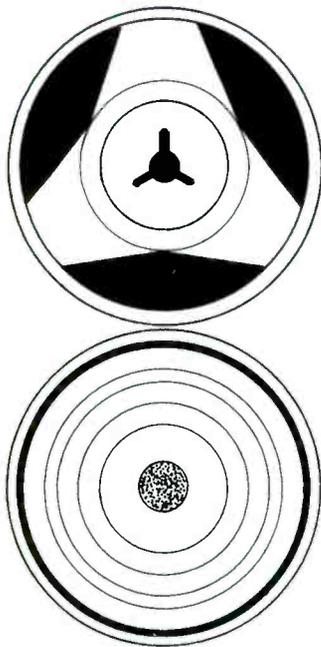
Circle 9 on literature card

March, 1967/PF REPORTER 19



*Modern Hi-Fi sets require more than a VTVM for effective servicing. Here's a quick review of the instruments needed to keep these sets performing well.*

## AUDIO EQUIPMENT



*by Monte J. Hasso*

**A**lthough the growth of the Hi-Fi portion of the industry cannot compare with color TV, there is an ever-increasing number of Hi-Fi instruments in the field. Many shops are unprepared to service these instruments when they arrive in the shop. True, many repairs can be made with a VTVM, but the majority of jobs require more equipment. The customers are developing more critical ears and will not accept the distortions, background noise, and hum that would have "gotten by" a few years ago. Specialized test equipment is needed to track down these problems. Let's take a look at some of this equipment.

### AC VTVM

The AC VTVM is only a distant cousin of the all-purpose VTVM. AC instruments employ feedback circuits and highly damped meters. The sensitivity of the lowest scales is typically .03 volts full scale, though many instruments have a .01 scale. The frequency response is flat over the entire audio spectrum and usually about  $\pm 1$  dB from 10Hz to 500kHz. Fig. 1 shows the face of one of the instruments. Note the lack of a zero control. The circuits are designed so that the instrument is insensitive to minor line voltage variations and tube aging, and the zero control is unnecessary. Fig. 2 shows a block diagram of an AC VTVM circuit.

The input attenuator is frequency compensated so that it is essentially flat from 10Hz to 600kHz. The cathode follower stage is a low-noise triode impedance matching stage. It matches the high impedance input to the low impedance voltage divider. The 6EJ7 pentode amplifiers were chosen for their stability and high gain. The feedback network insures that they operate at about the same amount of gain throughout their useful life.

Not shown is the power supply. In this particular instrument (Eico 250) the power supply has a regulator tube, and a small AC voltage is applied to a tapped bleeder resistor to buck out stray hum.

### Audio Signal Generators

Audio generators come in more shapes and sizes than people. They are of two general types though, the sine-wave, and the square-wave generators. They each have their advantages, though the square-wave generator is probably more versatile in the hands of a technician who knows how to use it. However, neither can completely replace the other, and it is advantageous to have both instruments. For the shop which has a limited equipment budget, the sine-wave generator is probably the best choice; the square wave can be added later. There also are some combination instruments available with both sine- and square-wave outputs.



Fig. 1. Front panel of an AC VTVM.

With either type of generator, the output should be flat over the entire audio spectrum, or else the instrument should have a built-in voltmeter. This is to insure that the test signal will not cause the amplifier to show an uneven frequency response.

The generator should have a low output impedance, since it can be fed into either a low or high impedance amplifier input. A high impedance output may show serious distortion when fed to a low impedance input stage.

The main use of an audio generator is to check frequency response of a stage or system. This is done by connecting the equipment as in Fig. 3. The input level is advanced until unacceptable distortion is evident on the monitor (scope or distortion meter), and the level is noted. Measurements are made at several points in the audio spectrum and the response can be graphically recorded. The measured response can then be checked against the manufacturer's specifications to see if the equipment is operating properly.

A general idea of frequency response can be obtained by connecting a square-wave generator to the input and a scope to the output of the system under test. Measurements need to be taken only at 200 Hz and 2000 Hz. If the wave is square at the output at both these frequencies, then the

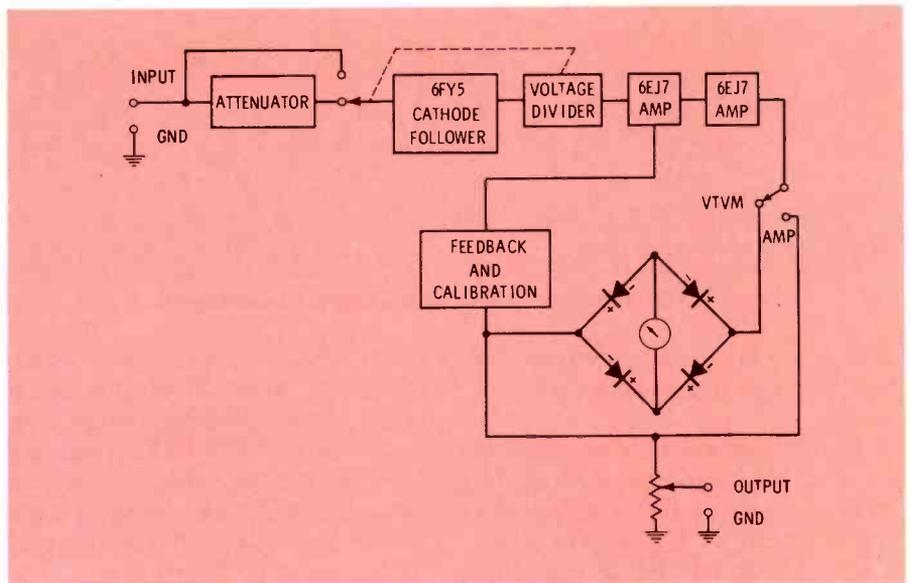


Fig. 2. Block diagram of an AC VTVM.

response is adequate from 20 Hz to 20 kHz. The reason is that the scope indicates any integration or differentiation of the input wave, which means poor low or high frequency response. Fig. 4 shows these waveforms. The square wave gives a good indication of the response about 1 octave either side of its actual frequency.

### Distortion Analyzers

Again, there are two main types; Harmonic and Intermodulation distortion meters. Each has its advantage. The harmonic analyzer is usually the more inexpensive, and easier to operate. The intermodulation analyzer, on the other hand, gives a more accurate test of distortions which are most objectionable to the listener's ear. An in-depth article about the two instruments appeared in August 1966 PF REPORTER; this article in turn was taken from a portion of Howard Tremaine's fine book "Intermodulation and Harmonic Distortion" (Howard W. Sams catalog INT-1).

For harmonic-distortion analysis, a signal is fed to the instrument under test. The output is measured, and then a bandpass filter inserted in the analyzer so that the test signal is rejected. The second reading is the total harmonic level. The meter is usually calibrated directly in % total harmonics. Fig. 5 is a block diagram of this type of meter. The bandpass filter usually is tun-

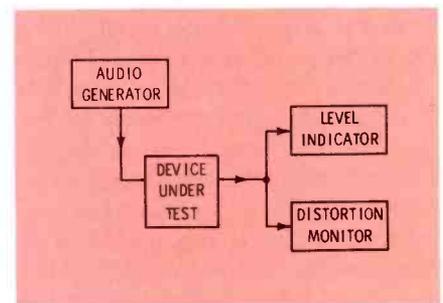
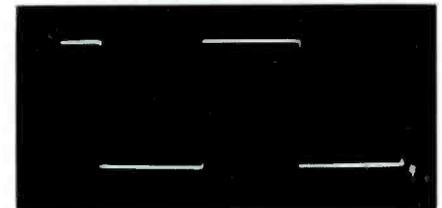
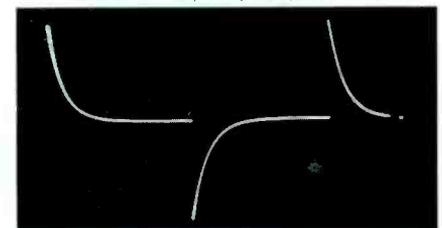


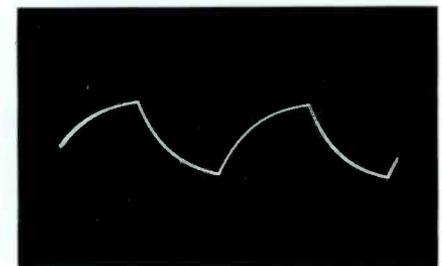
Fig. 3. Test setup for frequency response measurements.



A. Good frequency response.



B. Poor low frequency response.



C. Poor high-frequency response.

Fig. 4. Waveform of the square-wave test of a system.

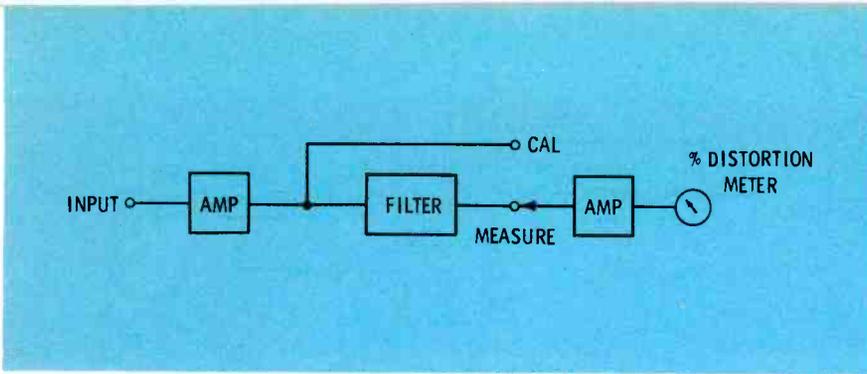


Fig. 5. Test setup for harmonic distortion measurements.

able over the audio spectrum so that test can be made at any frequency.

The intermodulation analyzer is quite a bit more complicated. A block diagram of the complete test setup appears in Fig. 6. The associated waveforms are shown. The distortion can be thought of as a beat-frequency, similar to that produced in a mixer stage of RF equipment. In audio instruments, IM distortion is usually quite objectionable, as compared to harmonic distortion. The reason is that the distortion products are unrelated to the fundamental signals. Harmonic distortion on the other hand is related to the desired signal, and as suggested by the name, sounds harmonious to the ear. However, neither type of distortion can be tolerated to any extent by Hi-Fi enthusiasts, so a distortion analyst is a must in any shop servicing Hi-Fi instruments. The two types of distortion often go hand-in-hand, that is, the causes are essentially the same, so shops with a limited budget can get by for a while with either instrument.

### Miscellaneous Equipment

There are many other instru-

ments which are peculiar to audio servicing. Several manufacturers make audio wattmeters, often as a feature of an AC VTVM. These are quite convenient, however, they are not absolutely necessary, as the power across a load resistor may be computed by Ohm's law.

When checking power output against manufacturer's specifications, make sure that you are both speaking the same language. There are several different power specifications popular in the Hi-Fi field. Among these are ESWP (equivalent sine wave power), EIA Music Power, and sine wave power. These may differ radically, and the serviceman is most likely to measure sine wave power; the output across a resistive load with a single frequency input. ESWP is equal to 1.47 times sine wave power.

Another handy device in audio work is the phase checker. This instrument is used to check the phase match of the loudspeakers in a multispeaker system, or between left and right speakers in a stereo system. It is an extremely simple device. A simplified schematic for the RCA phase checker appears in Fig. 7. The two receptors act as microphones in series with the pri-

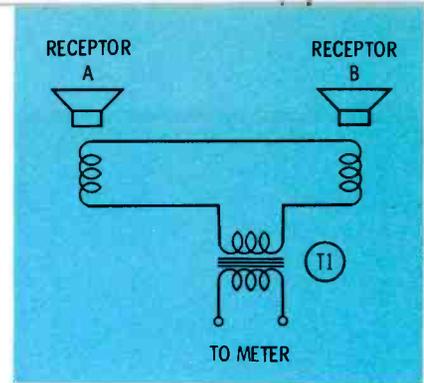


Fig. 7. Diagram of a phase checker.

mary of T1. When the outputs of the two speakers under test are in phase, the two microphones put out voltages in series aiding each other, and a voltage appears at the output of T1. If the speakers are out of phase, the voltages at the microphones are series opposing, and there will be no output at T1.

### Further Reading

The audio equipment field is a big area. No one magazine article can do more than just scratch the surface. Fortunately there are many good books on the subject. A very good book on practical applications of audio equipment is "101 Ways to Use Your Audio Test Equipment" by Robert Middleton. This book shows how to check the sets against manufacturer's specs and has many tips and tricks of the trade which should prove invaluable.

Another good book is Howard Tremaine's "Audio Cyclopedia." This 1280-page book is one of the best references available on audio work in general, from acoustics and design through studio techniques and maintenance. It answers such questions as "What is the best height above floor level for a loudspeaker?" and "At what output level should a frequency response measurement be made on an amplifier?"

Both of the above books are available from Howard W. Sams & Co. "101 Ways" is catalog number TEM-5 (\$2.00), and "Audio Cyclopedia" is ACT-1 (\$19.95). ▲

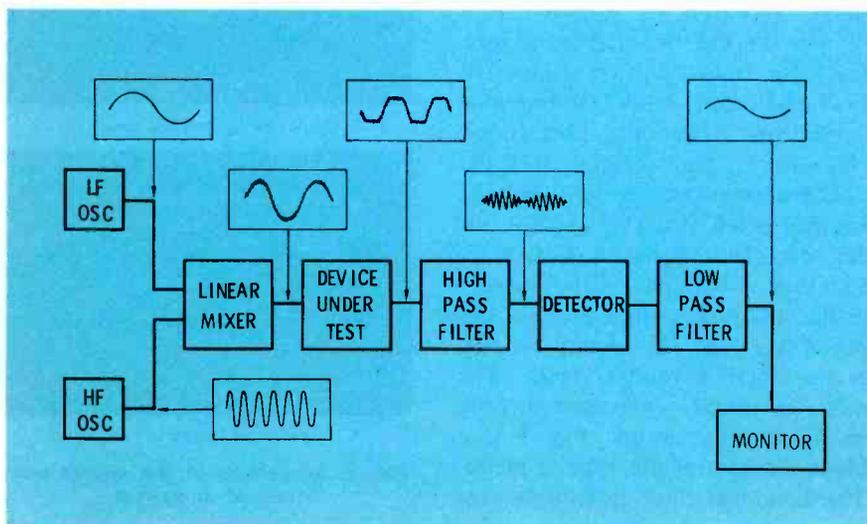


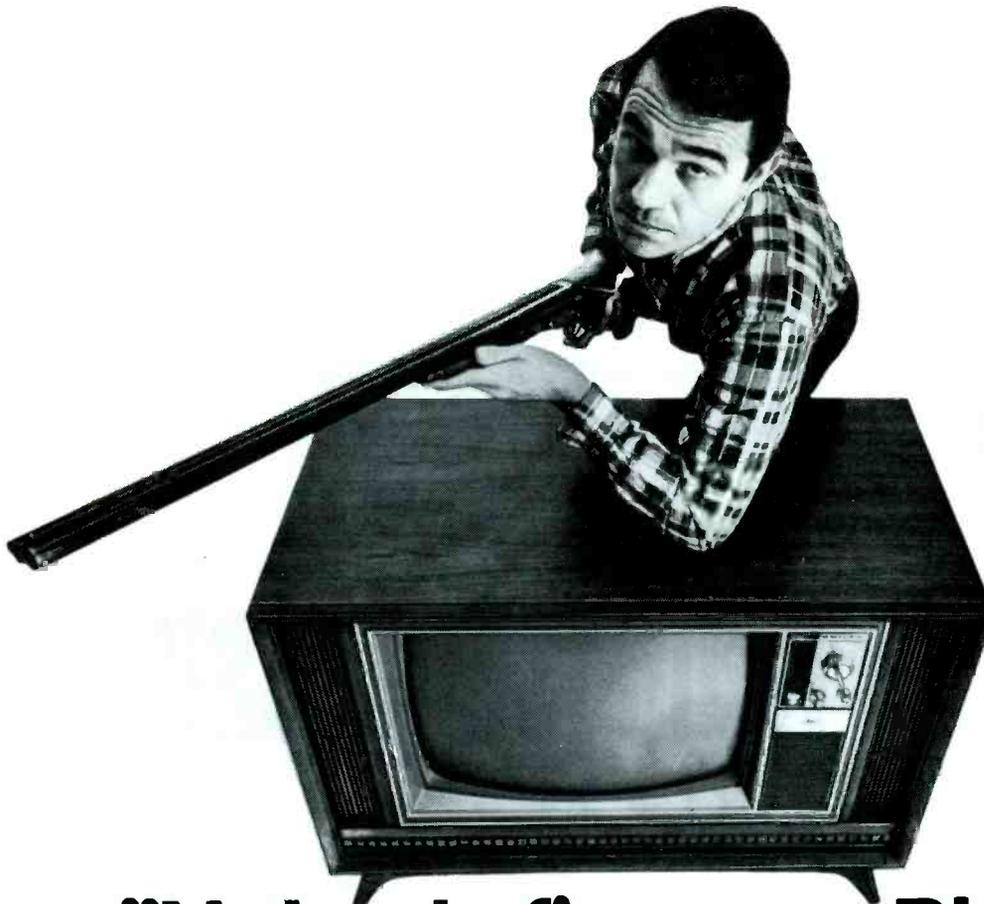
Fig. 6. Test setup for intermodulation distortion.

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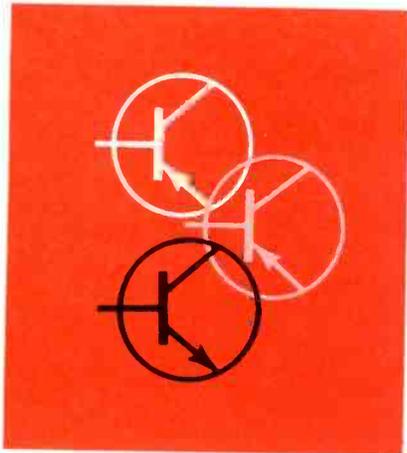
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*The key to efficient operation of a test instrument is knowing how it functions.*

*Here's the know-how on . . .*

# Transistor Testers

*by Chris Edwards*

The number of transistor testers available from test equipment manufacturers is increasing rapidly. It is time to take a close look at the models available, the tests they can accomplish, and the circuits they use.

In addition to the transistor test function, many instruments offer extra functions such as a power supply, signal generator, signal tracer, VTVM, voltmeter and ammeter, and tube tester. These extra measuring functions are usually switched and metered so that test leads do not have to be moved. Most instruments also offer in-circuit and out-of-circuit tests for transistors. Probably the most elaborate of the available instruments offers:

1. An in-circuit test.

2. An out-of-circuit test.
3. An RF signal generator.
4. An AF signal generator.
5. A metered supply to power the radio under test.
6. A VTVM.
7. An ohmmeter.

The actual transistor test is made in different ways, depending on instrument cost and manufacturer's preference. For instance, some make a check of actual DC or AC beta. Others make a relative reading which results in a GOOD/BAD meter indication.

The beta of a transistor is the ratio of collector current divided by base current when the transistor is connected in the common-emitter circuit. Since this circuit is the most commonly used, it is used in the majority of testers.

The primary function of the PN junction is to pass or to block current flow. The blocking action suggests a perfect junction; in practice this is not possible. Reverse leakage exists in any junction and is referred to as  $I_{CO}$  or  $I_{CBO}$ . As the subscript CBO implies, this is measured from collector to base with the emitter open.

