



Electronic Servicing

Primer on PA systems page 53



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NEW!
Shop talk, page 18

The first and only solid-state test equipment guaranteed for 5 years.

Now EICO, because of its emphasis on *reliability* in engineering and manufacture, offers the industry this breakthrough.

EICO's new line of solid-state test equipment comes with an unprecedented 5-year guarantee of performance and workmanship. (Send

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One all-purpose DC/AC OHMS Uniprobe®. Reads 0.01V to 1 KV (to 30 KV with optional HVP probe), 7 non-skip ranges, in 10 dB steps. AC or battery operated. RMS & DCV: 0-1, 3, 10, 30, 100, 300, 1000V P-P ACV: 0-2.8, 8.5, 28, 85, 280, 850, 2800V. Input Z: DC, 11 M; AC, 1 M Ω . Response 25 Hz to 2 MHz (to 250 MHz with optional RF probe). Ohmmeter reads 0.2 to 1 M Ω in 7 ranges. 4 1/2" 200 μ A movement. HWD: 8 1/2", 5 3/4", 5". 6 lbs.

EICO 242 Solid-State FET-TVOM \$69.95 kit, \$94.50 wired.

All the versatility of the EICO 240 plus: AC/DC Milliammeter, 1 ma to 1000 ma in 7 non-skip ranges; single all-purpose DC/AC-Ohms - MA Uniprobe®; and large 6 1/2" 200 μ A meter movement.

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Hum 60 dB below 400 mW, 105-132 VAC, 50/60 Hz, 5VA. HWD: 7 1/2", 8 1/2", 5". 6 lbs.

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5 fundamental bands 100 kHz to 54 MHz. Vernier control 0-100%. Output 300,000 μ V into 50-Ohm load. External signal modulation or internal 400 Hz, 0 to 100%. 105-132 VAC, 50/60 Hz, 1.7 VA. HWD: 7 1/2", 8 1/2", 5". 5 lbs.

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- EICO 443 - Semiconductor Curve Tracer \$69.95 Kit, \$99.95 Wired.
- EICO 633 - CRT Tester & Rejuvenator \$69.95 Kit, \$99.95 Wired.
- EICO 635 - Portable Tube Tester \$44.95 Kit, \$69.95 Wired.

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Circle 1 on literature card

Now the Chromacolor revolution comes to replacement tubes too!

Now you can install Zenith's patented Chromacolor picture tube that outcolors, outbrightens, outcontrasts and outdetails every other 23" diag. color picture tube.

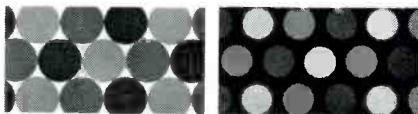
With a full 2-year warranty!

After years of pioneering research and development, Zenith has perfected a color TV picture tube different than any other on the market. So revolutionary that it outcolors, outbrightens, outcontrasts and outdetails every other 23" diag. color tube. And it's a Zenith exclusive—covered by U.S. Patent No. 3,146,368.

Before Chromacolor, every giant-screen color picture was made up of tiny dots on a gray background.

But Zenith made the dots smaller, surrounded them with jet black and, for the first time, *fully* illuminated every dot. Result: the brightest, sharpest picture tube in giant-screen color TV.

The Zenith Chromacolor tube will readily replace the 23" diag. tube in almost any TV, whatever brand. And, unlike most replacement tubes, it's warranted for two full years.



Magnified drawing of ordinary color TV screen before Chromacolor

Magnified drawing of Zenith Chromacolor TV screen

Order the Zenith Chromacolor picture tube from your Zenith distributor for your next installation. And put your customer in a better light.

At Zenith, the quality goes in before the name goes on.®

TWO-YEAR WARRANTY

Zenith Radio Corporation warrants the replacement CHROMACOLOR picture tube to be free from defects in material arising from normal usage for two years from date of original consumer purchase. Warranty covers replacement or repair of picture tube, through any authorized Zenith dealer; transportation, labor and service charges are the obligation of the owner.



Simulated TV picture

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ONLY ZENITH HAS IT

Circle 3 on literature card

May, 1970/ELECTRONIC SERVICING 1

Electronic Servicing

Formerly PF Reporter

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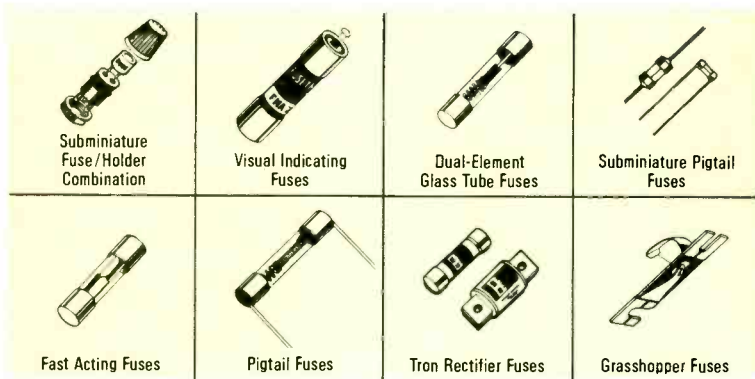
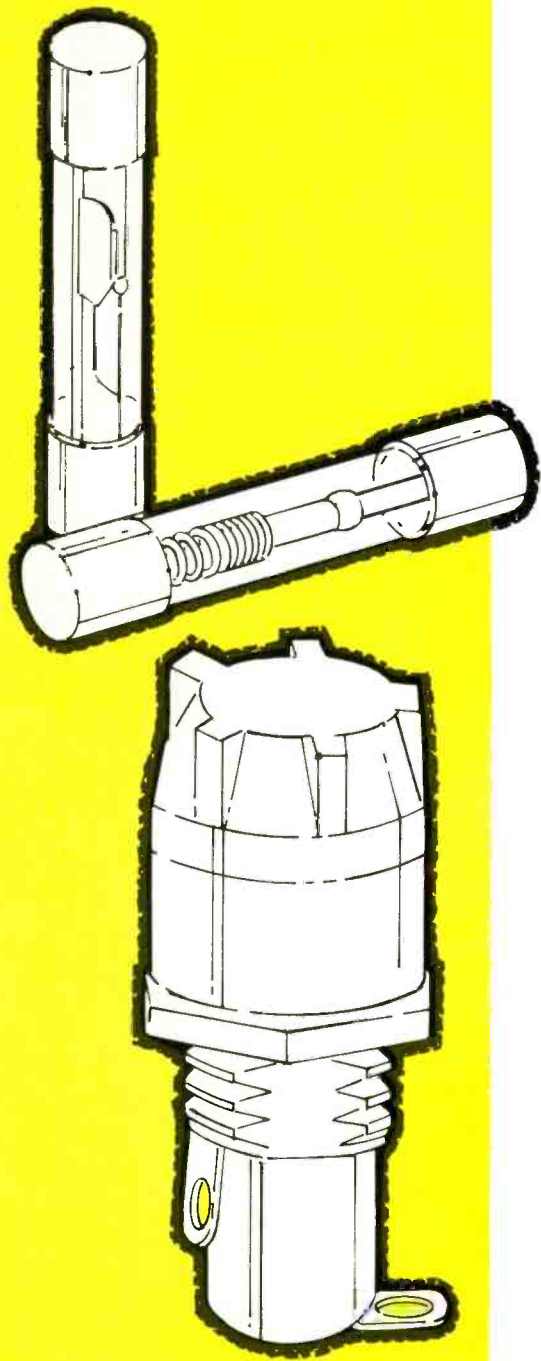
FUSES

SMALL DIMENSION

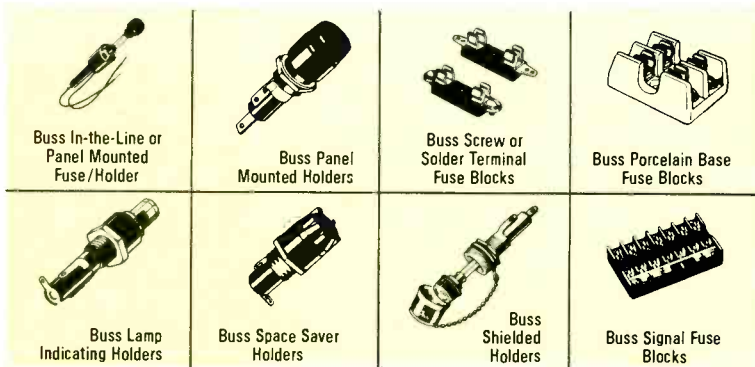
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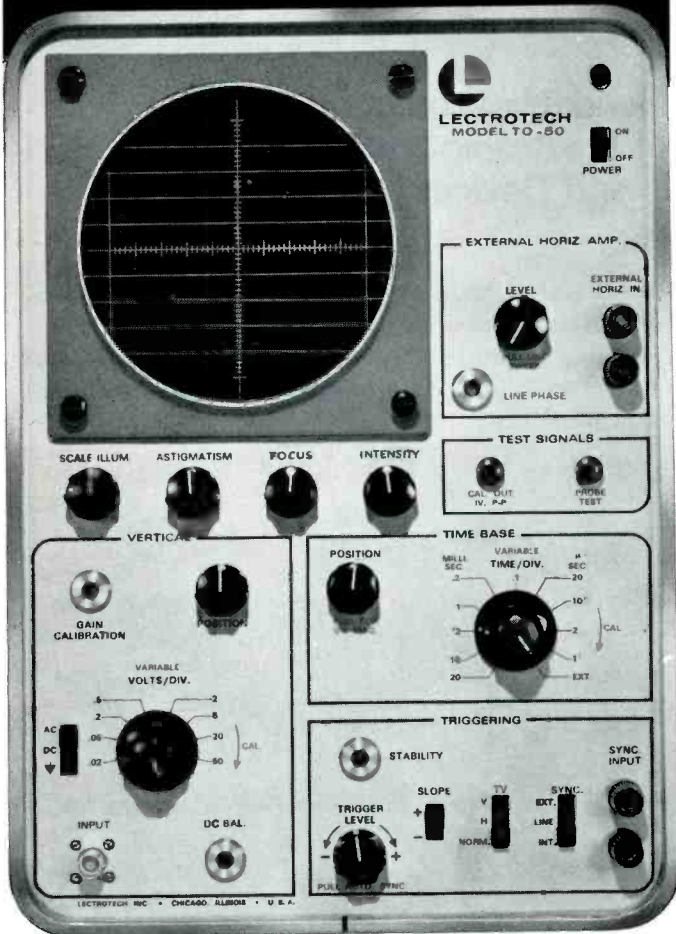


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Circle 5 on literature card

electronic scanner

news of the industry

RCA To Provide Service For All Makes of Television

RCA has announced plans for the establishment of a new subsidiary company to provide servicing of all makes of television sets and other home entertainment units.

Anthony L. Conrad, Executive Vice President, Services, said the new company will operate independently of the RCA Service Company branches, which will continue to concentrate exclusively on the servicing of RCA products and Whirlpool appliances.

"The decision to service other brands was based on extensive internal studies and governmental agency consumer reports which indicated an expanding need for service in the entire consumer products industry," Mr. Conrad said.

The new company will be established initially in selected urban areas and gradually expanded to operate on a national scale. Present plans call for the first of the new service centers to be opened in the Philadelphia area by mid-year, and in the San Francisco area by late September.

Mitsubishi Introduces New Brand Name

Mitsubishi, Japanese manufacturer of consumer electronic products marketed in the U.S., is celebrating its 100th anniversary by introducing to the U.S. a new line of consumer electronic and appliance products under the brand name "MGA".

MGA, a division of Mitsubishi International Corp., is headquartered in Chicago.

RCA Automatic Tint

"Accu-Tint" is the name RCA has given its new color TV circuit designed to maintain proper flesh tones regardless of changes in the broadcast signal.

Introduced in RCA high-end 23-in. color console models, the new circuit is designed to perform a function similar to Admiral's Color Monitor, Magnavox's TAC and Philco-Ford's Cosmetic Color automatic tint control circuits.

3-D TV Concept and 25-Inch CRT Shown

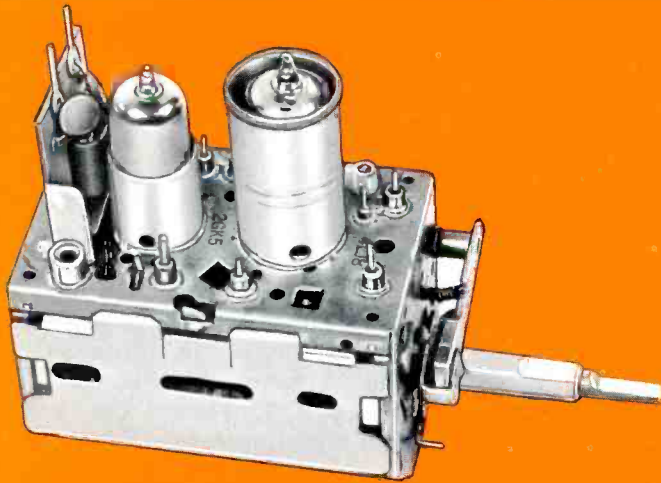
Dealers attending Philco-Ford's sales conference in Honolulu were treated to an engineering demonstration of how 3-D TV might be accomplished through the use of holography.

A new color set equipped with a square-cornered 25-inch CRT and pushbutton tuning also was shown along with 40 other "future" products.

TSA of Michigan Sued By Packard-Bell

A \$1.5 million libel suit has been filed against the Television Service Association (TSA) of Michigan, Inc. by Packard-Bell, California-based TV manufacturer.

The suit reportedly has been brought against TSA because of the printing of a letter in the July '69 issue



\$975

TUNER SERVICE CORPORATION

PROVIDES YOU WITH A COMPLETE SERVICE FOR ALL YOUR TELEVISION TUNER REQUIREMENTS AT ONE PRICE.

TUNER REPAIR

VHF Or UHF Any Type \$9.75.

In this price all parts are included. Tubes, transistors, diodes, and nuvistors are charged at cost.

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1 year guarantee backed up by the largest tuner manufacturer in the U.S.—SARKES TARZIAN INC.

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Replacement Tuner \$9.75.

This price buys you a complete new tuner built specifically by SARKES TARZIAN INC. for this purpose.

The price is the same for every type of universal replacement tuner.

Specify heater type

Parallel 6.3V
Series 450 mA
Series 600 mA

All shafts have the same length of 12".

Characteristics are:

Memory Fine Tuning
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If you prefer we'll customize this tuner for you. The price will be \$18.25. Send in original tuner for comparison purposes to our office in INDIANAPOLIS, INDIANA.



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Circle 6 on literature card

of TSA News, the official publication of the Michigan service association, which alleged that Packard-Bell "utilized regunned or rebuilt picture tubes" in sets which are sold as new. The letter, signed by Milton Kevreson, chairman of the TSA Business Activities Committee and also named in the suit, had been sent to Packard-Bell and reprinted in TSA News.

Packard-Bell charges that its "reputation has been greatly injured . . . and it has sustained . . . severe losses, all as maliciously intended by the defendants. . ."

Bill Introduced To License NYC TV Technicians

Posting of a \$2,500 bond by service shops, submission of a written estimate, and testing of all technicians, experienced and inexperienced, reportedly are included in the provisions of a technician licensing bill introduced to the New York City Council.

The New York City Council, according to a report in **Home Furnishings Daily**, has been evaluating for about a year the possibility of licensing technicians, and is now ready to act.

Underwriters Lab Proposes New TV and Radio Standards

Revision of required standards for TV and radio has been proposed to its members by Underwriter's Laboratories (UL).

Most of the proposed new standards, which reportedly are intended to reduce the probability of fire, would become effective January 1, 1971.

UL also proposes, as an interim safety measure until the new standards become effective, installation of

a fuse or similar protective device in the high-voltage or associated circuits of all color sets produced between July 1, 1970 and January 1, 1971.

RCA Produces Slide-Out Color TV Chassis

A slide-out color TV chassis reportedly is included in RCA's 1971 model line.

The slide-out chassis, designed for easier servicing, is included in three new 23-in. color consoles, according to a recent report in **Merchandising Week**.

Color TV Saturation Up To 39 Percent

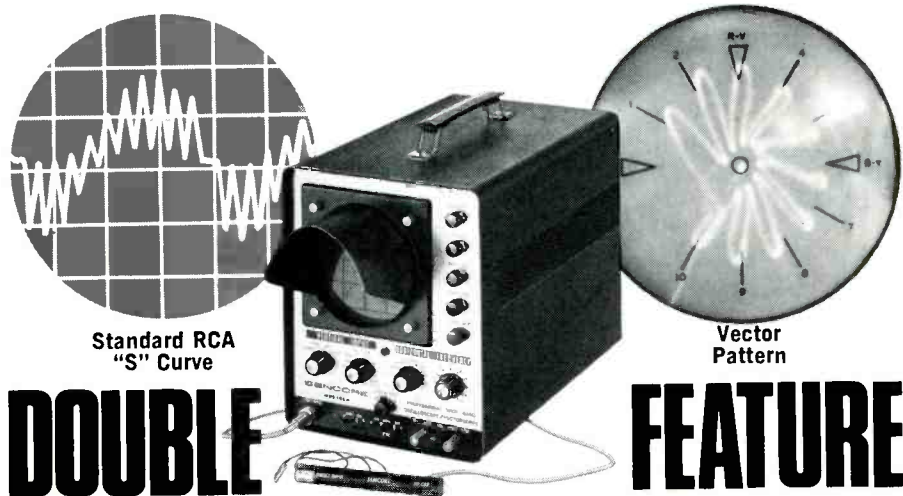
Thirty-nine percent of the households that are equipped with TV have color sets, according to a recent estimate by A. C. Nielsen Co., a research and inquiry service organization.

Nielsen estimates that 22,600,000 households now have color TV receivers, and 19,550,000 homes, or 33% of homes equipped with TV, have more than one set, either b-w or color.

Motorola Head Receives EIA Medal of Honor

Robert W. Galvin, chairman of the board and chief executive officer of Motorola, was awarded the Electronic Industries Association's highest personal award, the EIA Medal of Honor, at the annual EIA awards dinner in Washington on March 11.

Mr. Galvin, presently a member of the EIA Board of Governors and a former president of EIA (1966-1968), is the 19th recipient of the EIA Medal of Honor. The first award was presented in 1952 to David Sarnoff, former chief executive of RCA. ▲



Standard RCA "S" Curve

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Guaranteed to lock in composite video waveforms faster than a triggered scope or your money returned.

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(1960, or later)

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- UHF-VHF combination (one piece chassis) \$9.95
- TRANSISTOR tuner \$9.95
- COLOR tuner \$9.95
(Guaranteed color alignment . . . no additional charge)

Overhaul includes parts, except tubes and transistors.

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.

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

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

● **CUSTOM REPLACEMENTS**

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

● **UNIVERSAL REPLACEMENTS**

Prefer to do it yourself?

Castle universal replacement tuners are available with the following specifications.

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

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

These Castle replacement tuners are all equipped with memory fine tuning, UHF position with plug input for UHF tuner, rear shaft extension and switch for remote control motor drive . . . they come complete with hardware and component kit to adapt for use in thousands of popular TV receivers.

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Circle 9 on literature card

Consumer Electronic Sales Produce Record in 1969

1969 total color TV sales fell short of the total for 1968, while total 1969 monochrome sales pushed above the total figure for 1968, according to a recent report by the Marketing Services Department of the Electronic Industries Association (EIA).

Despite the slight slump in color TV sales, 1969 total U.S. sales of consumer electronic products, including domestic label and foreign label imports, were above the totals registered in 1968. ▲

TOTAL U. S. SALES OF CONSUMER ELECTRONIC PRODUCTS

YEAR-TO-DATE, 1969 (In Units)

PRODUCT DESCRIPTION	Factory Sales U.S. Produced	Imports Domestic Label	Imports Foreign Label	Total U.S. Sales
<u>RADIO</u>				
<u>Home Radio</u>				
AM	2,969,785	3,337,017	12,202,125	18,508,927
FM/AM or FM	1,766,990	2,326,156	16,811,784	20,904,930
TOTAL	4,736,775	5,663,173	29,013,909	39,413,857
<u>Automobile Radio</u>				
AM	8,643,219	-	1,619,098	10,262,317
FM/AM or FM	1,504,761	-	171,807	1,676,568
TOTAL	10,147,980	-	1,790,905	11,938,885
<u>TOTAL RADIO</u>				
AM	11,613,004	3,337,017	13,821,223	28,771,244
FM/AM or FM	3,271,751	2,326,156	16,983,591	22,581,498
TOTAL	14,884,755	5,663,173	30,804,814	51,352,742
<u>TELEVISION</u>				
MONOCHROME	3,994,697	1,195,735	1,925,651	7,116,083
COLOR	5,278,882	465,513	446,912	6,191,307
TOTAL	9,273,579	1,661,248	2,373,062	13,307,889
TOTAL PHONOGRAPH	4,257,236	707,782	1,355,230	6,320,248
TAPE RECORDERS	676,409	824,737	5,428,381	6,929,527
<u>TAPE PLAYERS</u>				
AUTOMOBILE	NA	NA	2,526,591	NA
OTHERS	NA	NA	2,505,285	NA
TOTAL	NA	NA	5,031,876	NA



Model 176 \$99.95

How low can you get?

Modern solid state circuitry demands lower voltage measurements. And no one goes lower than B & K. Because B & K makes products that really work.

Take the new Model 176 for instance. It has more new design features than any other portable FET/VOM today.

An exclusive complementary circuit protects FET's from over voltage transients, provides balanced temperature compensation. And a unique voltage regulation circuit maintains constant voltage for the life of the batteries.

You get a flat frequency response to 1 megacycle, plus high input impedance and instant drift-free transistor action.

Or consider the B & K Model 120 VOM. It features extra-low voltage and current ranges, 2% accuracy, and element-to-element voltage differentials of only a few tenths.

It's ideal for transistors and printed circuit boards. And for only slightly more, you can get 1½% accuracy with the special Model 120M.

Even if you need a VTVM, nothing beats B & K. Because Models 175 and 177 are loaded with exclusive features time-tested for rugged use.

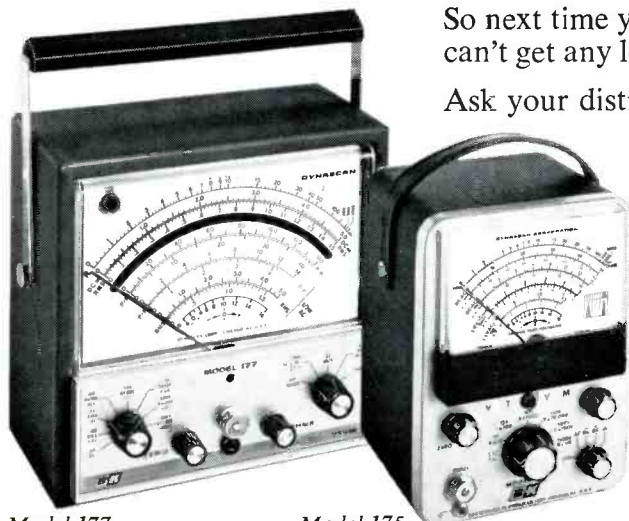


Model 120M
\$69.95

Model 120
\$64.95

So next time you measure volts, do it with B & K. You can't get any lower. And you can't get any better.

Ask your distributor for complete details.



Model 177
\$89.95

Model 175
\$69.95



PRODUCTS of DYNASCAN CORPORATION

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The Big Difference in Test Equipment: Ours Works.

Circle 10 on literature card

(Following are two letters directed to the technical editor of ELECTRONIC SERVICING, Carl Babcoke. Because of the highly relevant subjects discussed, I believe these letters and Mr. Babcoke's responses will be of interest to most readers.)

VSM Chroma Alignment Requires ACC Bias

I have a question concerning an article of yours titled "VSM Chroma Alignment" in the November 1969 issue.

In your VSM chroma alignment procedure, no mention was made of the correct application of automatic color control (ACC) bias to the 1st color amplifier. How can this particular amplifier be aligned properly without the proper bias?

During normal operation, this bias is supplied via the burst information—which is absent during your VSM chroma alignment

With the 1st color amplifier biased properly, either by artificial means (bias box) or through a color signal, the transformer (L214) can be adjusted for proper operation quite easily using your swept method or the Zenith factory recommended approach. Either method should produce the same result.

Failure to properly bias the 1st chroma amplifier, and the addition of a core to the 2nd color amplifier output stage, produces improper color bandpass. Remember, only amplitude responses were examined in your article, and no phase distortion measurements were shown. For true color fidelity, the proper amplitude and phase relationships must be established and adhered to, if you continue to use the NTSC system. Waveforms which you have called "proper" do not mean a thing to a customer who will have poor color fidelity.

John B. Sutherland
Villa Park, Ill.

There is a very simple explanation why no fixed ACC bias was specified during the VSM part of the alignment: I forgot to mention it.

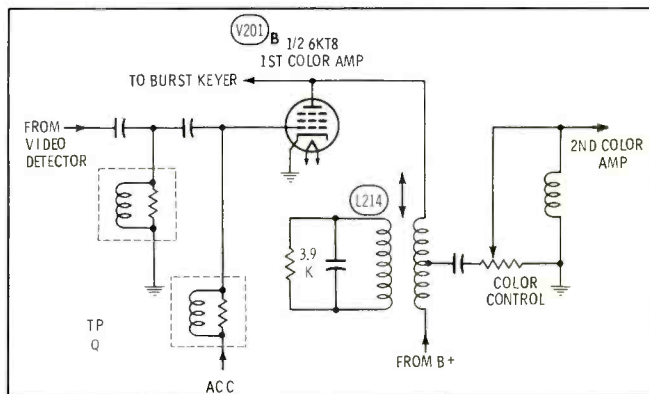
I agree it is important that an ACC bias voltage be applied during chroma IF alignment; other brands and models suffer a curve tilt of around 25 percent without it. The voltage applied should be about the same as the average ACC for normal operation on colorcasts. In this case, about -5 volts should have been applied to terminal "Q".

However, I doubt that incorrect ACC voltage would tilt the curve produced by this Zenith chassis as much as that of some other models, since the input to the 6KT8 is through two high-pass filters, and not a tuned circuit as in some other chassis.

You have every right to raise a shocked eyebrow at the addition of a core to L216. However, you will look in vain for any statements that advise the technicians to do the same. The key words in this section are "curiosity" and "experimentally". I did say an excellent overall VSM curve was obtained. Zenith has made no VSM specifications, that I have ever read, so the

article explained the method given was developed by experience through trial and error. While we never would publish information we knew to be wrong, this series of articles primarily is about test equipment. The rest is just one specific example of how the equipment *could* be used.

You commented that only amplitude responses were examined in the article and no phase distortion measurements were shown. Very true. Because the VSM method of alignment will show up the minor hills and valleys in the response, caused by partial phase addition and cancellation, it is superior to regular swept-carrier curves. I am not aware of any instruments available to service technicians that will measure the



phase of the chroma signal or harmonics of the video against low-frequency video. Consequently, we have no such instrument against which to check our phase results. Instead, we do a careful analysis of the color bars from the face of the color picture tube, and, in this case, they were quite good.

We naturally prefer roses to brickbats and compliments to complaints, but we accept either if we can learn from them and do a better job next time.

Alignment Method Too Complicated

I read your article in the February '70 issue which tells how to align an Admiral 6H10 color chassis using the Sencore Model SM152 sweep/marker generator.

I've been in the radio and TV service business for over 30 years and I know a lot of service men . . . and most service men want a piece of test equipment that you hook up here and another lead there and, bingo, you start aligning.

When you tell them they have to make up a link amplifier, that means time to gather up the parts, time to buy parts, time to wire it together, etc.

So what does the technician do? He turns the TV set to a station, touches up a trap here and an IF coil there and lets it go at that, feeling he doesn't get enough money out of the repair to go through all that trouble (to completely align the set).

Believe me, the price of the test equipment doesn't discourage him as much as the alignment instructions and the various jigs he has to make up for some sets—and which he may never use again.

Did you ever read about a method of alignment whereby you start with the 3rd IF and work back toward the tuner? It seems less complicated and less time consuming.

I hope you realize I'm not criticizing your article, but

just trying to acquaint you with how service men think, hoping that you can use it to your advantage.

G. Esposito
Ft. Lauderdale, Fla.

If anything I have written has discouraged any technicians from performing technically competent adjustments or repairs, then I am truly sorry, for such was not my intention.