Reverse leakage is a variable factor dependent on many conditions of the transistor. It is a good measure of transistor quality because, as leakage increases, transistor efficiency decreases. Leakage, as well as gain, can change with temperature. Tests should be made quickly, and sufficient time for junction cooling should be allowed. Never hold the transistor with a hand while it is being tested. The

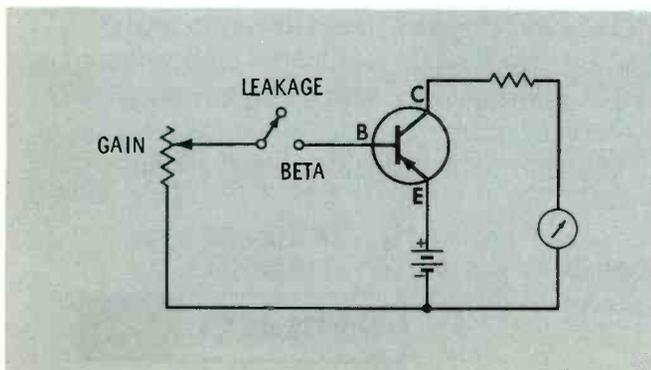


Fig. 1. Beta and leakage tests.

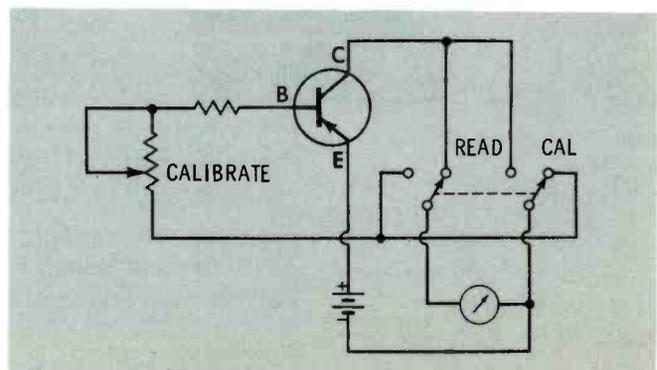


Fig. 2. A test for actual DC beta.

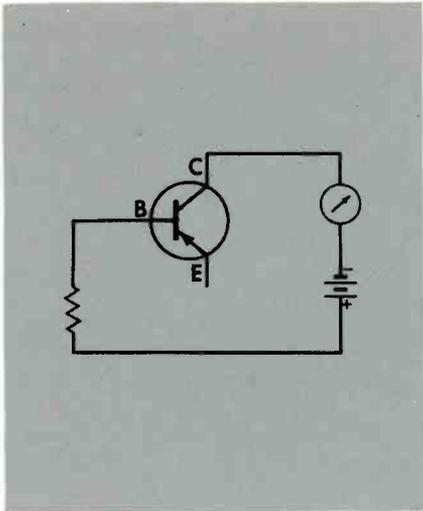


Fig. 3.  $I_{CEO}$  leakage test.

increase of temperature can cause a faulty reading.

### Beta Tests

The simplest method of checking gain and leakage is shown in Fig. 1. For the leakage check, a voltage is applied between the emitter and collector, with the base open, and leakage current is read on the meter. When the switch is closed to read beta, a current is inserted into the base through the GAIN control. The control must be preset for the desired meter scale. The gain of the transistor is the meter reading in the beta switch position minus the leakage reading with the difference multiplied by the control setting.

A more elaborate test circuit is shown in Fig. 2. This circuit measures the actual value of DC beta. In the switch position shown, the meter is in the collector circuit and the CALIBRATE control must be set for exactly 1 ma of collector current. The switch is then set to the READ position, and the value of base current is read. The meter is calibrated for the ratio of base-to-collector currents. This is the beta of the transistor under test. This circuit is typical of most testers that read actual DC beta.

### Leakage Tests

The majority of leakage tests measure  $I_{CEO}$ , the leakage between collector and emitter with the base open. The  $I_{CBO}$ , collector-to-base, leakage is not measured but does affect the  $I_{CEO}$  reading. Some instruments measure  $I_{CBO}$  with circuits similar to that in Fig. 3. The col-

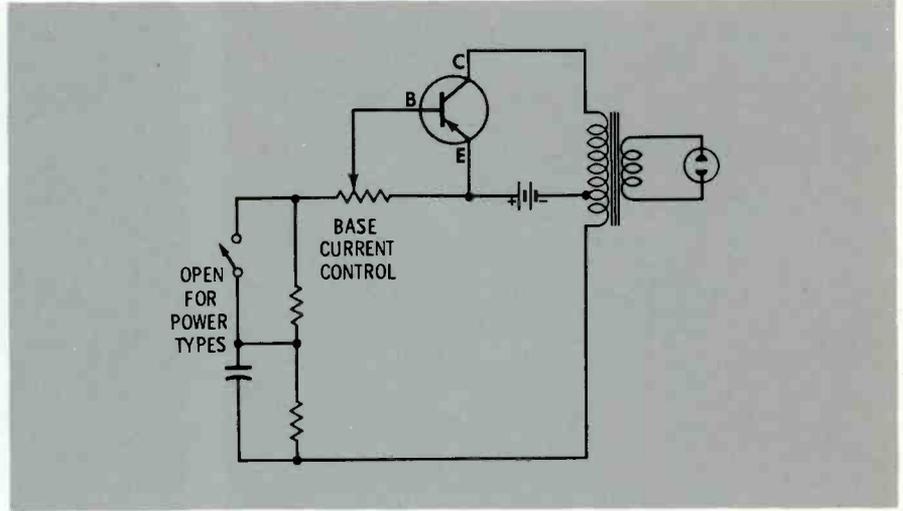


Fig. 4. Oscillator circuit for relative AC beta.

lector-to-base junction is reverse biased, and the emitter is open.

Relative AC beta can be checked with the circuit in Fig. 4. This is an oscillator circuit with the transistor being checked serving as the amplifying device. It can be used for both in-circuit and out-of-circuit checks. The in-circuit test is limited by the values of shunt impedance and capacitance in the circuit under test. A low value of impedance or a high capacitance can "swamp" the oscillator and stop the oscillations. Usually impedances above 150 ohms and capacitors below 0.5 mfd will not affect the circuit.

A direct measurement of AC beta is possible with the circuit in Fig. 5. A close look will reveal that this is a bridge circuit with  $R_1$ ,  $R_2$ , the transistor being tested, and the resistor network forming the four legs of the bridge. An audio oscillator injects a calibrated signal into the base circuit. For a typical small-signal transistor, the calibrated AC

base current is 5  $\mu$ a. This current is measured by an AC voltmeter which is switched to read the voltage drop across the 50  $\Omega$  resistor in the base circuit.

To read AC beta, the AC voltmeter is switched to read the voltage drop across the 1  $\Omega$  resistor in the collector circuit.

The purpose of the bridge circuit is to enable this instrument to measure and then cancel the effects of the circuit impedance during an in-circuit test. Fig. 6 shows the bridge circuit for this function. The  $I_C$  potentiometer is set to zero to cut off the transistor. This removes the transistor impedance and leaves only the circuit impedance in the upper right-hand leg of the bridge. The ZOHMS potentiometers are then set for a null reading on the voltmeter connected across the bridge. The value of the circuit impedance can be read directly across from the calibrated ZOHMS dials.

The input impedance of the tran-

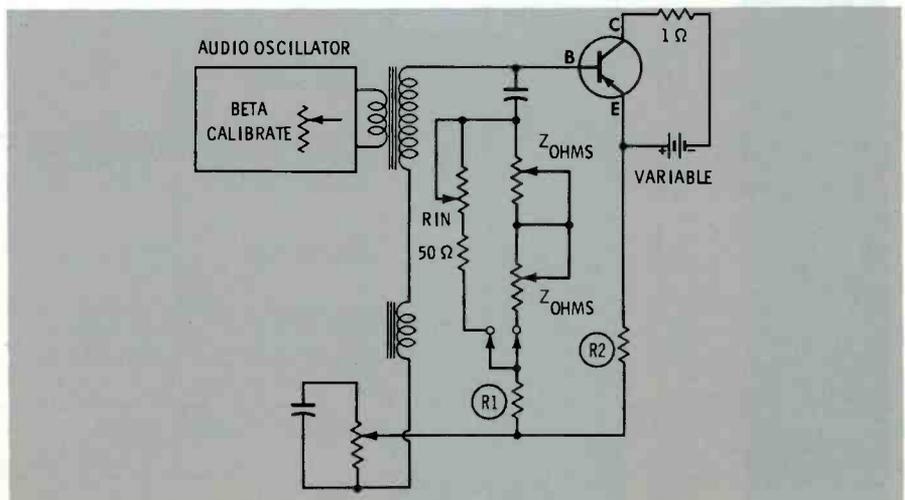


Fig. 5. Bridge circuit for AC beta.

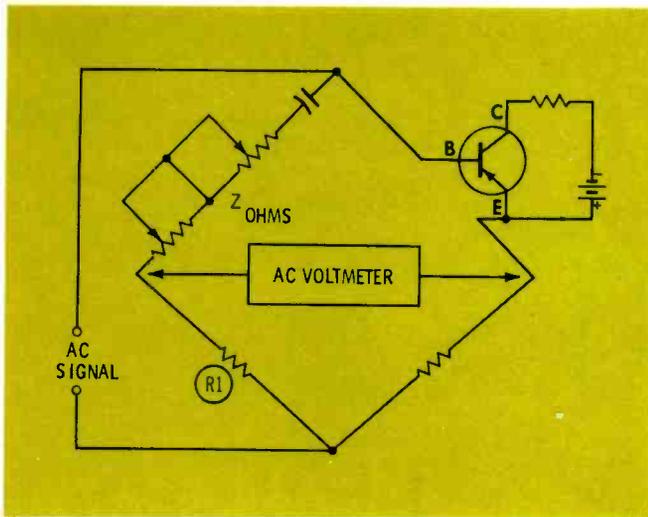


Fig. 6. Measurement of circuit impedance.

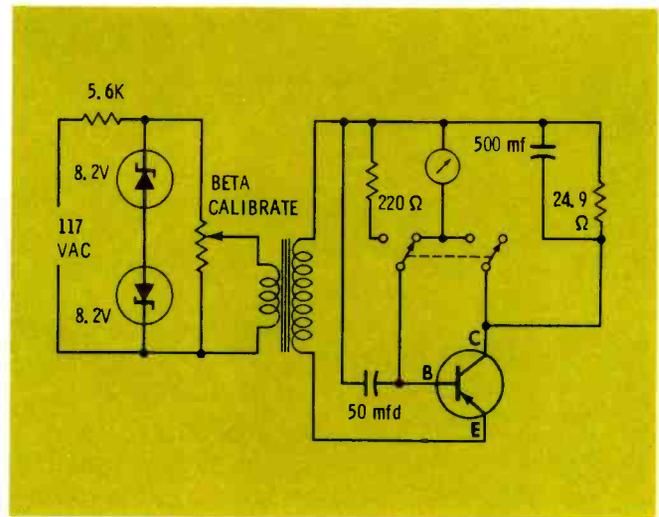


Fig. 7. Dynamic check of AC beta.

sistor itself is then measured by switching the  $R_{IN}$  potentiometer of Fig. 5 across the  $Z_{OHMS}$  potentiometers and setting the  $I_c$  potentiometer to bias the transistor on. A second null is found by varying the  $R_{IN}$  potentiometer. Now the circuit and transistor impedances are balanced out and only the AC beta of the transistor is effective in the circuit. These are the conditions

under which beta is measured in the circuit of Fig. 5.

A unique method of measuring AC beta is shown in Fig. 7. A signal from the AC line is coupled into the test circuit through the transformer. In the CAL position of the switch, the meter reads the voltage across the collector load resistor. The BETA CAL control is used to set the meter to full

scale; this equals approximately 2 ma of collector current.

When the switch is changed to read beta, the meter is transferred to read the voltage across the base resistor. The meter scale is calibrated directly in beta. Note that there are no DC power supplies in the circuit; the test is made under dynamic conditions simulating actual operation. ▲

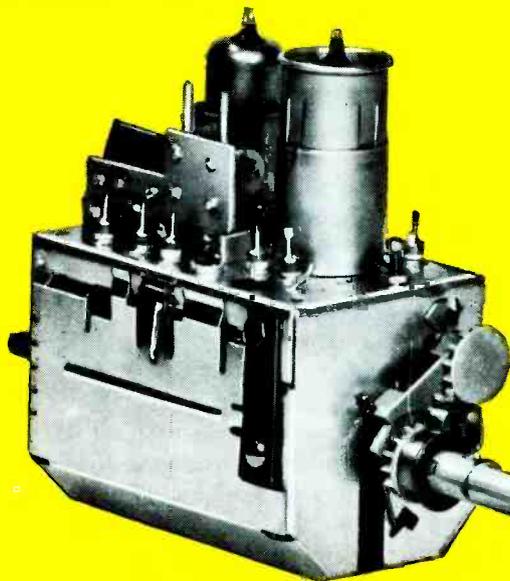
MFR.	MODEL	$I_{ceo}$	$I_{cbo}$	SHORTS	GAIN TEST	OTHER TESTS	PNP/NPN	MISC. NOTES	
B & K	960	✓	✓	✓	actual DC beta	in-circuit tests	switch	pwr. sup., sig. gen., VTVM pwr. sup., sig. gen., VOM	
	970	✓	✓	✓	actual DC beta	in-circuit tests	switch		
EICO	680	✓	✓		actual DC beta	indirect AC beta	switch	VOM	
HEATH	IM-30	✓	✓	✓	actual DC beta	checks diodes & DC alpha	switch		
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	870	✓	✓	✓	actual AC beta		switch		
	890	✓	✓	✓	actual AC beta		switch	2 sockets	tube tester
	6000A	✓	✓	✓	good-bad scale				
MERCURY	1200	✓			good-bad scale		switch	tube tester tube tester	
	2000				actual DC beta		switch		
SECO	100			✓	oscillator go/no-go	in-circuit tests in-circuit tests	switch		
	260	✓	✓	✓	oscillator go/no-go		switch		
SEMITRON	1000		✓	✓	actual DC beta	in-circuit osc. test	switch	E & I tests	
SENCORE	TR115	✓	✓	✓	actual DC beta	checks diodes in-circuit tests	switch	checks diodes	
	TR139		✓	✓	actual AC beta		switch		
SIMPSON	650				incremental DC beta	$I_{co}$ test	switch	Adapter for Model 260	
TRIPLETT	2590	✓	✓	✓	actual DC beta	checks Diodes $I_{co}$ & Reach-thru tests	switch	actual DC beta	
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# SCOPE PROBES

by J. W. Phipps

*An understanding of the circuits and uses of typical scope probes will assure more accurate troubleshooting information and increase the value of your scope.*

The versatility and accuracy of an oscilloscope is dependent, in part, upon the ability to perform voltage and waveform measurements without upsetting the operating characteristics of the circuit being tested. To meet this prerequisite, the instrument must be adaptable to a variety of circuit characteristics, including impedance, signal level, and frequency. Consequently, these same factors—impedance, signal level, and frequency—are what determine the limitation of a scope. Such limitations can be overcome, for the most part, by selecting a probe designed to compensate for both the characteristics of the circuit being tested and the design characteristics of the scope. In effect, the probe tailors the scope to the test application, or vice versa. The probes most commonly used with scopes are the shielded direct probe, low-capacitance probe (sometimes referred to as a high-impedance probe), and the demodulator probe. Other types include the capacitance voltage-divider probe, and the isolation probe. Although each probe has its own particular advantages, their use may overlap for some circuit applications.

## Direct Probe

The input impedance of most scopes ranges from .5 megohms to about 5 megohms of resistance, shunted by a capacitance varying from 20 to 50 pf. This is the load felt by a circuit under test when an unshielded direct probe is used, as shown in Fig. 1. However, unshielded probes are seldom used with the scope because of their tendency to act as an antenna, thereby introducing spurious signals into the circuit being tested. Such spurious signals not only produce extraneous waveforms on the scope, but can also cause oscilla-

tions, upsetting the operation of the circuit under test. To prevent this lead reaction to stray fields, shielded cables are used.

Adding the shield to the test lead introduces an additional 25 to 50 pf of shunt capacitance to the overall input impedance of the scope and test probe. Fig. 2 illustrates the loading effect imposed upon the circuit by a scope and shielded direct probe. At lower frequencies, the total reactance of the shunt capacitance is high and does not appreciably increase the circuit loading; however, as the frequency of the signal increases, the reactance of the shunt capacitance decreases, and lowers the input impedance to the scope. This, in turn, increases the circuit loading and alters the characteristics of the signal. From this, it can be seen that frequency is one determining factor in the

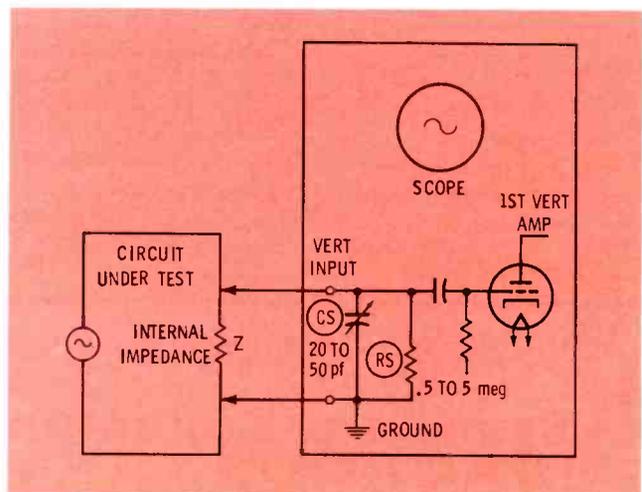
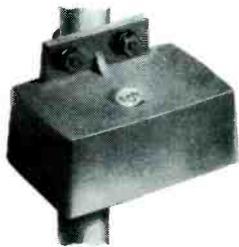


Fig. 1. Loading effect of unshielded probe.

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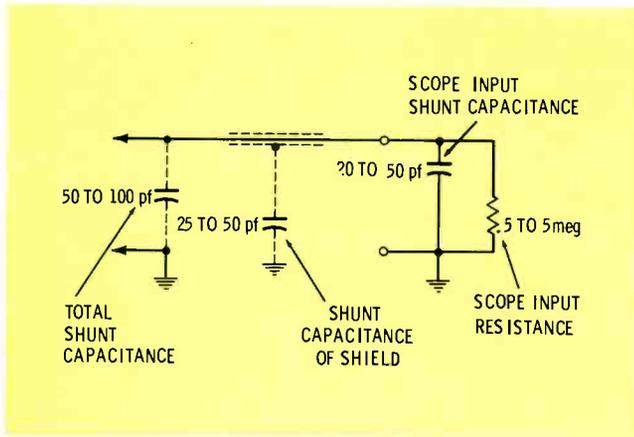


Fig. 2. Shield adds shunt capacitance to loading effect.

application of a direct probe.

The relative values of the scope input impedance and the impedance of the circuit under test must also be considered. To avoid excessive circuit loading, the scope input impedance should be at least 10 times the impedance of the circuit being tested. In Fig. 3, a scope and shielded direct probe are used to measure the ripple content of a low-voltage power supply. The reactance of the shunt capacitance to the 60-hertz ripple frequency is about 26 megohms. The reactance of the 250-mfd filter capacitor is about 10 ohms. Therefore, the ratio of the impedance of the reactive components more than meets the criteria required to avoid excessive loading. Fig. 4 shows a scope connected through a shielded direct lead to the grid of a vertical blocking oscillator. Again, the frequency involved is 60 hertz; however, in this case, the impedance at the point where the probe is applied is much higher, and offers 106 megohms of reactance to the 60-

hertz signal. Shunting this reactance with the 26.5 megohms of reactance produced by the shunt capacitance of the probe and scope will greatly load the circuit and upset its operating characteristics—even to the point of disabling it. From the foregoing comparisons, it can be seen why the impedance ratio between the circuit under test and the scope must also be considered.

Another factor limiting the test application of a shielded direct probe is the signal level. This factor is related directly to the fact that the blocking capacitor employed in the input circuit of most scopes is rated at about 600 volts. Obviously, if this level is exceeded, the capacitor will be destroyed and the input circuit to the scope could be seriously damaged. Aside from the loading effect of the scope input impedance, the direct probe does not attenuate the voltage being measured; what is applied across the probe tip is felt at the scope input. For this reason, the direct probe is not suitable for high-level

measurements beyond the working volt rating of the scope input blocking capacitor.