However, in all fairness, I believe you have misinterpreted some of the statements in the article. In your letter you say, "When you tell them they have to make up a link amplifier . . ." But the article on page 49, paragraph 2, says, "If your scope does not have enough gain to produce a large waveform during step 2, you may need to build the 'link amplifier' . . ." This is a combination load, detector and transistor amplifier suggested by Admiral . . ." There is a vast difference between "have to" and "may need" or "suggested by". How do you know your scope doesn't have enough gain unless you try it?

There is no reason for the Sencore SM152 generator to be blamed in any way; it emits as strong a signal as any generator offered on the market. The link amplifier was suggested by Admiral in their service literature, and was for use with other brands of sweep equipment. Certainly this has no bearing on Sencore. The final paragraph of the article says the procedure given for aligning the Admiral also can be used to align 3-tube-IF RCA or copies of RCA chassis. So the link amplifier can be used on *any* color set for which it is recommended the link circuit be aligned as a separate step. More on that later.

After the article was prepared for publication, we learned Sencore had developed a new probe that makes the link amplifier unnecessary. It is stated at the bottom of page 51: "An optional link detector probe, part No. 39G26, is available from Sencore. Equipped with a voltage quadrupler and built-in IF load, the probe can be used for link alignment of both tube and solid-state TV receivers."

Taken together, these options give technicians several paths to follow without a "have to" sign on any of them. Your scope may have enough gain to show the curve. It is possible, although not desirable, to make the adjustments when the curve is only 1/4 inch high. The link amplifier does well the job it is intended to do, and will work on many Admirals, Motorolas, RCAs, copies of RCAs, etc. Or, better yet, the Sencore quadrupler probe could be obtained.

I have completely aligned many hundreds of color TV's after technicians have "touched up" the traps and IF's monitoring only the picture. After seeing that many horrible examples, I still insist good alignment cannot be done without equipment. This is the reason I have been so pleased with the new generation of test equipment that, contrary to your present opinion, is easy and fast to use. Any time you can change from IF sweep to VSM by flipping or sliding a few switches, that's real progress.

You asked about a system of alignment that starts at the last IF and works back toward the tuner. I cannot approve of any method that does not adjust overcoupled transformers as a separate operation. Space does not permit a full listing here of the reasons why. ▲



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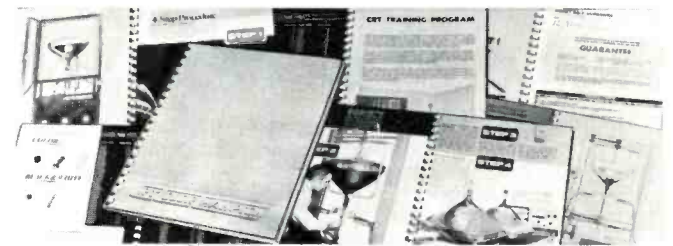
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Step-by-Step Operation of a service

How to use the scope to measure simple and complex waveforms, by Robert G. Middleton

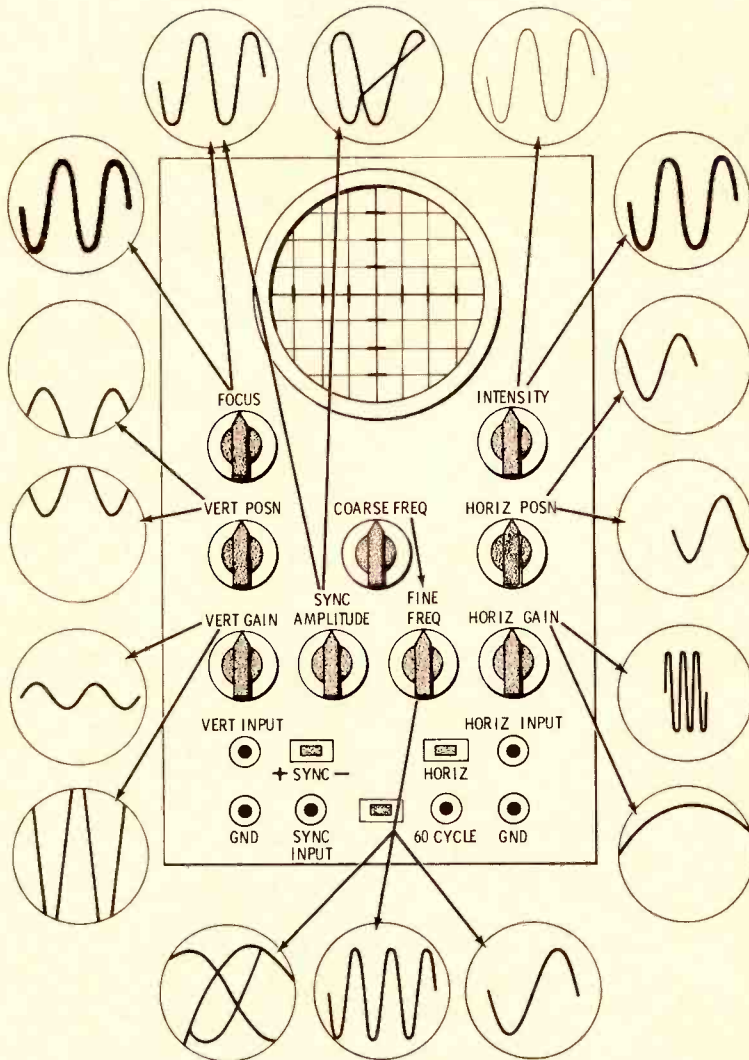


Fig. 1 Effects of oscilloscope control adjustments.

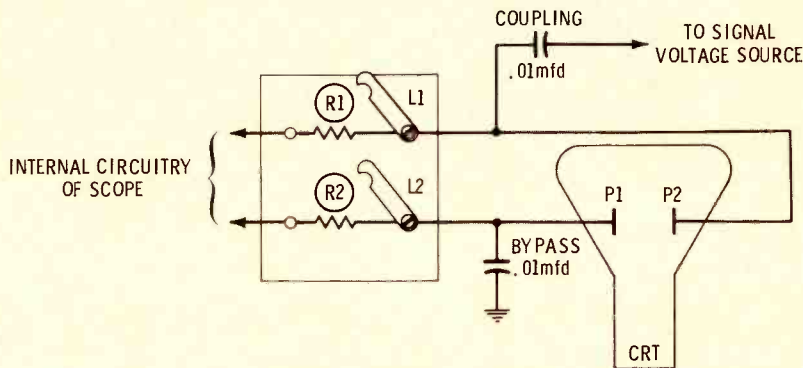


Fig. 2 Signal is coupled directly to plate P2.

The oscilloscope can be the most useful instrument on the service bench, with the exception of the VOM. Basically, an oscilloscope is a voltmeter; however, it is a more complete voltmeter than a VOM because it shows the waveform as well as the amplitude of the voltage. A scope shows three basic characteristics of voltage:

- Peak-to-peak amplitude
- Waveshape, or pattern form
- Frequency, or repetition rate.

A scope has a comparatively large number of controls, as shown in Fig. 1. However, only a few of the controls are in use at any given time. In some applications, only four of the controls are used, and these usually are not varied after they have been preset properly.

Setting Up the Display Section of a Scope

Basically, the display section of a scope is comprised of the intensity, focus and centering controls. After AC power has been applied to the scope, allow a short interval for warm-up. With the vertical- and horizontal-positioning controls set to the approximate midpoints of their ranges, a spot or horizontal line of light will become visible on the CRT screen when the intensity control is advanced sufficiently. (Do not employ excessive brightness, or screen damage may result.) The displayed spot or line can be centered on the screen by adjusting the vertical- and horizontal-positioning controls. Adjust the focus control for a sharply defined spot or line. You now are ready to display simple patterns.

Direct Coupling to CRT Deflection Plates

When signals are applied directly to the deflection plates of the scope, coupling capacitors should be used to avoid disturbance of the DC voltages on the plates. In Fig. 2, the

-type scope

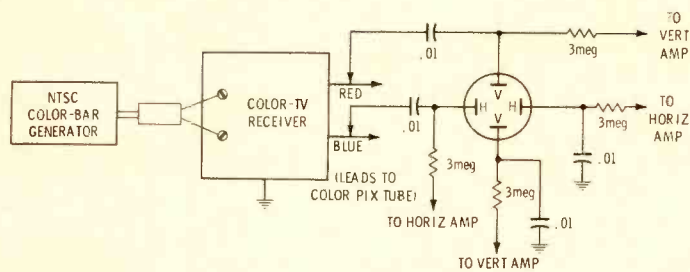
signal voltage is being applied to P2, with the opposite plate, P1, by-passed to ground. This is the usual arrangement, because chroma circuits usually are single-ended configurations. Note that R1 and R2 are connected between P1 and P2 and the internal circuitry of the scope. R1 and R2 usually have a value of about 0.5 to 3 megohms. They provide a DC path from the deflection plates to the internal circuitry of the scope so that the centering controls remain operative after we open links L1 and L2. Since R1 and R2 have high resistance values, they impose negligible loading on P1 and P2. In most service-type scopes, L1 and L2 are mounted on an insulating board at the rear of the scope case.

Fig. 3 shows how this direct-coupling method is used to display a vectorgram. The red lead of the color picture tube is coupled to a vertical-deflection plate of the scope and the blue lead of the color picture tube is coupled to a horizontal-deflection plate of the scope. The opposing deflection plates are coupled to ground. If a color-bar signal is applied to the receiver, a vectorgram pattern is displayed on the scope screen, as shown in Fig. 3C. When a keyed-rainbow color-bar signal is used, the pattern appears as shown in Fig. 4. These direct connections to the scope deflection plates are possible because the chroma signal level is sufficiently great at the input of the color picture tube to provide adequate CRT deflection. On the other hand, a low-level or medium-level signal will not produce adequate CRT deflection and, therefore, must be fed to the vertical amplifier of the scope, so that it can be amplified before being applied to the deflection plates.

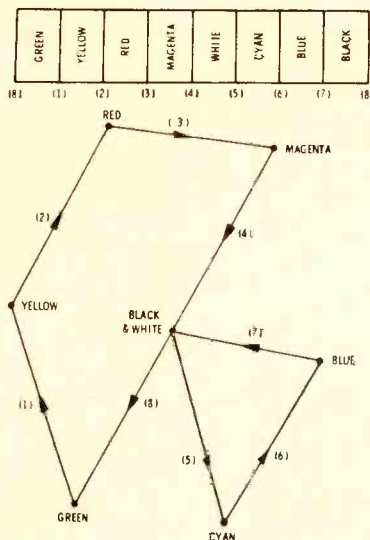
Display of Sine Waves

Low-level signals in the range from 0.01 to 100 volts are displayed by amplifying the signal in the vertical amplifier. The links to the CRT deflection plates (Fig. 2) are closed when the vertical amplifier is used.

It is general practice to display



(A) Test setup



(B) Ideal vectorgram.

Fig. 3 Display of vectorgram using NTSC color-bar generator.

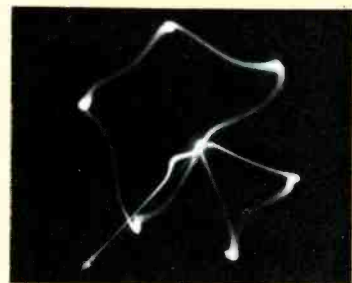
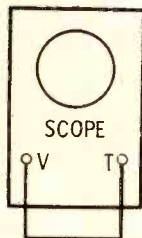
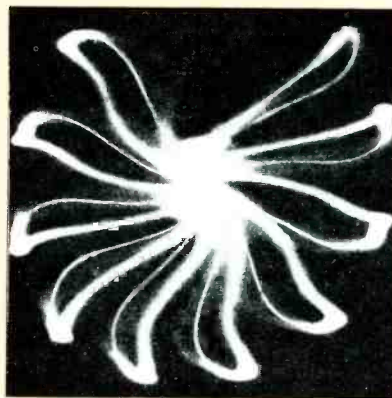
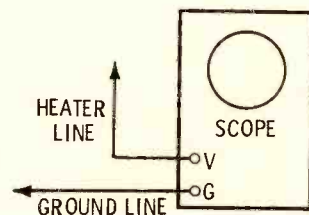


Fig. 4 Photo of typical vectorgram produced by keyed-rainbow color generator.



V = VERTICAL INPUT TERMINAL
T = 60Hz TEST VOLTAGE TERMINAL

(A)



V = VERTICAL INPUT TERMINAL
G = GROUND TERMINAL

(B)

Fig. 5 Connections for viewing a 60-Hz waveform on a scope screen. (A) Using internal 60-Hz signal (B) Using external 60-Hz signal (heater line).

Fig. 6 Horizontal sweep rate set much too high.

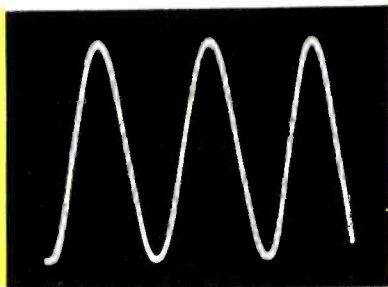
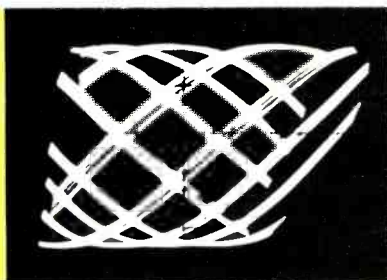


Fig. 7 Waveform when a 60-Hz sine wave is viewed at a horizontal sweep rate of 20 Hz. Three cycles are displayed. NOTE: A portion of one cycle is lost on retrace.

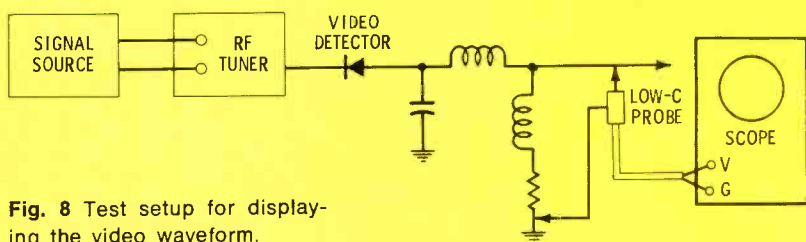


Fig. 8 Test setup for displaying the video waveform.

waveforms other than vectorgrams on a linear time base. This requires use of sawtooth horizontal deflection. Following is the technique:

1. If a spot is displayed on the CRT screen when the links to the deflection plates are closed, set the coarse-frequency, fine-frequency, and horizontal-gain controls to their approximate midrange positions. A horizontal line should be displayed now. The length of the horizontal line can be adjusted by rotating the horizontal-gain control.

2. Connect the vertical-input terminals of the scope to a 60-Hz source of voltage, as shown in Fig. 5. Set the sync-selector switch or control to its internal position. The display will have the general appearance shown in Fig. 6; if too low in amplitude, advance the vertical-gain control; if too great in amplitude, reduce the setting of the vertical-gain control.

3. Set the coarse-frequency control to a comparatively low position, so that a multiple pattern is eliminated. Adjust the fine-frequency control until two or three cycles of the sine-wave pattern are displayed, as illustrated in Fig. 7. One complete pattern will be displayed when the frequency of the horizontal sweep of the scope is the same as that of the signal applied to the vertical input terminals. Two complete patterns will be produced when the horizontal sweep frequency is $\frac{1}{2}$ that of the vertical input signal, three if the horizontal frequency is $\frac{1}{3}$ the vertical frequency, etc. If the horizontal sweep frequency is greater than that of the vertical input signal, the pattern will move continuously across the screen of the scope.

4. If the waveform is not locked tightly (stationary) on the screen, advance the sync-amplitude control, as required. Note that excessively high settings of the control will cause false sync action and pattern distortion.

Display of Complex Waveforms

The method for displaying complex waveforms is basically the same as for display of sine waves, with one important exception: A low-capacitance (low-c) probe is desirable, and often essential, to avoid objectionable circuit loading and resulting waveform distortion. Fig. 8 shows how a low-capacitance probe is applied in the video detector output circuit of a TV. If a

Fig. 9 Video signal displayed on 30-Hz time base.

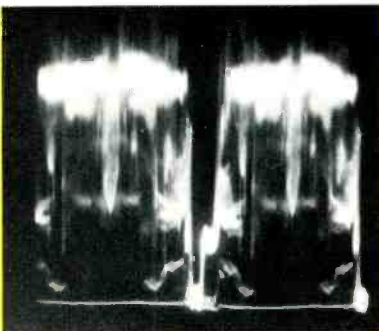
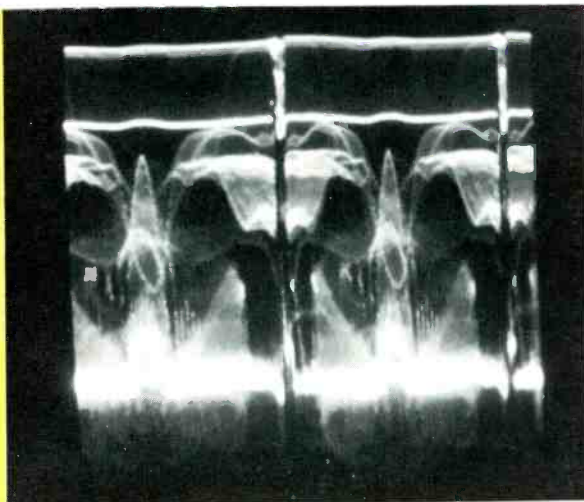


Fig. 10 Video signal displayed on 7875-Hz time base.

pattern generator (or a station signal) is used in this test, you can select one of two distinct waveforms by changing the horizontal-deflection rate of the scope:

1. If the horizontal-deflection rate is set to 30 Hz, the "frame" waveform in Fig. 9 will be displayed. You might find that this waveform is difficult to lock at any setting of the sync-amplitude control, on either the positive or the negative position. In such a case, operate the scope on its external-sync function, and feed a vertical-deflection signal into the sync-input terminal. (Many scopes have a rotary switch for +, -, 60 Hz and external sync. If so, it should be used here in "ext" position.) For example, a test lead can be connected from the sync-input terminal to the vertical-hold control in the TV receiver under test. This is an effective method of synchronization because unwanted TV horizontal sync pulses are eliminated from the locking signal fed to the scope.

2. If the horizontal-deflection rate is set to 7875 Hz, the "line" waveform in Fig. 10 will be displayed. Note that the frame waveform has practically disappeared from view. This happens because the 60-Hz component is now moving through the display, and is effectively "wiped off" the screen.

Many scopes are equipped with preset 30- and 7875-Hz horizontal sweep, available by merely switching the sweep selector switch to either of these positions.

Fig. 11 shows the advantage of using a low-capacitance probe. If a direct cable is used to apply the signal to the input of the scope, the high-frequency components of the waveform are attenuated, as seen in the lower photo. On the other hand, when a low-capacitance probe is used, the waveform is displayed with high-frequency components, as seen in the upper photo in Fig. 11.

Peak-to-Peak Voltage Measurements

It has been noted that an oscilloscope is basically a voltmeter. Waveform amplitudes are measured in peak-to-peak volts, whereas VOM's indicate only the rms voltages of sine waves. Fig. 12 shows the relation of rms voltage to peak and peak-to-peak voltages in a sine

wave. Since the positive peak voltage of a sine wave is equal to its negative peak voltage, the relationships can be expressed as equations, as in Table 1.

It follows that when we use an rms sine-wave voltage to calibrate the vertical amplifier of a scope, we

must change this rms voltage to its corresponding peak-to-peak value. For example, suppose we use the voltage from a heater line to calibrate the scope. A service-type VOM will indicate that the heater voltage is 6.3 volts rms. In turn, we multiply 6.3 by 2.83 to find the p-p

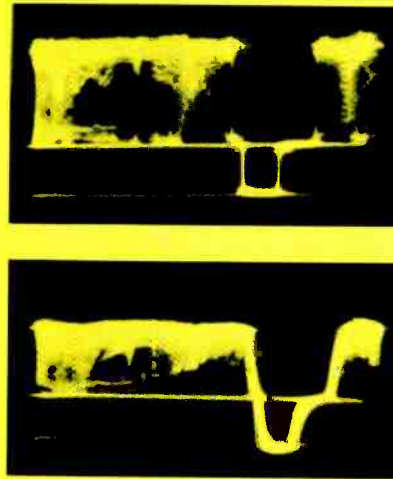


Fig. 11 Comparative waveforms, showing result of circuit loading. Upper photo shows waveform obtained using low-c probe. Bottom photo shows waveform obtained using direct probe—high frequencies are attenuated.

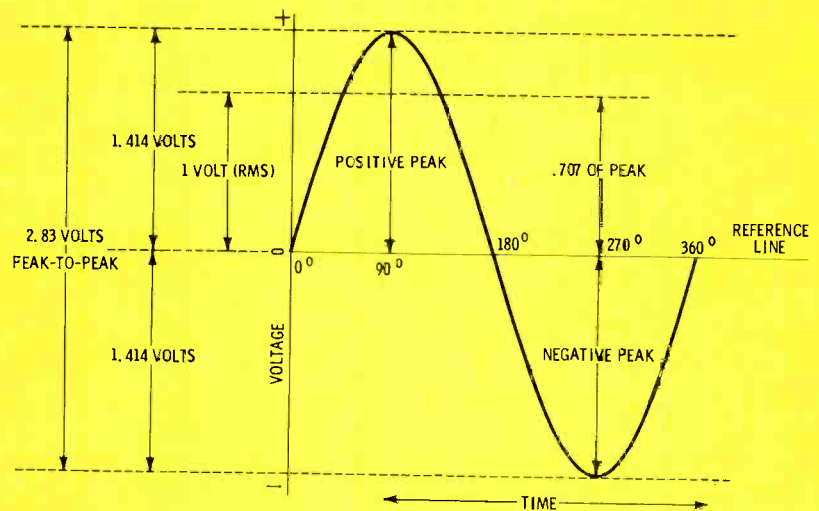


Fig. 12 Voltage relationships of the fundamental sine wave.

TABLE 1—VOLTAGE RELATIONSHIPS

Peak-to-peak voltage =	$2 \times$	peak voltage
Peak voltage =	$0.5 \times$	peak-to-peak voltage
Rms voltage =	$0.707 \times$	peak voltage
Peak voltage =	$1.414 \times$	rms voltage
Peak-to-peak-voltage =	$2.828 \times$	rms voltage

voltage, and obtain 17.8 volts p-p, approximately. Then if we adjust the vertical-gain control of the scope to obtain 17.8 squares (usually centimeters) of vertical deflection, the scope is calibrated for 1 volt p-p per square. Thereafter, we simply count squares of vertical deflection to measure waveform p-p voltages,

regardless of the waveshape that might be displayed.

DC Scope Operation

If a scope has DC response (vertical amplifiers direct-coupled), the level of the horizontal baseline will change when a DC voltage is applied to the vertical-input terminals.

The amount of baseline shift is a measure of the value of DC voltage. Therefore, if an AC waveform with a DC component is applied to a DC scope, the baseline will shift to indicate the value of the DC component, as shown in Fig. 13. Note that if a scope has been calibrated for p-p voltage measurement, the DC voltages will be measured in the same unit of measurement.

Scope Operation

With Demodulator Probe

A demodulator probe also is called a "traveling detector". Fig. 14 shows the circuit and characteristics for a typical demodulator probe. Note that its modulation-signal range (detection capability) extends from 30 to 5,000 Hz. This means that the probe can reproduce envelope waveforms only half way through the audio-frequency range, and that video-frequency envelopes will be "wiped out" completely. For example, if a keyed-rainbow signal is being traced through the IF amplifier in a color receiver, the displayed waveform using a demodulator probe will appear as illustrated in Fig. 15. The most prominent feature of this waveform is the vertical sync pulse.

The scope must be deflected at a 30-Hz rate when a demodulator probe is employed so that the low-frequency envelope components are locked on the screen of the scope. Note in Fig. 15 how the horizontal sync pulses following the vertical sync pulse have been attenuated to a small sawtooth waveshape.

A demodulator probe is chiefly useful to show the presence or absence of signal. That is, the loading effect of a demodulator probe is quite appreciable, with the result that IF circuit action is disturbed and waveform amplitudes are not correctly displayed. Nevertheless, a demodulator probe is a very useful analytical tool at the service bench.

Conclusion

In my visits to many shops throughout the country, I find that in some shops scopes are merely "bench warmers". This is a deplorable situation, because a scope becomes one of the most valuable service tools when properly used. It is hoped that this article has shown technicians that scope operation is actually quite easy. ▲

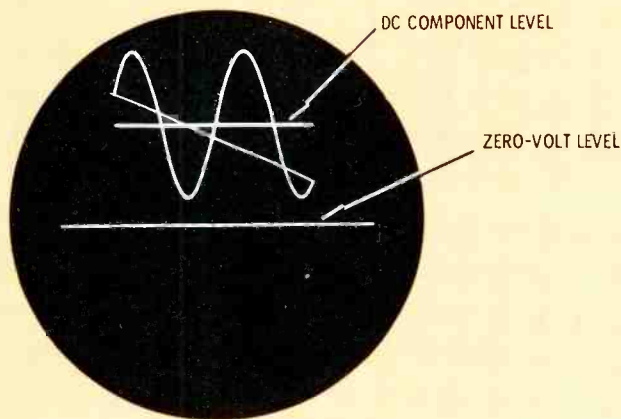
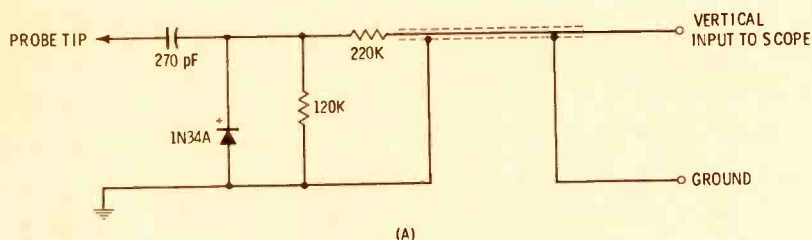


Fig. 13 Response of DC scope to AC voltage having a DC component.



FREQUENCY RESPONSE CHARACTERISTICS:

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

(B)

Fig. 14 Demodulator probe circuit and characteristics.

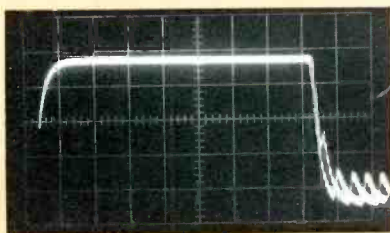
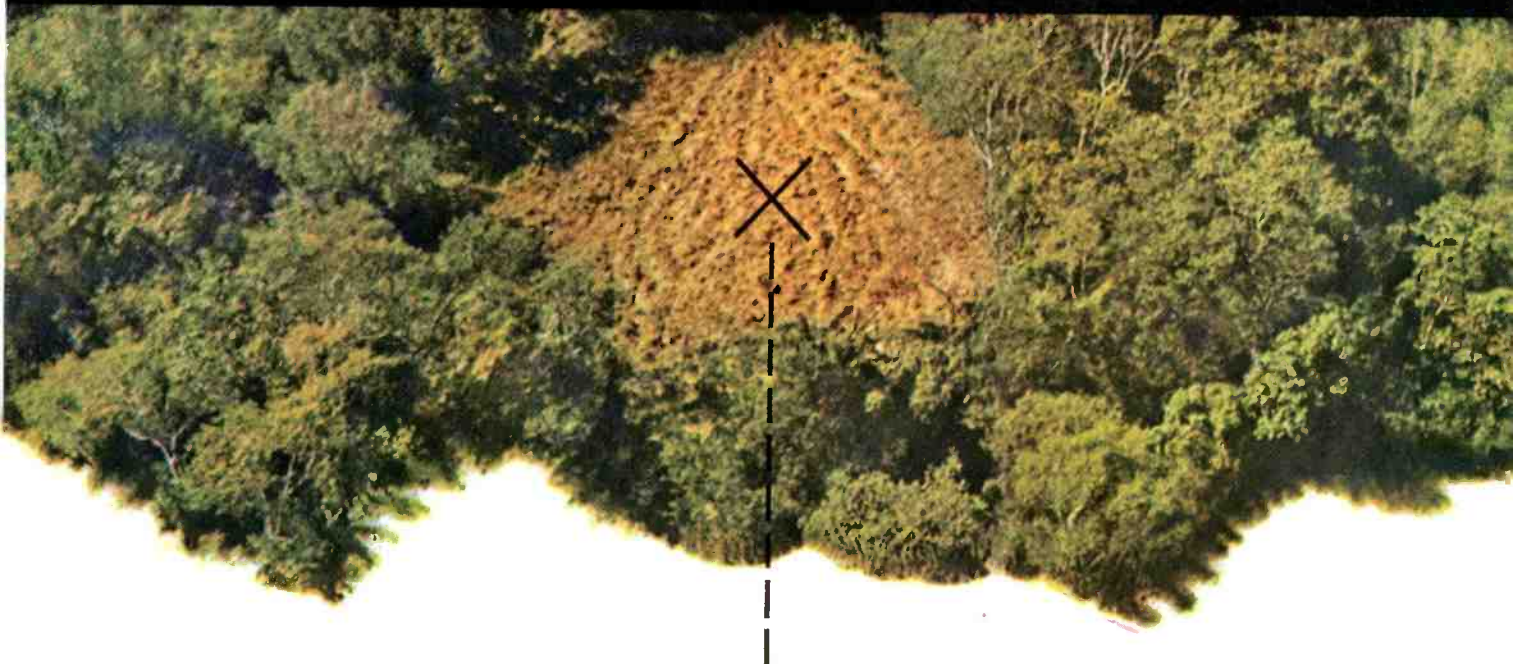


Fig. 15 Waveform produced using demodulator probe and keyed-rainbow signal.

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shop talk

With Carl Babcoke
ES Technical Editor



Meter loading and its effects

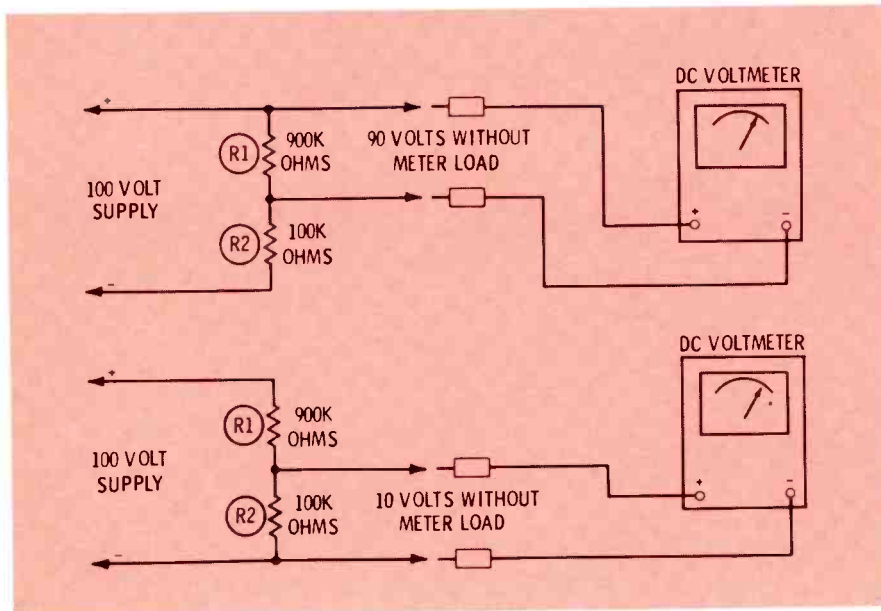


Fig. 1

- Measured with a 1,000 ohms-per-volt meter on the 100-volt scale (internal resistance 100K ohms), the voltage indicated across R1 is 47 volts, or 48% low. (The resultant resistance of R1 and the meter in parallel is 90K ohms.) The 100-volt scale of the same 1,000 ohms-per-volt meter (internal resistance 100K ohms) produces a reading of 5.02 volts, or 50% low. (The total resistance of R2 and the meter is 50K ohms.)
- Measured on the 100-volt scale of a 20,000 ohms-per-volt meter (internal resistance 2 megohms), the voltage indicated across R1 is 86.1 volts, or 4% low. (Total resistance of R1 and the meter is 620K.) The same meter produces a reading of 9.57 volts, or 4.3% low, across R2. (Total resistance of R2 and the meter is 95K ohms.)
- Measured with a VTVM having 11 megohms input resistance, the voltage indicated across R1 is 89.2, or .9% low. (Total resistance is 832K ohms.) With the VTVM across R2, the total resistance is 99,100 ohms, producing a voltage reading of 9.91, or .9% low.

Voltmeters and ammeters introduce shunt or series impedance to the circuit being tested. Even the effects of vacuum-tube-voltmeters (VTVM's) and field-effect or transistorized volt-ohm-meters (FET VOM's), which typically have a high input resistance of 11 megohms or more, cannot be ignored in high-impedance circuits.

Many electronic circuits can be analyzed as voltage dividers, with the voltmeter acting as another resistor in parallel with one of the voltage divider resistors. First, determine the resistance produced by the meter and resistor in parallel; second, use this new resistance value to calculate the voltage actually obtained at that point of the voltage divider.

Fig. 1 shows the voltages indicated across a typical voltage divider by a 1,000-ohms-per-volt meter, 20,000-ohms-per-volt meter, and a VTVM with a constant input resistance of 11 megohms, compared to a theoretical meter of infinitely high resistance.

You probably were not surprised that, of the three types of meters, the VTVM produced the least amount of loading error. But did you notice one very peculiar pattern? The percentage of error is the same across R1 and R2, even though one resistor is 9 times the value of the other. How can this be?

The answer is the circuit impedance, or the total resistance, in this case. A practical approximation of the total circuit resistance can be obtained by paralleling the two legs of the voltage divider. For example, in Fig. 1, paralleling 900K ohms and 100K ohms produces a total circuit resistance of 90K ohms (assuming the internal resistance of the 100-volt power supply to be zero—which it never is). This method of calculation also can be used to estimate the impedance in audio circuits, where shielding or other stray capacitance can cause loss of high frequencies.

Because the loading of VOM's varies with the scale selected, it is difficult to develop a rule to cover all conditions. However, by arbitrarily selecting a 5% error as the

maximum to be tolerated, and using the 100-volt scale, as shown in Fig. 1, we can state the following rules-of-thumb:

- A 1,000 ohms-per-volt meter should be used for circuit resistances of 5K ohms or less.

- A 20,000 ohms-per-volt meter should be used on circuits with impedances under 100K ohms.

- VTVM's are satisfactory if used on circuits with an impedance of less than 400K ohms.

- Add 1% to the VTVM voltage reading for each 100K ohms of circuit impedance.

Look at the schematic in Fig. 2. Can you tell at a glance what the circuit resistance is without a meter? In this example, we parallel the 1 meg-ohm resistor with an open circuit; the total resistance (or impedance) is the value of the resistor, 1 megohm. From the previous paragraph, we would expect the 1,000 and 20,000 ohms-per-volt meters to produce completely wrong readings—and they do. However,

using the previously stated rule-of-thumb, we can add 10% (1% of each 100K) of the VTVM reading as a correction factor. The original voltage reading is 91.6, so add 10% (9.16) to it, and the answer is 100.76, which is reasonably close

to the 100 volts actually present.

More practical examples of meter loading can be observed by demonstrating its effects on measurements of tube voltages.

The schematic of a typical resistance-coupled audio amplifier

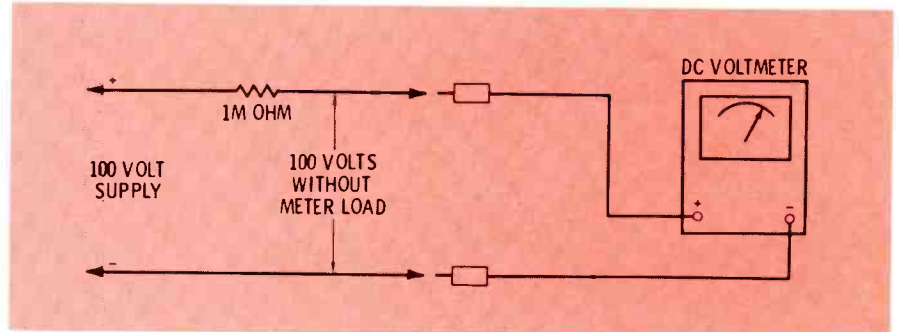


Fig. 2 Comparison of readings produced by meters with different input resistance.

- The larger the input resistance, the more accurate the meter indication.
- Measured with a 1,000 ohms-per-volt meter on the 100-volt scale (internal resistance 100K ohms), the voltage indicated by the meter is 9.09 volts, or 91% low.
 - Measured with a 20,000 ohms-per-volt meter on the 100-volt scale (internal resistance 2 megohms), the voltage indicated by the meter is 66 volts, or 34% low.
 - Measured with a VTVM having an input resistance of 11 megohms, the meter reads 91.6 volts, or 8.4% low.

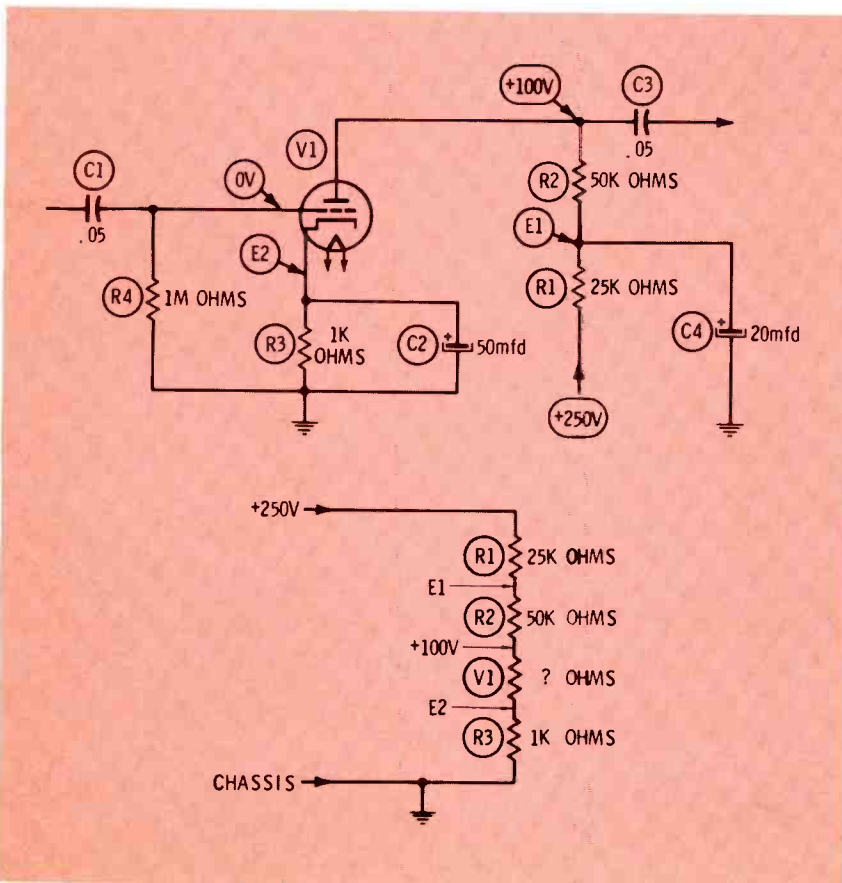
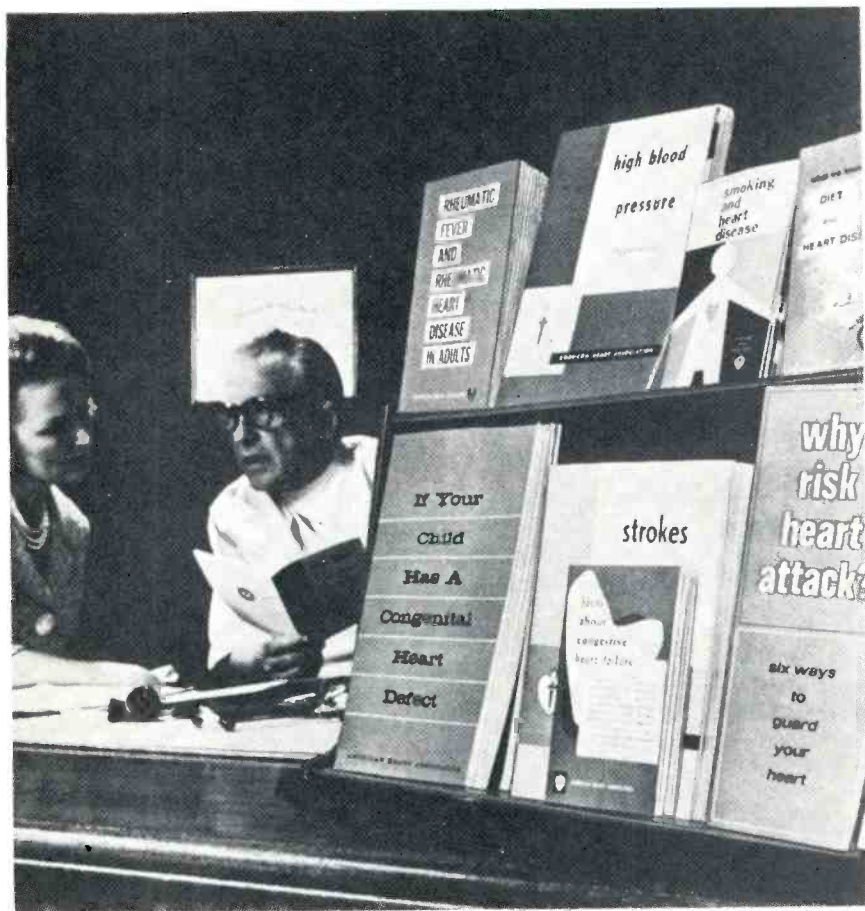


Fig. 3 A) Schematic diagram of amplifier. B) Voltage divider equivalent of amplifier above.

- What is the total current in the circuit?
Formula $I = E/R$
 $250 \text{ volts} - 100 \text{ volts} = 150 \text{ volts across } R1 + R2$
 $R1 (25K) + R2 (50K) = 75K \text{ ohms}$
 $I = \frac{150}{75,000} = .002 \text{ amperes}$
(or 2 milliamperes)
- What is the voltage at E1?
Voltage across R1 is $E = IR$
 $E = .002 \times 25,000$
 $E = 50 \text{ volts across } R1$
Supply voltage (250) - 50 volts across R1 = 200 volts at E1.
- What is the DC resistance of the tube V1? (How many volts across plate to cathode? 100 volts at plate, 2 volts at cathode, $100 - 2 = 98 \text{ volts across the tube}$)
 $R = E/I$ $R = \frac{98}{.002}$
 $R = 49,000 \text{ ohms}$
- What is the impedance at the plate of V1?
 $V1 (49K) + R3 (1K) = 50K$ one leg of voltage divider.
 $R1 + R2 = 75K$ other leg of voltage divider.
Parallel 50K and 75K = $R_T = \frac{50K \times 75K}{50K + 75K}$, or 30K ohms
Impedance at the plate of V1 is 30K ohms.

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stage is shown in Fig. 3. The tube circuit is redrawn in Fig. 3B, with the tube shown as a resistor.

One of the strong points of the method given here for finding circuit impedance is that a useful approximation can be obtained by almost a mere glance at the circuit. Try estimating the impedance at the various points in the circuit diagrams in Fig. 3. Then answer the following questions, and check your answers against mine:

• **Q.** Which of the three types of meters will provide a truthful reading at point E1?

A. The total impedance is about 20K ohms. However, the VOM's must use the 300- or 500-volt scale. The 1,000 ohms-per-volt meter will read slightly low; the other two will be acceptable.

• **Q.** Which of the three will give a true reading at the plate of the tube?

A. The impedance is 30K ohms. A reading on the 100-volt scale of the 1,000 ohms-per-volt meter will be very low; on the 300- or higher-voltage scale, the reading will be slightly low. The other meters will indicate levels within acceptable tolerance.

• **Q.** Which of the three will read correctly the cathode voltage at E2?

A. The impedance will be less than the 1K-ohm cathode resistor, so all three will read accurately, provided the 1,000 ohms-per-volt meter is not used at less than the 30-volt scale.

• **Q.** What about measuring any DC voltage at the grid of the tube?

A. The impedance is very high, unless C1 is leaky. Only the VTVM will give an accurate reading, and it should have the "add-10%-to-the-reading" correction.

Next

In the next installment of this series, we will discuss right and wrong resistor substitutions; what happens to resistors when they are overheated; describe special resistors, such as light-sensitive and heat-sensitive types; analyze transistors as resistors in DC circuits; and any other subjects you, the reader, would like discussed in Shop Talk. It's your magazine, so let's hear from you. ▲

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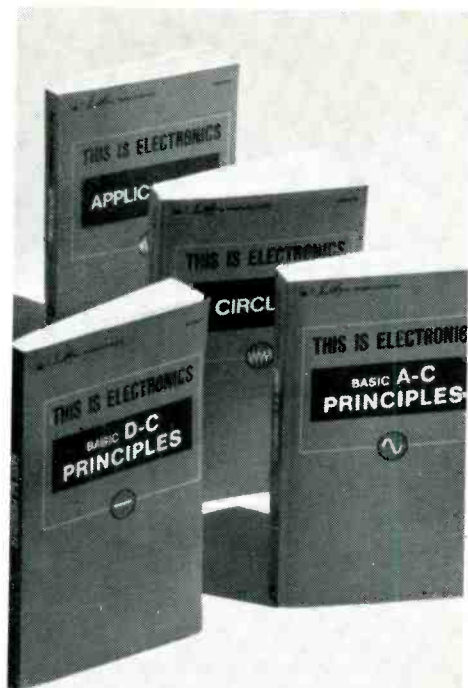
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Solving Intermittent Color

Troubleshooting methods that get you to the source of the trouble in less time—and with less frustration.

by Bruce Anderson

Basic Technique

Following are procedures and tips that can make the cause of intermittent color a little less difficult to isolate.

- Vary the line voltage and see what happens when it is changed. If a slight reduction in line voltage causes the trouble symptom to appear, there probably is a marginal condition somewhere in the receiver, rather than a true intermittent. If this is the case, don't overlook the power supplies and filters.

- Decide on a definite series of tests to isolate the trouble to a general area of the chassis. Watching the raster while thumping the chassis or applying the heat lamp won't tell you much, since you already know that there is an intermittent condition. Connect the scope or a VTVM (or both simultaneously) to key test points in the circuits; when the color again disappears, you will have several indications, instead of just one.

- After isolating the trouble to a general area, it is often a good idea to resolder all the connections in that area, as a start, rather than trying to find one bad connection or component by normal troubleshooting techniques.

- If you are dealing with a new receiver, be more suspicious of the possibility of defective solder joints and broken leads. Remember that the receiver may have been handled roughly on its way from the factory to you. Receivers which have been operated for awhile are more prone to component failures.

- Freeze spray can be used to good advantage since many intermittent components are temperature sensitive.

- Be particularly selective when choosing spray compounds of any type for use in the tuner. Some of these can detune a tuner so far that color will be completely lost; others can shift the tuning far enough to produce a marginal signal, which can cause intermittent color.

- If you can isolate the trouble to half-a-dozen parts or less, it's no disgrace to change them all. Resistors and capacitors are cheaper than your time—you are doing the customer a favor if you use five dollars worth of parts and save ten dollars worth of labor.

- On the other hand, don't try to "shotgun" the whole receiver. Narrow the possibilities as far as you economically can before starting to change parts.

Troubles in the Receiving Section

One good way to get into trouble while tracking down the cause of an intermittent color problem is to assume that it must be in the chroma circuit. **Be sure that all necessary color information is getting to the chroma circuits before focusing your attention on them.**

To perform its function, the chroma system must have three inputs (Fig. 1): chroma (W1 and W2), color burst (W2), and burst-gate pulse (W5). Lose one of these, and there cannot be any color. With this in mind, consider the common defects that can prevent one of the chroma signals from coming out of the video detector.

Antenna system defects

Antennas and reception in general are a continuing source of no-color problems. An antenna with excessive "suck-outs" in its frequency-response curve (dotted line in Fig. 2) can do some strange things to color reception. While not intermittent in the strictest sense of the word, the no-color problem often does "come and go". Combine 1) an antenna which discriminates against the chroma portion of the signal and 2) a variable in the propagation path from transmitter to the receiving site, and you have the basic ingredients for intermittent color.

Suppose, for example, that we are dealing with channel 6. The video carrier frequency is 83.25 MHz (Fig. 3). Nearly all of the black-and-white information and the sync pulses are contained in the passband from 82.25 MHz to 84.25 MHz, so a reasonably good monochrome picture will be produced, even if the antenna response drops off sharply toward the high end of the channel. However, the burst signal frequency is 3.58 MHz, making its position in channel 6 fall at 86.83 MHz. If the antenna response is down toward the high-end of the channel, the amplitude of burst at the video detector might be much less than normal. If the strength of the received signal drops significantly, the burst and chroma signals (which also are centered about 86.83 MHz) can drop to a level that produces little or no color.

Even in areas close to the transmitter, there can be large variations in the propagation losses. Some of the causes are aircraft, trains, and even trucks passing between the station and the home. A better antenna system is the solution to these problems.

A deteriorated or improperly installed lead-in can produce effects similar to an inadequate antenna. A well-installed lead-in which is in good condition has flat frequency response, but one which has a high standing-wave ratio can be very frequency selective. If a bad lead-in already is making burst and chroma amplitudes marginal, it takes little more to cause loss of all color.

Improper alignment

The alignment of the tuner and IF strip in the receiver also can lead to loss of color, although not usually on an intermittent basis. However, if the response is poor in the vicinity of 42.17 MHz (the IF frequency of the chroma subcarrier), the color-burst level at the video detector may be marginal. As stated before, marginal signals can cause intermittent color under some conditions.

The Horizontal System

The horizontal-deflection circuits might seem an unlikely place to find

the cause of intermittent color, but it can produce such problems. For the chroma circuits to operate normally, they must be turned on by the color burst signal, which is separated from the rest of the chroma signal by a gating system. This gating system is triggered on by the horizontal retrace pulse, which is obtained from the horizontal-deflection system.

Poor synchronization of the horizontal oscillator can cause the burst amplifier to be gated on at the wrong time. **If color is intermittent and there appears to be a slight shift in horizontal locking at the**

same time, look into the horizontal-sync problem before tackling the color circuits—if this is fixed, the color problem might disappear.

The Burst Amplifier

One of the first places to look when there is loss of color is the input of the burst amplifier. There are several reasons for this: It is usually an easy point to locate; all burst amplifiers operate in about the same way; and a check at this point can give more information about the source of the trouble than any other test point in the receiver.

Fig. 4 shows three typical burst

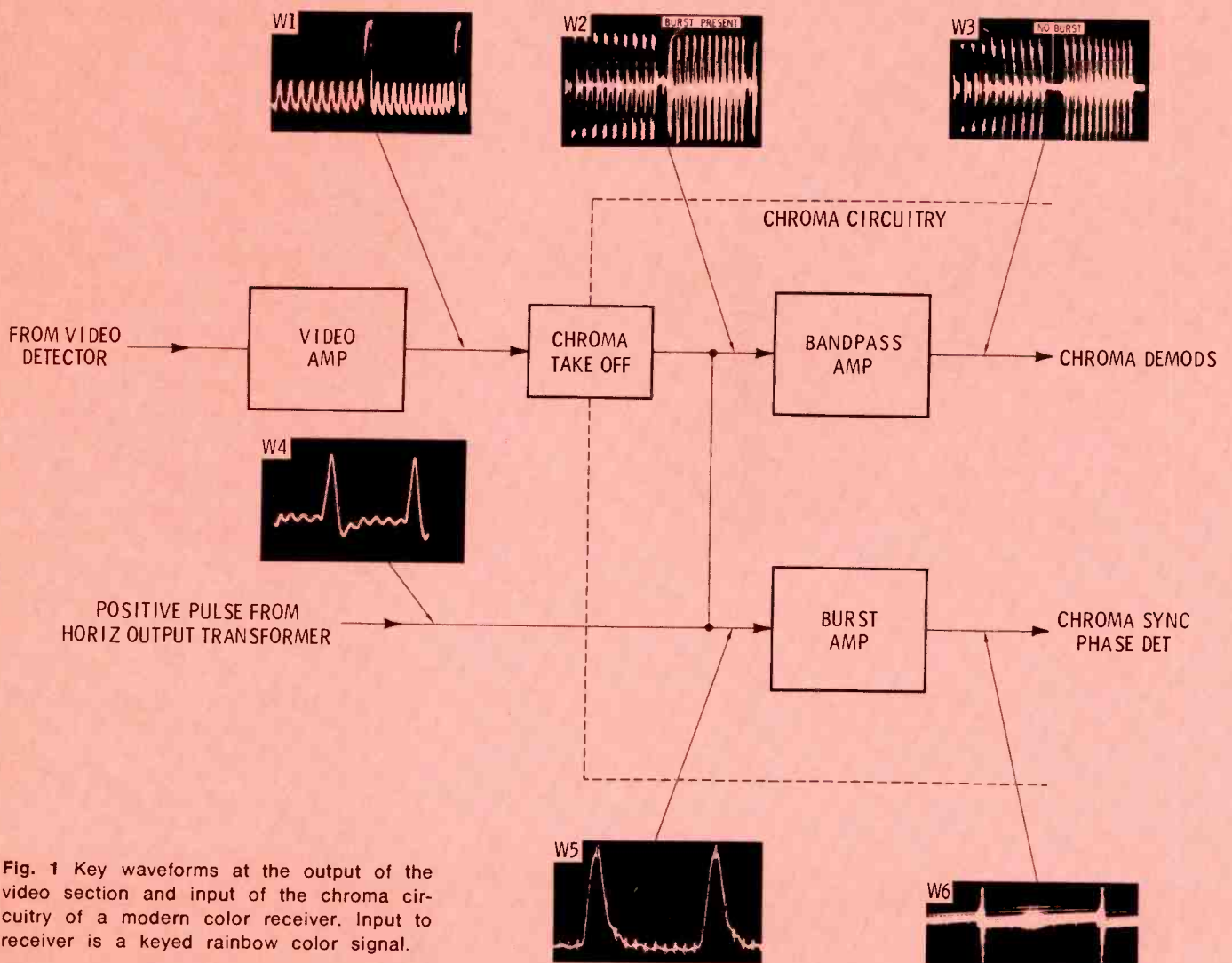


Fig. 1 Key waveforms at the output of the video section and input of the chroma circuitry of a modern color receiver. Input to receiver is a keyed rainbow color signal.

amplifier circuits, vacuum-tube and solid state. In each case, there are two inputs: 1) the chroma signal, which contains both the chroma sidebands and the color burst, and 2) a positive gating pulse, taken

from the horizontal-output transformer. Both signals usually are fed to the control grid of the burst amplifier, as shown in Fig. 4A.

Each time the control grid of the burst-amplifier tube is driven posi-

tive by the gate pulse, the tube is driven into conduction, and whatever chroma signal is present at that time on the grid is amplified in the plate circuit. During normal operation, the gate pulse and the color burst arrive simultaneously at the burst amplifier, so the color burst passes through the amplifier, and all other chroma signals are excluded.

During conduction of the burst amplifier, the cathode current causes the cathode voltage to increase almost to the same positive potential as the gate pulse. Unlike the grid circuit, the cathode circuit has no way to discharge between pulses, and, consequently, remains positive. This cuts off the tube until the arrival of the next gate pulse.

The operation of the solid-state burst amplifier in Fig. 4C is essentially the same as the circuit just described. During the interval between gate pulses, the diode in the emitter lead isolates from the emitter itself the positive voltage at the top of the emitter resistor. Otherwise, the emitter-to-base inverse voltage rating of the transistor might be exceeded. (A triode could be used in approximately the same circuit configuration in which this transistor is used.)

The circuit in Fig. 4B is slightly unusual: The chroma signal and gate pulses are fed to different tube elements. When the positive gate pulse is applied to the control grid, the tube conducts and amplifies the burst, which is present on the cathode at that instant. Cut-off bias is developed by the discharging of grid current (which flows during conduction) through the 82K resistor to ground.

The gating pulse from the horizontal-output transformer might be generated at nearly the same time, or slightly before the arrival of the color burst, depending on a number of design factors. The 27-pf capacitor in Fig. 4A and the 680-pf capacitor in Fig. 4B slightly delay the gate pulse. This capacitor is not used in some color receivers.