The fact that the direct probe does not attenuate the signal being measured (beyond the loading effect of the scope input impedance) is the one single advantage of the shielded direct probe. This absence of appreciable attenuation allows use of the full sensitivity of the scope.

#### Combination Isolating and Direct Probe

The probe shown in Fig. 5 is designed to overcome some of the disadvantages inherent in the simple, shielded direct probe. When the switch is closed, the 47K-ohm resistor provides increased resistive isolation between the circuit under test and the scope. One major advantage of increased resistive isolation is that it reduces the effects of the shunting capacitance associated with the direct shielded cable. For example, if a 200-kHz signal is being measured with a shielded direct probe, the effective reactance of 100 pf of shunt capacitance will be 8000 ohms. The circuit under test is therefore being shunted by only 8000 ohms. Add-

• please turn to page 42

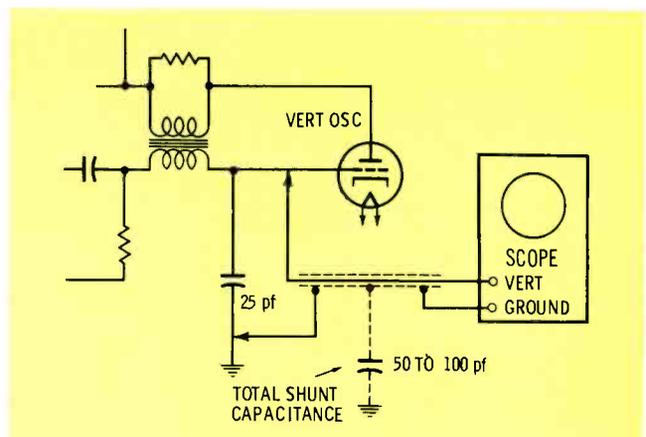


Fig. 4. High-Z circuit can be disabled by direct probe.

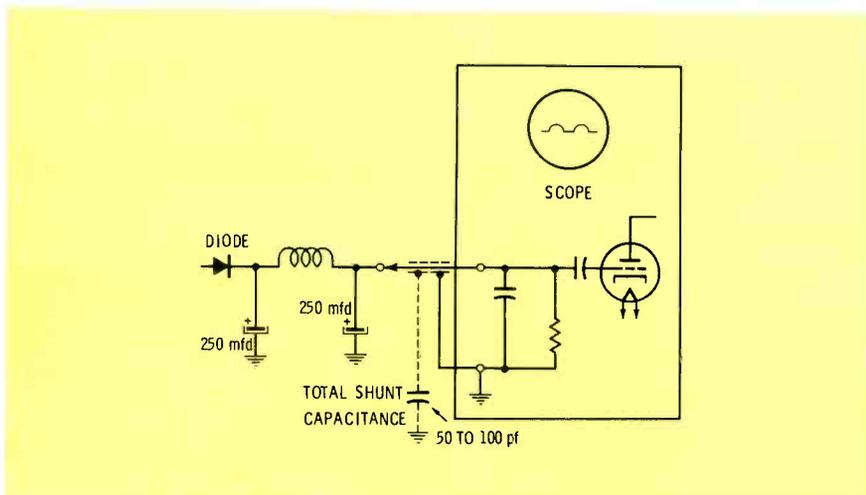


Fig. 3. Scope applied to low-impedance circuit.

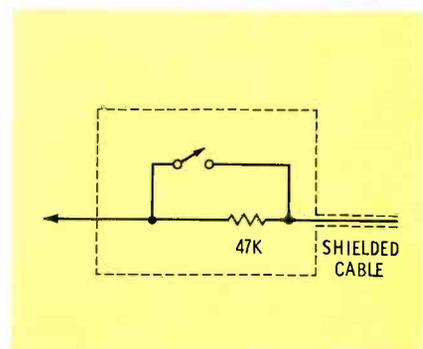
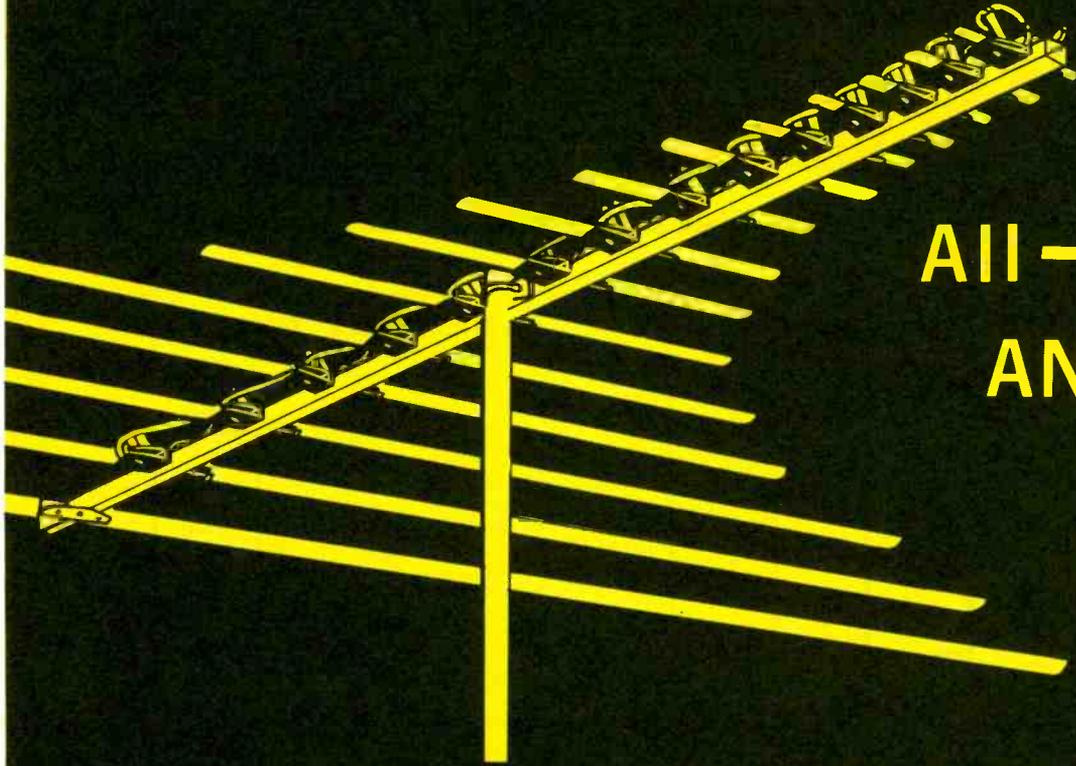


Fig. 5. Combination probe.

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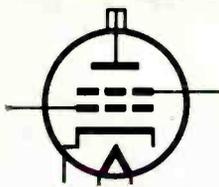
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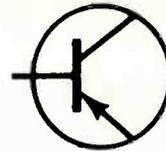
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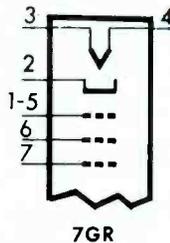
# TUBE AND TRANSISTOR DATA



## CATHODE-RAY TUBES

### 9WP4

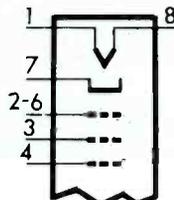
Protection—tension band  
Deflection—90°  
Filament—12.0V @ 0.075A  
Grid 2—100V  
Neck Diam.—.788"



7GR

### 11KP4

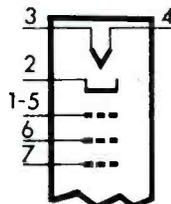
Protection—tension band  
Deflection—110°  
Filament—6.3V @ 0.45A (11 sec)  
Grid 2—50V



8HR

### 12BZP4

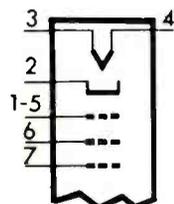
Protection—tension band  
Deflection—104°  
Filament—12.0V @ 0.157A (11 sec)  
Grid 2—100V  
Neck Diam.—.788"



7GR

### 12CFP4

Protection—tension band  
Deflection—110°  
Filament—4.2V @ 0.45A (11 sec)  
Grid 2—200V  
Neck Diam.—.788"

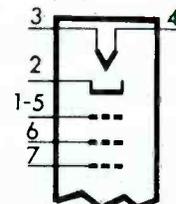


7GR

## CATHODE-RAY TUBES

### 12CHP4

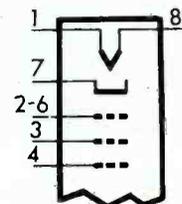
Protection—tension band  
Deflection—110°  
Filament—6.3V @ 0.45A (11 sec)  
Grid 2—300V  
Neck Diam.—.788"



7GR

### 16CMP4A

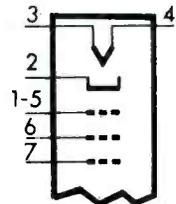
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Deflection—114°  
Filament—6.3V @ 0.45A (11 sec)  
Grid 2—300V



8HR

### 16CNP4

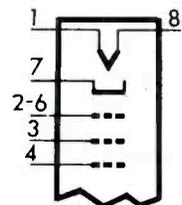
Protection—tension band  
Deflection—104°  
Filament—12.0V @ 0.157A (11 sec)  
Grid 2—100V  
Neck Diam.—.788"



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### 16CTP4

Protection—tension band  
Deflection—114°  
Filament—6.3V @ 0.45A (11 sec)  
Grid 2—400V



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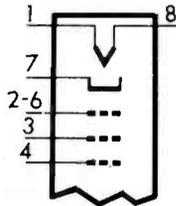


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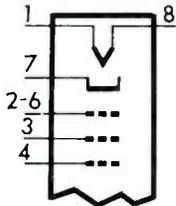
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Deflection— $114^\circ$   
Filament—6.3 @ 0.45A (11 sec)  
Grid 2—400V



8HR

### 19FCP4

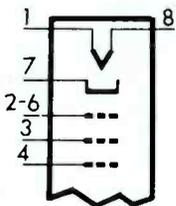
Protection band  
Deflection— $114^\circ$   
Filament—6.3V @ 0.45A (11 sec)  
Grid 2—400



8HR

### 19FEP4B

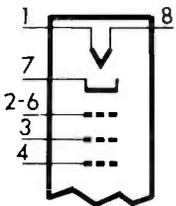
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Deflection— $114^\circ$   
Filament—6.3V @ 0.45A (11 sec)  
Grid 2—30V



8HR

### 19FKP4

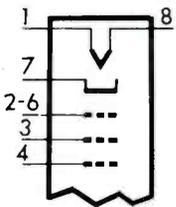
Protection—tension band  
Deflection— $110^\circ$   
Filament—6.3V @ 0.3A  
Grid 2—300V



8HR

### 19FLP4

Protection—tension band  
Deflection— $114^\circ$   
Filament—6.3V @ 0.45A (11 sec)  
Grid 2—300V

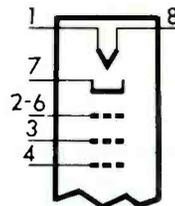


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## CATHODE-RAY TUBES

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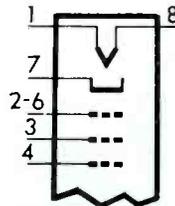
Protection—bonded glass  
Deflection— $114^\circ$   
Filament—6.3V @ 0.45A (11 sec)  
Grid 2—50V



8HR

### 21FWP4

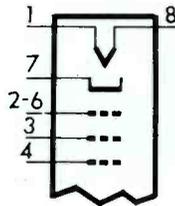
Protection—tension band  
Deflection— $114^\circ$   
Filament—6.3V @ 0.45A (11 sec)  
Grid 2—400V



8HR

### 23ERP4

Protection—tension band  
Deflection— $114^\circ$   
Filament—6.3V @ 0.6A (11 sec)  
Grid 2—300V

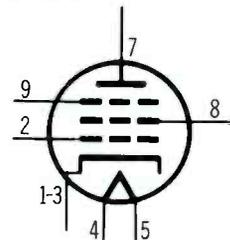


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## RECEIVING TUBES

### 3KT6

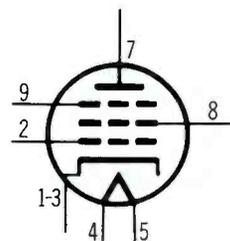
Video IF Amplifier  
Fil.—3.5V @ 0.6A (11 sec)



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### 4KT6

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Fil.—4.5V @ 0.45A (11 sec)



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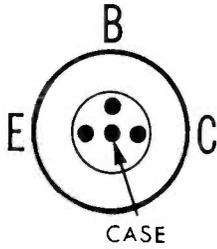
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## TRANSISTORS

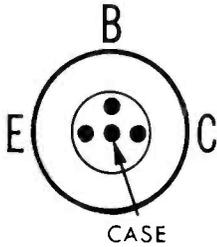
### 2SA360

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PNP—Germanium



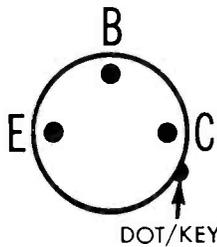
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FM IF Amplifier  
PNP—Germanium



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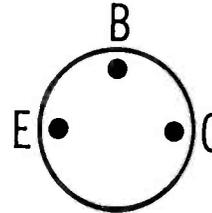
FM IF Amplifier  
PNP—Germanium



## TRANSISTORS

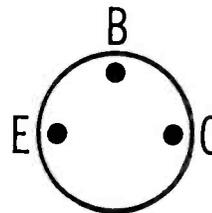
### 2SB181A

Horizontal Output  
PNP—Germanium



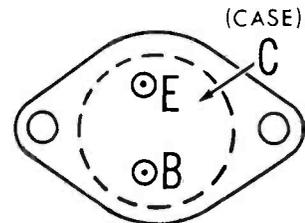
### 2SB405

Audio Output  
PNP—Germanium



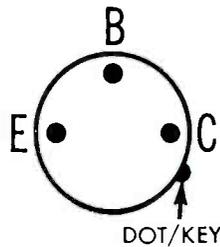
### 2SB407

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PNP—Germanium



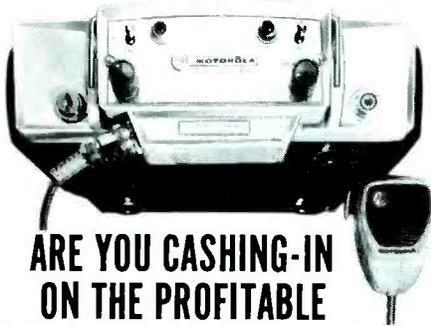
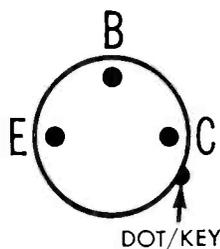
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PNP—Germanium



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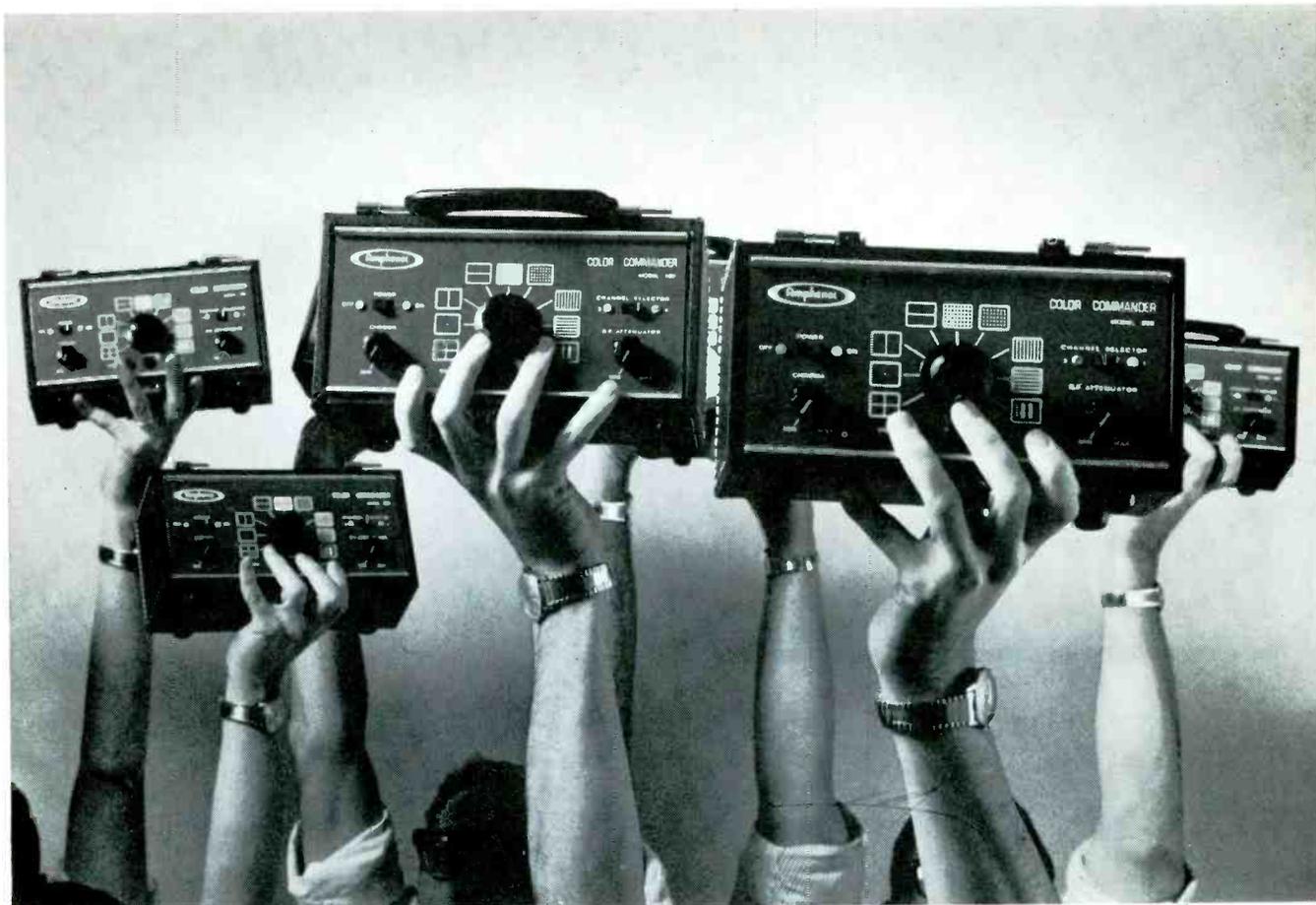
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# NOTES ON TEST EQUIPMENT

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

by T. T. Jones

## Solid-State Generator Features Small Dots

Mercury's new Model 1900 has some of the most up-to-date features we've seen in color generators. This unit has all of the main patterns — horizontal and vertical lines, crosshatch, dots, and keyed rainbow. It has the usual gun killers, frequency adjustable RF output, and

color level control. Just about all you'd want except 4.5-MHz audio carrier, which many servicemen don't use.

It has many little "extra" features which at first look are hidden. The horizontal and vertical lines are both adjustable in thickness with front panel controls. Fig. 2 shows a portion of the crosshatch pattern with these controls set for

the narrowest practical lines. The horizontal line is 1 scan line thick. The horizontal line pulse width is set so that it just begins to overlap. It can be set so that it is six scan lines thick. The vertical pulse is very narrow in the picture, but it can be set to about 3/8" width on a 21" screen. It follows that the dot size can be set from a very tiny dot to a 3/8" square.



Fig. 1. New solid-state color generator.

### Mercury Model 1900 Specifications

#### Outputs:

10 Vertical lines, adjustable width. 14 Horizontal lines, adjustable thickness.  
140 Dots, adjustable size.  
Crosshatch.  
10 Keyed rainbow bars, adjustable color level.

#### RF output:

Adjustable channel 3-5.

#### Gun killers:

100-K ohms.

#### Power requirements:

117 VAC 3 watts.

#### Size (HWD):

6¼" x 10" x 4½".

#### Weight:

4 pounds.

#### Price:

\$89.50.