Fig. 5 and W5 in Fig. 1 show the burst gate and the color-burst signals as they appear at the input to the burst amplifier. Because the level of antenna-input signal was reduced to the point where the pic-

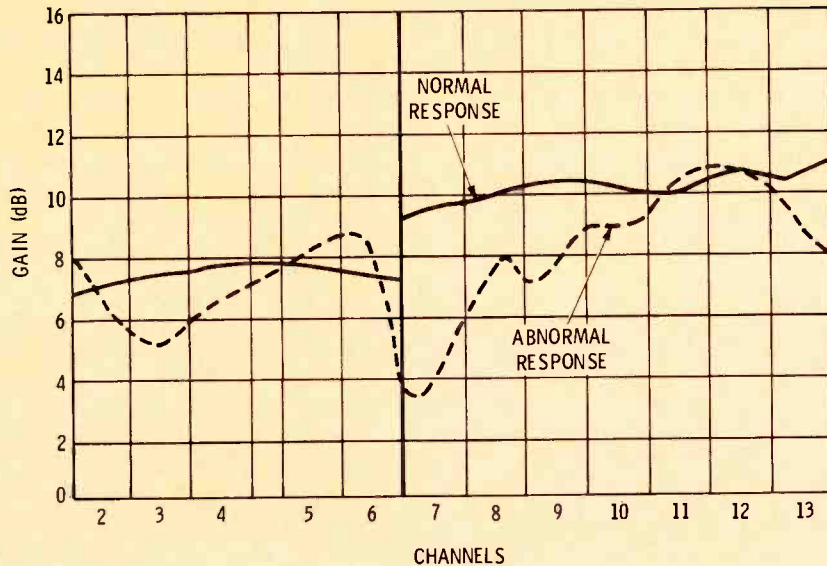


Fig. 2 Chart showing gain versus frequency response characteristics of two antennas. Solid line is typical response of a good color TV antenna. Dotted line shows response of an antenna not suited for color reception.

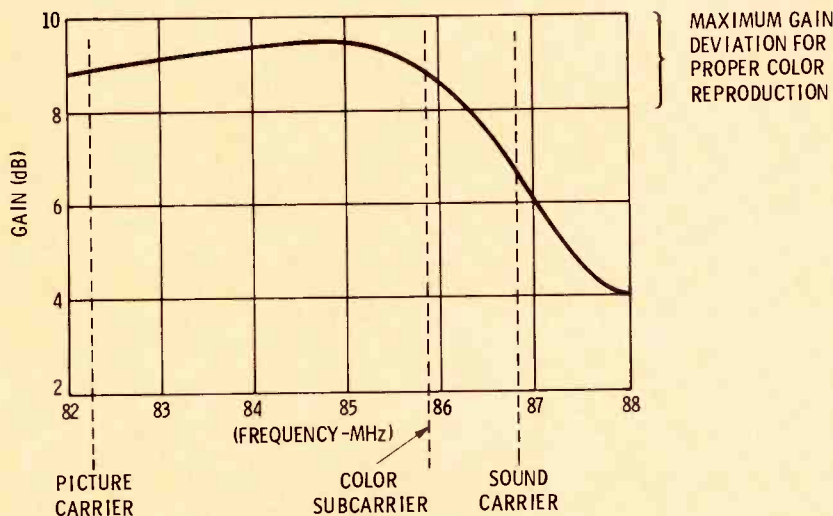


Fig. 3 Gain versus frequency response curve of an antenna with excessive response loss on channel 6. Excessive drop in antenna gain at upper frequencies can reduce amplitude of chroma burst (3.58 MHz) to marginal level that causes intermittent color. If loss of antenna gain is substantial, color loss will be constant instead of intermittent.

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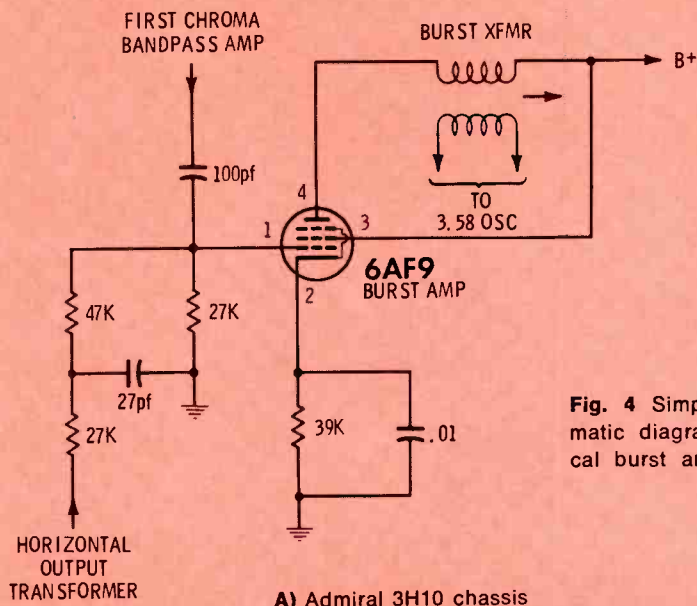
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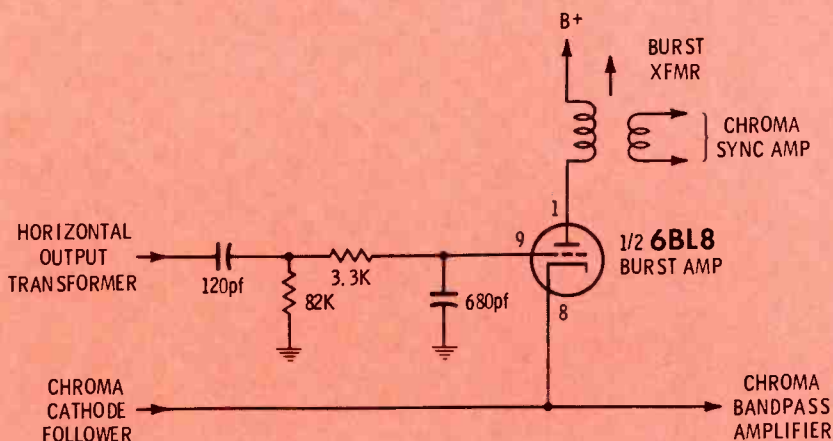
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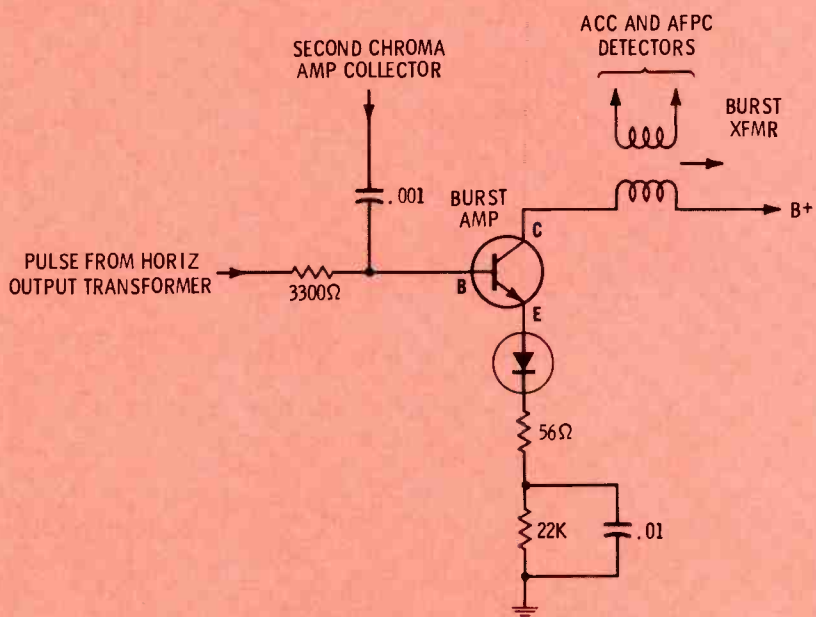


A) Admiral 3H10 chassis

Fig. 4 Simplified schematic diagrams of typical burst amplifiers.



B) Motorola TS-918A chassis



C) RCA CTC 40 chassis

ture became snowy, the burst signal shown in Fig. 5 should be considered as "minimum acceptable." The actual burst signal begins just at the left of the crest of the gate pulse and ends exactly at the crest. The burst signal can occur either just before or just after the crest, but preferably at the very top of it. It will move slightly as the horizontal-hold control is rotated, even though horizontal sync is maintained.

The normal amplitude of the gate pulse is different for different models of receivers. The normal waveform and its typical amplitude is shown in most service literature.

Only a slight amount of burst signal might be necessary on the crest of the gate pulse, as shown in Fig. 5. Usually, it has more amplitude than that shown in Fig. 5, but the normal peak-to-peak amplitude often does not exceed about two volts.

The amplified burst pulse at the plate or collector of the burst amplifier (W6 in Fig. 1) will have an amplitude twenty or more times the input amplitude. When observing the output of the burst amplifier, be careful not to be led astray by a noise pulse which almost looks like a normal burst signal. Figs. 6A and B illustrate this point.

Fig. 6A is a photograph of a normal burst pulse. Fig. 6B is a photograph of the noise signal at the same point with all conditions the same, except that the receiver fine tuning was adjusted to a point where no color was displayed. If an actual scope display was being viewed, instead of these photographs, the differences would be more apparent; nevertheless, do not be fooled into thinking an output burst pulse is present when it actually is not. A wide-band scope is necessary to see the color burst, because its frequency is 3.58 MHz.

An excellent approach to intermittent color is to connect the scope to the input of the burst amplifier and observe the signal. If the amplitude of either signal is less than normal, the intermittent symptom seen on the raster might not be caused by an intermittently defective component, but, instead, by some continuously defective part which permits either the burst or the gate pulse to be just at the thresh-

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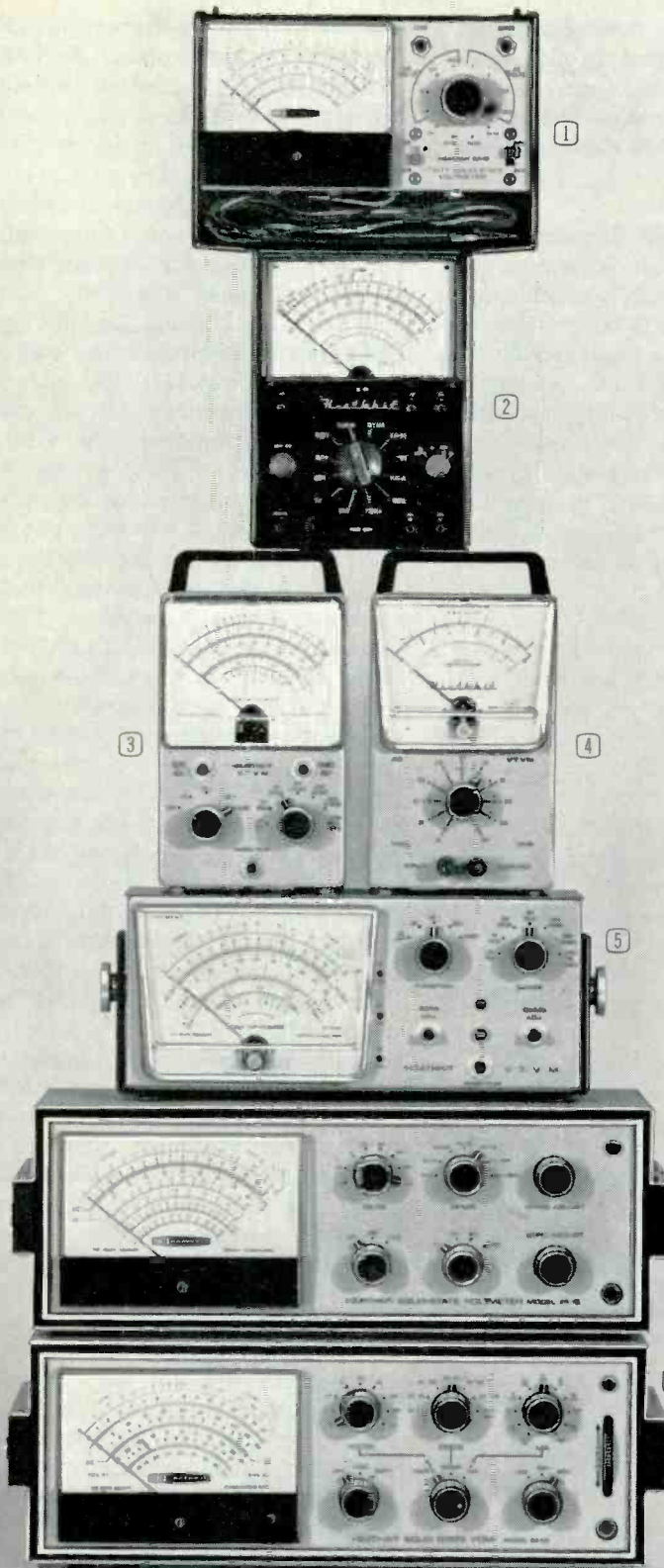
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hold of operation. If this is the case, any slight drop in line voltage, local-oscillator drift, or variation in signal strength can cause loss of color.

In addition to marginal amplitude of either signal, it is possible that their timing is marginal. If the burst is not near the crest of the gate pulse, some small variation may cause the difference in timing to increase enough to prevent all color reception.

If the cause of color loss is an intermittent component in a stage prior to the burst amplifier, the appearance of the input signal to the burst amplifier (W5 in Fig. 1) will change radically when the receiver switches from normal to abnormal

operation. If color comes and goes, but the input signal to the burst amplifier remains the same, the reference oscillator, color-killer or automatic color-control circuits should be checked.

Color-Killer Circuits

Although the color-killer circuits in many modern receivers use transistors, there are still many vacuum-tube color killers in existence. As we shall see later, there are two popular methods of providing the necessary grid signal, but most color-killer circuits are very similar. The one shown in Fig. 7A is typical.

If the voltage on the grid is above cutoff (no color signal received), the

color-killer tube conducts during each horizontal retrace interval, charging C1. During scanning time, this capacitor discharges to ground through R1 and R2, placing negative voltage at the top of C2 and the grid of the chroma bandpass amplifier. This cuts off the amplifier, killing the color circuits when no color is being received.

When color is being received and color burst is present at the output of the burst amplifier, the grid of the killer is driven negative into cutoff, making it impossible for C1 to become charged. This, of course, removes the negative bias from the grid of the chroma bandpass amplifier, allowing it and the remaining chroma circuits to function when color signals are received.

Because the color-killer tube normally is part of a multi-function tube, it is best not to disable it by the standard practice of pulling the tube. Instead, disable the killing action (and turn on the chroma-bandpass amplifier) by grounding the plate of the killer. There might be a killer circuit in which grounding the plate will damage a component; however, I have not yet come across one. If one does exist, the color-killer action can be eliminated by disconnecting either the plate or cathode lead of the color-killer tube, or by biasing the grid below cutoff.

The plate circuit of the killer is more or less "fail safe", because a failure in this area normally will swing the plate voltage to ground potential, turning on the chroma circuits. Therefore, the grid circuit is the most logical place to look if the color killer is suspected.

A simpler method of "sensing" the presence of color burst is used with injection-locked oscillators and ringing amplifiers. In these, the color-killer grid is coupled to the oscillator grid via a large resistor. The oscillator grid normally is 1 to 3 volts negative under no-signal conditions. When the burst signal is injected, this voltage swings from about 1.5 to several volts more negative. This is sufficient to cut off the killer, as described previously.

If an intermittent color condition exists, and it is known that the burst amplifier is operating normally, connect a VTVM to the oscillator grid to see if this voltage is normal. (It

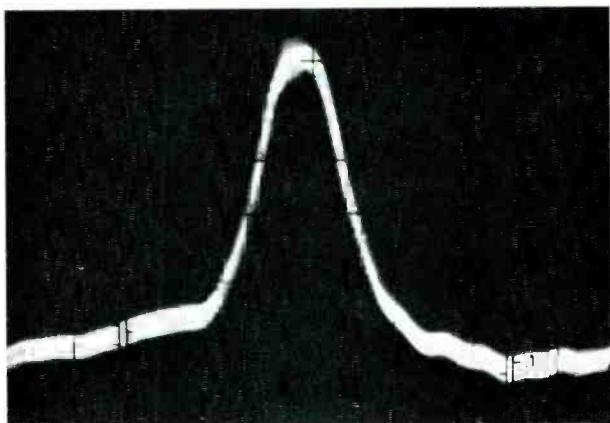


Fig. 5 Input to burst amplifier, with marginal signal.

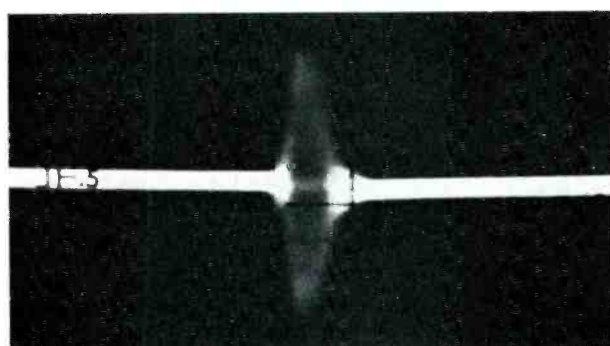
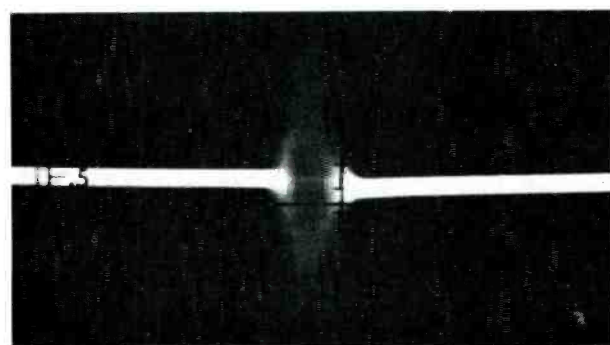


Fig. 6 Noise and burst pulses at plate of collector are very similar.

(Top—A) Amplified burst



(Bottom—B) Amplified noise

is good practice to use a 100K resistor in series with the meter probe, to prevent loading of the oscillator.) Most manufacturers specify the oscillator grid voltage with and without color signal. **If this voltage remains normal as the color comes and goes, the cause of the problem is in another circuit. If the voltage is not normal, suspect the oscillator circuit or the coupling between the burst amplifier and the chroma reference oscillator.**

An alternate method of "sensing" burst is necessary in receivers which use a phase detector to control the oscillator, rather than a burst-injection system. In RCA CTC28 and CTC40, and Zenith 20X1C36 color chassis, for examples, a separate phase detector is used to sense the presence of burst.

The phase detector has two inputs: one from the burst transformer and one from the oscillator itself. When both of these signals are present, **and in the proper phase relationship**, the color killer is cut off, and the chroma circuits are allowed to pass color signals. Since the oscillator phase must be the same as the burst signal before the killer circuit can turn on the chroma amplifier, these receivers might not "barber pole" (visual symptom of loss of color sync) in some instances. Instead, color might appear each time the oscillator drifts into phase, and might disappear each time it falls out of phase by more than about 45 degrees. If this is the cause of the intermittent, it can be verified by disabling the killer, as described above, after which the raster should display color of a continuously changing hue.

The circuit in Fig. 7B shows a typical solid-state color killer. In this circuit, the transistor is turned on when burst is present—the opposite of the tube circuit just described.

With burst present, the potential on the oscillator grid swings more negative, causing the color-killer transistor to conduct heavily, which, in turn, swings the voltage on the killer collector to ground potential, and the chroma demodulators conduct.

With no burst present, the killer transistor is cut off, and the collector assumes a potential set by the

voltage divider consisting of R1 and R2. This voltage is sufficiently negative to cut off the demodulators, the stages to which the color killer is connected.

Although the circuit shown in Fig. 7B is designed to be used with a burst-injection oscillator, burst sensing could be accomplished as well with a phase detector. In either case, the troubleshooting techniques are very similar to those described for the vacuum-tube circuit.

Automatic Color Controls

Many modern receivers use some type of circuit to adjust the gain of the chroma-bandpass amplifiers to compensate for variations in the input level of the chroma signal. Some chassis do this by adjusting the chroma gain according to the level

of the burst signal; others sample both burst and chroma-signal levels as a means of controlling the gain. One input to the ACC amplifier almost always is obtained from the output of the burst amplifier, as shown in Fig. 8.

One method of sensing burst level is to sample the oscillator grid voltage in much the same manner as the killer circuit is driven. Alternatively, a phase detector might be used, as in killer circuits of receivers which have phase controlled oscillators. In some instances, the same phase detector operates both the killer and the ACC.

A second input to the ACC circuit might be used. This is a heavily filtered sample of the chroma signal, which can be taken from any convenient point. Also, some means

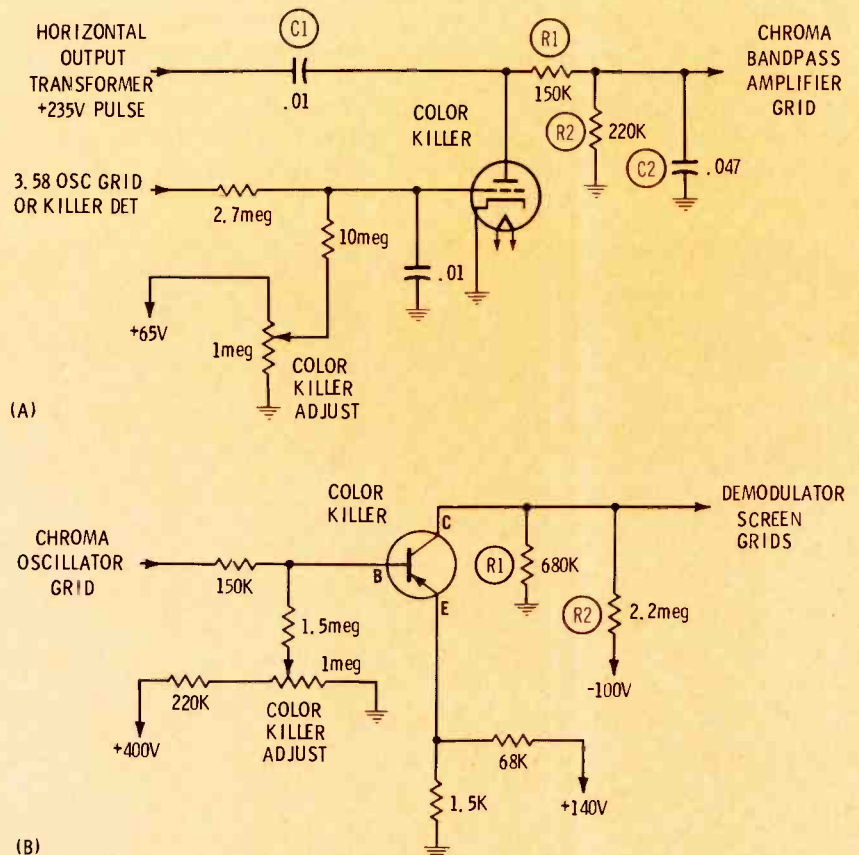


Fig. 7 Schematic diagrams of typical color-killer circuits. **A)** In vacuum-tube circuit, color killer is turned off when burst signal is present. **B)** Solid-state circuit is turned on when burst is received.

of limiting the effect of this signal must be included in the circuit; otherwise, all scenes would have the same level of color.

If the bias voltage developed in the ACC amplifier is fed to a chroma amplifier beyond the sensing point, the system is known as an **open-loop ACC** system. Conversely, if the bias is fed back to a point located prior to the sampling point, it is called a **closed-loop ACC** system.

To check an ACC system for possible causes of intermittent color, first clamp the control bias level to a fixed value which will allow the amplifier under ACC control to operate. If this restores normal operation, starting at the input to the ACC amplifier, check for constant levels at successive points until the defective circuit is located.

Determining the correct level of clamping bias is not as difficult as it might seem. Most schematics show the no-signal grid voltages of the chroma amplifiers, and some also show the voltages to be expected with a color signal present (usually from a keyed-rainbow generator). If this latter voltage is indicated, the grid of the gain-controlled stage can be clamped to this

value. It is safe to assume that the no-signal voltage is one which will cause the tube to operate near maximum gain. (There is an exception: In some receivers, both the ACC and color killer biases are supplied to the same amplifier grid. If this is the case, the no-signal voltage will be cut-off for the tube; however, simply clamping the grid to zero volts bias normally will bring the bias "into the ball park.")

Reference Oscillators

Generally speaking, oscillators either oscillate, or they do not. They seldom operate intermittently; but, anything is possible.

An intermittent oscillator is relatively easy to spot, because the grid voltage is several volts negative when the oscillator is operating, zero when it is not. (When checking grid voltage, it is a good idea to use a 100K resistor in series with the VTVM probe, since the probe capacitance, if it is not isolated, might stop the oscillator.)

As mentioned before, receivers which use a phase-sensitive detector and AFC tube (or a varactor) to control the oscillator can produce intermittent color if the phase of the color oscillator does not correspond

with that of the color burst. The usual source of such trouble is a detuned resonant circuit in the oscillator, but it also is possible that a detector diode is bad, or the burst transformer defective. Burst-transformer tuning is not usually the trouble—**wrong** color is a much more likely result of this defect than intermittent color. At any rate, alignment of the burst transformer, oscillator tank circuits and oscillator output transformer should be checked.

Chroma Demodulators and Post-Detection Circuits

Loss of **all** color, intermittent or continuous, is not likely to be caused by a defect in these circuit areas, because there are not many things which are common to all three color-difference circuits. About the only circuits which can affect all three are the power supply and the blanking circuit, if one is used. Failures can be located in the demodulators by use of the color-bar generator and a scope. Start at the demodulators and proceed toward the CRT grids.

Summary

To find the cause of intermittent loss of color, first determine whether there really is an intermittent problem or whether some continuous malfunction is causing a marginal condition in the color chain. If the latter is the case, the approach is conventional troubleshooting, but with special attention to **exact** signal and voltage levels.

If the trouble is truly intermittent, first isolate the problem to a general area. This is done by 1) closely observing the general symptoms—Are they affected by line voltage? Does changing signal level produce the intermittent? Does horizontal sync appear to be solid? 2) Attach the test equipment to key points in the section under suspicion, and observe what happens to the voltages and waveforms when the color disappears. 3) Narrow the field even further, using the same technique, until some specific stage or circuit is isolated.

When the trouble is isolated to a few components, use the quickest method—either substitution or testing—to determine exactly which component is defective. ▲

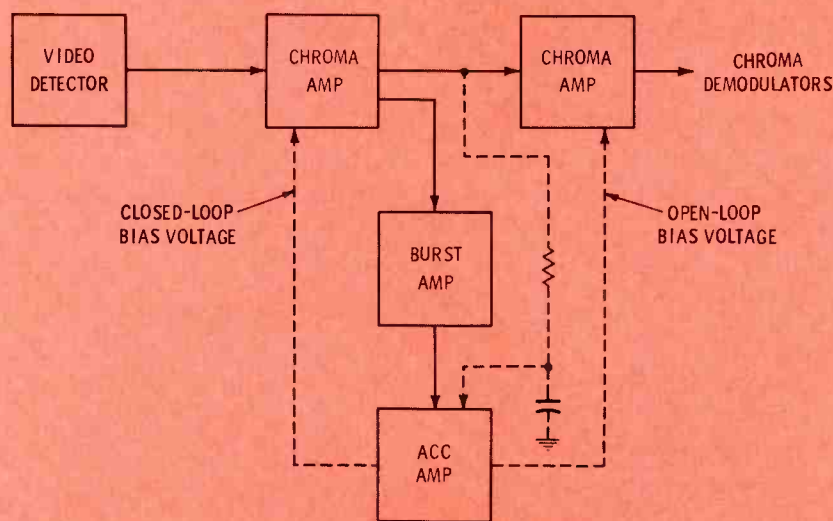


Fig. 8 Block diagram showing fundamental operation of the two basic ACC systems. In an open-loop system the control voltage is fed to a stage following the "sensing" point. The control voltage of a closed-loop system is applied to a stage prior to the sensing point.

There are now eight new SK devices to broaden replacement coverage in AGC, horizontal deflection, vertical deflection, damper, and audio stages of color TV; and in transmitting stages of CB radio, amateur radio, and communications equipment. Result: RCA now offers you a complete system of 47 "Top-of-the-Line" universal semiconductor replacements. Use them with confidence in all entertainment-type electronic equipment.