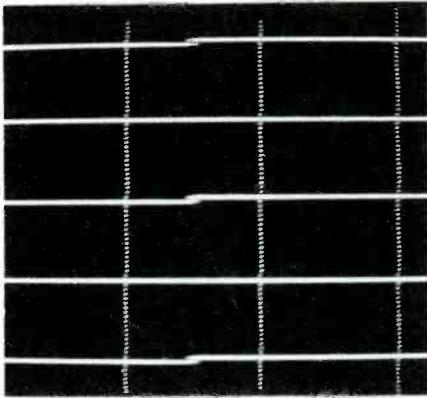


Fig. 2. Portion of crosshatch display.

Another operator convenience is that all internal adjustments can be reached through holes in the cabinet. The RF adjustment can be reached through the rear with a standard hex alignment tool. The Model 1000 is factory set to channel 3, and according to specs, may be adjusted to 4 or 5. The unit we tested however, had sufficient range to cover all channels on the lower band, 2 through 6.

All counter adjustments can be reached through the bottom of the Model 1000, with test jacks exposed at the rear. The unit should not need adjusting under normal use,

### Transistor Multitester

Multitester is a name we think fits the Semitron Model 1000. The Semitronics Corp. calls it a Transistor Tester and Set Analyzer. No matter what you call it, it's a very versatile instrument.

It checks transistors for leakage and beta, both in-circuit and out-of-circuit. It also can be used as a diode tester, voltmeter, ammeter, and continuity checker. With a transistor in the test socket, it can be used as a signal generator; the output is a 5-kHz note with high harmonic content. The signal is useful at both

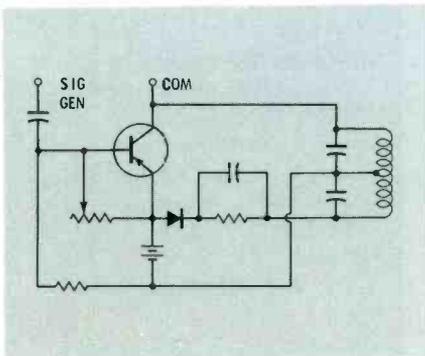


Fig. 5. Schematic of the generator.

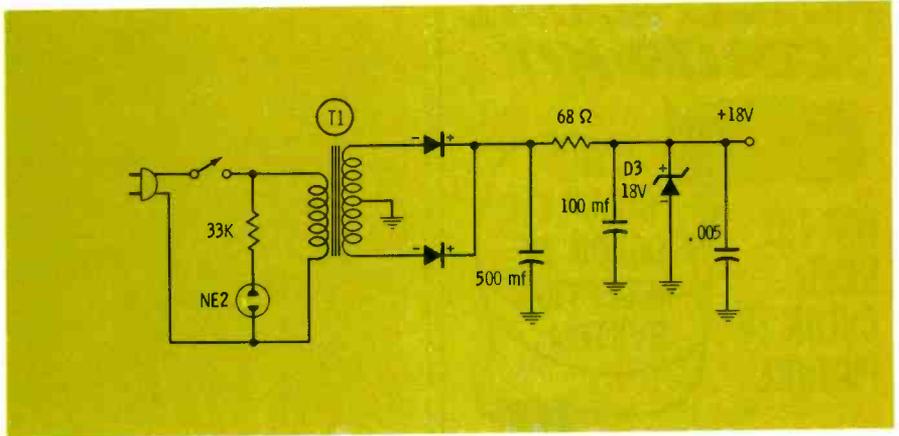


Fig. 3 Partial schematic of power supply.

as it has unijunction transistors in the counter stages, and shows very low drift. The color-crystal trimmer is also reachable through the rear panel.

The circuit is pretty much standard; it starts with a 189-kHz crystal oscillator and counts down to the vertical and horizontal sync rates. The horizontal lines are derived from a 900-Hz flip-flop oscillator. The pulse width of this oscillator is controlled by the front panel "HOR LINE ADJUST."

The power supply section (Fig. 3) is especially "beefy." Not only

is it a full-wave configuration, but very large filters are used, and then the output is regulated by zener diode D3. The DC output is nearly as pure as a battery source. This insures that there will be no false sync pulses caused by power supply ripple.

The unit is housed in a grey crackle-finish steel case, and has a convenient storage compartment for leads. The power lead is a standard TV jumper, and stores in the same compartment.

*For further information circle 59 on literature card*



Fig. 4. Model 1000 makes 8 tests.

audio and RF frequencies, so it can be injected anywhere in a receiver under test and traced through to

the speaker. The Model 1000 can also be used as a code-practice oscillator, if you want to be a Ham.

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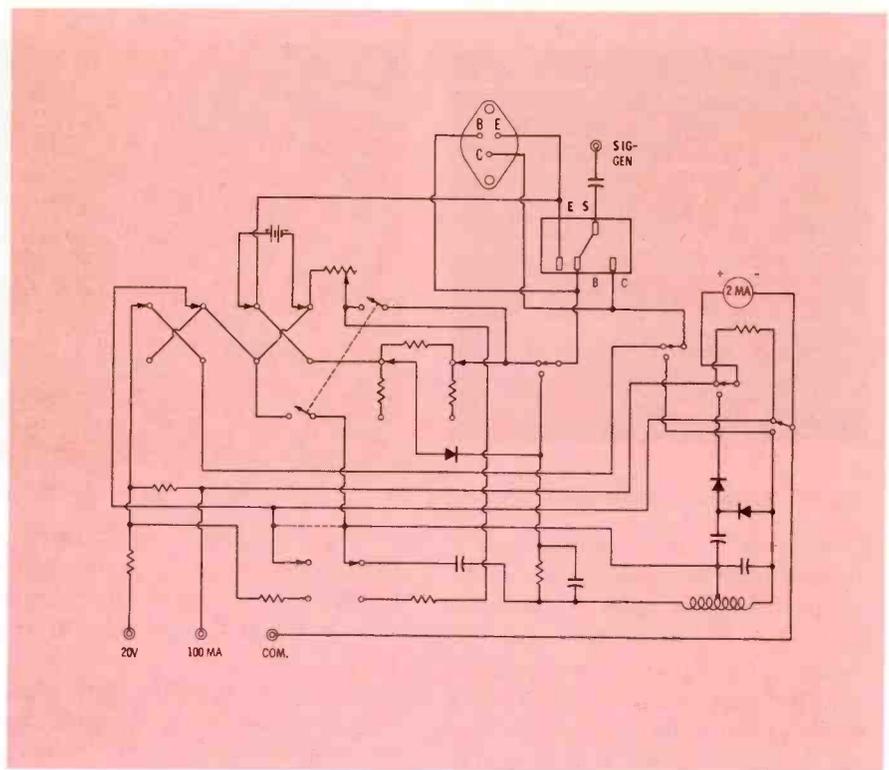
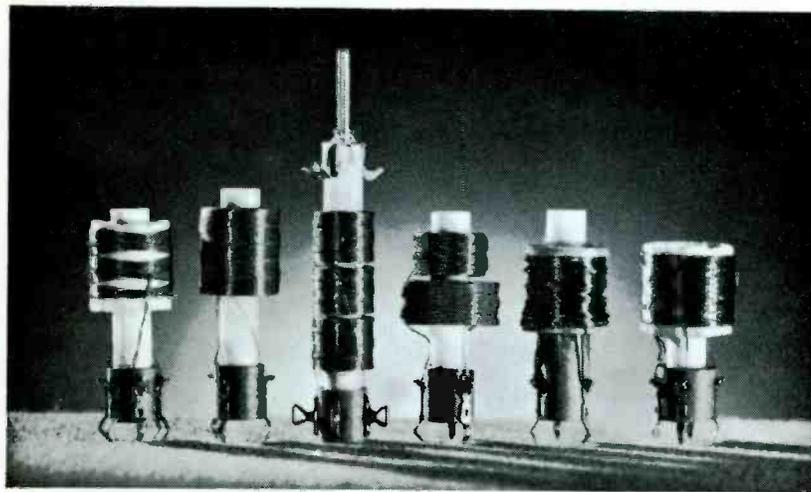


Fig. 6. Overall schematic.

The circuitry of the Model 1000 is extremely simple, yet quite complicated. This is because of the many functions, with several switches involved for each function. Any one individual test involves a simple

circuit, such as the signal generator shown in Fig. 5. However, the many different switches make the overall schematic resemble a maze (Fig. 6).

The whole instrument is housed in a bakelite case with a fold-over handle so the instrument can sit at an angle on the bench. The price is quite low—\$34.95 including all test leads.



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### Semitron Model 1000 Specifications

- DC Beta ( $H_{FE}$ ):  
0-400 in 3 ranges, out-of-circuit.
- AC Beta ( $H_{fe}$ ):  
In-circuit, uncalibrated
- DC Beta (power transistors):  
0-200
- Diode:  
Good-Weak-Poor scale
- Volts DC:  
0-20 V
- Ma DC:  
0-100
- Continuity (Ohms):  
0-∞. 1000 ohms center scale  
(must be calibrated).
- Signal Generator output:  
1½ V p-p on fundamental
- Size (HWD):  
5¼" x 7¼" x 3¼" o.a.
- Weight:  
1½ lbs.
- Price:  
\$34.95

For further information circle 60  
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## SCOPE PROBES

(Continued from page 30)

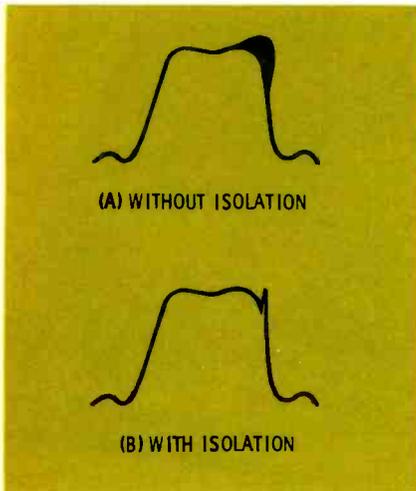


Fig. 6. Isolating resistor sharpens marker pip on response curve.

ing the isolation resistor assures a shunting impedance of at least 47K ohms — quite an increase over the relatively small impedance provided by the simple shielded direct probe. This added shunting impedance becomes even more significant at higher frequencies, where the shunting capacitance of the shielded direct probe can reduce the input impedance to only a few hundred ohms.

The addition of an isolation resistor in a probe is particularly useful when performing an IF sweep alignment. First, it helps filter out any IF signal which may have gotten through the detector, preventing such RF frequency components from reaching the scope and radiating back into the receiver. Also, together with the shunt capacitance of the shielded cable and scope input, it forms an in-

tegrating network to bypass and attenuate any frequency above several kilohertz. This high frequency attenuation results in a sharper marker pip on the response curve, as shown in Fig. 6.

### Low-Capacitance Probes

As mentioned previously, the combined shunt capacitance of the shielded direct probe and scope input circuit produces a shunt capacitance of approximately 50 to 100 pf. At low frequencies, the reactance of this shunt capacitance is sufficient to maintain a relatively high input impedance with respect to the low impedance normally found in low-frequency circuits. However, 50 to 100 pf of shunt capacitance can cause serious distortion in the high-frequency, high-impedance circuits found in the sync and video amplifier sections of a TV receiver. Also, the loading effect of the scope input impedance can detune the resonant high-frequency circuits of these sections.

Adding an isolation resistor to the probe increases the input impedance and overcomes some of the effects of the shunt capacitance; however, as pointed out, the isolating resistor introduces an integrating action. This high-frequency attenuation is suitable for viewing a response curve or other waveform where high-frequency response is not needed, or not present. However, when viewing complex waveforms containing high-frequency components, the isolating resistor tends to round off all sharp wavefronts.

A small capacitor placed in series with the probe and scope shunt

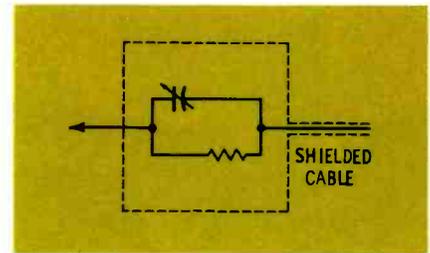


Fig. 7. Basic low-capacitance probe.

capacitance will effectively reduce the shunt capacitance and provide isolation. However, again we encounter the problem of frequency response—the series capacitor and input resistance of the scope form a differentiating network, resulting in low-frequency attenuation.

The low-capacitance (low-C) probe shown in Fig. 7 combines the advantages of both the isolating resistor and the series capacitor to provide decreased shunt capacitance, frequency compensation, and a known amount of signal attenuation. Obviously, knowing the exact amount of signal attenuation is an absolute must in determining the peak-to-peak amplitudes of a waveform.

Fig. 8 shows the low-C probe and its components in relation to the shunt capacitance of the shield and scope input, and the input resistance of the scope. The parallel combination of C1 and R1 are in series with the shielded cable and consequently in series with the scope input. Since C1 is in series with the combined shunt capacitance of the scope and shield, it decreases the total effective capacitance, thereby increasing the capacitive reactance. R1 acts as an isolating resistor, as described earlier, and also decreases the total input capacitance.

The two parallel circuits consisting of C1,R1 and C2,R2 are connected in series and act as a voltage divider, decreasing the amplitude of the measured signal. This attenuation is one minor disadvantage of the low-C probe, limiting its use to circuits having sufficient signal level to offset this inherent attenuation. Such circuit include the sync and video amplifiers stages in TV receivers.

To avoid waveform distortion, the voltage attenuation must be the same at all frequencies. Therefore, not only must C1,R1 be selected to

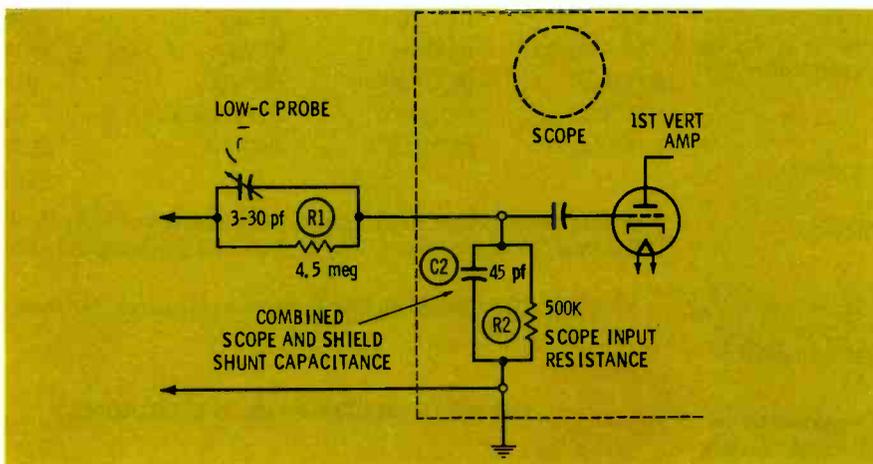


Fig. 8. Low-C probe in series with scope and cable input impedance.

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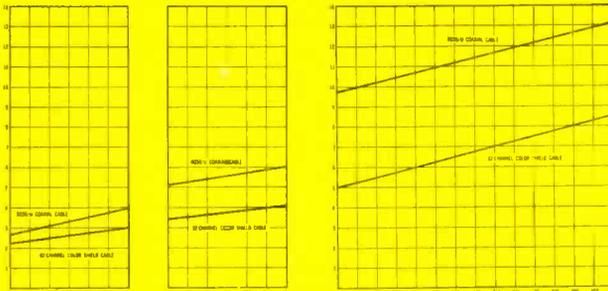


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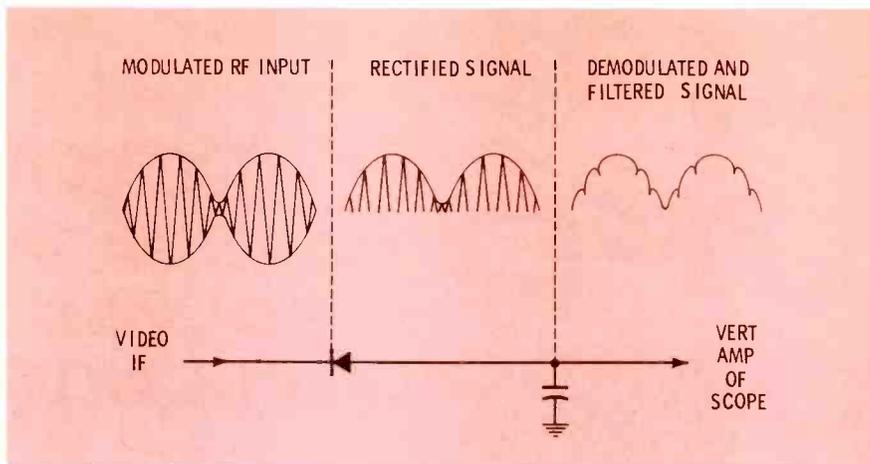


Fig. 9. Rectifying and filtering action of basic demodulator probe.

provide a voltage ratio of 100 to 1, 10 to 1, or some other fraction, but  $C1, R1$  must be equal to  $C2, R2$ . With these two time constants equal, the voltage will be divided at all frequencies by the same ratio.

As an example, to construct a probe with a 10-to-1 ratio,  $C1$  must be equal to  $1/9$  the capacitance of  $C2$ , paralleled by a resistor nine times the value of  $R2$ . With these ratios satisfied, the input impedance is effectively shunted by ten times its former resistance, while the combined shield and scope input capacitance ( $C2$ ) is reduced to  $1/10$  its former value.

The probe components shown in Fig. 8 are for a 10-to-1 probe, with the component values selected for use with a scope having an input resistance of 500K ohms and a combined shield and input shunt capacitance of 45 pf. The formulas for determining the correct probe component values for the characteristics of a particular scope are:

$$R1 = R2 (A-1)$$

$$\text{and } C1 = \frac{C2}{(A-1)}$$

The component designations refer to the components in Fig. 8. "A" is the desired ratio; if a 10-to-1 ratio is desired, 10 will be substituted for "A," etc.  $C1$  is normally a small adjustable ceramic with a minimum capacitance lower than the calculated value for the specific application (5 pf for the scope characteristics in this application).

In actual practice, after the probe is constructed (or pur-

chased), it should be connected to the scope, and the trimmer ( $C1$ ) adjusted to provide uniform frequency compensation. This can be done by applying the output of a square wave generator to the probe, and adjusting  $C1$  for the best square wave reproduction at 20 to 20,000 hertz. A sine-wave generator can also be used, with  $C1$  adjusted for sine waves of equal amplitude at the frequency extremes.

#### Demodulator Probe

Servicing a television receiver often requires observation of the composite video signal in the tuner output or video IF circuits. Obviously, the RF frequencies of these circuits are beyond the frequency response of even a wide-band scope. Therefore, it is necessary to extract the video signal from the modulation envelope of the RF signal—a function normally accomplished by the video detector. However, since we are testing circuits prior to the video detector, we must, in effect, employ an auxiliary video detector in the scope input circuit. The demodulator probe is designed to serve this function.

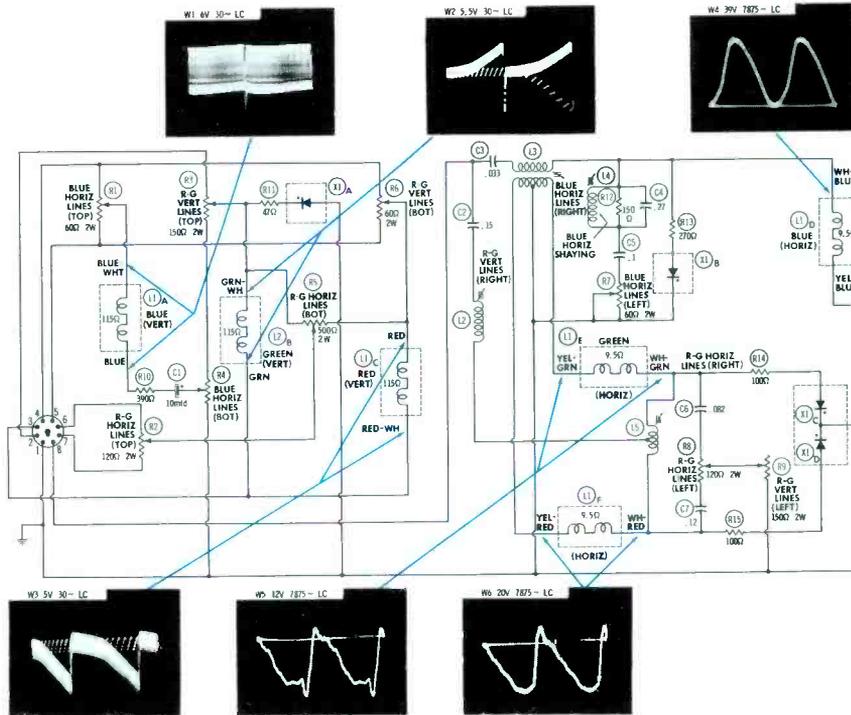
The essential difference between a demodulator probe and a rectifier probe is that the demodulator probe must have a shorter time constant. The time constant of the filter circuit associated with the demodulator probe should be long enough to remove the high-frequency carrier, yet short enough to respond to the lower frequencies in the modulated envelope. The basic operation of the demodulator is shown in Fig. 9.