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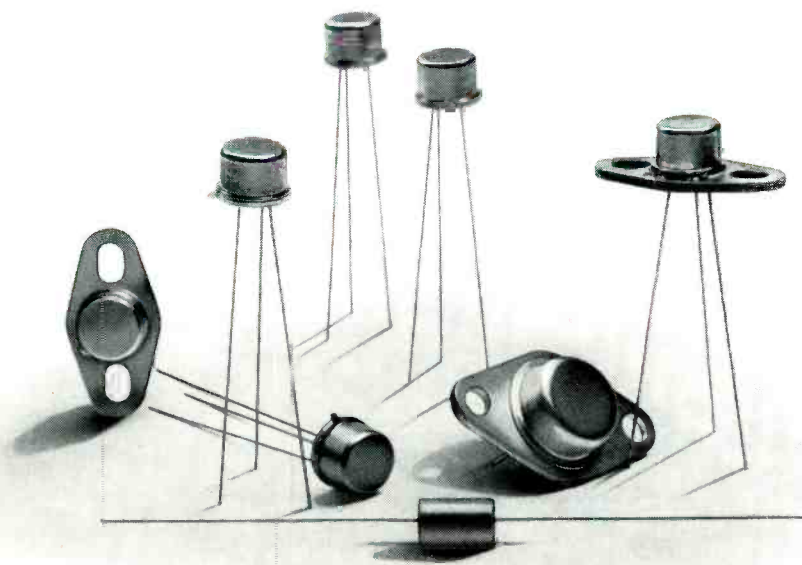
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RCA

8 more SK ways to repair and forget



Tubes Used Most In '69

The 36 types of tubes listed here account for over 56 percent of 67 million tubes used in 1969, according to a recent General Electric report covering usage of 600 tube types. The three types listed last were not included in the 1968 listing of tubes used most.

TUBE TYPE	USAGE	TUBE TYPE	USAGE
6GH8A	3,650,000	6AX4GTB	890,000
6FQ7/6CG7	2,950,000	6AW8A	830,000
6CJ3/6DW4B/6CL3	2,390,000	6AU6A	760,000
6EA8	1,710,000	12BY7A/12BV7/12DQ7	750,000
6BK4C/6EL4A	1,700,000	6BZ7/6BQ7A	740,000
5U4GB/6AS4A	1,490,000	8FQ7/8CG7	730,000
6JE6B	1,330,000	6GU7	720,000
3A3A/3AW3/3B2	1,200,000	6EW6	630,000
6AQ5A/6HG5	1,170,000	3AT2	620,000
6DQ6B/6GW6	1,170,000	6SN7GTB	600,000
6JS6B	1,060,000	1V2	570,000
6BZ6	1,050,000	6EM7/6EA7	550,000
6CB6A/6CF6	1,050,000	6JC6A	550,000
50C5	1,040,000	12BA6	550,000
6GF7A	950,000	12BE6	530,000
6U8A/6KD8/5KD8	930,000	6HM5/6HA5	500,000
6CG8A	910,000	6JU8A	500,000
35W4	900,000	6GY6/6GX6	480,000

Forty-one types of tubes representing nearly 50 percent of the more than 98 million tubes used in 1968 were listed in the August, 1969, issue of *ELECTRONIC SERVICING*. The following seven types of tubes were included in that list but are among those not included in the 1969 listing:

12AX7/ECC83	6BQ5/EL84
12AU7A/ECC82	6AY3B/6BS3A
1G3GT/1B3GT	6AV6
12AT7/ECC81	

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Four tips on how to become an unforgettable American memory.

1. Stop, look and listen. That's the easiest way to encounter a foreign visitor. (And, if you don't encounter one, what will he, she—or perhaps they—have to remember you by?)

2. Prepare to jump a hurdle. What sort of hurdle? Well, let's say you've just stopped, looked and listened in a bustling bus terminal. Your alert eye catches the tentative movement of someone who takes a quick step forward. An even quicker step back. Then stands stock still, looking lost. You've spotted one! Your foreign visitor. And he (or perhaps she) is lost, but too shy to ask directions. And you're just about to offer help. But, suddenly, you can't? You're too shy too? Then that's your hurdle. Jump it. Or simply step across.

3. That's not your hurdle, but you've just run into another? Your English-speaking visitor doesn't understand your answer to his question, even though it was direct and exact? It's probably his ears. Perhaps they're long attuned to British English, or Australian English, or Irish English, and they find your rapid-fire American English difficult to catch. So repeat your answer, slowly.

4. You have no trouble communicating, you just don't know the place he seeks? Take a moment to glance around. And another to dig into your memory. Chances are you do know a Tourist Information Center, or Travelers Aid, or Chamber of Commerce Office and you could take him there.

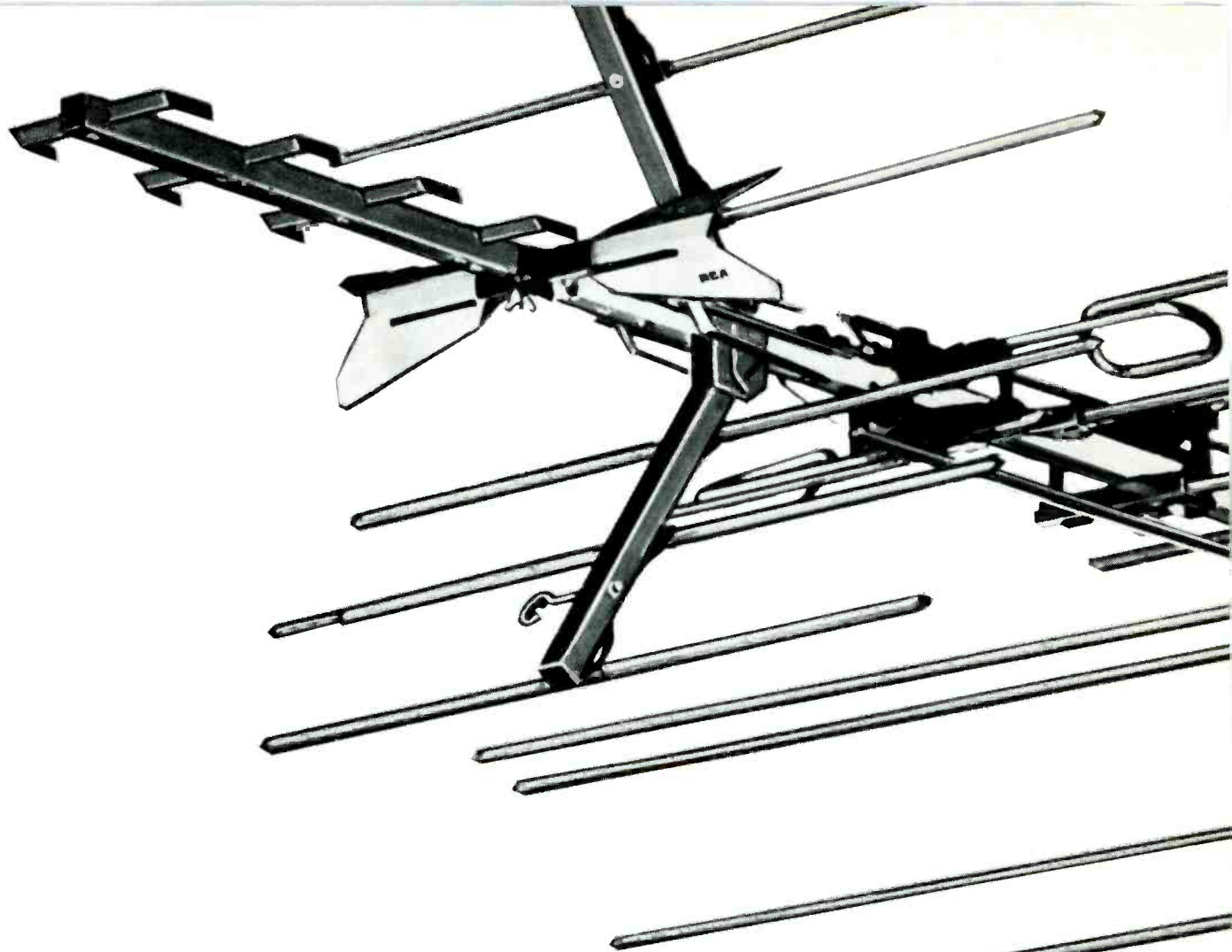
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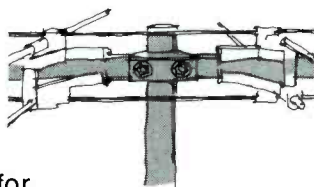
Permanent Connections.

Any antenna is as permanent as its electrical connections. Particularly between the elements and the feed line. If a connection fails, ghosts, streaks, "noise," even total reception failure may occur.

On a Permacolor an aluminum strap solidly connects every active element to the feed line. Connection failure is virtually eliminated.

Tuned Circuits.

Permacolor elements are integral parts of tuned circuits and many perform more than one function. Circuits stay "perma-tuned" because elements are permanently connected. Feed lines are unbroken aluminum strips perfectly balanced for optimum impedance match and minimum ghost pick-up.

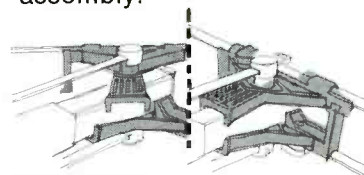


Revolutionary Insulators.

Permacolor insulators are polypropylene, a tough, flexible, waterproof plastic with superior electrical properties. Their unique design includes many ribs and barriers to make leakage paths longer.

On a Permacolor, elements do not pivot. Instead, the elements are assembled right into the insulators. Each insulator, gripping 5½ inches of element, pivots as a unit. When the Permacolor unfolds, insulators snap in place and permanently lock to form a rigid truss. There's no point of high

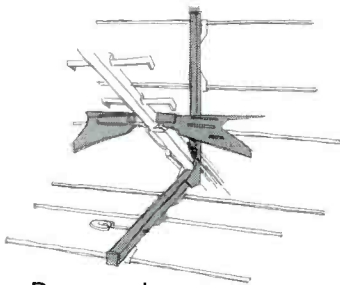
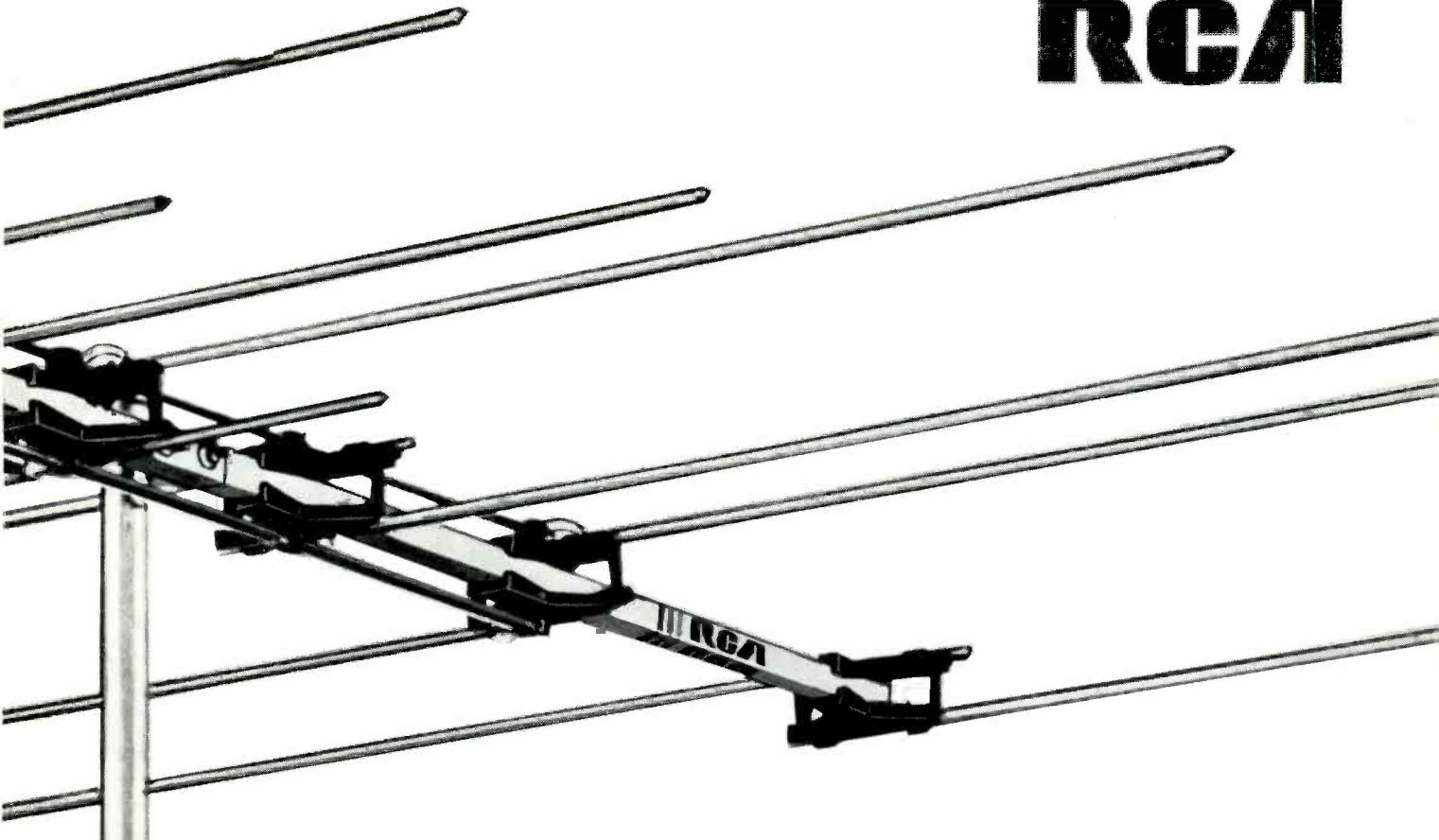
stress along the entire assembly.



Superior Combinations.

UHF and VHF get bigger boosts on Permacolor combinations. On the corner reflector, the angle is increased to 110° for optimum efficiency. And for the first time, a bow tie is included. This best type of UHF dipole is integrated into a single downlead, made possible by a newly designed three-tuned-circuit coupling/isolating network.

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And installation is just as easy on larger models. A double boom gives added strength, yet takes up only 10 inches on the mast. This allows Permacolor to be placed closer to a

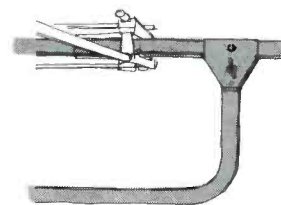
rotator, thus minimizing stress on the rotator as well as the mast.

Tough Finish.

Permacolor has a tough blue and gold vinyl finish on all aluminum parts—even the hidden areas. It's similar to the long-lasting coating on

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Dale's service bench

by Allan Dale

AM & FM SIGNAL SEEKERS, part 2

In this department the past month, you got a detailed introduction to search tuners in auto radios. I explained signal-seeker operation of the Delco "Wonder Bar" and of a Becker multiband auto set.

In case you missed it, I'll briefly recap for you what a signal seeker does. Follow this quick description on the schematic diagram in Fig. 1. It's the Becker model "Mexico TR" I explained last month.

Searching Out a Signal
The search tuner moves under

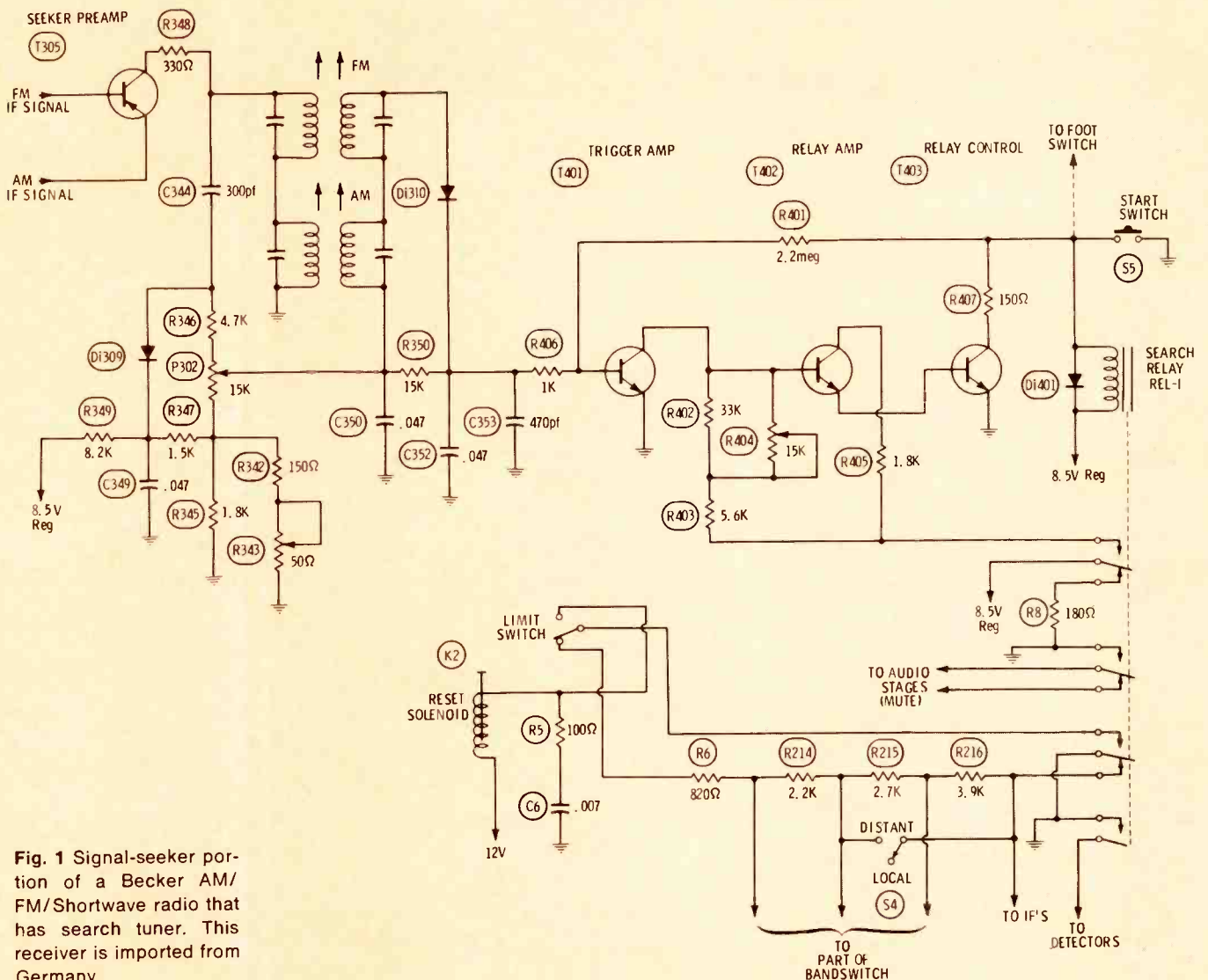


Fig. 1 Signal-seeker portion of a Becker AM/FM/Shortwave radio that has search tuner. This receiver is imported from Germany.

power from a spring. A gear and a whirling governor control the speed at which the tuning elements and the dial scan from the lowest frequency to the highest.

At the high-frequency end, the mechanism activates a solenoid that pulls the tuner elements and dial back to the low end. That stretches the spring tight. The tuner starts scanning across the dial again.

Search is initiated by the search relay, which is activated by a start switch. Once pulled in, the search relay contacts carry power to the trigger and relay amplifier stages; they let the control transistor keep the relay energized.

While the tuner is scanning, other search-relay contacts 1) mute the sound, 2) connect an adjustable sensitivity network to an IF stage, and 3) "arm" the solenoid pull-back circuit by putting a ground at the limit switch.

At some point the tuner encounters a station. The station signal must be strong enough to get through the IF stage that has the sensitivity network. The signal is applied to diode Di310 by the seeker preamplifier. The diode develops a DC voltage.

Since the tuner is moving, the DC voltage develops rather suddenly. In fact, it is a pulse that makes the trigger transistor conduct heavily, producing a negative pulse at the collector of T401 which turns off the relay amplifier transistor. This stops conduction of the relay control transistor, which opens the search relay.

The relay contacts then shift operation of the radio back to normal. A ratchet bar on the relay armature also clicks into the teeth of the gear driving the tuner. It stops the tuner's scanning. A station has been tuned in automatically.

To make the tuner stop exactly on-station, diode Di309 develops a DC voltage pulse shaped like the one that triggers T401—except it's broader and of the opposite polarity. This pulse opposes any tendency to trigger the search into stopping before the tuner nears the true peak

at the center of a station signal.

I explained all those actions in greater detail last month. This recap, however, plus the following suggestions for servicing, should put

you on solid ground with signal-seeker radios.

Mechanical Adjustments

The place to start servicing is in

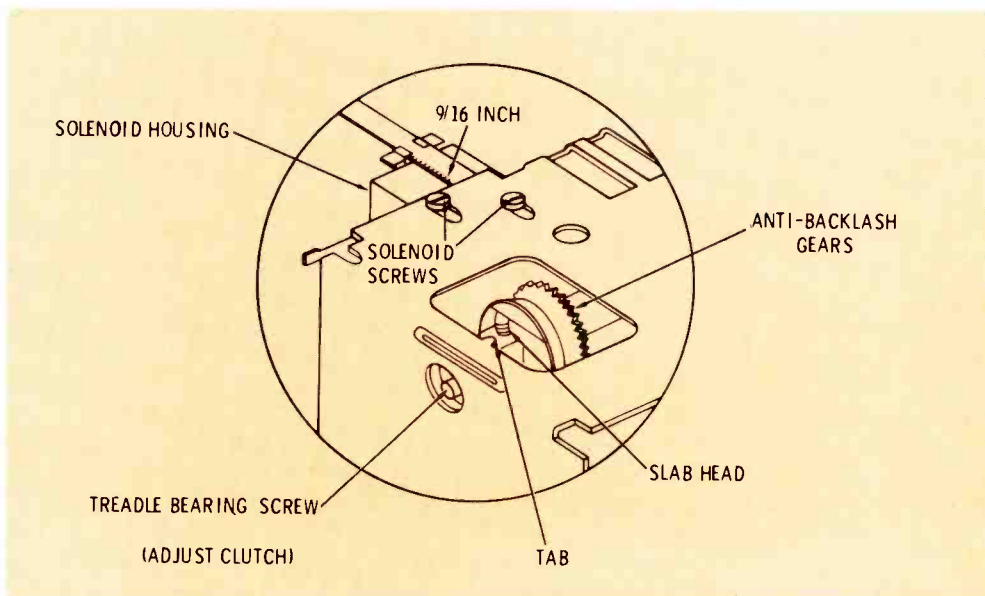


Fig. 2 Solenoid adjustment in search tuner. Plunger must not hit bottom when tuner is pulled all the way to the starting end.

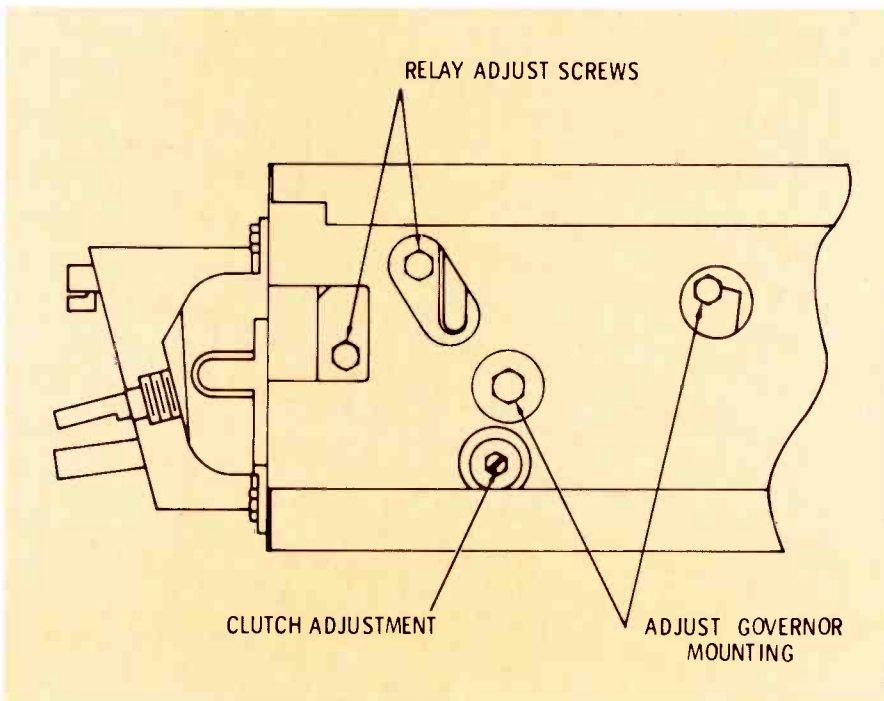


Fig. 3 Positioning adjustment for the governor. If it isn't right, the search tuner may move erratically as it scans the dial.

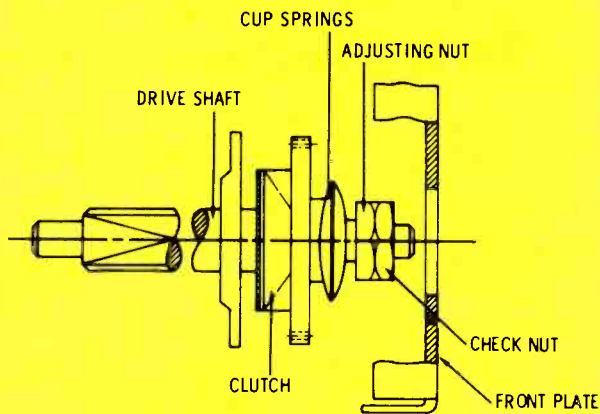


Fig. 4 The clutch adjustment must be loose enough to let the tuner and its dial scan freely, and yet tight enough to tune manually.

the tuner mechanism. If it's not okay, the rest won't operate correctly. So check it out first.

The quickest way is by going over various adjustments. If they're already right, leave them alone. Following are the adjustments in the Delco search tuner.

The solenoid housing should project 9/16 inch beyond the tuner chassis, as shown in Fig. 2. The mounting screws are in slots. Loosen them and slide the solenoid housing back and forth till it is in the right position. Then tighten them.

Set the dial all the way to the high-frequency end. Loosen the slab-head setscrew. Set up pushbutton number 1 and hold it in. Align the clutch and the slab-head setscrew with the little tab projection on the tuner chassis (Fig. 2), and then tighten the setscrew.

If manual tuning feels sloppy, there's probably not enough tension between the anti-backlash gears. To get at the gears, you have to lift the clutch and treadle bar up and out. (Loosen the bearing screw to free them.)

Turn the dial shaft so you can see the tension spring. Push a screwdriver against the teeth of the outer gear, rotating it clockwise. A 1/4-inch gap between the ends of the tension spring is about right. Keeping the tension on the gears, lower them back into mesh with the worm gear, and put the treadle bearing screw back in.

Adjust the treadle bearing screw just tight enough to let you push the tuning bar (with the tuning-coil cores) in and out without excessive drag. Set up a pushbutton near the low end of the dial and one near the high end. They should move the

tuning bar back and forth without tightness. (Be sure to tighten the bearing-screw locknut.)

The treadle bar pushes a solenoid turn-off tab against a switch when the solenoid is almost into its housing. If it doesn't hit the switch about 1/32 inch before the solenoid bottoms, bend the tab so it does.

Disengage the relay latch from the governor. Push the tuner to the high end and make sure the other tab turns on the solenoid switch. The tuner should move at least 1/16 inch further after the switch has clicked on. Bend the tab so it flips the switch soon enough.

The governor has a positioning adjustment. Loosen its mounting screws (Fig. 3). Apply tension to the drive spring by pulling the tuner bar back (dial to left end). Release it. Position the governor gear so the tuning bar moves forward smoothly. Tighten the screws.

A ratchet bar on the search relay latches the governor gear train to stop the movement of the tuner. Loosen the relay mounting screws. Pull the tuner back, thus applying tension to the drive spring. Slide the relay up until the tuner starts moving. Move it slowly downward until it stops the tuner. Tighten the screws. Now push the relay armature in and make sure the bar disengages. Release the armature, and the tuner should stop instantly.

The Becker search tuner has some additional adjustments:

The tightness of fit between the worm gear and the pinion drive gear is adjustable. Set it so the teeth do not touch bottom in the worm-gear grooves.

The search-relay latch shouldn't touch bottom between the teeth of the drive gear. It should reach in only about half the depth of the teeth. The latch is adjusted by bending it.

Clutch drag in the Becker tuner is adjusted by a nut, on top of which is a locknut (Fig. 4). Clockwise tightens the clutch, if it slips when tuning manually; counterclockwise loosens it, if the system binds during search.

Solenoid turn-on and turn-off are activated by a switch plate on the drive-gear shaft (Fig. 5). Push the tuning assembly to the low end of the dial and let it latch there. Loosen the switch-plate setscrew.

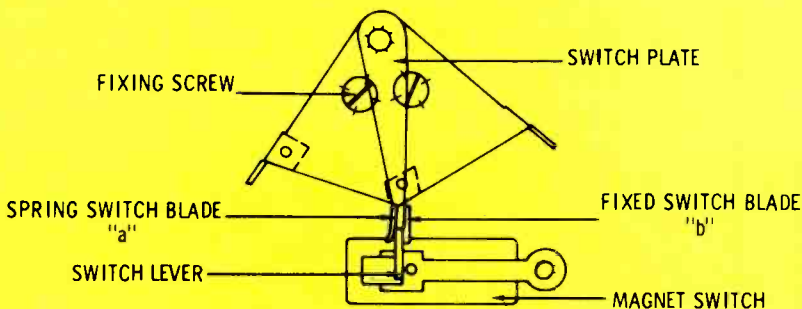
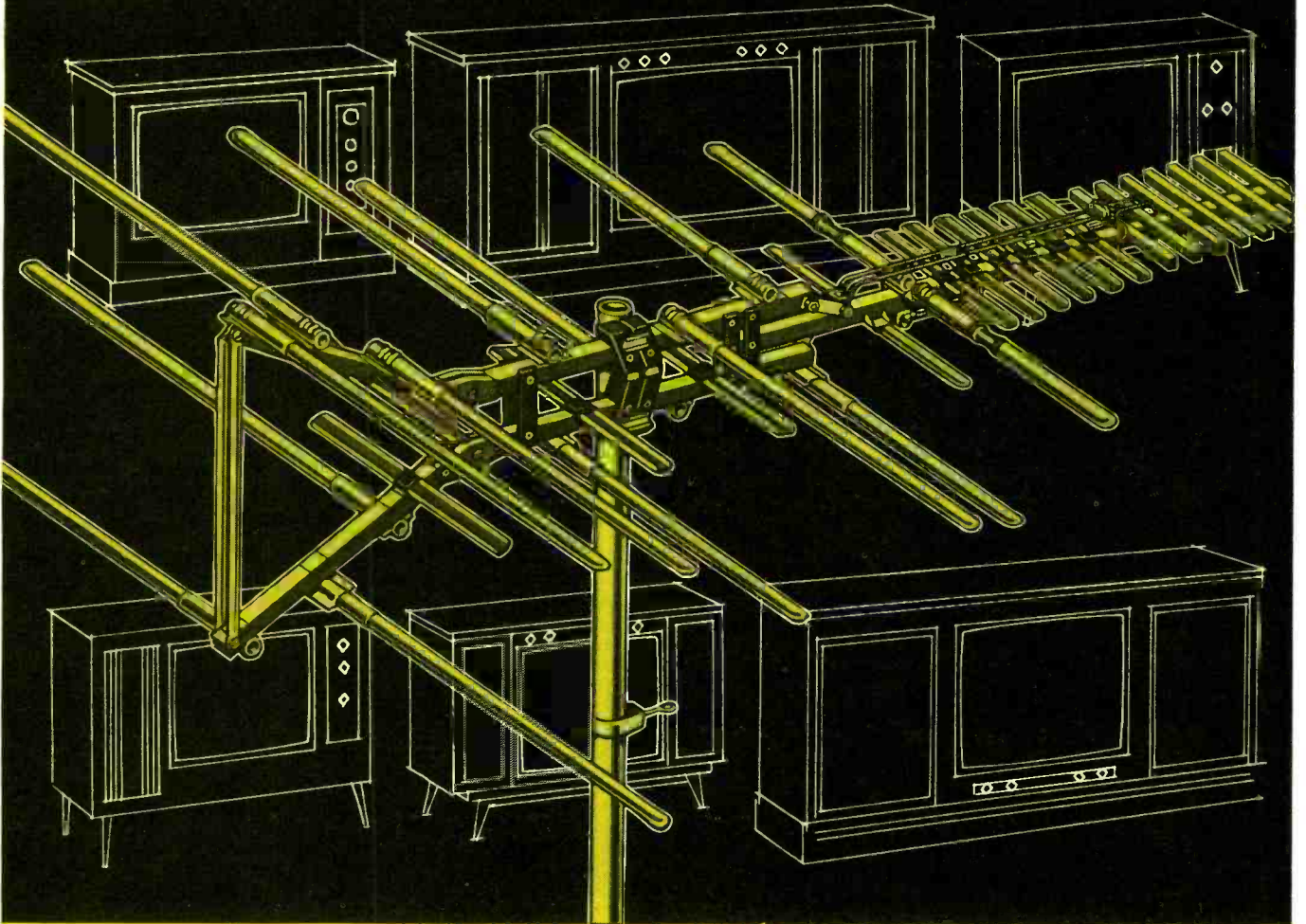


Fig. 5 Switching the plate mounted on the drive gear turns the solenoid on and off.

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Push the plate so its tab throws the solenoid switch off, and tighten the setscrew.

Release the tuner. Let it scan forward to the high-frequency end. Bend the tab at the side of the switch plate so it throws the switch on while the tuner is still moving. The tuning bar should travel at least 1/16 inch beyond where the switch clicks.

Those are the chief mechanical adjustments that affect operation of search tuners. If they're not right, you can't really service the electronic portion.

Troubleshooting Signal Seekers

Of course, the radio must operate okay manually before you set about hunting trouble in the seeker stages. Pay particular attention to alignment. Once you know it is correct, start from the mechanical end of the seeker section.

Apply power to the radio. Set the tuner searching by pushing down the relay armature with a finger or a small screwdriver. If it doesn't search, check the drive spring, the governor wheel and gear, and make sure the tuner movement itself is free (try it manually). Be sure the latch from the relay is actually releasing the gear.

Disconnect power. The tuner

stops. When you again apply power, the tuner shouldn't start searching unless you again push in the relay armature.

If the tuner happens to be at the right end when you try this, pull it back by hand to the left end. The solenoid that resets the mechanism might be faulty. Or the limit switch might be bad. Check both units for continuity.

If you can start the tuner searching by pushing in the relay by hand, but not with the starting switch, the relay might be faulty. If searching continues only while the switch is held closed, there's trouble in either the relay amplifier or the control transistors.

Now you can inject voltages from an external power supply, to verify normal operation in the control stages. Keep the power supply at zero to begin most tests. The negative lead always goes to the radio chassis.

Clip the positive supply lead to the base of the relay control transistor. Turn the voltage up to about 1.5 volts or slightly higher. Depress the starting switch. If the relay won't hold in, the control transistor is probably bad. Test or substitute it.

If the voltage does make the relay hold, turn the supply down to

about 0.5 volt. The relay should drop out, which indicates the control transistor also is turning off okay.

Next, clip the positive lead to the base of the relay amplifier transistor. If it's working, a voltage between 1.5 and 2 volts should hold the search relay in. Turning the voltage down to zero should make the relay drop out and the searching stop.

If the relay amplifier and control stages are okay, the tuner searches continuously—once started—until the trigger stage turns these stages off. If a station won't stop the tuner, clip the supply test lead to the base of the trigger amplifier. A mere .5 volt of positive DC should stop the tuner from searching. If it won't, suspect the trigger transistor or its collector resistors.

For the Delco unit, you should set the test voltage and then just touch the lead to the base of the trigger transistor; that makes the DC a sort of pulse. Do this because of the coupling capacitor between the trigger and relay stages. A steady DC trigger will not operate the relay transistors.

Seeker Input Alignment

Besides the regular RF and IF alignment coils, there are tuned circuits at the input of the signal-seeker stages. Those for the Becker tuner are diagrammed in Fig. 6.

Alignment for these is usually critical; it's what determines how closely on-station the tuner stops. That's because of the gain-control arrangement for the trigger amplifier; the shape of the response curve of the transformers affects the trigger point.

The two transformers are seeker-preamplifier loads for the AM and FM IF signals. Neither transformer affects the signal of the other, because of the large frequency difference. Here's how to align them:

Jumper the power contacts of the search relay—the stages can operate without the tuner scanning.

Set potentiometer P302 counterclockwise. That eliminates its effect on the voltage developed across R350. Clip a voltmeter across R350, with the positive lead at the junction with Di310. Tune the receiver to a weak 1000-KHZ signal from an RF generator; tune care-

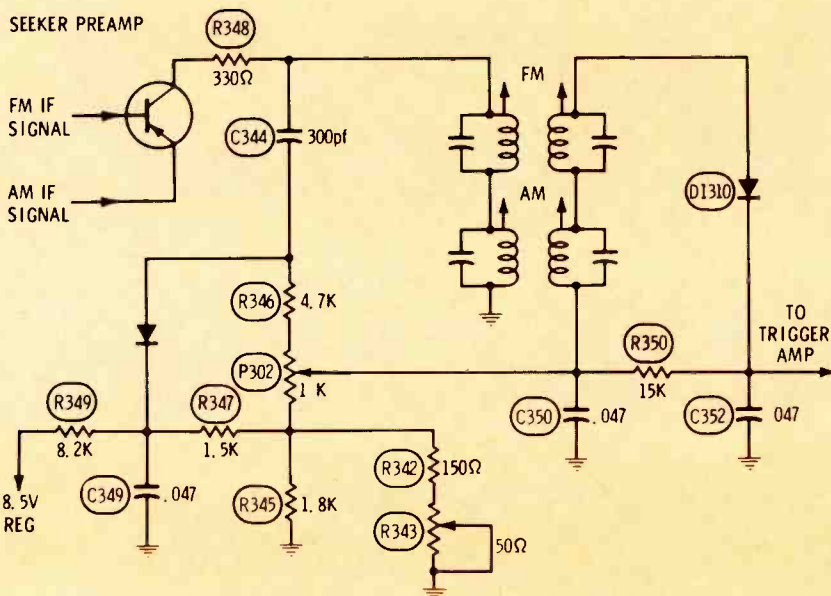


Fig. 6 Input circuits of signal-seeker section in Becker receiver.

fully for maximum voltage on the meter.

Next, align the AM seeker transformer for maximum voltage on the meter. Both coil cores should be adjusted carefully for a peak.

Set the generator output for about 1 mV (1000 μ V) of the 1000-KHz signal. Note the meter reading across R350. Increase the generator signal to about 100 mV. Adjust potentiometer P302 to keep the DC voltmeter reading about the same as it is with 1 mV of input signal.

Remove the generator and voltmeter. Plug in an antenna and try the signal seeker. Note where the tuner stops. If it's slightly below the center of station tuning, turn the secondary core of the AM seeker transformer slightly clockwise. If the tuner stops slightly above station, turn the secondary slightly counterclockwise. Make this final AM adjustment in very small steps until the tuner stops exactly at the center of the station signal.

Alignment of the FM input of the seeker is similar, but you'll need a meter to tell you when the tuner is stopping right. Set your VTVM for center-zero, and connect it to the output of the FM discriminator.

Start the tuner searching. It should stop with the meter indicating exactly zero. If it doesn't, retune by hand to see if the tuner stopped above or below station center (zero). If above center, turn the slug in the secondary of the FM transformer slightly clockwise; if below station center frequency, slightly counterclockwise.

Turning the transformer slug doesn't alter the meter reading; it changes where the tuner stops. So after each adjustment, you'll have to let the tuner search to the next station.

In the Delco receiver, alignment of the relay is important for proper station stopping. There's only one input-coil adjustment; it's for FM (T1 in the Fig. 1 schematic last month). Once the latching bar properly catches the gear, the coil adjustment refines the stopping point.

Preliminary alignment for T1 is made with a strong, unmodulated 108-MHz signal tuned in. Jumper the search-relay contacts that power the 8.4-volt regulated supply. Clip a voltmeter at one diode of the FM discriminator (not at zero-center).

Then tune T1 for **minimum** reading (the coil is then absorbing the most 10.7-MHz IF signal). Finally, adjust the core in small, critical steps for accurate stopping on the correct station.

Looking Ahead

You've learned in these last two months that troubleshooting a signal seeker is both mechanical and electronic. Some technicians don't really like that sort of servicing. The reason is usually lack of familiarity with mechanical operations.

But mechanical servicing can be

made as logical and step-by-step as electronic troubleshooting. And familiarity with the "machinery" isn't as important as you might think.

Next month, I'll write about something that's almost all mechanical—automatic turntables (another name for record changers). From **Service Bench** in the next issue, you'll find out some of the real logic that makes fault-finding easy in any mechanical equipment. If you have found record changer servicing difficult, my next column will be of particular interest to you. ▲



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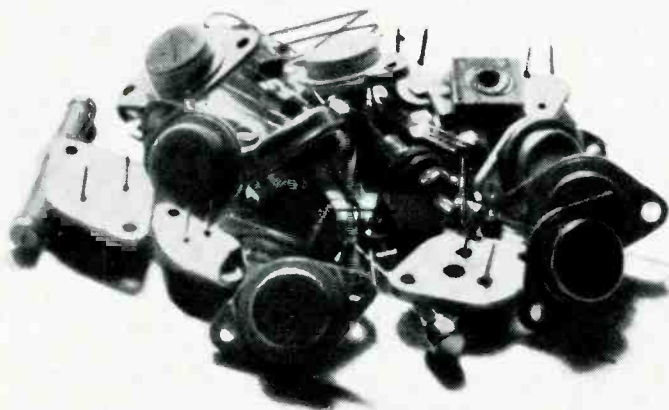
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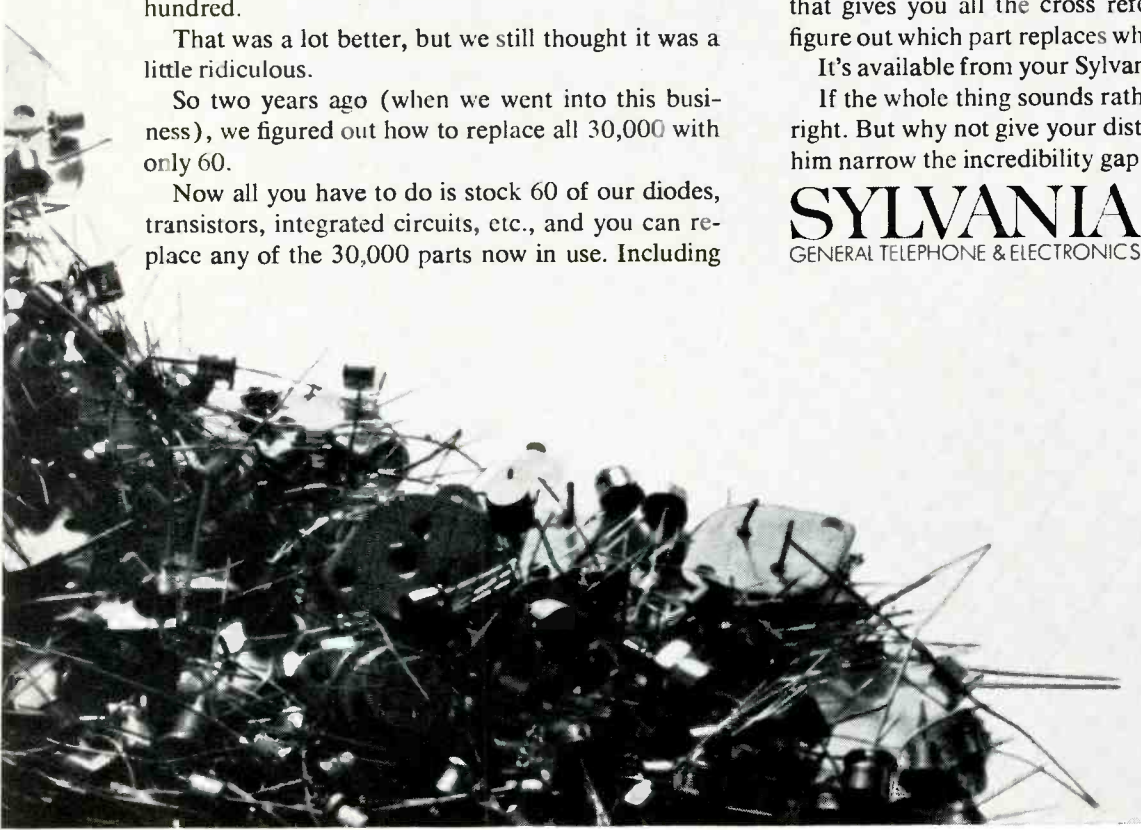
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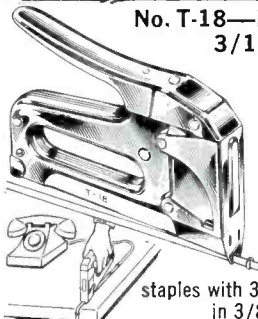
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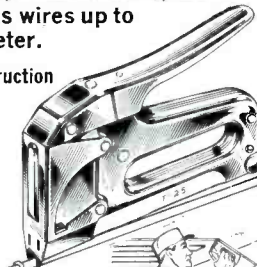
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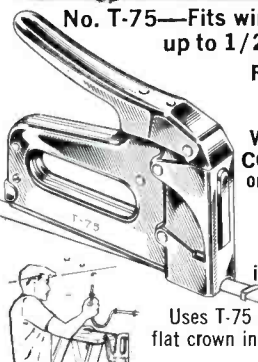
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Circle 23 on literature card

test equipment

notes on analysis of test instruments, their operation and applications

AC Current Leakage Tester

Simpson Electric Company has introduced its Model 229 current leakage tester, which is designed for testing 120-volt AC appliances and electrical equipment.

Performance approximates the normal perception curve to within



± 1.0 dB, and it will measure leakage currents as small as 5 ma, states Simpson. It is built for use on production lines and for "in-field" servicing.

Characteristics

- Ranges: AC Current: 0-0.3; 1; 3; 10 ma.
- AC Voltage: 0-150 volts.
- Battery Test: Replace—good.
- Resolution: $5 \mu\text{a}$ on 0-0.3 ma range.
- Accuracy: $\pm 2\%$ at 60 Hz.
- Input Impedance: 1.5K ohms.
- Input Resistance: 500K ohms on voltage range.

The cost of Model 229 is \$90.00, and the leather carrying case, No. 00805, sells for \$14.00.

Circle 50 on literature card

Color Generator

Sencore's new compact CG18 color generator provides 10 RCA color bars, full-line crosshatch, dots, and individual vertical and horizontal lines. Snap tuning from channel 2 through 6 eliminates co-

channel interference. Timer controls are on the front panel, and range has been doubled to make it virtually impossible for timers to jump time, according to the manufacturer.

Other features include interlace control to stop dot bounce, crystal-controlled 4.5-MHz sound carrier



for adjusting fine tuning, and solid-state battery operation with zener regulated DC power supply for maximum stability. An unusual feature is automatic shut-off when the lid is closed, which prevents battery drain if the color generator is left on accidentally.

The unit is housed in Sencore's new "Handicase" of vinyl-clad steel with brushed aluminum trim. The removable protective lid contains a shock-mounted plate glass mirror.

Price is \$129.95.

Circle 51 on literature card

Scope and Meter Calibrator

An X-Y calibrator for oscilloscopes and volt-ohm-milliammeters (VOM's) has been introduced by Paramatron Corp.

Model 132 reportedly provides accurate DC or square-wave output up to 1.0 MHz and from 0.10 to 10.0 volts. Precision time-base calibration with a stated accuracy of 0.005% is provided by a crystal oscillator and integrated-circuit dividers. The manufacturer states that voltage accuracy is assured by a regulated, temperature-compensated power supply and an output attenuator using 1% precision resistors. Frequency of the square-wave out-



put is selected by push-buttons. Rise and fall times of square waves is less than 40 nanoseconds when the output is loaded with a normal 10-times scope probe.

With the push-button selector set to the DC position, the instrument calibrates VOM's and other DC voltmeters up to 10 volts. The signal amplitude of the Model 132 itself reportedly is easily calibrated by internal adjustment using an external standard. The frequency is crystal-controlled.

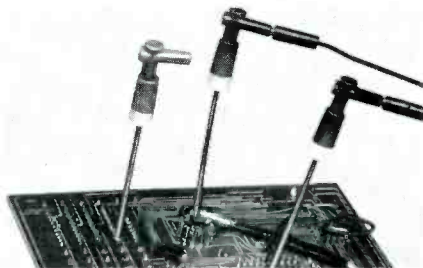
Suggested uses are: calibration of horizontal time base and vertical input of scopes; adjusting scope probe response; calibrating DC scales of VOM's and VTVM's; and calibrating peak-reading or RMS-reading AC voltmeters at frequencies up to 1 MHz. It also can be used as a precision square-wave generator.

Model 132 requires 115/230 volts AC power, 50/60 Hz at 3.0 watts. The unit measures 3 in. X 11 in. X 6 in., and weighs 4 lbs. The price is \$99.50 in kit form or \$198.50 assembled and tested.

Circle 52 on literature card

Universal Test Clamp

Hunter Associates has made available the Type P1 Hunter Universal Test Clamp. The device consists of a retractable spring clamp which is activated by light pressure on the head, according to the manufacturer. The clamp reportedly will



grip the finest wire or printed circuit and then retract into the insulating sleeve. The head contains a standard banana plug which is said to allow the most flexibility in rapid interconnection. It also comes with a two-hook flat gripper, which is notched for the probe.

Available in red, green and black, the Type P1 universal test clamp sells for \$2.35. ▲

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Circle 24 on literature card

Tracking down spurious noises in auto radios

How to isolate common causes of static, whistling, motorboating and other unwanted noises. Supplemented by case histories.

by Joseph J. Carr

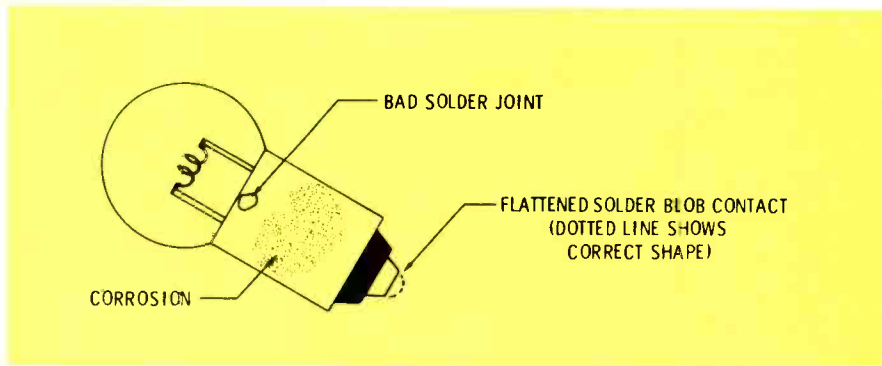


Fig. 1 Common noise-generating defects in pilot lamps.

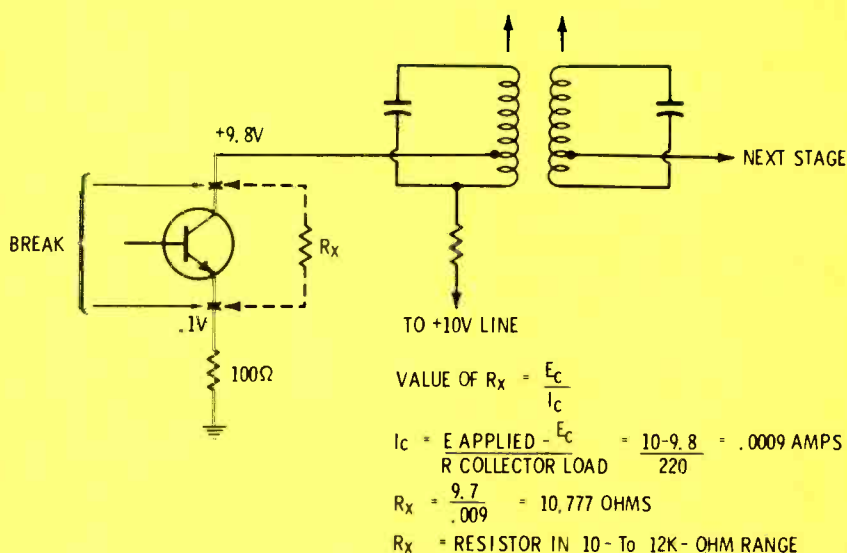


Fig. 2 Disconnecting the transistor and replacing it with a resistor of the correct value can help isolate the source of noise in solid-state circuits. If the noise stops, the replaced transistor is the noise source. If the noise continues, the IF transformer or collector load resistor is the source of noise.

One of the most common ailments of the modern car radio is noise. There are oscillations, assorted forms of static, noises created by the car's electrical system, and even a special noise peculiar to stereo multiplex FM receivers. The following paragraphs analyze some of the more common forms of noise and the methods used to successfully locate and suppress them.

Static-Type Noises

Static is characterized by its peculiar sound and, in its effects, by its electrical nature. The sound made by static has often been compared to the sound of frying eggs. Although this is a fairly accurate description, the customer is likely to call almost every possible noise "static". For our present purpose, we will consider the "frying" sounds as true static.

Electrically, static is an irregular, transient waveform of short duration and usually high amplitude. As an irregular waveform, especially when it is short in time with high amplitude, static is particularly bothersome in radio circuits. Such waveforms contain many harmonics of frequencies between DC and VHF. This makes even tuned circuits susceptible to interference from static.

Unfortunately, the short duration of a static burst will not allow the AGC circuits usually found in consumer products time enough to react. Even if the AGC could operate fast enough, the static would probably still win because of the limited dynamic range of most AGC systems.

Many sources of static are outside the receiver. Such sources include static electricity discharges, lightning storms (even many miles away), motors and generators, and automobile ignition systems. However, sources within the receiver are of more concern to the bench technician.

Tuned circuits employing IF transformers are a very common source of static. Intermittent leakage currents between the windings and through the tuning capacitors are usually the cause of the defect. This problem still exists, to some extent, in low-voltage, solid-state equipment. It is a lot more prominent, however, in tube designs em-

ploying high anode voltages.

Oscillator, RF amplifier and antenna-peaking trimmer capacitors also are prime sources of static in car radios. Static can be produced whenever an intermittent leakage path exists between opposite plates of these capacitors. It has been observed that trimmer-related static occurs most frequently in humid locales or immediately after extended rainy periods.

Another common cause of static in auto radios is an arcing pilot light assembly. If the lamp is loose in its socket, if the socket is loose from its ground, or if a certain bulb defect exists (Fig. 1), the result can be static. The most usual situation is for the bulb to be operating in an intermittently resistive circuit, causing arcing whenever car vibration or other movement jars the radio.

All types of sets are prone to static caused by loose connections. This problem is even more pronounced in car radios because they receive more vibration and jarring. Most loose connections seem to be caused by improper soldering on the printed-circuit board. The author has seen car radios with large areas of the board accidentally left unsoldered (still bare copper). Such cases probably were the fault of malfunctioning automatic soldering equipment used in the manufacturing process.

Localizing the Static to a Stage

Signal tracing often is used to locate the stage of the radio that is causing the interference. Either a high-gain signal tracer or an oscilloscope can be used. Scope tests usually are made best under no-signal conditions, so the spikes in the scope pattern will not be obscured by any miscellaneous external noise or by audio from the received signal. This advice, however, is not absolute. There are some forms of static that are not present or not quite as evident unless a signal is being received. A defective antenna-peaking trimmer capacitor, for example, occasionally will exhibit such a condition.

The signal tracer, equipped with a demodulator probe, in many cases will be of more benefit than a scope. It, however, must be a signal tracer with high enough gain to pick up

weak signals off the tuned input circuit of the RF amplifier. Otherwise, the noise signal might not be uncovered.

Disabling the emitter-base bias voltage of each stage in succession is another method of stage isolation. If the noise is not present when the volume control is turned down completely, it is a safe bet that the source of the noise is one of the "front end" stages—RF, Converter, IF, and/or AGC. Starting with the RF amplifier stage, disable each transistor by shorting together the emitter and base leads of the transistor. If, for example, the noise still exists when the RF amplifier is disabled, but not when the converter is cut off, the trouble most likely is in the converter stage, or the coupling between the two stages.

Finding the Defective Component

Once the defective stage is located, wherever possible separately diagnose the AC and DC current paths. (Although this procedure cannot be carried out 100 percent, it often will make diagnosis easier and quicker.) Disconnect suspect components one at a time wherever feasible, so that only the DC operating voltages remain applied to the transistor. Monitor the noise as each component is disconnected. The last component disconnected before the noise disappears probably is the source of it.

The transistor itself can be the noise source. Transistors and capacitors should be checked by substitution. Items like trimmer capacitors and IF transformers, however, are a bit troublesome to check in this manner. Defective trimmers often can be located by disconnecting one end and hooking a DC blocking capacitor in series with the suspected trimmer. The value should be in the .01- to .1-mfd range so that only a minimal change in over-capacitance, as seen by the oscillator circuit, will result. If the static ceases when the DC blocking capacitor is connected, the trimmer probably is bad.