Two types of series demodulator probes are shown in Fig. 10.

• please turn to page 52



## Controls And Yoke



**DC RESISTANCES** taken with VTVM with interconnecting cable unplugged from main chassis. All controls set for proper convergence.

**WAVEFORMS** taken with wideband scope; low-capacitance probe (LC), connected across convergence yoke windings, used to obtain all waveforms shown.

### Normal Operation

Convergence assembly alters path of three electron beams in picture tube so that they pass through same hole in aperture mask at any given instant. This is necessary since picture tube face plate is relative flat and beams sweep in an arc. Three beams will converge at center of screen, but without modifying path, beams will come together before reaching edges of face plate. Most popular method uses three section convergence yoke—one section for each beam. Each section consists of a permanent magnet for static or center convergence and an electromagnet with both vertical and horizontal windings for dynamic or edge convergence. Current through vertical and horizontal coils must have parabolic waveform for strong control of beams at edges, declining towards middle, and increasing to maximum again at edges. Waveforms from sweep circuits are shaped and mixed to supply proper control current across convergence yoke windings. Vertical waveforms are from separate windings on vertical-output transformer and output cathode. Horizontal pulse is from flyback winding. Circuitry shown here connects sweep waveforms to separate convergence board for shaping; resulting waveforms are connected to convergence yoke. While there is interaction between controls, convergence board circuitry is divided into two sections—vertical and horizontal. Vertical section controls converge red and green vertical lines at center and red-green-blue horizontal lines at top and bottom. Horizontal section controls converge red-blue-green horizontal center lines, and vertical lines at edges.

### Operating Variations

#### W1

Blue horizontal lines (bot) control changes angle of tilt of horizontal portion of waveform. Blue horizontal lines (top) varies spike amplitude and polarity.

#### W2, W3

R-G vertical lines (bot) control changes spike amplitude and polarity. R-G vertical lines (top) varies tilt of horizontal portion of waveform. R-G horizontal lines (top) control changes amplitude and polarity of spike portion. R-G horizontal lines (bot) varies overall amplitude as well as tilt of sawtooth.

#### W4

Blue horizontal lines (left) control varies amplitude of waveform. Blue horizontal lines (right) coil moves harmonic "bump" up and down declining portion of waveform.

#### W5, W6

R-G horizontal lines (left) control moves hump up and down on declining portion of waveform. R-G vertical lines (left) control changes hump location on declining trace, overall amplitude, and angle of leading edge. R-G horizontal lines (right) and R-G vertical lines (right) coils vary overall amplitude.

#### Blue Horizontal Shaping Coil Adjustment

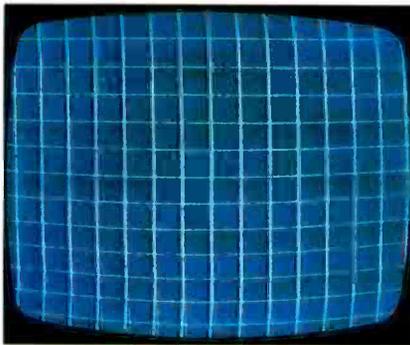
Connect scope across blue horizontal winding (L1D) of convergence yoke and adjust coil so that harmonic "bump" is halfway up declining trace.

## Symptom 1

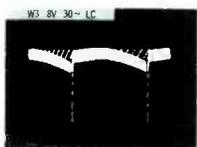
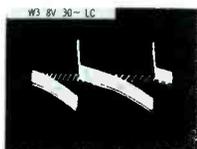
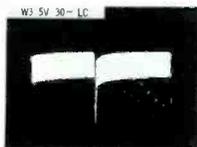
### Vertical Red Lines Displaced

Entire Screen Affected  
**R6 Wiper Arm Open**  
(R-G Vertical Lines (bot)  
Control—60 ohms, 2W)

#### Symptom Analysis



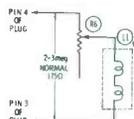
B-W picture has excessive red vertical fringing on picture information. Cross-hatch pattern shows red vertical lines bowed right of other lines at top, left in middle, right again at bottom. Green bowed opposite. Blue straight. R3 and R6 inoperative.



#### Waveform Analysis

Waveform W3 is slightly higher than normal 3 volts p-p, but normally, amplitude and polarity of spike can be changed to converge red and green vertical center lines with R6. Positive spike is connected to one end of R6, negative to other — center tap can be any amplitude of either polarity. Second and third pictures show W3 with R6 set at either end under normal conditions. Best clue from W3 is lack of tilt in horizontal portion.

#### Voltage and Component Analysis



DC voltages are small and insignificant when troubleshooting convergence board. Resistance readings are best. Waveform analysis points to L1C and associated circuitry—resistance measurements in this area turn up good clue. Resistance between pins 3 and 4 of plug (plug disconnected) should be about 175 ohms maximum, but now reads about 3 megohms. Trouble can be quickly isolated with one or two more continuity checks. W3 is result of several input waveforms—loss of any one can make proper convergence impossible.

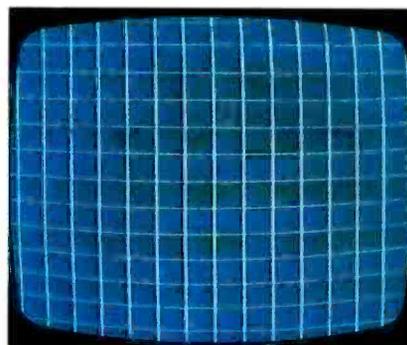
**Best Bet:** Scope; VTVM for resistance measurements.

### Blue Horizontal Lines Bowed

Other Convergence Near Normal  
**C1 Open**  
(Coupling Capacitor—10 mfd)

## Symptom 2

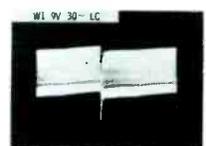
#### Symptom Analysis



Black-and-white program has blue and yellow fringing on horizontal edges of picture information. Cross-hatch pattern shows blue horizontal lines bowed over entire screen. All other lines are straight and converged. R1 and R4 are inoperative.

#### Waveform Analysis

Amplitude of W1 approximately one hundred times higher than normal 6 volts p-p. W1 contains no vertical information. Second waveform is normal except R4, blue horizontal lines (bot) control, is at one end. Waveform with R4 at other end (not shown) is similar, except spike is positive going. Third waveform is also normal except R1, blue horizontal lines (top) control, is at maximum clockwise point to show tilting effect.



#### Voltage and Component Analysis

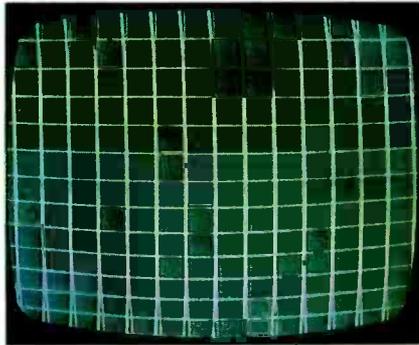
In this instance, resistance measurements only verify continuity of components in suspected circuit. Waveform analysis and component substitution are necessary to solve problem. L1A positions blue horizontal lines at top and bottom of screen. Normally, some horizontal information is induced into vertical windings (from horizontal winding). With C1 open, L1A is “floating”—vertical waveforms have no effect and induced horizontal information becomes much stronger, bending horizontal blue lines into near sine wave.

**Best Bet:** Scope; resistance measurements; component substitution.

### Symptom 3

## Vertical Red Lines Displaced Controls Will Not Correct Broken PC Board (Vertical-Output/Cathode Input)

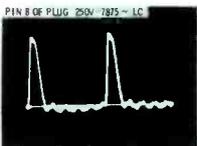
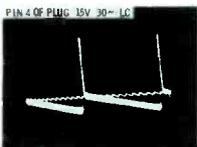
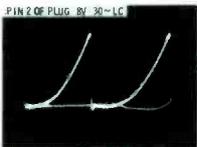
### Symptom Analysis



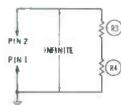
Black-and-white program has vertical red and green "edging" over entire screen. Cross-hatch signal, displayed with blue gun killed, shows green and red vertical lines are not converged. R3 and R6 move lines slightly but will not converge them.

### Waveform Analysis

Loss of first waveform shown here (from cathode of vertical output tube) causes symptoms. W3 (not shown) indicates trouble because there is no tilt in horizontal portion of waveform. Other vertical inputs are from tapped winding of vertical output transformer. Second waveform shown is positive going spike at pin 4 of plug. Waveform at pin 5 (not shown) is negative going spike. Third waveform is horizontal pulse input at pin 8.



### Voltage and Component Analysis



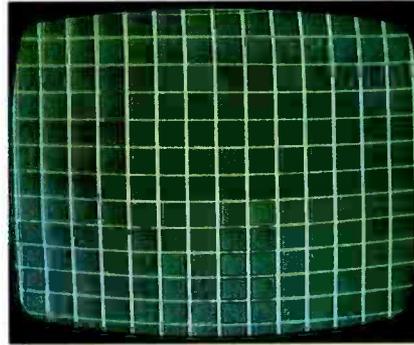
Since sweep waveforms are used, sweep circuits must be operating properly for good convergence. Scope check of inputs would locate these problems quickly. Open PC on convergence board is located by systematic elimination of circuits by resistance measurements. Pin 2 of plug to common (pin 1), with plug disconnected, should measure about 210 ohms, but now shows infinity. This symptom could be caused by open PC or defective component on main chassis, open wiring harness, or cold solder joint in plug or socket.

Best Bet: Scope; VTVM for resistance.

## Red and Green Vertical Lines Not Converged Left Side Only X1C Open (Wave Shaping Rectifier)

### Symptom 4

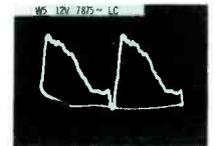
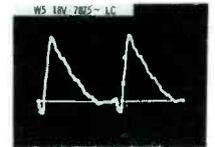
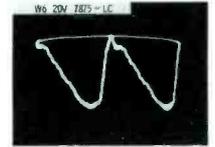
### Symptom Analysis



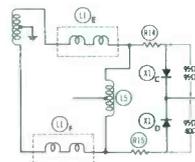
Cross-hatch pattern, with blue gun killed, shows red and green vertical lines are not converged on left side. R9, R-G vertical lines (left), corrects trouble, but then middle is off. Static adjustments converge middle again, but then range of R9 is insufficient.

### Waveform Analysis

While W6 may vary somewhat according to adjustments, it has necessary ingredients for good convergence — sufficient amplitude and hump on declining trace. W5 (second waveform shown here), across green horizontal winding, indicates trouble compared to normal W5 (third waveform) — amplitude is excessive and hump is missing in declining line. Result is sawtooth waveform that will not produce proper control of green beam.



### Voltage and Component Analysis



Resistance measurements across X1C and X1D should be similar, since DC path for each section is similar. X1D readings show expected diode action when meter leads are reversed, but readings across X1C are same. X1C-R14 and X1D-R15 act as variable resistors to sinewave produced by L5 and associated circuitry and, in effect, form parabolic waveform necessary for proper convergence. Loss of shaping action by rectifier makes waveform across convergence yoke winding wrong, and proper convergence is impossible.

Best Bet: Scope; then resistance measurements.

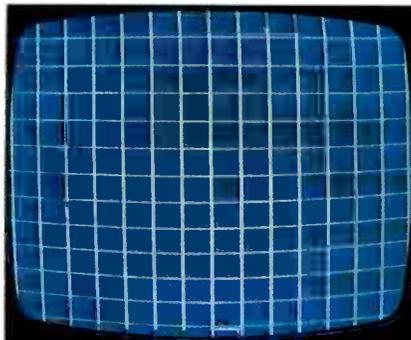
## Symptom 5

# Horizontal Lines Not Converged

All Colors Affected

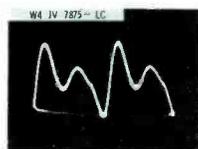
## L3 Primary Open

(Blue Horizontal Lines Coil—Right)



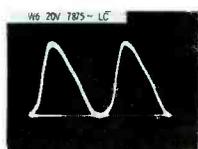
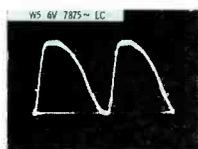
### Symptom Analysis

B-w picture has blue and yellow fringing on horizontal edges. Cross-hatch shows horizontal lines bowed—blue more than others. Lines low at left and right edges, high in middle. Static convergence only makes edges more separated. Controls have little effect.

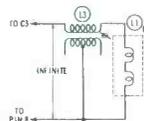


### Waveform Analysis

Waveforms across horizontal convergence yoke coils are incorrect. W4 is almost nonexistent (1 volt, normally about 39 volts p-p) and content is distorted. W5 half normal amplitude (6 volts p-p, normally 12 volts p-p) and sharp change of direction in waveform is missing. W6 near normal amplitude, but looks more like sine wave than normal waveform. Horizontal input pulse at pin 8 of plug (not shown) is normal.



### Voltage and Component Analysis



Symptom and waveform analysis indicate blue horizontal lines are affected most. Resistance check from junction of C3 and L3 to common shows open—normally 20 ohms. One or two more checks will isolate. L3 primary shapes horizontal pulse to some extent and couples it to blue horizontal circuitry. Tapped secondary of L3 supplies opposing horizontal pulses to red and green horizontal convergence circuits. Horizontal lines do not converge—blue because coil receives no signal, red and green because signal reduced.

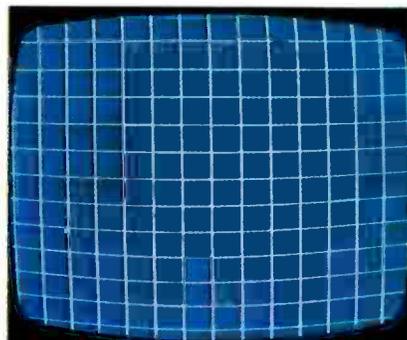
**Best Bet:** Scope and symptom analysis; then VTVM.

# Red Displaced

Both Horizontal and Vertical

## L2 Open

(R-G Vertical Lines Coil—Right)



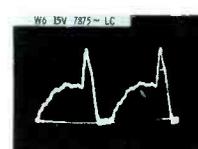
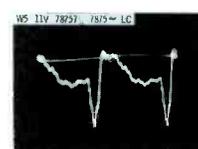
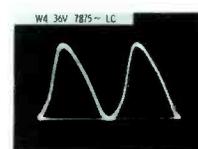
## Symptom 6

### Symptom Analysis

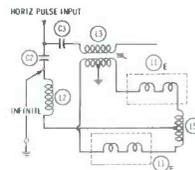
Green and blue converged over entire screen. Horizontal red lines low. Vertical red lines displaced to right of blue-green at either side, but to left in middle. Static convergence corrects horizontal and middle vertical lines, but makes red vertical at edges worse.

### Waveform Analysis

W4 across horizontal blue winding of convergence yoke normal, both in amplitude and content. W5 and W6 both appear to have something missing. About all that shows in these waveforms is horizontal pulse from secondary of L3 (negative going across green winding and positive going across red). The polarity of these waveforms may be reversed by scope connections, but important point is that pulses are present and opposite.



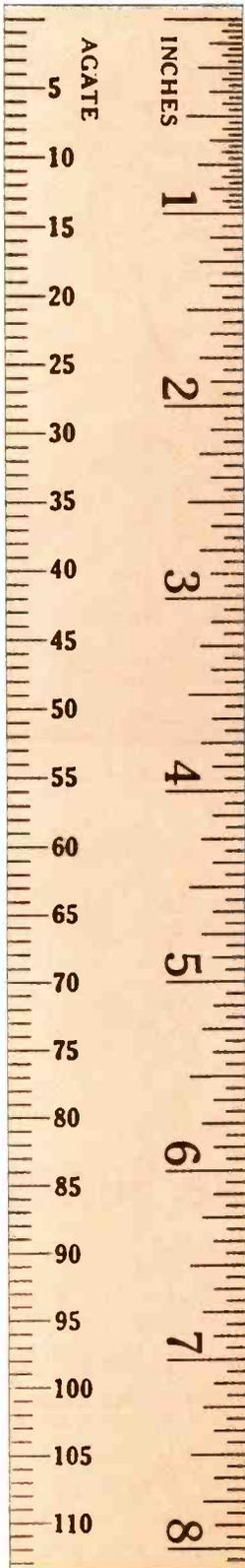
### Voltage and Component Analysis



Horizontal input pulse is coupled through C2 to tuned circuit which is shock excited into oscillation by pulse. This produces sine wave at horizontal frequency that is connected to red and green circuitry and shaped by diodes X1C and X1D. Without this signal the only waveforms across red and green windings are opposing pulses from secondary of L3. Resistance checks in this circuitry give best clue—reading from junction of C2 and L2 to common (pin 1 of plug) is infinity—should be 15 to 20 ohms.

**Best Bet:** Scope; then resistance measurements.

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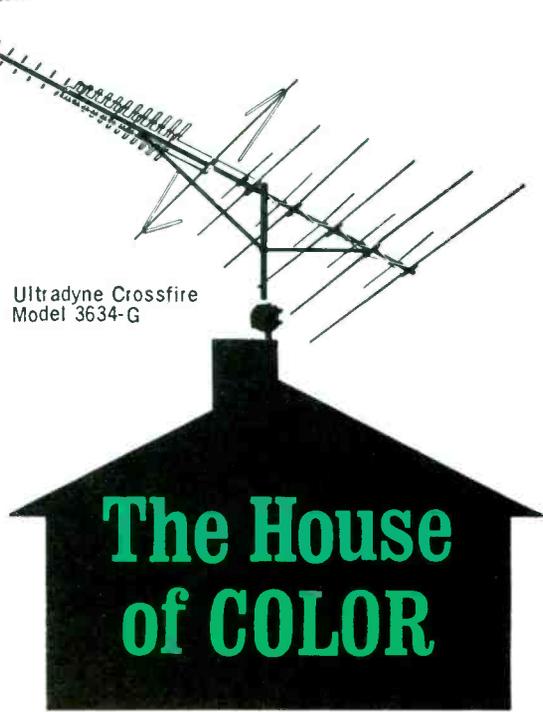
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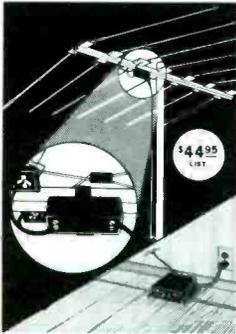
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## SCOPE PROBES

(Continued from page 44)

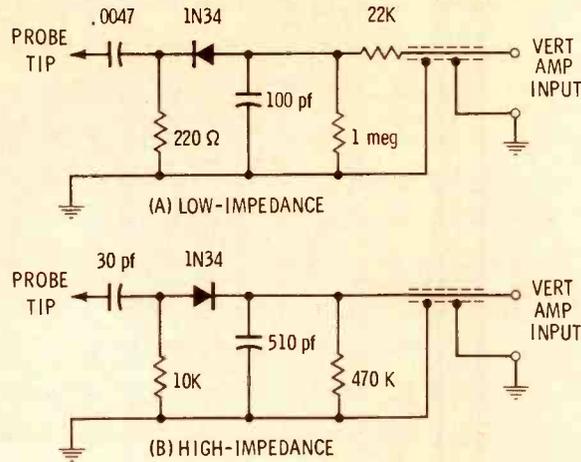


Fig. 10. Common series-type demodulator probes.

The low-impedance type is preferred over the high-impedance type because of its ability to swamp out the resonant response of the tuned circuit, thereby avoiding unwanted oscillation. Although the low-impedance probe has lower sen-

sitivity than the high-impedance type, and consequently, lower output voltage, this can be compensated for by increasing the vertical gain control of the scope.

The shunt-type demodulator probe illustrated in Fig. 11 has less

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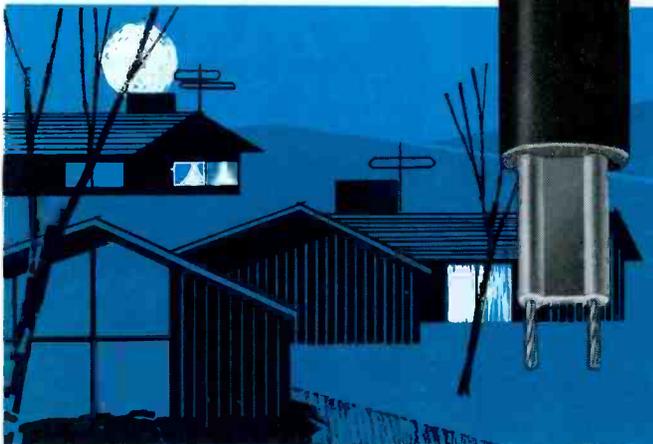
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\*Patent No. 2,782,251 and Pat. Pending  
†Patent No. 3,032,604

B-8-6

sensitivity than either type of series demodulator, and therefore, less signal amplitude at the output. However, unlike the series type, it effectively attenuates any hum voltages in (or on) the tested signal. Because of its low sensitivity, the shunt-type probe is not as adaptable to video IF signal tracing as the series type. In some applications, even the series-type demodulator probe does not provide enough voltage for proper waveform reproduction. As the video IF waveform is

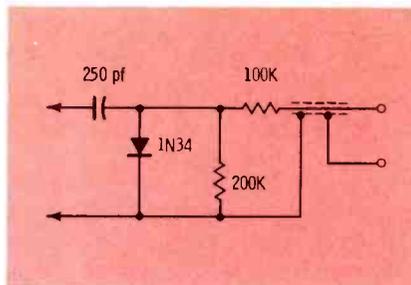


Fig. 11. Shunt-type demodulator probe has less sensitivity.

traced from the video detector input to the tuner output, the meas-

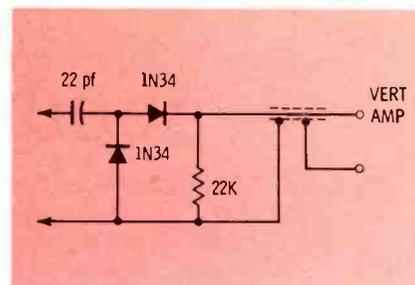


Fig. 12. Voltage doubler demodulator probe doubles sensitivity.

ured signal becomes increasingly smaller. To offset this decrease in signal amplitude, it is sometimes necessary to resort to the voltage-doubler-type of demodulator probe for waveform observations at the tuner output. This demodulator probe type is shown in Fig. 12. Because the voltage-doubler probe provides twice the sensitivity available with the series or shunt type, it is particularly useful for relatively low-level signal observation. However, there are two disadvantages to be considered with this

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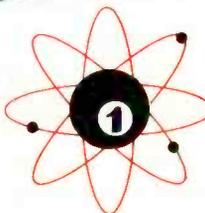


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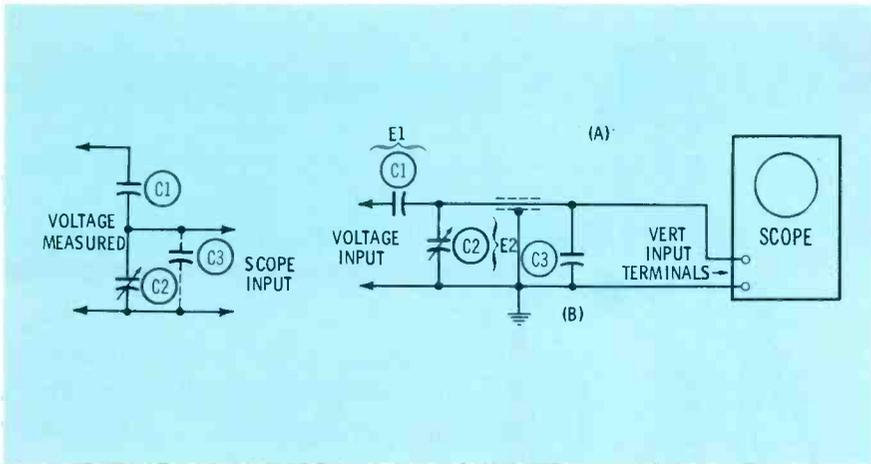


Fig. 13. Voltage dividing action of capacitance divider probe.

probe: (1) a lower input impedance than either the series or shunt demodulator probes, limiting its use to relatively low-impedance circuits, and (2) the frequency response is not as good as the series or shunt types.

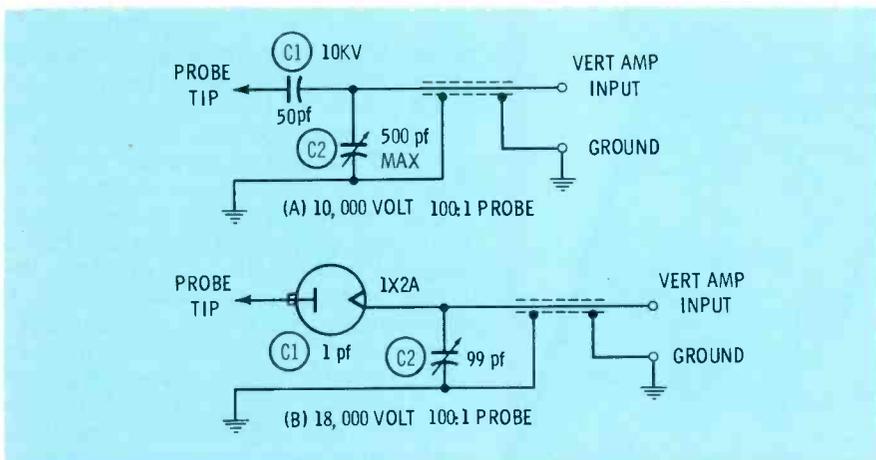
It must be remembered that the demodulator probe is used only to determine the presence or absence of a signal at a particular stage. The loading effect of this probe makes accurate peak-to-peak voltage measurements impossible. Also,

most types of demodulator probes have poor high-frequency response, and as a result, horizontal sync pulses are usually attenuated and slightly rounded.

#### Capacitance-Divider Probe

Although the vertical input terminals of most scopes are rated at about 600 volts maximum, it is occasionally necessary to measure much higher voltages, such as those found in horizontal sweep circuits. The capacitance-divider, high-voltage probe makes it possible to meas-

Fig. 14. Two common types of high-voltage capacitance dividers.



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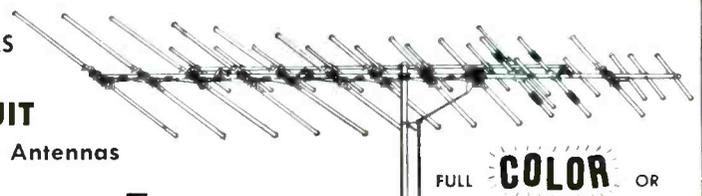
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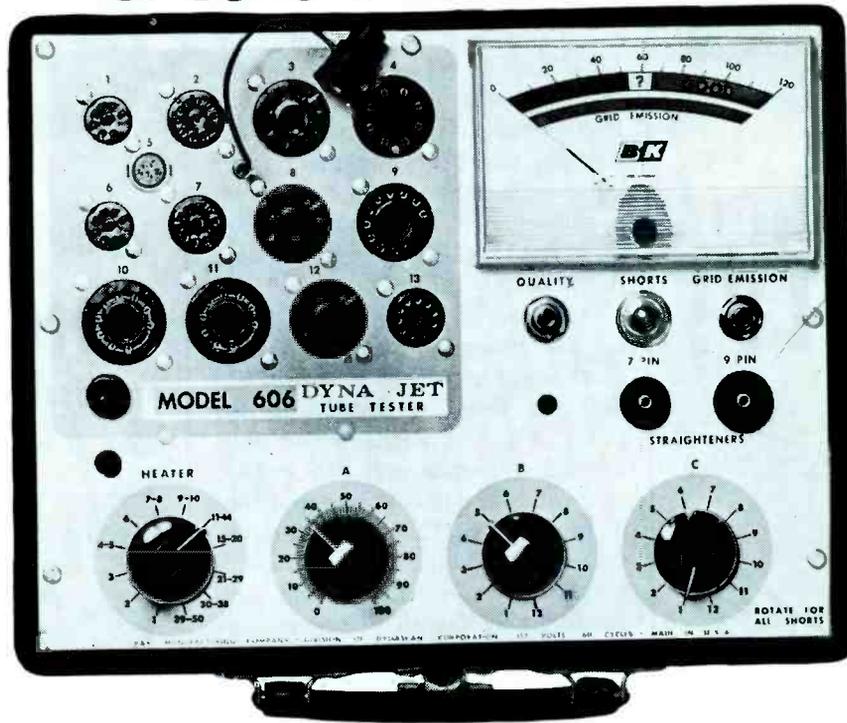
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ure horizontal sweep circuit voltages, and yet, not exceed the maximum input rating of the scope.

As shown in Fig. 13A, C1 and C2 are connected in series across the probe input. The input voltage divides across the two capacitors in inverse proportion to their capacitance. Since C1 is normally much smaller than C2, most of the input voltage will be dropped across this capacitor, leaving only a relatively small voltage across C2. The formula for expressing the relative component values of C1 and C2 for a particular voltage ratio is:  $C_2 = C_1 (R-1)$ , where R is the step-down ratio.

Referring to Fig. 13B, if C1 and C2 are chosen to produce a step-down ratio of 100 to 1, and a 10,000-volt signal is applied to the probe, E1 will equal 9,900 volts and E2 will equal only 100 volts—well within the maximum input limits of the scope. C3 is used to represent the combined shunt capacitance of the shielded cable and scope input circuit. Because this shunt capacitance is in parallel with trimmer C2, the probe will have to be recalibrated each time it is used with a different cable or scope. Calibration is accomplished as follows: (1) Connect the vertical terminals of the scope directly across a low-impedance, low-voltage source, and set the scope attenuator to the X100 position. (2) Vary the vernier attenuator for any convenient vertical amplitude and note the number of squares covered. (3) Connect the probe between the same voltage source and the vertical terminals of the scope. Advance the scope step attenuator to the "X1" position. The waveform should now occupy the exact same number of scale divisions as it did in step 2—if not, adjust the probe trimmer capacitor (C2) with a nonmetallic screwdriver until the waveform is the same. Once this is accomplished, the probe is calibrated to deliver to the scope 1/100 of any voltage applied to its tip.

Fig. 14 illustrates two commonly used types of 100-to-1 capacitance-divider probes. The probe in Fig. 14A is limited to 10KV by the breakdown rating of C1. This probe is suitable for measuring at the plate of the horizontal output tube or at

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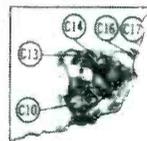
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the grid of the horizontal oscillator—actually, a 10-to-1 low-C probe can also be used here, but the 100-to-1 capacitance divider is preferred because its lower input capacitance detunes the circuit less. The probe shown in Fig. 14B is rated at 18,000 volts and can be used, along with a high-voltage filter capacitor, to measure the high voltage in some b-w receivers. However, in some large screen b-w sets, and in nearly all color receivers, the high voltage at the anode is beyond the maximum rating of this probe. The relative high voltage rating of this probe is possible because of the large breakdown voltage rating of the 1X2A used in the probe input in place of a conventional capacitor. The interelectrode capacitance of this tube is the equivalent of a 1-pf capacitor—with the added advantage of an 18,000 volt breakdown rating.

As implied previously, the 100-to-1 high-voltage, capacitance-divider probe can be used to measure the voltages at the horizontal oscillator grid and horizontal output plate. In addition, it can be used to measure the waveform across the horizontal deflection coils. The probe should *not* be used for measurements in the vertical sweep circuits. At such low frequencies, the shunt resistance and input capacitance of the scope react with the probe capacitance to cause differentiation. As a result, voltages at the vertical frequency would be greatly distorted.

### Specific Probe Applications

The shielded direct probe is limited to low-impedance circuits having relatively low-level signals. In television servicing, such a probe is normally used only for checking the ripple frequency of the low-voltage power supply, or for checking the waveform at the damper cathode.

The 10-to-1 low-capacitance probe is more adaptable to television servicing and can be used for nearly all scope checks in the video amplifier, sync, vertical oscillator and sweep, and chroma circuits. In addition, it can be used to check the waveforms at the grids of the horizontal discharge and horizontal output stages, as well as the ver-

tical retrace blanking signal at the picture tube grid or cathode. Although the 10-to-1 low-C probe can be used in the horizontal AFC circuit and at the horizontal oscillator grid, the 100-to-1 capacitance-divider probe is preferred because it causes less circuit loading.

Other uses for the high-voltage, capacitance-divider probe include waveform and peak-to-peak voltage measurements at the plates of the horizontal output and damper stages. This probe can also be used to check the high-voltage ripple at the picture tube 2nd anode, provided a 250- to 500-pf filter capacitor is employed in series with it. The demodulator probe is limited to use in the video IF section and tuner output circuit.

### Conclusion

There are five primary factors to be weighed when selecting a scope probe for a particular test application: (1) the input impedance of the scope, (2) the impedance of the circuit under test, (3) the frequency response of the scope, (4) the frequency of the signal to be measured, and (5) the relative amplitude of the signal. Disregarding any one of these considerations can result in inaccurate voltage measurements, or distorted waveforms that prove meaningless. Selecting the correct probe not only assures more accurate troubleshooting information, but also compensates for many of the characteristics that can limit a scope's usefulness in television servicing. ▲



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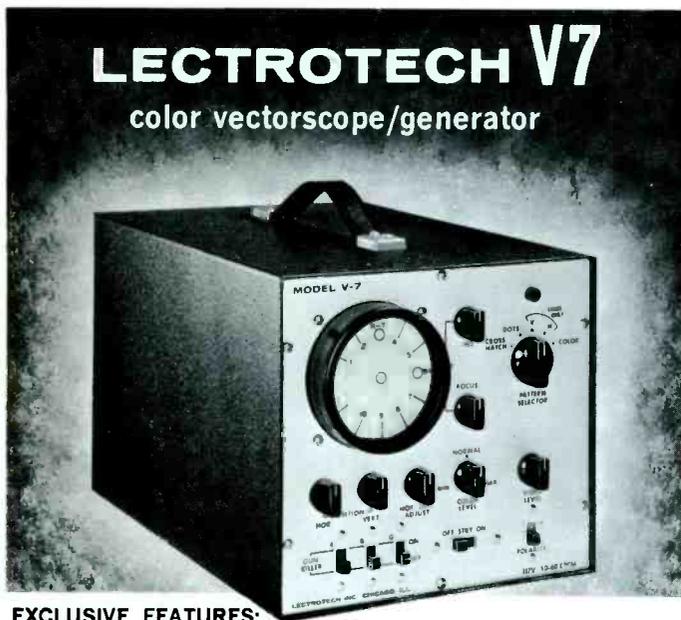
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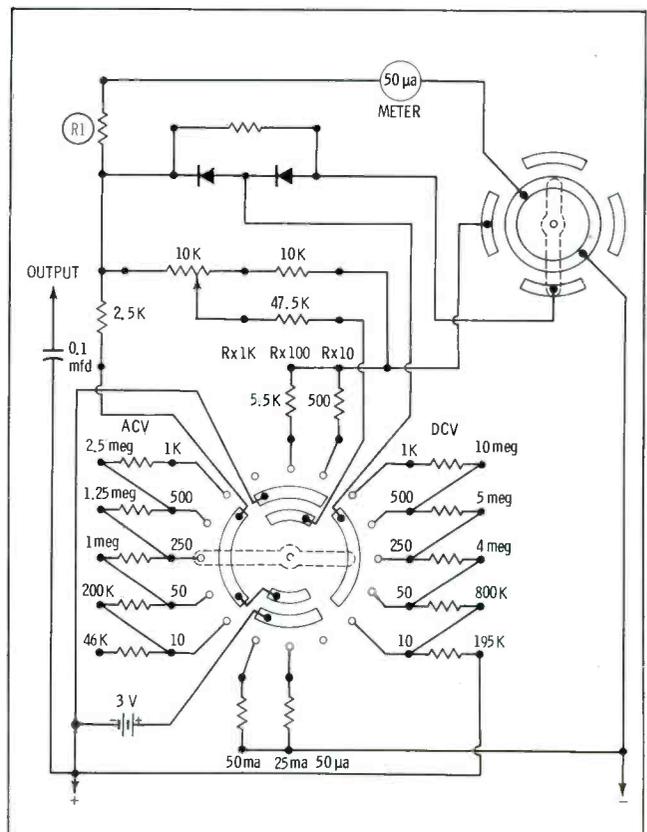
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## Double Trouble

I have two unrelated problems that I would like your opinion on. The first concerns arcing from the "S" winding of a flyback to the iron core. I have applied both red and black (which jelled and set better) corona dope, but to no avail. Even after letting the corona dope dry a couple of days, the arcing returned about one minute after the set was turned on. Should I remove the old corona dope, and recoat the transformer again, or is there a better method to stop such arcing?

The second problem concerns an Olson TE-168 VOM that I use on house calls. It has suddenly become defective with no indication on ohms or AC functions. There



is a small indication on the DC ranges. This small deflection corresponds to .5 volts on the 10-volt DC range and is the same on all other ranges. I have replaced the batteries and checked the continuity of all the circuits. The only components I have not checked (and do not know how) are the meter movement and the two rectifiers. What is the proper troubleshooting procedure for test equipment and how can I check the meter movement?

C. B. KACZYNSKI

Cheektowaga, N.Y.