If a collector load resistor or IF transformer is suspected of causing the noise, use the following method to prove or disprove it: Remove the transistor. Connect a resistor between the points where the collector and emitter terminals of the transistor normally are found (Fig. 2). The resistor must have a value that will allow approximately the same amount of current flow as did the transistor. This can be determined by dividing the value of either the collector or emitter resistors into the voltage drop across it. Then divide this value of current into the voltage drop that normally appears between the collector and emitter of the transistor (8-12 volts in most car radios). Typical values of the resistor will be in the 6- to

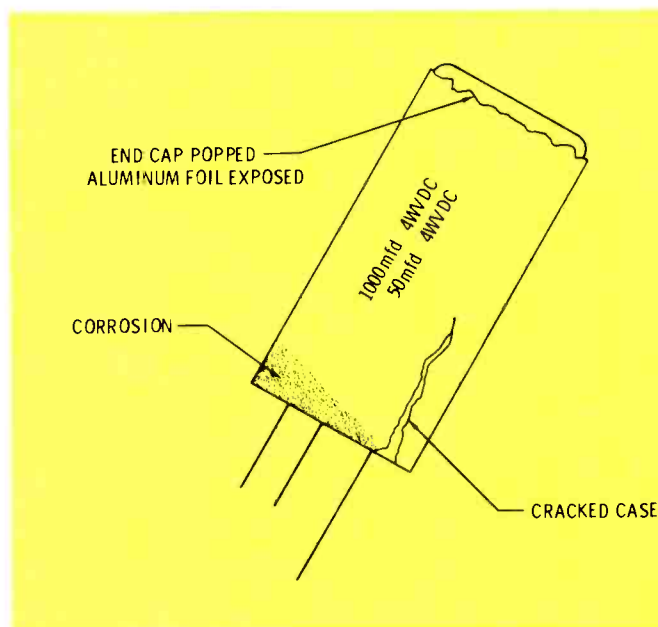


Fig. 3 Physical evidence of electrolytic capacitor failure, which can produce "motor-boating". Electrolytic shown here is used for decoupling in audio preamplifier stage of Bendix auto radios.

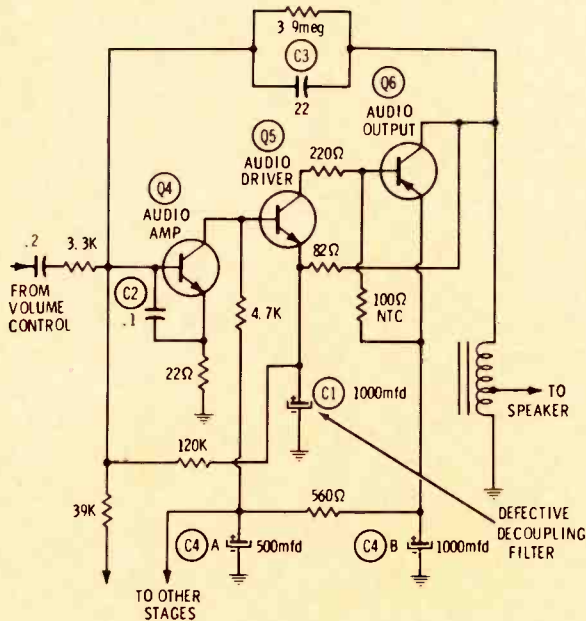


Fig. 4 Failure of decoupling capacitor, C1, has caused Bendix Model 78V to produce "motorboating" sound. Fluctuation of "A" lead current is one clue to trouble.

circuit board is another source of static noise. Defects in soldering during production produce more trouble in car radios than in comparable home sets. This is because of the more intense vibration and shock in which car radios are subjected. As is usual in most printed circuits, the defect is not always evident to the naked eye. One good method for locating the break (or other defect) is to use a magnifying glass. A watchmaker's eyepiece and/or binocular magnifier also are highly useful for this purpose. The binocular magnifier comes with an adjustable headband. Both of these tools are easy to use and leave the technician's hands free. They are available from watchmakers' and jewelers' supply houses.

Most magnifiers cannot eliminate the inherent glare caused by directly lighting a printed-circuit board. This glare can easily mask a small, but important, defect. Because of this reason, it is advisable to use indirect, soft light when searching for defects on printed-circuit boards. It also has been found advantageous to scan the same area of the circuit board several times, with the light coming from a different angle each time. One technician I know claims that his polaroid (prescription) sun glasses are an immense help for this type of operation.

Another method for locating a defective printed circuit involves the use of a VTVM. Connect the common lead of the meter to one end of the suspected printed circuit. Move the probe along the track of the circuit until you either run out of track or find a significant voltage drop. Any section of printed circuit or solder joint that exhibits a voltage drop is defective.

Oscillations

Another type of noise often encountered in car radio sets is audible oscillation. Two common oscillation noises are "motorboating" and the high-pitched whistle.

Motorboating almost always involves the audio portion of the receiver. It usually will be accompanied by a rapid fluctuation of the current through the "A", or primary, hot lead. The cause generally is failure of one of the large electrolytic filter and decoupling capacitors used in these circuits. (Look for a 300-

12K-ohm range. If the noise stops when this substitution is made, the noise source is probably the transistor. If, on the other hand, the noise persists, then either the IF transformer or collector load resistor probably is the source of the noise.

Pilot lamp noise, explained earlier in this article, is quite often the last type expected by the technician. It is a static-like hash that is very sensitive to vibration. It can be caused by a loose lamp, or lamp socket, or a defective bulb. The quickest way to determine whether

or not the light circuit is at fault is to disconnect it and jar the radio. If the noise does not return, you know the lamp was the trouble.

We will not dwell on the problems of loose lamp assemblies because they are simple and usually are self-explanatory. A defective lamp, however, can be a puzzler. Most bulbs found causing this type of problem will have either a flattened "tip" contact, loose or resistive internal contact, or corrosion on the brass base (see Fig. 1 again).

A loose or defective printed-cir-

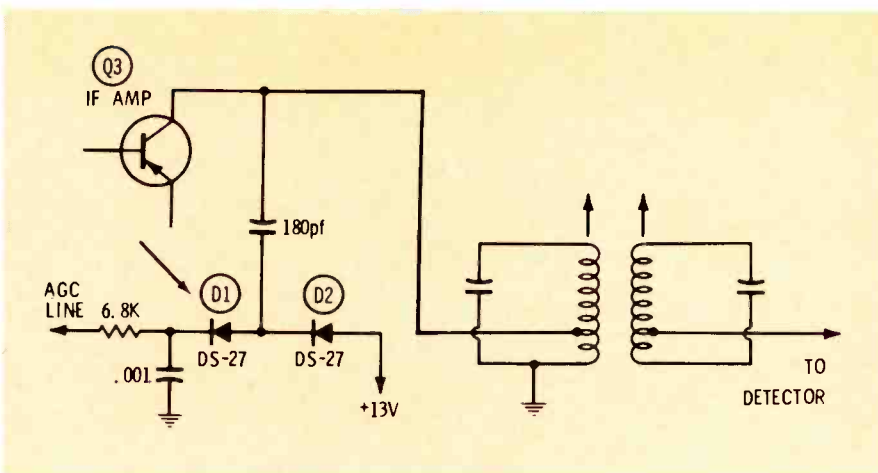
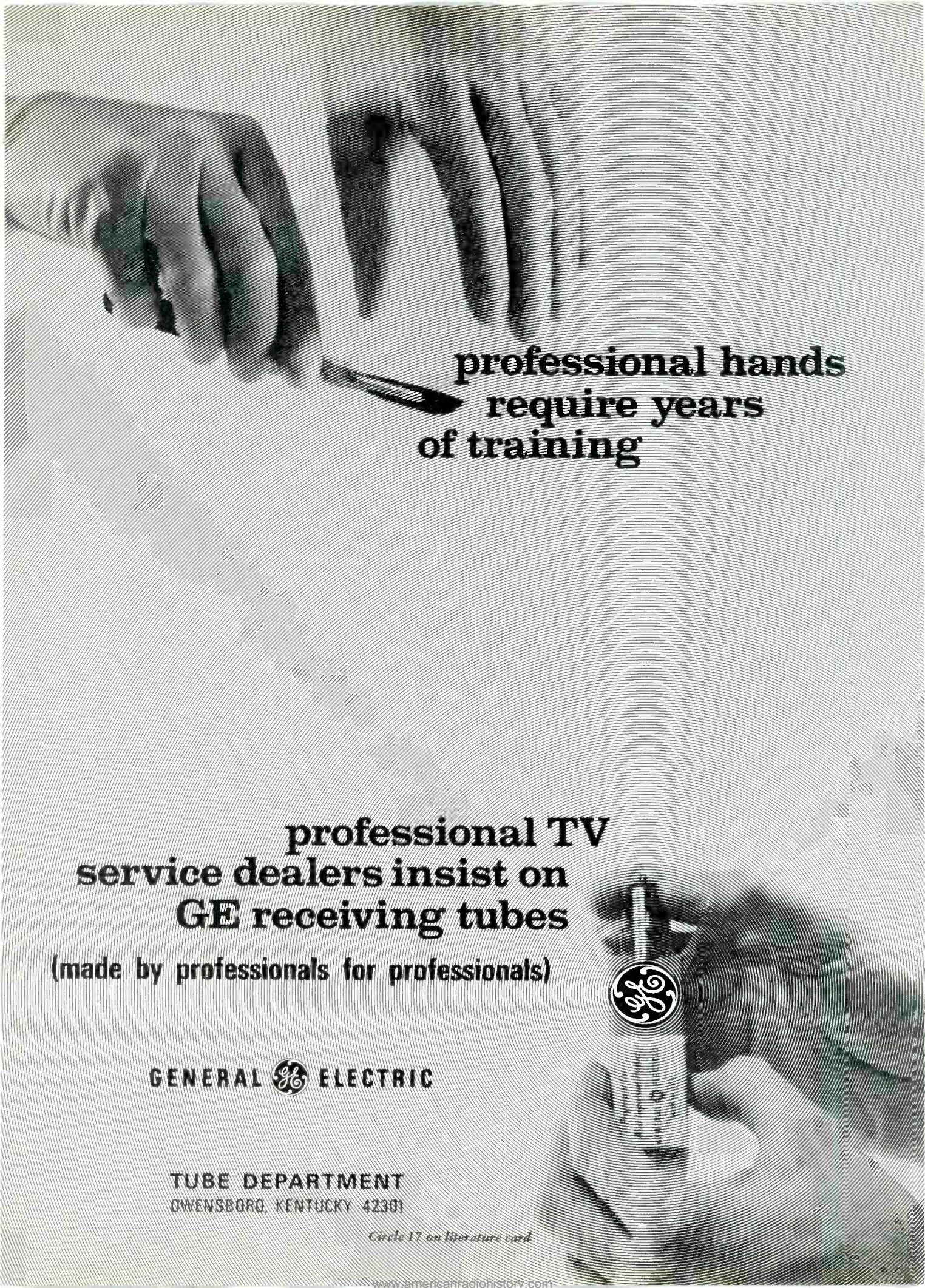


Fig. 5 Shorted AGC diode, D1, caused overamplification of strong signals in Oldsmobile radio, producing "whistling" sound.



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to 1000-mfd unit in one of the audio preamplifier circuits.) Bendix car radios use a capacitor that has been especially noted for this problem. It is a two-section unit: a 50-mfd section and a 500- or 1000-mfd section, both rated at 4 WVDC. If just one section of the capacitor is defective, replace the entire unit. Do not rely on bridging a new single-section electrolytic across the defective section. Many of these capacitors will exhibit some physical sign of failure, such as a cracked plastic case, end cap popped off, or a grayish liquid leaking out of the bottom (see Fig. 3). Any one of these signs is justification for replacement.

Open capacitors are the chief causes of oscillation in the RF, Converter or IF stages. Most car radio circuits use a number of bypass capacitors that are easily capable of causing oscillation should they open. The main electrolytic in the power supply is a major offender in many brands. Since these radios operate from a battery source, this filter is used primarily for decoupling.

The AGC circuit is another common source of oscillations. Besides open AGC bypass capacitors, there is the possibility of a defective diode. This last type of problem usually will cause the set to distort on

strong signals, yet remain clear on weak signals.

Oscillation in the first three stages of a set can cause a similar distortion by overdriving the AGC circuit. In most cases, however, this will distort all stations rather than just the stronger ones, although the distortion usually will be more acute on strong signals.

Other Noises

There are a number of noises that are either not encountered with any degree of regularity or that simply defy classification into one of the areas just covered. Noise associated with "spark plate" capacitors is one example. The incidence of this trouble, in most areas, is so small that many technicians do not know what a spark plate is or does. The spark plate is a capacitor made of two strips of copper foil sandwiched over a paper dielectric. The spark plate usually is soldered right to the radio chassis, connected between the chassis and the power input "A" lead. Occasionally they are connected between the pilot lamp lead and ground or across the speaker leads. In older sets, especially in highly humid areas of the country, corrosion sometimes will be found around the edges of the spark plate, and can cause arcing, if it

doesn't blow the fuse. Usually, only replacement is a sure cure. Radios installed in older Volkswagens often have this problem no matter the make or year of the radio. The cause is a loose windshield washer gasket positioned just above the radio. Have the customer replace the gasket before reinstalling the set; otherwise, you might receive a call-back after the next rainstorm.

The speaker and antenna also are causes of certain types of noise. The usual problem with speakers involves a rattling and/or rubbing voice coil. Car radio speakers take a beating. Because of this fact, it is good to pull the speaker along with the radio, whenever feasible. Unfortunately, the design of some cars makes this uneconomical.

The antenna is the source of at least two common forms of noise. The first is caused by the fact that the radio will pick up an abnormal amount of ignition noise if the braided shield in the lead-in wire is broken, or if it is improperly grounded. The other antenna-related problem is an intermittent, vibration-sensitive static caused by a break in the center conductor of the lead-in wire. Most antenna problems can be isolated by substituting a known-good antenna for a suspected unit.

FM stereo multiplex auto radios, an ever increasing percentage of the auto radio market, will occasionally produce a buzzing sound when tuned to a stereo station. This is caused, in most instances, by misadjustment of the 38-KHz transformer, which feeds the demodulator matrix.

A technician that does any amount of car radio servicing occasionally will encounter a customer who has an engine-noise complaint. This is a topic in itself. Briefly, though, we can state that anything in a car that arcs, sparks, or switches on and off can cause "engine" noise. Every car, whether radio-equipped or not, should have certain basic noise suppression devices. These include a certain type of capacitor that should be connected between the battery terminal of the ignition coil and ground, and either a resistor in the high-tension lead of the ignition coil, or graphite radio suppression wires for all high-tension circuits. The graphite wires seem to be the most effective.

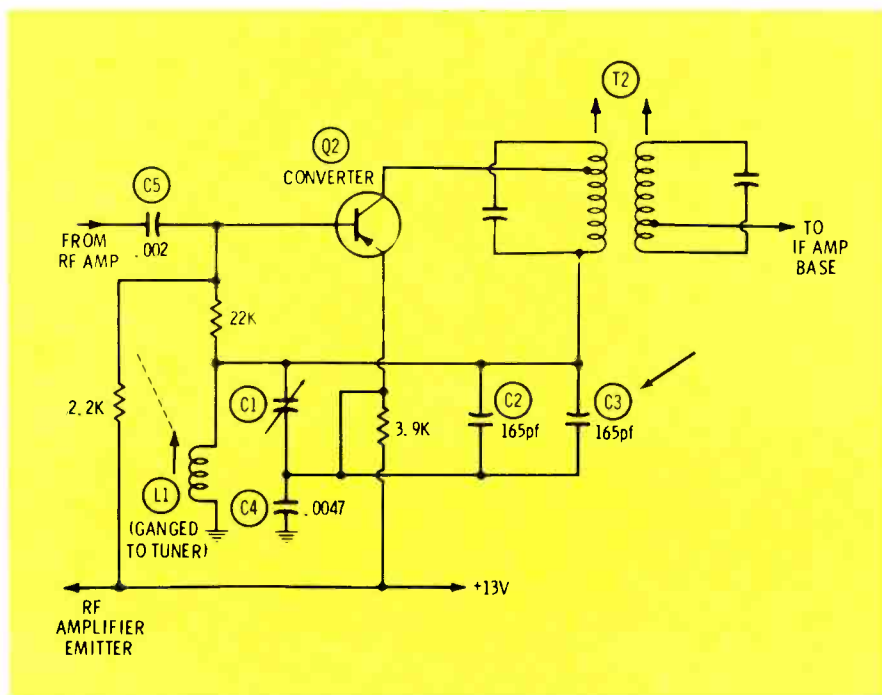


Fig. 6 Defective trimmer C3 in Olds radio caused static.

Casebook of Common Troubles

Following are actual case histories of troubles encountered in car radio shops.

The first case involved a 1967 Volkswagen "factory" radio manufactured by Bendix (Model 7BV) which frequently broke into "motor-boating". When the set was tested on the bench, we noticed that the "A" lead current seemed to be fluctuating between 0 and 1 amp, at about the same rate as the motor-boating. On this type of set, motor-boating is a good indication that the electrolytic decoupling the audio preamplifier stages is defective (C1 in Fig. 4). When a good 1000-mfd capacitor was bridged across the filter, the oscillation stopped. A new capacitor cured the motorboating.

Take another look at the circuit in Fig. 4. When C1 opens, the audio section can function as an RC oscillator. The long time constants of the resistors and capacitors make it a very low-frequency oscillator. The oscillations alternately bias this direct-coupled circuit on and off. This accounts for the fluctuation of "A" lead current.

The second case involved a 1968 Oldsmobile Model 7303143 radio, manufactured by Delco. The problem with this one was two-fold: a static condition and a "whistley whiney" sound. We decided first to eliminate the whistle.

We had noticed that the local stations were distorted when the radio was operated in the car. The weaker stations were comparatively clear. These clues pointed to the AGC section. An ohmmeter, set on the RX100 scale to measure the forward and back resistances of the two AGC diodes, quickly showed that diode D1 (Fig. 5) was shorted completely. A new DS-27 diode solved the "whistling" problem, and allowed us to tackle the static.

The bias-disabling technique discussed earlier was used to localize the source of the static to one stage. The noise seemed to originate in the converter circuit. Disconnecting the capacitors one-by-one pinpointed a 165-pf disc ceramic unit (C3 in Fig. 6) paralleled across the trimmer as the problem. ▲

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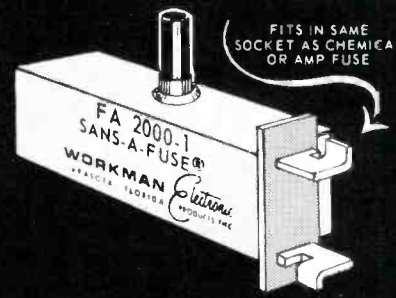


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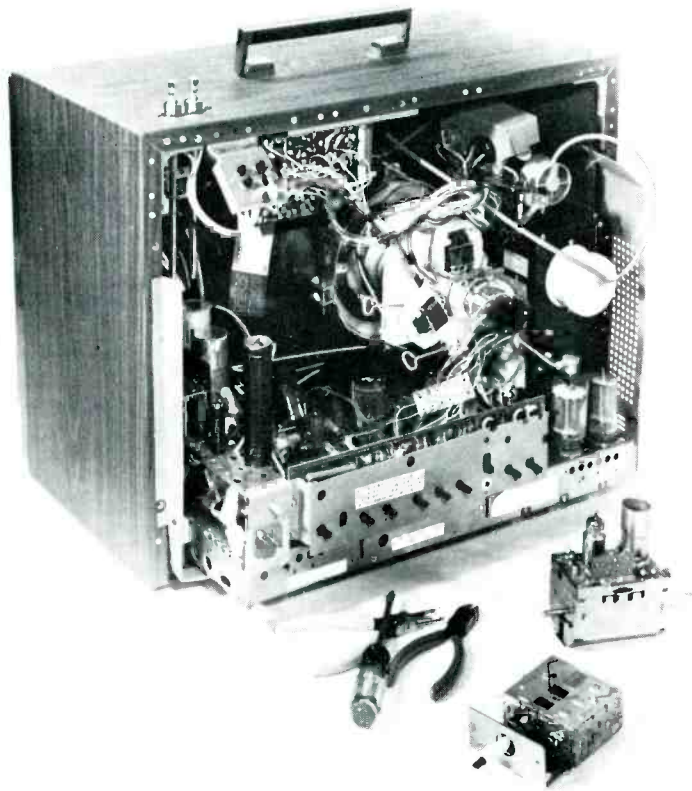
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Primer on PA Systems

Basic facts about designing and installing public-address systems, by Leo G. Sands

Basic Systems

The simplest public address (PA) system consists of a microphone, amplifier and one or more speakers, as illustrated in Fig. 1. If the mike and speakers are in the same room, it is a **sound reinforcement system**. When the amplified sound is delivered to other rooms, as shown in Fig. 2, it is a **paging or sound distribution system**. When there are two or more input signal sources, and sound is distributed on a controlled basis into various rooms, as shown in Fig. 3, it is a **central sound system**. And when two independent sound channels are provided (Fig. 4), with both channels reproduced in the same room, it is a **stereo public address system**.

Audio Power

Monophonic PA amplifiers are available with power output ratings from 5 watts to over 100 watts. When one amplifier is incapable of delivering enough power, booster amplifiers can be added, as shown in Fig. 5.

How much power is required depends upon the dimensions of the room—its acoustics and ambient noise level—the number of people in the room, and the efficiency of the speakers. Often, more power is made available than is required.

Early Western Electric motion picture sound systems, using a 5-watt amplifier and an elephant ear horn speaker with diaphragm type driver, could fill a 500- to 750-seat theater with ample sound.

Radio City Music Hall has an 85-watt, 3-channel stereo PA system. The cubic dimensions of the hall are larger than the combined dimensions of more than 1000 average living rooms. Even when jammed by more than 6000 people, the sound system is more than adequate, in spite of the fact that cone-type dynamic speakers are used.

The public, as well as some in the electronics industry, have become accustomed to hearing about hi-fi

systems rated up to 200 watts output power. However, domestic manufacturers of hi-fi equipment refer to **music power**, which is not real electrical power. If amplifiers manufactured in the U.S. were rated in terms of rms power, as in England, the power output figures would not be as impressive.

There are various ways to estimate audio power requirements for a given room. Some loudspeaker catalogs contain an "audio power estimating guide." But calculations still can be wrong because of misjudgment of acoustics. Perhaps an easier way is to select the type and number of speakers to be used. Then add the power ratings of the speakers to determine maximum permissible power.

Amplifiers

The amplifier should be capable of delivering enough power to drive the speakers at full capacity, but no more. When selecting an amplifier, look at the rms power rating, not the "peak" or "music" power rating. Frequency response should be 40 to 10,000 Hz or better for general purpose use; for "speech only" applications in industrial installations, 300- to 3000-Hz frequency response is adequate.

Amplifier gain, from mike input jack to output terminals, should be approximately 118 dB or better, and at least 85dB for auxiliary inputs. Hum and noise of the mike channels should be no less than about -43dB, preferably better than about -60dB, and better than -66dB for the auxil-

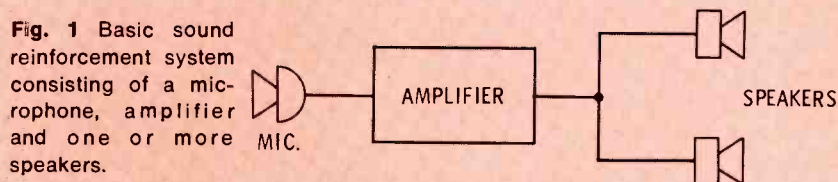


Fig. 1 Basic sound reinforcement system consisting of a microphone, amplifier and one or more speakers.

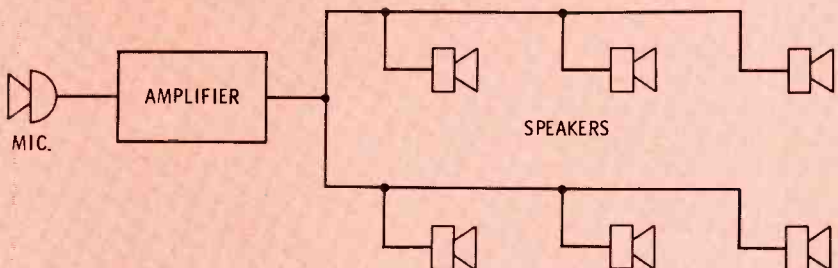


Fig. 2 Paging or sound distribution system delivers sound to other rooms or buildings.



Fig. 3 Block diagram of basic central sound system, which has two or more input signal sources and distributes sound on a controlled basis into various rooms.

ary channels, below the rated output of the amplifier.

There is a wide variety of amplifiers to choose from. Some have several inputs—two or more for microphones, and one or more for auxiliary devices such as a record player or radio tuner. Most are designed to accommodate high-impedance microphones and auxiliary devices, although there are some designed for use with low-impedance input devices.

Each input of the amplifier generally has its own level (volume) control. When designed for use with high-impedance microphones and auxiliary inputs, the level of the input is controlled at high impedance, as illustrated in the simplified schematic in Fig. 6. The levels of the signals from the microphones are controlled with potentiometers at the output of each preamplifier. Preamplifiers are not employed at the auxiliary inputs. Each input is fed to its own triode amplifier. R1, R3, R5 and R7 are isolating resistors, and R2, R4, R6 and R8 are individual plate load resistors for each triode.

Low-impedance mixing is used in broadcast and recording studios and in expensive sound systems. As shown in Fig. 7, step-type attenuators (T, H ladder, etc.) are used for controlling the level of each input. The master level control also is a step-type attenuator.

Both tube and solid-state amplifiers are popular. The big advantages of solid-state amplifiers are lower electric power consumption and less heat generation. Tube-type amplifiers are preferred by many sound installers because they are more familiar with the characteristics and circuitry of tube designs.

Most tube-type PA amplifiers have a push-pull output stage, although some low-power amplifiers use a single-ended 6L6G tube in the output stage.

A simplified schematic of the output stage of a typical tube-type PA amplifier is shown in Fig. 8. It essentially is similar to the output circuit of a hi-fi amplifier.

Fig. 9 shows examples of transistor output stages: A) an auto-transformer for impedance matching; B) a typical push-pull output circuit using an output transformer.

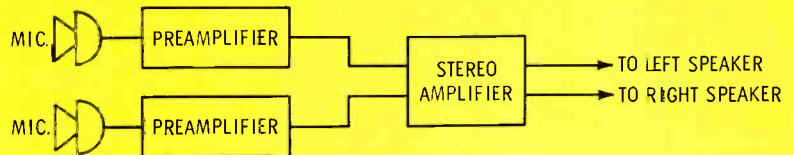


Fig. 4 Stereophonic public address system utilizes two independent sound channels.

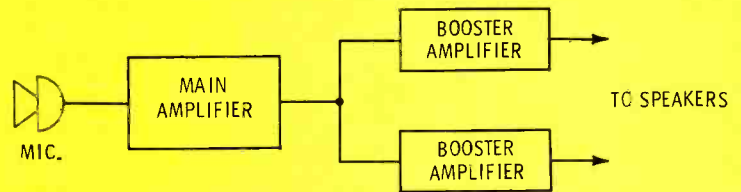


Fig. 5 High-power public address system using booster amplifiers for additional power.

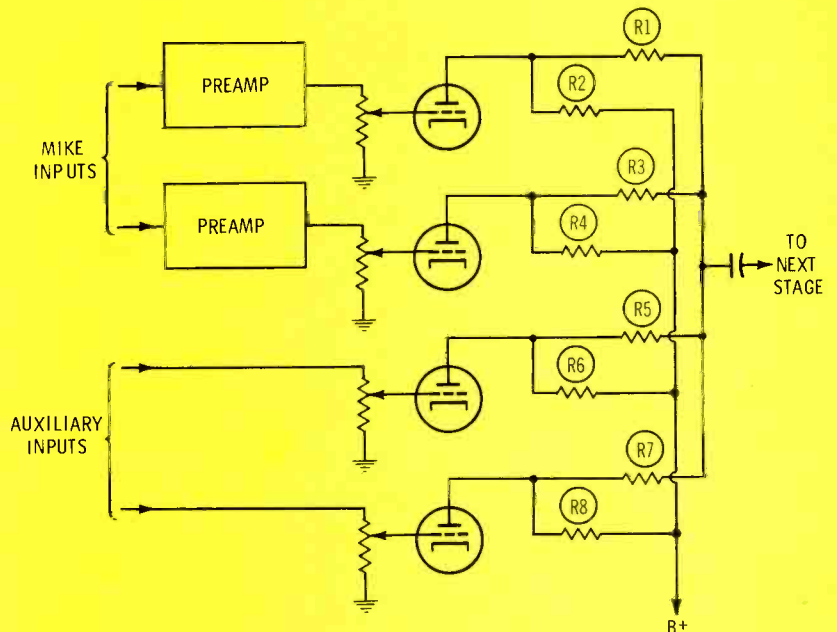


Fig. 6 Potentiometers are employed as level controls in amplifiers designed for use with high-impedance microphones and for amplifiers having auxiliary inputs.