*The arcing you are experiencing from the "S" winding of the flyback to the core is not easily corrected, and in many instances, the only positive solution is replacement of the flyback. However, in cases where the arcing has just begun and has not greatly deteriorated the winding insulation, it is possible to save the flyback by wrapping heavy plastic sheeting, or several layers of electrical tape, around the core at the point where the arcing has occurred. (This point is usually easily distinguished by a charred or blackened area on the core, or by a hole through the coil form.) After the core has been wrapped, apply anti-corona dope to both the wrapped portion of the core and the winding itself.*

*Troubleshooting VTVMs and VOMs need not be any more difficult than other electronic equipment—in most cases it is much easier. From your description of the trouble symptoms you are experiencing with the VOM, it can be seen that you are already aware of the proper troubleshooting procedure to be used with test equipment. Using the various functions of the VOM itself, you have, through the process of elimination, isolated the fault. The fact that all functions of the VOM were either inoperative, or gave an erratic indication, quickly pointed to a circuit or component that was common to all functions. In this particular VOM, as in most, this would point to either the meter movement, series resistor R1, or the test leads or sockets. Since a continuity check cleared the test leads, sockets, and associated wiring, only the meter movement and R1 remained as possible suspects. R1 can be checked easy enough; however, the meter movement is another matter. Never use another VOM to check the resistance of a meter movement—excessive current could possibly destroy the movement beyond repair. Instead, use the following procedure to determine the condition of the meter: Remove all connections to the terminals on the back of the movement case. Calculate the value of resistance needed for 2/3 full-scale deflection. In this case, since the full-scale current rating is 50ua with a 250mv drop across the movement, the value of series resistance required for full-scale deflection is 5K ohms ( $R = .250/E0 \times 10^{-6}$ ). Meter deflection can be reduced to 2/3 full-scale by increasing the size of the series resistor by about 1/3, resulting in a resistance of 6650 ohms. A standard resistance value of 6800 ohms will serve the purpose. Connect the 68K ohm resistor and 1 1/2-volt dry cell in series across the meter. If the meter fails to deflect to approximately 2/3 full-scale, you can assume the meter movement to be defective. Never attempt to repair a defective meter movement; instead, return the meter movement to the manufacturer, according to instructions in the operation manual supplied with the VOM. (It is usually wise to write the manufacturer for shipping instructions before shipping the meter).* ▲

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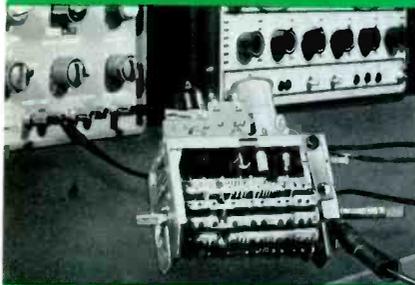
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# COLOR

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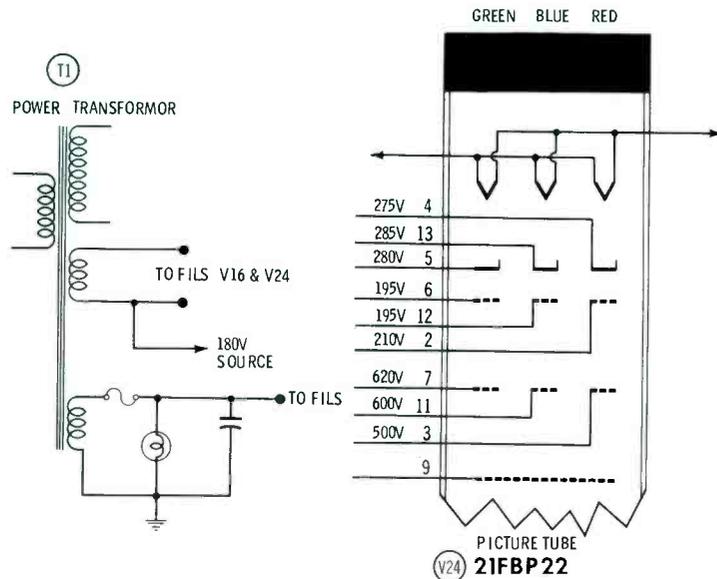
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**Tip:** Check for heater-cathode short in V24 (CRT).

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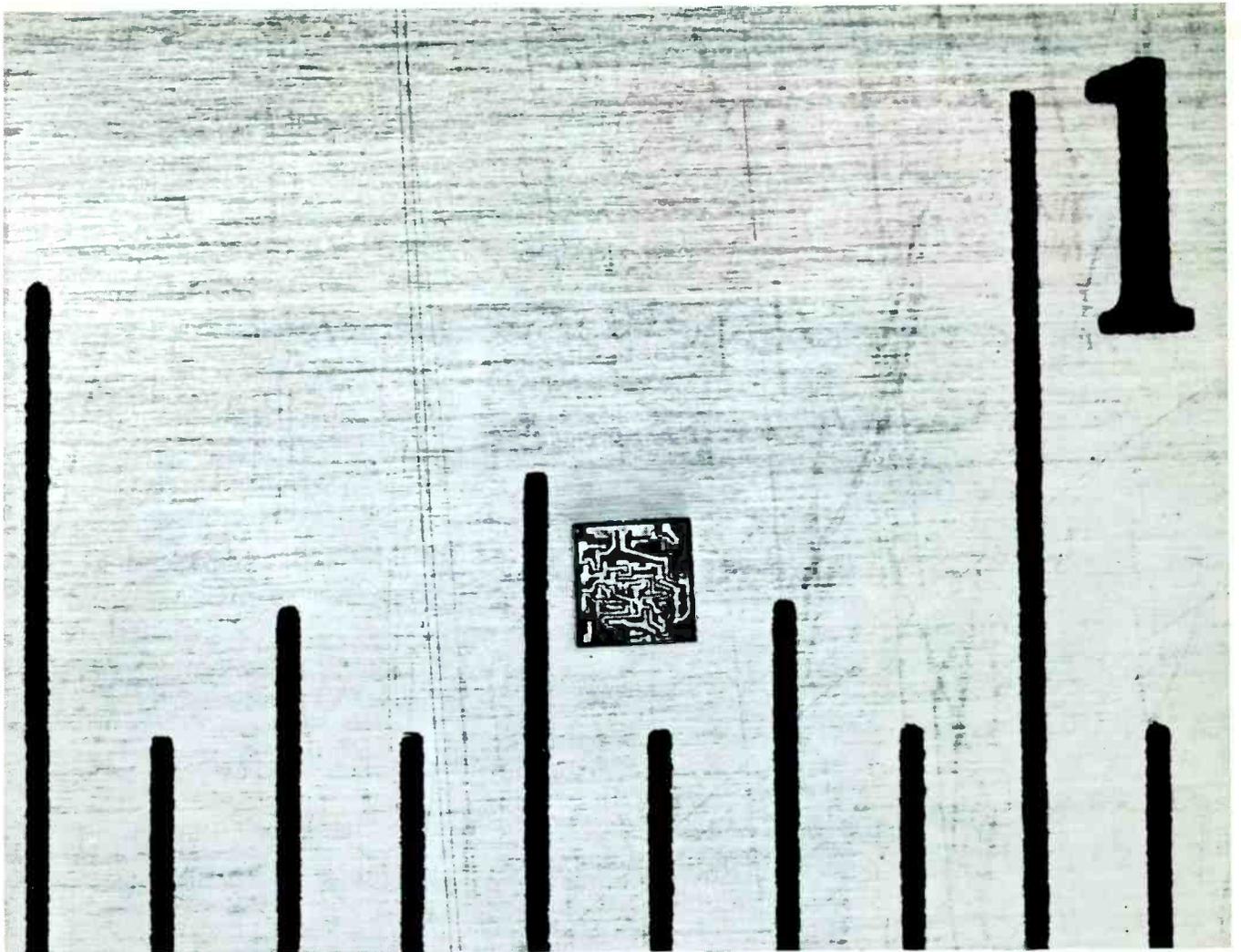
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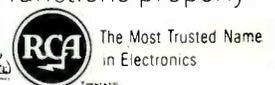


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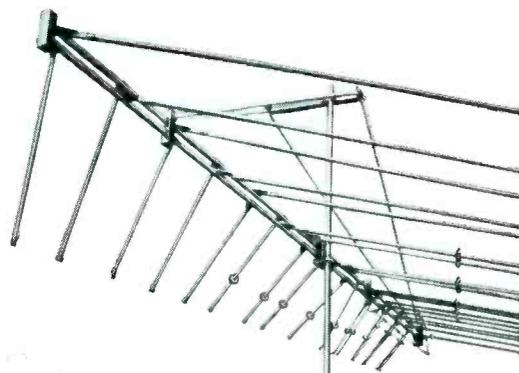
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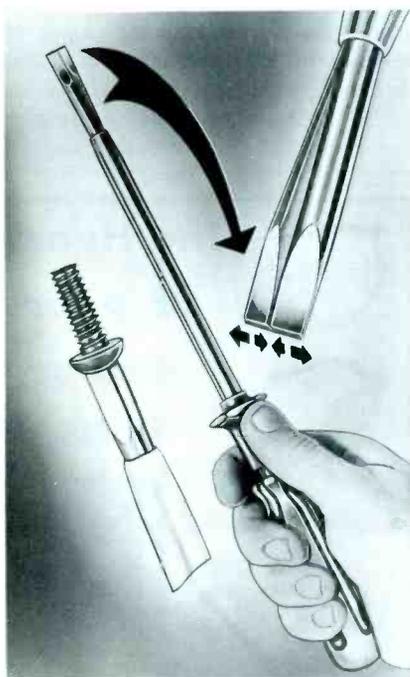
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The new tube tester features sockets of phosphor bronze construction and built-in custom pin-straighteners for all tube types. Additional features of the unit include automatic line voltage regulation and a 4½" D'Arsonval meter movement that is protected against accidental burn-out.

The tube tester is housed in a leatherette-covered carrying case and measures 18¼" x 10¾" x 4½". Price of the unit is \$99.95. The optional Model MH-3 Multi-Head CRT Adapter is priced at \$12.45.



**Screw Launcher**  
(66)

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wedge that firmly grips the slot of the screw, holding it securely while the driving action is started. When the screw has been set, the driver is released from the slot by sliding the gripping sleeve back toward the handle. This relaxes the overlapping double blades, freeing the driver from the screw.

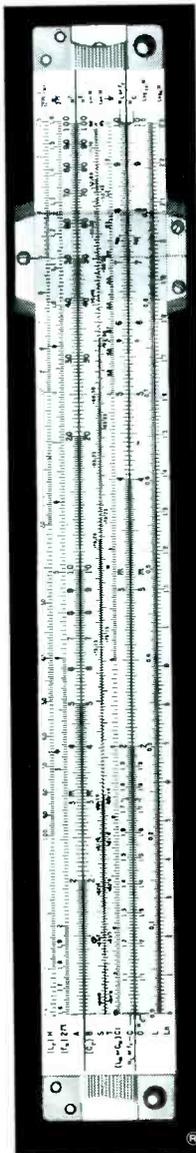
The tool is equipped with a "Comfordome" handle for comfort and driving power. The double-blade bit is made of durable spring steel and is available in ⅛", ⅜", and ¼" blade diameters, and three blade

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(67)

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**A-104/UV**—similar to A-102U/V except for 4 sets.

**MDC-2VU**—connects two coax (75-ohm) cables from TV sets to a single coax downlead.

**TV-2**—economy indoor model. Connects two sets to a single 300-ohm twin-lead. Not recommended for weak signal areas.

Quality combiners and splitters are also essential to a good all-channel color TV system. When you specify Blonder-Tongue, you get high quality, low loss and high isolation.

**UVF-1**—deluxe 300-ohm weatherproof model. Provides separate UHF, VHF and FM outlets from downlead carrying all three signals or feeds a single downlead from separate UHF, VHF and FM antennas.

**UVF-C/S**—a lower priced version of the UVF-1.

**A-107**—deluxe, weatherproof unit combines UHF and VHF antennas to one 300-ohm downlead or provides separate UHF and VHF output at set.

**UV-C/S**—indoor unit provides separate UHF and VHF outputs from a single 300-ohm cable carrying both signals, for connection to converter or TV set with separate UHF and VHF inputs.

Write for free catalog #74.

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*Blonder-Tongue, the name to remember, for TV reception you'll never forget*



technicians, and hobbyists, the Model 100A4 combines minimum circuit loading with a wide-range of applications. In addition to a 100,000 ohms/volt DC sensitivity, the multi-meter also features an AC input resistance of 12,500 ohms/volt. Other features include a double jewelled  $\pm 2\%$  D'Arsonval meter movement; two-color, 4" mirror-back scale to



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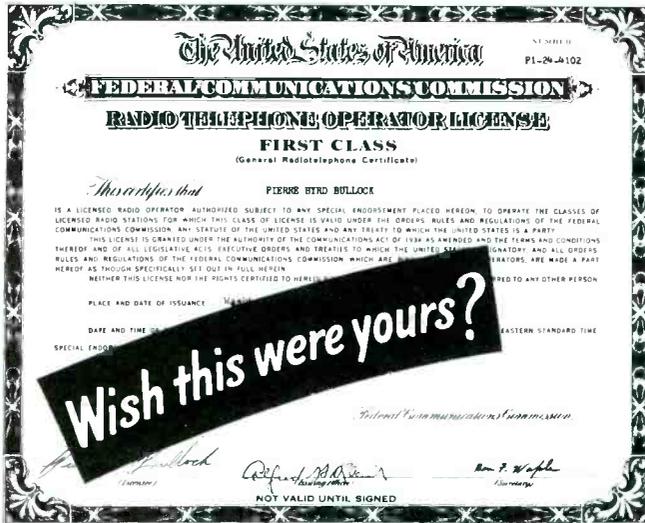
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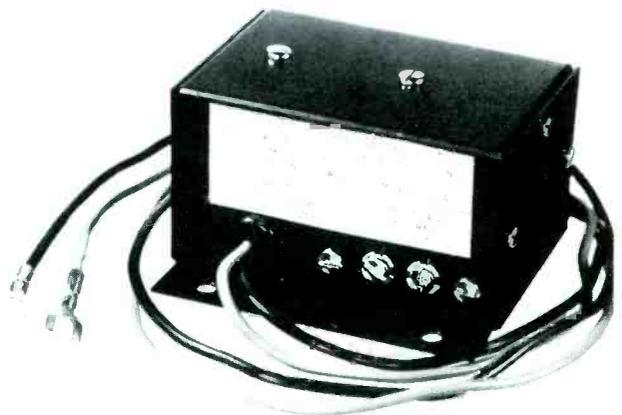
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eliminate parallax; a matched pair of silicon diodes to provide meter overload protection; and a high-impact case with integral handle for convenient positioning and portability. DC voltage ranges are 0-500 mv, 2.5, 10, 50, 250, 500, and 1000 volts. AC voltage ranges are 0-2.5, 10, 50 250, and 1000 volts. DC current ranges include 0-10 $\mu$ a, 250 $\mu$ a, 2.5ma, 250ma, and 10 amps. Resistance can be measured from 0 to 20 megohms in four steps. A decibel function is also included and extends from -20 dB to +62 dB in 5 ranges. The multimeter measures 7 $\frac{1}{2}$ "  $\times$  5 $\frac{1}{4}$ "  $\times$  3 $\frac{1}{4}$ ". Price is \$34.95, complete with batteries and test leads.



**Inconverter And Voltage Regulator (68)**

The ability to operate low-powered communications and other electronic equipment from practically any DC power source ranging from 6 to 32 volts is now possible with two new accessories from the E. F. Johnson Company. Called the In-Converter and the Voltage Regulator, these units can be used to operate equipment drawing up to 14 watts of power and can correct improper input voltages or incorrect polarity.

The In-Converter is particularly adaptable for installing a two-way radio system, auto tape player, car radio, auto reverberation unit, or other electric appliance in a foreign car with a 6-volt electrical system or in a vehicle that uses a positive ground. The unit has an input

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B & K has done it again . . . put you a "jump ahead" by looking into your future . . . your problems, *your* needs. This is the "Little Corporal," the CRT Rejuvenator and Checker, designed to provide maximum obsolescence protection by providing continuously variable voltages for all CRT elements. You can make the most accurate possible tests, even on future CRT types, because the heater

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Take advantage of the growing profit potential in this area. Add color TV to your skills with this home training course, newly revised to include information on the latest techniques, receiver circuitry and equipment. Train under the direction of RCA Institutes... experts in Color TV home study training.



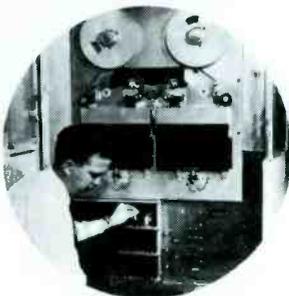
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of 6 or 12 volts DC and an output of 6 or 12 volts with either negative or positive polarity, or an output of 18 or 24 volts DC with the same polarity as the input.

The voltage regulator accepts any DC voltage from 24 to 32 volts and furnishes an output of 13 volts DC at 14 watts. Applications for the voltage regulator include material handling vehicles, aircraft, boats, and construction equipment. Prices of the voltage regulator are \$14.95 with positive ground and \$17.95 with negative ground. The In-Converter is priced at \$22.95.



### Transistor Tester and Set Analyzer (69)

Completely selfpowered, this portable unit is actually 8 analyzers in 1 unit. Designed for bench or home-servicing, it can be used as a transistor tester, a diode tester, as a wattmeter, an ammeter, a signal generator, an in-circuit tester, and will also function as an AC and DC beta tester. The Semitronics Model 1000 Transistor Tester and Set Analyzer can check all transistors for gain, leakage, and oscillating ability, either in or out of the circuit. In addition, it can be used to determine whether a transistor is a P-N-P or N-P-N type. The unit can also be used as a signal tracer for detecting faults in transistor radios, hi-fi amplifiers, TV receivers, and similar electronic equipment. As a complete testing lab in one unit, the tester and analyzer can be used to check all sections of transistor receivers, including audio, IF, and RF circuits. The tester can be used to check battery voltage and current drain. It is designed to test both diodes and rectifiers. Sockets are conveniently mounted on the face of the instrument for testing both voltage- and power-type transistors.

Included with the unit (which comes completely wired, ready for bench or home use) is the *Semitronics Interchangeability Guide*, supplying replacement information on approximately 5,000 different semiconductors. Also included is a copy of the "Transistor Tester and Set Analyzer." This book not only supplies complete information on the operation and practical use of the unit, but also gives practical servicing hints. The complete package, consisting of the Model 1000 Transistor Tester and Set Analyzer

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All devices and kits are packaged in easily identifiable see-through packs for your convenience. Included with each device is broad performance data or specific ratings and characteristics where applicable.

RCA Solid-State Center Includes:

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imenter or replacement use.

- RCA Technical Manuals. Four manuals include: RCA Experimenter's Manual, RCA Transistor Manual, RCA Linear Integrated Circuits Fundamentals Manual, and RCA Tunnel Diode Manual.
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March, 1967/PF REPORTER 71

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the Interchangability Guide, the book entitled "Transistor Tester and Set Analyzer," a transistor, and a set of needle-point test leads, is priced at \$34.95.



## Battery Pack

(70)

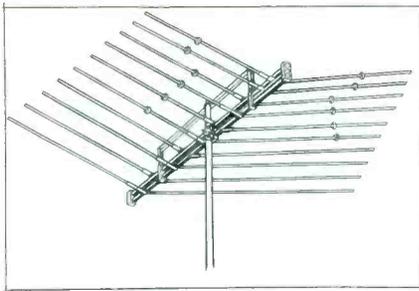
A new, self-contained battery pack, especially designed to make all Courier solid-state CB rigs completely portable, has been introduced by **Courier Communications, Inc.** Model PAP-1 PORT-A-PAK, features a rechargeable nickel cadmium battery that provides continuous operation in the receive position for up to 8 hours and can be left on trickle-charge position continuously to insure ready-to-go operation, or can be recharged while in standby. The unit is reliable at all temperatures from  $-30^{\circ}\text{F}$  to  $+140^{\circ}\text{F}$  and cannot be damaged by overcharge when used with a CHARGE-A-PAK Battery Charger (Model CAP-1). When using PORT-A-PAK and CHARGE-A-PAK together, the Courier solid-state CB rig can be used as a base station.

The PORT-A-PAK is priced at \$59.95, complete with collapsible antenna, Texion carrying case, rechargeable battery, battery meter, charging connector, mounting hardware, microphone bracket and shoulder strap. CHARGE-A-PAK is priced at \$12.95.

## TV-FM Antenna

(71)

The antenna shown here is one of 8 different models offered in the **JFD** LPV-TV/FM Color Log Periodic series. Designated Model LPV-TV-100, this 10 element log periodic is designed for color, VHF, (up to 125 miles) and FM stereo reception (up to 40 miles). Features of this antenna



include capacitor-coupled dipoles which respond on the third harmonic mode, as well as the fundamental mode, resulting in more elements optimally tuned to work on both low- and high-band VHF channels. A low-impedance twin-boom feeder provides a better impedance match to the dipoles for increased signal transfer on all VHF channels. Also, an integrated transformer design achieves impedance match to the 300-ohm downlead. Dimensions of the antenna include a tip measurement of 92" and a boom length of 112¾". Weight is approximately 14½ lbs. The price of the Model LPV-TU100 is \$41.95. Other antennas in the series range in price from \$14.95 to \$79.95.



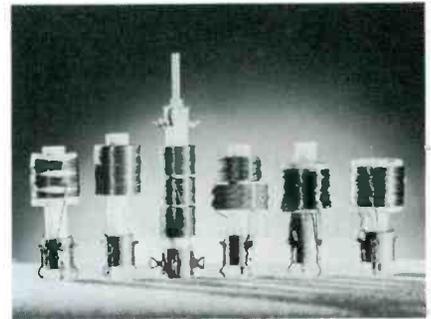
**Anti-Static Record Spray**  
(72)

A special lubricant designed to prolong record life by reducing groove wear is now manufactured by **Colman Electronic Products**. Klear Tone Anti-Static Record Spray, No. 1632-65, is safe to use on all records, including the old shellac type. It is non-flammable and safe to use around all plastics used in photographs. In addition to cleaning and lubricating records with

a fine silicone film that prevents static build up, the record spray may be used to spray-clean dirty phono needles and cartridges. The price is \$1.79.

**Sweep Circuit Replacement Coils**  
(73)

Exact replacement sweep circuit coils for color TV sets produced by more than 25 manufacturers have been introduced by the **J. W. Miller Company**. The focus, convergence, and sweep circuit coils are directly interchangeable with original coils in color TV sets by manufacturers such



as RCA, Philco, Westinghouse, Motorola and Muntz. Single unit prices start at \$1.20.

## How to break into the big money servicing 2-way radios!

**H**OW WOULD YOU LIKE to start collecting your share of the big money being made in electronics today? To start earning \$5 to \$7 an hour...\$200 to \$300 a week...\$10,000 to \$15,000 a year?

Your best bet today, especially if you don't have a college education, is probably in the field of two-way radio.

Two-way radio is booming. Today there are more than *five million* two-way transmitters for police cars, fire trucks, taxis, planes, etc. and Citizen's Band uses—and the number is growing at the rate of 80,000 new transmitters per month.

This wildfire boom presents a solid gold opportunity for trained two-way radio service experts. Most of them are earning \$5,000 to \$10,000 a year *more* than the average radio-TV repair man.

**Why You'll Earn Top Pay**

One reason is that the U.S. doesn't permit anyone to service two-way radio systems unless he is *licensed* by the FCC (Federal Communications Commission). And there aren't enough licensed electronics experts to go around.

Another reason two-way radio men earn so much more than radio-TV service men is that they are needed more often and more desperately. A two-way radio user *must* keep those transmitters operating at all times, and *must* have them checked at regular intervals by licensed personnel to meet FCC requirements.

This means that the available licensed experts can "write their own ticket" when it comes to earnings. Some work by the hour and usually charge at least \$5.00 per hour, \$7.50 on evenings and Sundays, plus travel expenses. Others charge each customer a monthly retainer fee, such as \$20 a month for a base station and \$7.50 for each mobile station. A survey showed that one man can easily maintain at least 15 base stations and 85 mobiles. This would add up to at least \$12,000 a year.

**How to Get Started**

How do you break into the ranks of the big-money earners in two-way radio? This is probably the best way:

1. Without quitting your present job, learn enough about electronics fundamentals to pass the Government FCC Exam and get your Commercial FCC License. Then start getting practical experience in servicing two-way radio systems in your area.
2. As soon as you've earned a reputation as an expert, there are several ways you can go. You can add mobile radio maintenance to the present services offered by your shop, or start your

own separate mobile radio business. You might become a franchised service representative of a big manufacturer and then start getting into two-way radio sales, where one sales contract might net you \$5,000. Or you may be invited to move *up* into a high-prestige salaried job with one of the major manufacturers.

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### CB Transceiver (74)

A new model has been added to General Electric's line of solid-state Citizen's Band transceivers. The Model Y7050 transmits and receives up to ten miles, depending on terrain and conditions. Either of two crystal-controlled frequencies—CB channel 11 or 16—may be used simply by flipping a channel selector switch.

A special feature of this walkie-talkie is power-source flexibility. It can be operated with standard "AA"

penlight batteries, or with rechargeable nickel cadmium batteries (optional). Also, with optional accessories, AC house current, a car cigarette lighter socket, or a 12-volt storage battery can be used to power the unit. Input power is 1½ watts. In addition to the 51" telescoping antenna, a jack is provided for connection to an external antenna. This feature, along with adaptability to a variety of power sources, makes the unit useable as a base station.

Each unit features a squelch control, for reduction of background noise, and a battery checking meter. The unit is supplied with "AA" batteries, earphones, and carrying case. Also included is an application form for a Citizens Band license—required by the FCC because of the unit's power output level. Application is by mail. The only requirements are that the applicant be 18 years of age and a U.S. Citizen.

The set weighs 1.7 lbs. with batteries, and measures 7⅝" high by 3¼" wide by 1⅝" deep. Optional accessories include an auto power cord, Ni-Cad rechargeable batteries, and combination AC converter/Ni-Cad battery charger. Price is \$125 per pair.



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It's a good habit to acquire, because Quam makes good speakers for public address, background music and other sound system needs, as well as for radio-tv-automotive replacements.

Whatever kind of speaker you need, look for Quam, the Quality line, in the red, white, and blue package at your distributor.

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Circle 47 on literature card

74 PF REPORTER/March, 1967

Circle 48 on literature card

# SWITCH to Hi-Q precision instrument switches!



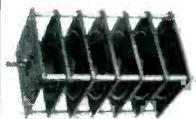
#18 Series Switch available one to eight poles per deck. Meets MIL-S-3786-B.



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Typical type CES six deck, single pole per deck multiple position switch.



Special design incorporating resistors and rear terminals to meet customer needs.



CES type switch with terminal boards. Available 1 3/4" to 8" square. Up to 144 shorting positions.



Hi-Q precision instrument switches readily fulfill standard, special, and military requirements at attractive prices through the use of modular stock units from which an almost unlimited series of configurations may be assembled...and minimum delivery time is guaranteed!

This kind of flexibility is typical of the engineering precision found in every feature—brush blades lapped and edges stoned; insulating parts custom drilled to critical tolerances; contacts of homogeneous alloys for minimum EMF, positive metal-to-metal wiping, and low electrical resistance; maximum contact wiping surface to distribute frictional wear and promulgate longer life. For installation flexibility, all units are available with either solder pot or turret type terminals.

The terminal board switch is a further indicator of the advanced engineering you may expect from Hi-Q. The use of terminal boards facilitates modular wiring harness design and reduces overall assembly costs.

Whatever your product, if design decision requires precision instrument switches, contact Hi-Q and see what they have to offer. It's quite probable that you won't find a better answer anywhere.



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Circle 49 on literature card

# SERVICE PUZZLER

What circuit would you first suspect if you were confronted with the picture on the RCA portable (Chassis KCS 151) in Fig. 1? Read the following clues before making an educated guess.

The picture changes from the effect shown in Fig. 1 to a normal

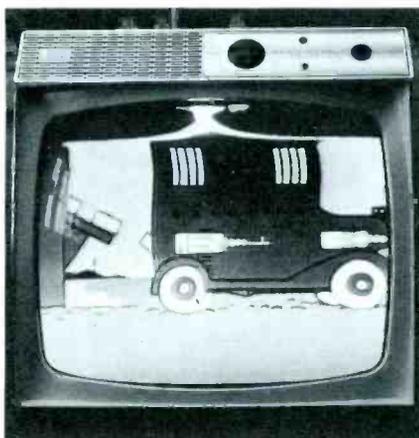


Fig. 1. Odd symptom displayed on screen of RCA portable.

picture, indicating an intermittent component. The effect stays at the top of the screen, even when the vertical is rolled, and it is not changed by height or linearity adjustments. The same effect is seen on a blank channel.

### Right or Wrong?

After careful analysis, you should have concluded that the vertical pulse was killing the horizontal sweep shortly after the vertical retrace time. But how are the two getting together? How about a yoke short? The picture was still the same with a new yoke. Open filter

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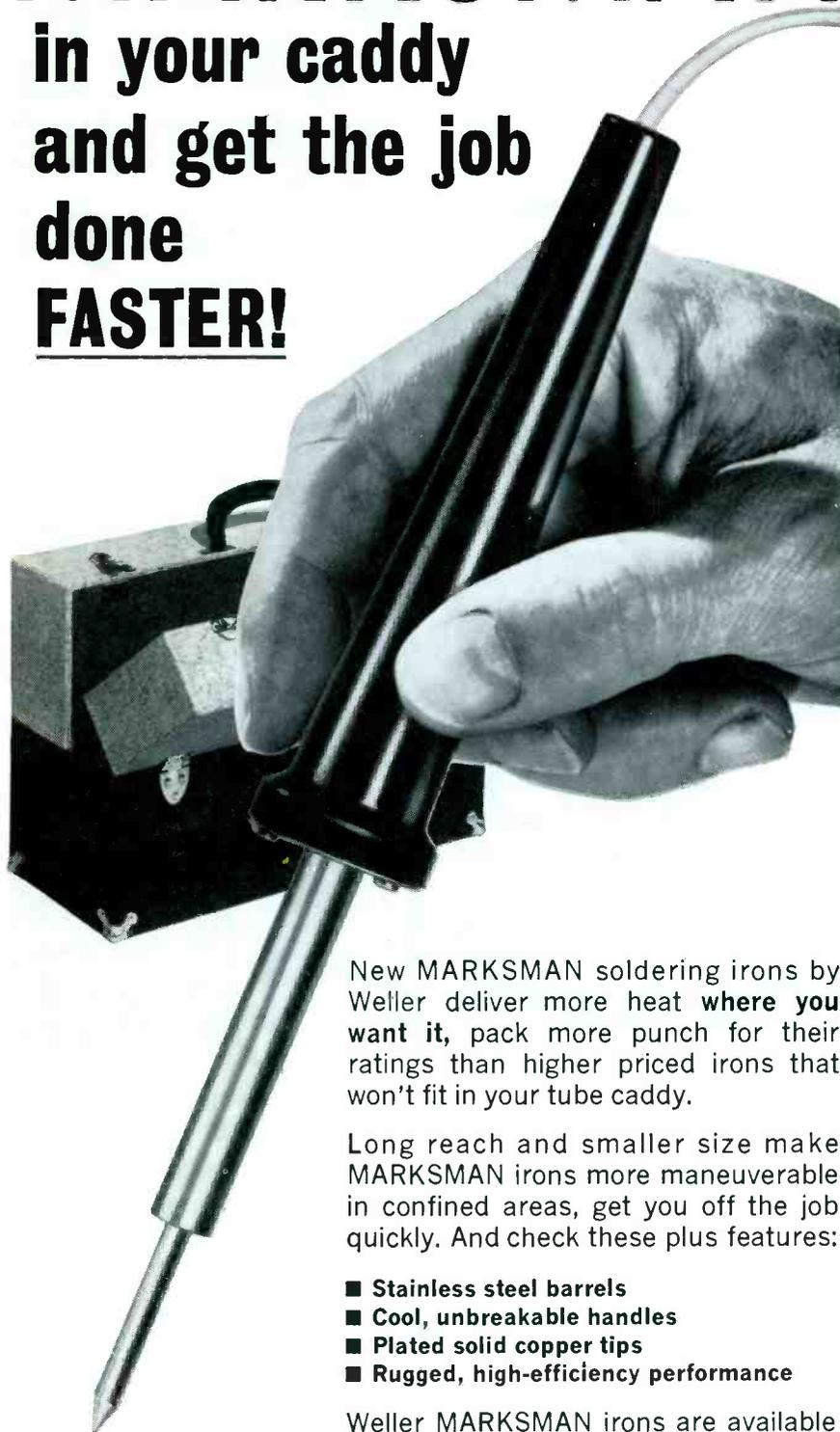
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capacitor? Sounds logical, but the scope showed no such disturbance on the B+ line, and test capacitors shunted across the filters did not help. CRT blanking? No connection at all.

**Solution**

Study of the PHOTOFAC schematic (730-3) showed one possibility of an accidental cross-feed, and then only if C62 opened (Fig. 2).

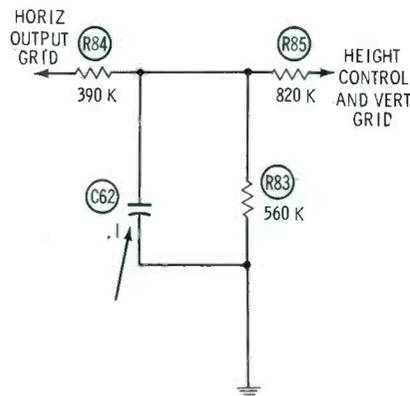


Fig. 2. Open capacitor causes symptom.

The scope showed both vertical and horizontal pulses on the capacitor when the trouble appeared on the screen. A new capacitor cured the trouble. Of course, a bad ground at C62 would also produce the same symptom.

Several schematics showed more models with the same circuit. These include RCA Chassis KCS 143, KCS 144, KCS 148, and KCS 149. All of these are 1965 models. ▲



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# BOOK REVIEW

**How to Build Speaker Enclosures:** Alexis Badmaieff and Don Davis; Howard W. Sams & Co., Inc., Indianapolis, 1966; 144 pages. 5½" x 8½", soft cover: \$3.25.

The volume begins with an evaluation of the five basic enclosure types: finite baffle, infinite baffle, bass reflex, horn projectors, and combination units. This is followed by an analysis of driver units, with statements regarding their limitations and effects of changing sizes and types.

Next, speaker and enclosure placement are considered, with particular emphasis on phasing, efficiency, and equalization, both electronically and mechanically. This involves discussion of phasing and crossover networks, and how they are best related to individual components.

In the work are photographs, graphs, curves, and construction plans (including material lists) for many examples of each type of enclosure, including complex folded horns and combination units. Information in the book is sufficient to permit an individual to design the changes required for adapting any specific unit to the particular room or driver unit with which it will be employed.

Concluding chapters deal with crossover networks and how their design is achieved. Graphs and charts indicate frequency and power demands of various orchestral groups, and for the "coil winders" there is sufficient information to permit construction of networks in the workshop or home. The chapter dealing with constructing and testing describes the materials, tools, and methods by which the most satisfactory results can be obtained. Testing techniques, from simple arrangements to elaborate professional setups, are then presented.

This book has been written for a wide range of readership and essentially requires little more knowledge than what a speaker is. Source material is from those who manufacture both enclosures and speakers of the professional type. The authors are engineers who have been engaged in the design of enclosures and speakers for commercial manufacture. ▲



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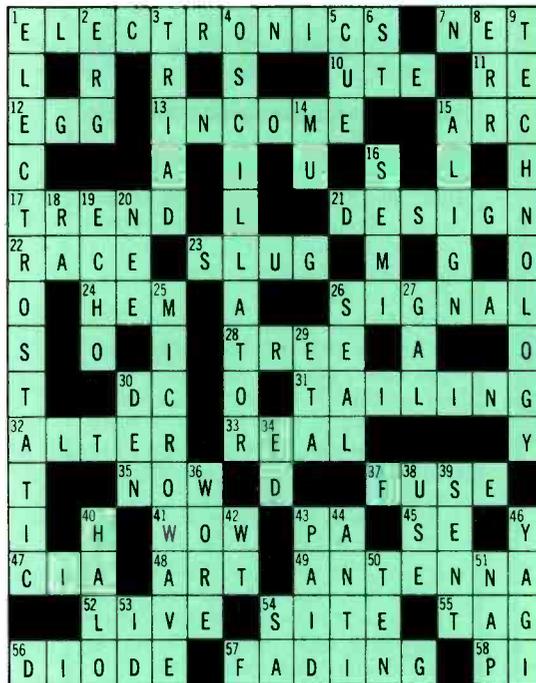
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March, 1967/PF REPORTER 77

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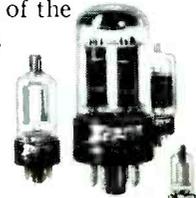
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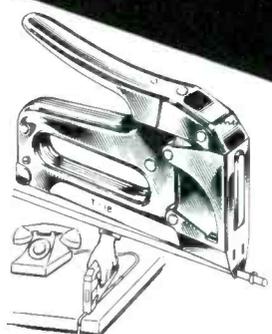
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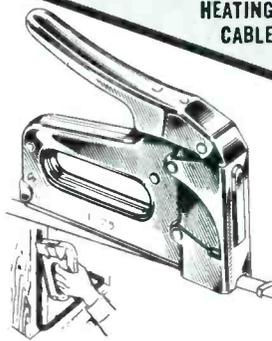
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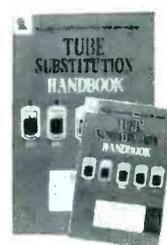
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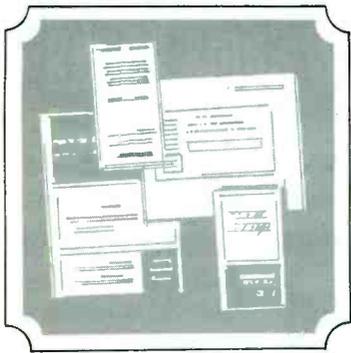
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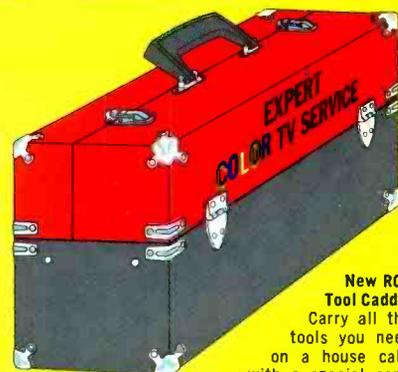
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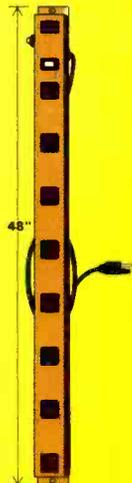
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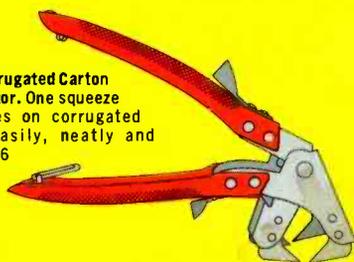
**Motion Display on RCA Receiving Tubes and Picture Tubes for Window or Counter.** Ingenious, striking! Service truck moves back and forth atop a simulated color set. Draw attention to your window or counter with this novel display which promotes all of your services—color TV, black and white TV, radio and hi-fi. Electrically powered, it combines your receiving tube and picture tube story in one visually compelling unit. Put one in your window and watch the reaction! Two auxiliary serviceman pieces carrying additional service messages, can be used in conjunction with the center display or as separate units. 1A1621



**The Agfa Isoflash Camera Kit...** is also available with your purchase of RCA Receiving Tubes. You'll be a winner when you bring home this easy loading beauty complete with film, battery, bulb, flash cube adapter, carrying case and shoulder strap. 1A1629

Many other attractive and valuable items are available through THE WINNER'S CIRCLE program, including ad mats, RCA's Color TV Fastcheck series of helpful hints, the famous RCA Receiving Tube Manual, postcards and new business cards, and a bottle opener premium. Check with your local RCA tube distributor. He can supply you with the finest in receiving tubes for color and black-and-white TV, radio and hi-fi. And he can tell you how to STEP INTO THE WINNER'S CIRCLE.

**Swingline Corrugated Carton Staple Extractor.** One squeeze opens staples on corrugated cartons... easily, neatly and safely. 1A1626



RCA Electronic Components and Devices, Harrison, N.J.



**The Most Trusted Name in Electronics**

# Introducing a Complete Line of Littelfuse Quality Circuit Breakers



Actual Size  
1 $\frac{3}{4}$ " x 1 $\frac{3}{16}$ " x  $\frac{1}{2}$ "

## Exact replacement from factory to you

Designed for the protection of television receiver circuits, the Littelfuse Manual Reset Circuit Breaker is also ideally suited as a current overload protector for model railroads and power operated toy transformers, hair dryers, small household appliances, home workshop power tools, office machines, small fractional horsepower motors and all types of electronic or electrical control wiring.

# LITTELFUSE

DES PLAINES, ILLINOIS

Circle 57 on literature card