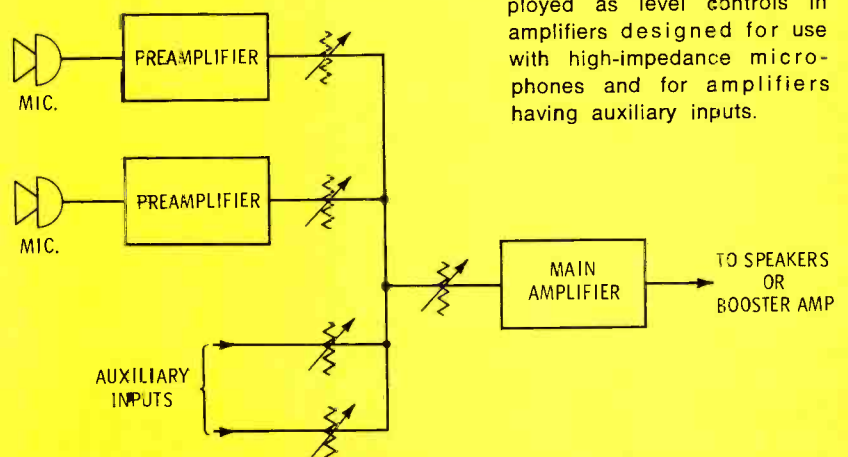


Fig. 7 Step-type attenuators are used to control the input level in PA systems employing low-impedance mixing.

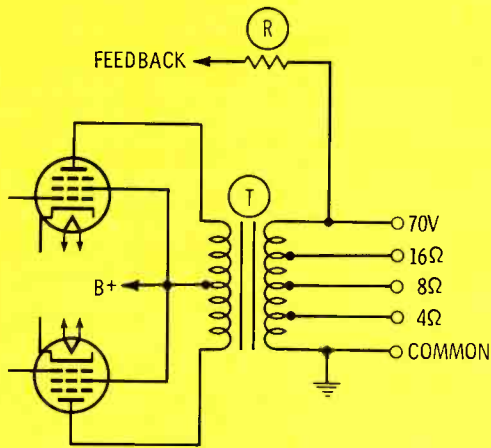


Fig. 8 Output stage of a typical tube-type PA amplifier is similar to that of a hi-fi amplifier.

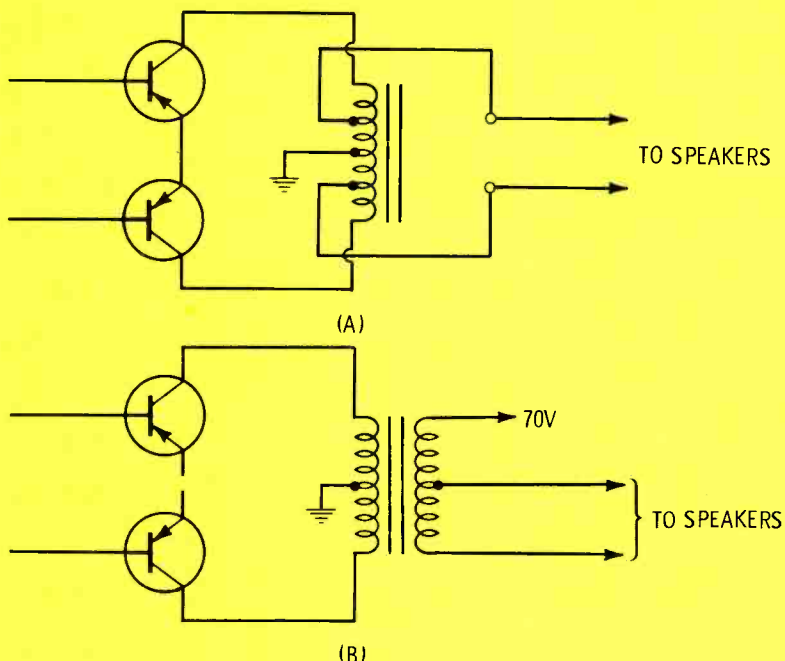


Fig. 9 Typical output stages of solid-state PA amplifiers.
(A) Autotransformer for impedance matching.
(B) Push-pull circuit with conventional output transformer.

Fig. 10 A few PA amplifiers utilize transformerless output stage.

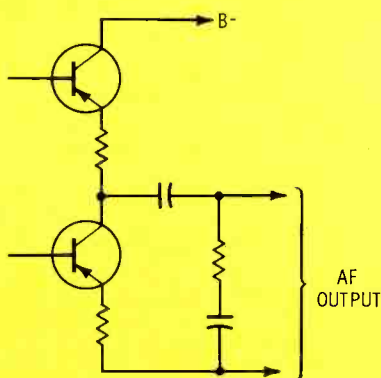
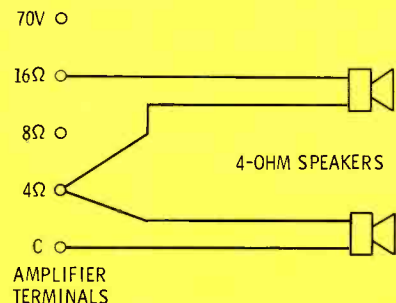


Fig. 11 Method of connecting 4-ohm speakers for independent feed.



Although used mostly in hi-fi amplifiers, the transformerless output circuit shown in Fig. 10 also is used in some PA amplifiers.

How to Connect Speakers

Common arrangements

A PA amplifier typically has 4-, 8- and 16-ohm outputs plus a 70-volt output terminal. Some also have a 2-ohm output plus 25-volt and 115-volt outputs. These multiple outputs provide flexibility. For example, two 4-ohm speakers can be connected in series to the 8-ohm output, or in parallel across the 2-ohm output, or to the 4-ohm and 16-ohm terminals, as shown in Fig. 11.

Four 16-ohm speakers can be paralleled across the 4-ohm output terminals, as shown in Fig. 12. Four 8-ohm speakers can be connected in series-parallel across the 8-ohm terminals, as shown in Fig. 13. The same series-parallel arrangement can be used to feed four 4-ohm speakers from the 4-ohm output, or four 16-ohm speakers from the 16-ohm output.

It also is possible to feed four 4-ohm speakers in series from the 16-ohm output as shown in Fig. 14, but the amplifier could be damaged if one of the speakers is opened.

Four 8-ohm speakers can be fed from the 4-ohm output through Alco "Mix-N-Match" transformers (T1 and T2), as shown in Fig. 15. These transformers are designed to couple audio into two 8-ohm speakers. To feed only two speakers through one transformer, use the same circuit, but connect the transformer primary to the 8-ohm amplifier output terminals.

High-impedance speaker feed

Some amplifiers also have 500-ohm output terminals. A single 8-ohm speaker, for example, can be fed through a 500-ohm to 8-ohm matching transformer. However, the 500-ohm output normally is used for feeding two or more speakers, each equipped with a **line-matching** transformer, as shown in Fig. 16. The line transformers (T1, T2, T3) are tapped so impedances can be matched. When connecting three speakers to the feed line, the matching transformer at each speaker is adjusted to produce a primary impedance of 1500 ohms so that the

three paralleled speakers will present a 500-ohm load to the amplifier. Speakers of different impedances can be paralleled in this manner by selection of the appropriate impedance tap on the primary of the line-matching transformer.

Constant-voltage speaker feed

The impedance-matched, 500-ohm speaker feed system has been made almost obsolete by the constant-voltage speaker feed system, although both achieve the same basic purpose: Speaker feed line current and loss of power in the wires are reduced by feeding audio power to speakers at higher impedance or voltage, instead of at speaker voice coil impedances.

You don't have to be concerned with impedances when you use the constant-voltage feed speaker system. Just think in terms of voltages. The speakers are fed through voltage step-down transformers, as shown in Fig. 17. Three types of transformers are shown. T1 has a tapped primary; voltage fed to the speaker is determined by the ratio of secondary turns to active primary turns. T2 has a tapped secondary; selection of secondary taps determines speaker voltage. T3 is an autotransformer whose voltage ratio can be changed by tap selection.

This system allows individual adjustment of speaker power without affecting the level of other speakers fed by the same amplifier. For example, an 8-ohm speaker can be fed 4 volts so it will consume 2 watts ($W = E^2/Z$). A 4-ohm speaker fed by the same amplifier can be supplied 6.3 volts so it will consume 10 watts. And, a 16-ohm speaker on the same line can be fed 18 volts so it will consume approximately 20 watts. Speakers can be added in the same manner until the total power consumption of all speakers reaches, but does not exceed, the power output capability of the amplifier.

The same technique is used in 25-volt and 115-volt speaker feed systems. The actual amplifier output voltage, obviously, varies with the audio signal. When an amplifier does not have a 70-volt (or 25-volt or 115-volt) output terminal, a step-up transformer can be used to raise the voltage to the speaker line, as shown in Fig. 18. This would be necessary particularly in the case of

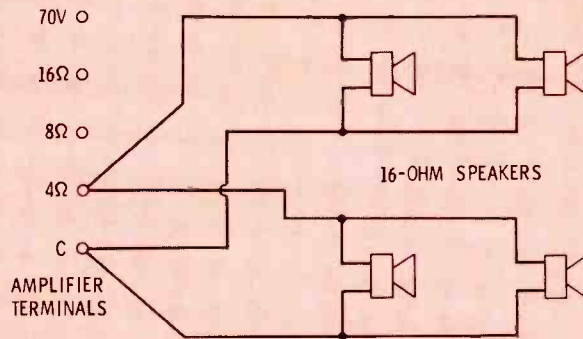


Fig. 12 Four 16-ohm speakers paralleled across 4-ohm output terminals of amplifier.

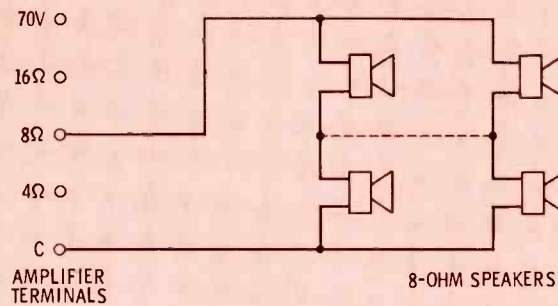


Fig. 13 Series-parallel arrangement of 8-ohm speakers across the 8-ohm output terminals of a PA amplifier.

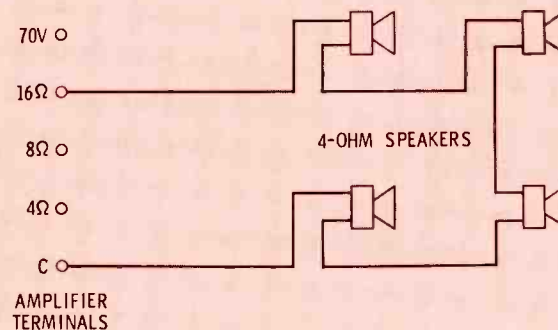


Fig. 14 Four 4-ohm speakers connected in series across 16-ohm output of amplifier. Output stage would be damaged if one of the speakers opens.

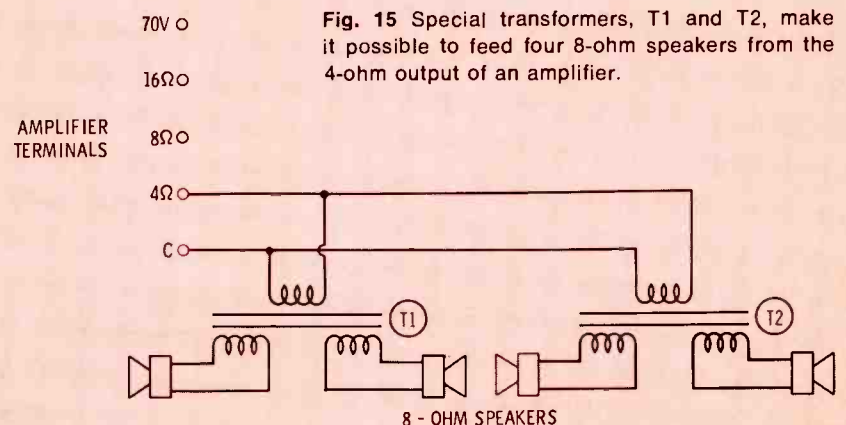


Fig. 15 Special transformers, T1 and T2, make it possible to feed four 8-ohm speakers from the 4-ohm output of an amplifier.

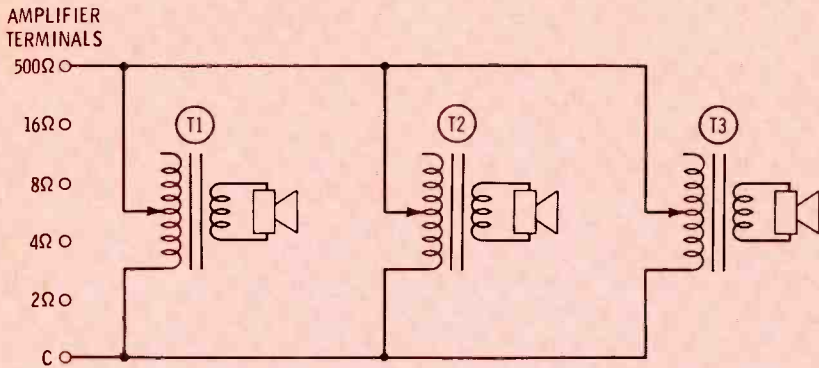


Fig. 16 The 500-ohm output, provided on some amplifiers, normally is used to feed two or more speakers through line-matching transformers, as shown here. Impedance of transformer is varied by positioning primary tap.

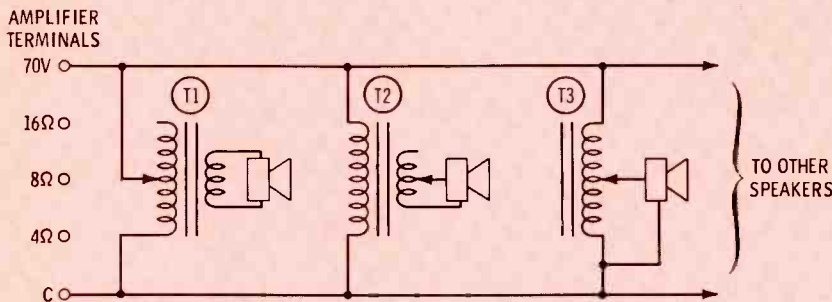


Fig. 17 Constant voltage system of feeding speakers makes it possible to adjust power of individual speakers without affecting the level of other speakers in the system.

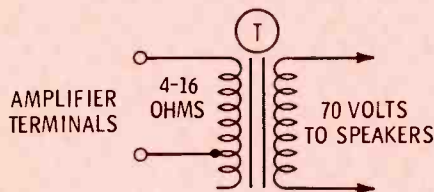


Fig. 18 A step-up transformer can be used to increase the speaker line voltage if the amplifier is not equipped with a 25-, 70- or 115-volt output terminal.

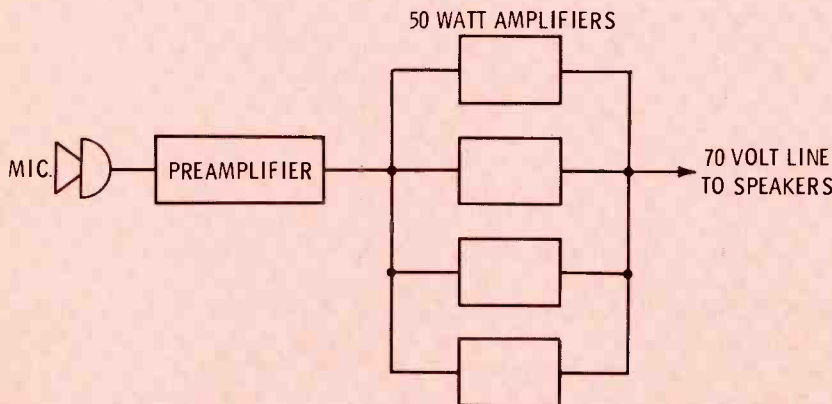


Fig. 19 Additional audio power is obtained by paralleling four 50-watt amplifiers, providing phase shift of signal in all amplifiers is identical.

a solid-state amplifier without an output transformer.

Although the circuits presented here employ a single two-wire line, across which speakers are bridged through transformers, it is common practice to run separate two-wire lines to each speaker transformer, with the lines paralleled at the amplifier output terminals.

Although an amplifier might have 70-volt (and/or 25-volt and/or 115-volt) output terminals, the amplifier might not be designed for true constant-voltage speaker feed. For maximum flexibility, the amplifier should have excellent output voltage regulation. This can be achieved by generous use of negative feedback; some also use AGC. For example, the output voltage of at least one amplifier on the market will not change more than 1.5 dB between the operating extremes of no load and full load. When delivering 70 volts to the speakers, the voltage at the amplifier output terminals will not increase beyond 84 volts when the speaker feed line is opened (no load). An open speaker feed line could cause serious damage to a nonregulated amplifier.

Speaker Types

A wide selection of speakers is available today, ranging from horns of various sizes to cone speakers up to 15 inches in diameter. Fortunately, we no longer have to worry about power for speaker field excitation, now that all employ permanent magnets.

For general purpose indoor use, there is a large selection of woofers, tweeters and wide-range cone speakers and baffles, from slim columnar types to more bulky bass reflex types. The cone types are preferable for indoor use because of their wide frequency response. For outdoor use, the horn types are preferable because they are generally weather-proof and more efficient converters of electrical power into sound power, although they have narrower frequency response than the better cone types.

Booster Amplifiers

When more than 100 watts of audio power is required, a lower-powered main amplifier can be used to drive one or more booster ampli-

fiers, as shown previously in Fig. 5. A typical booster amplifier is rated at 200 watts output, available at 8-ohm, or 25-, 70- or 115-volt taps. It is connected to its driver at high impedance (500,000 ohms), or through a 500/600-ohm transformer.

Another manufacturer produces 50-watt amplifiers which can be **stacked**, with inputs and outputs paralleled, as shown in Fig. 19. It is possible to increase power output to 200 watts in this manner because of the uniform phase shift within the amplifiers.

High vs Low Microphone Impedance

Two basic factors must be considered in judging the desirability of high-impedance compared to low-impedance microphones in specific installations.

First to be considered is the effect of cable capacitance on the high-frequency response. To keep such response at maximum, the cable on high-impedance microphones should not exceed a length of approximately 25 feet. If some reduction of treble can be tolerated (voice only, for example), an extension cable of another 25 feet may be added. One of the most popular types of single-conductor-shielded cable has about 25 pf of capacitance per foot. Consider that 10 feet of such cable would add 250 pf in parallel with the microphone, or 100 feet would add about 2,500 pf, and it becomes clear why long cables affect high-impedance frequency response.

An inductive component is part of any microphone impedance, because a pi-filter network is created in conjunction with the cable capacitance. The frequency response of such a filter is similar to that obtained if the output of an audio generator is connected to a coil (equal in inductance to the microphone transformer secondary) and the other end of the coil is connected to the amplifier input in parallel with the shielded wire of the cable, with the outer shield grounded. A resonant peak is obtained, with a very sharp roll-off above this point. If the cable capacitance is large enough, this peak and treble loss could be in the middle of the desired frequency response and could cause poor

sound quality plus increased acoustic feedback.

Low-impedance circuits, even in shielded cables, are not affected by several hundred yards of cable capacitance, but the performance, including the treble response, depends upon the quality of the line-to-amplifier transformer. Low-impedance microphone systems are more costly because of this extra transformer, even though the microphones are either adaptable to both high or low impedance or can be purchased for the same price in high- or low-impedance versions.

The other primary consideration is hum, buzz or noises which may be injected into the cable part of the system. Two-wire shielded cable used with a low-impedance microphone, especially if used with the circuit methods shown in Figs. 20, 21 or 22, can be far superior to the use of single-wire shielded cable and a high-impedance microphone. However, for this system to be of maximum benefit, the transformers must be of very high quality, with wide frequency response, hum-bucking construction and accurately balanced windings. Even with excellent transformers, it is often desirable to position the transformers carefully to minimize the inductive pickup by the transformers of 60-Hz hum.

Input Circuits

As stated earlier, most PA amplifiers are provided with two or more input connectors. A high-impedance microphone is connected to the amplifier through single-conductor shielded cable, as shown in Fig. 20A. A low-impedance microphone can use the same kind of cable, or a two-conductor shielded cable, as shown in Fig. 20B. The latter is preferred because of its superior hum and noise rejection.

A microphone or other low-level input line can pick up hum if not adequately shielded or if improperly grounded. The shield of a single-conductor microphone or phono cable should be grounded to the amplifier chassis, as shown in Fig. 21A. The microphone housing usually is grounded to the cable shield, but not directly to an earth ground. However, when coaxial cable is used and the microphone output imped-

ance and amplifier input impedance are the same as the cable impedance, the cable shield can be grounded at both ends, as shown in Fig. 21B. The shield of a balanced line (two-wire) is usually grounded to the chassis, as shown in Fig. 21C.

When hum pickup is a problem, a balanced line can be used together with a transformer at each end of the cable, as shown in Fig. 22. Here, it is assumed that a high-impedance microphone is used, and the microphone signals are fed to a high-impedance amplifier input. Transformer T1 steps down the microphone impedance and T2 steps up the impedance to restore voltage to essentially the same level as when the microphone is fed directly to the amplifier through a short single-conductor shielded cable. The windings of the transformers connected to the two-wire shielded cable should have the same impedance. By adjusting potentiometer R, it should be possible to balance out hum pickup.

When it is necessary to have the microphone at a great distance from the amplifier—for example, in another building—a leased telephone circuit can be used. At the microphone location, the microphone is fed to a preamplifier which delivers signals at 0 dBm level into a 600-ohm balanced line. At the amplifier location, the line can be fed directly to the amplifier if it has provisions for 600-ohm telephone line input. Otherwise, the arrangement shown in Fig. 23 can be used.

Here, transformer T has a primary impedance of 600 ohms, and a low-impedance or high-impedance secondary, whichever is necessary to match the amplifier input. R1 is a fixed or variable attenuator which reduces signal level.

To offset variations in signal level, a compandor can be used between the line and the amplifier, as shown in Fig. 24. The compandor output should match the amplifier input. The compandor **compresses** excessively high-level signals and **expands** low-level signals.

Wireless microphones are becoming increasingly popular (Fig. 25) because they allow performers freedom of movement and no cable to worry about. A wireless microphone system consists of a microphone and

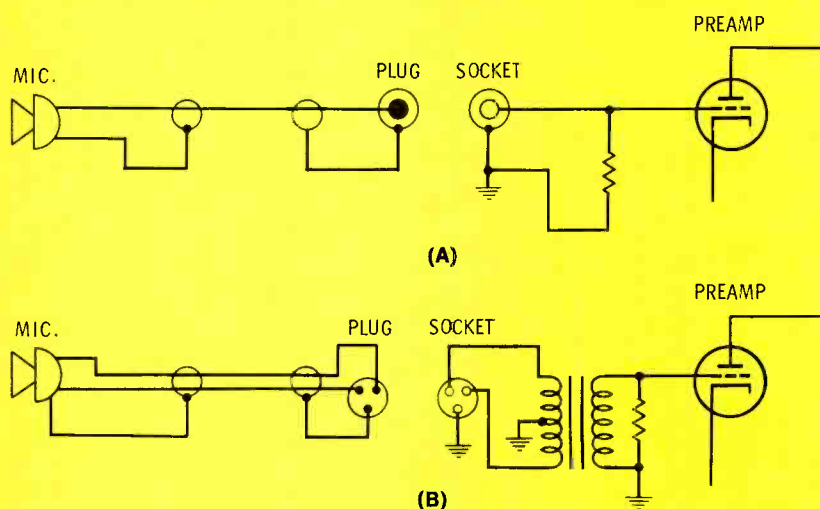


Fig. 20 Microphone connections to input of PA amplifier (A) Single-conductor (unbalanced) shielded cable for high-impedance microphone (B) Two-conductor (balanced) shielded cable for low-impedance microphone.

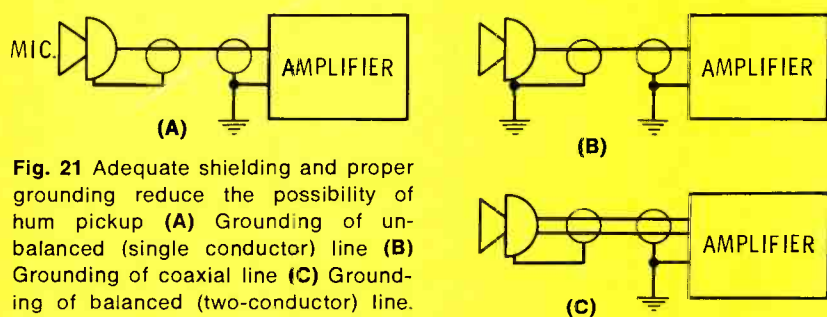


Fig. 21 Adequate shielding and proper grounding reduce the possibility of hum pickup (A) Grounding of unbalanced (single conductor) line (B) Grounding of coaxial line (C) Grounding of balanced (two-conductor) line.

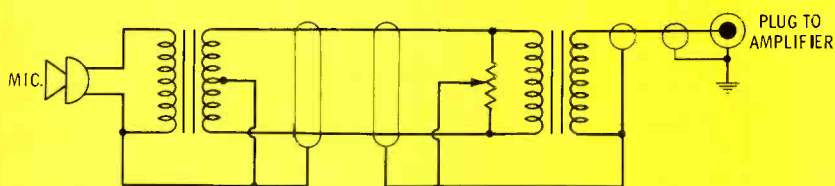


Fig. 22 A balanced line with a transformer at each end can reduce the possibility of hum.

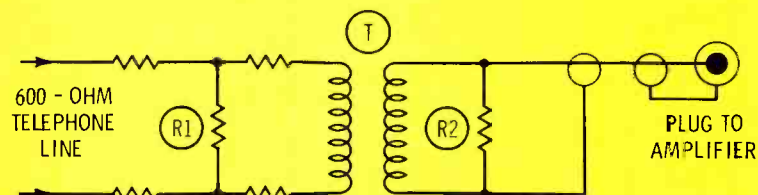


Fig. 23 Setup for using telephone line between microphone and amplifier when amplifier is not equipped with a 600-ohm telephone line input circuit.

a radio transmitter within the microphone housing, and a radio receiver at the amplifier location. Licensed by the FCC, a wireless microphone may be operated on a specifically assigned frequency. Other types may be operated without a license on any frequency in the 10- to 490-KHz, 540- to 1600-KHz, 26.96- to 27.26-MHz, or 88- to 108-MHz bands.

Where an FM radio is used as a background music source for a PA system, as in a restaurant, an 88- to 108-MHz FM wireless microphone can be used to enable cutting off the music program to make a PA announcement without touching the amplifier or tuner controls. The radio is set to receive an FM station and the wireless microphone is tuned to the same frequency. To cut in the mike, it is simply turned on. Its signal "captures" the FM receiver and silences the radio program. This will work only if the FM station's signal is weaker than the wireless microphone's signal.

Regardless of whether a wireless microphone is used in this manner, or on a clear frequency, the output of the associated receiver must be connected to the PA amplifier. If the receiver is a tuner only, its output is connected to an auxiliary input. If it is a complete receiver and has no low-level output, one must be added at the output of the detector. Of course, receivers provided with wireless microphones, as a system, have the proper output terminals.

Acoustic Feedback

Acoustic feedback is an unpleasant, audible sound that is created when the normal sound from the speakers feed back through the microphone into the PA system. The amplitude is increased by the amplifier and is heard by the microphone as it emerges more loudly from the speakers. Again the amplitude is raised by the amplifier and is heard more loudly by the microphone as it is emitted from the speakers, and so on. This regenerative process continues until a loud, single audio tone is heard, which drowns out the desired sound. In borderline cases, there is no continuous tone, but a ringing sound will follow each word or sound coming from the speakers.



Fig. 24 Compandor, installed between line and amplifier, compresses excessive low-level signals to offset variations in signal level.

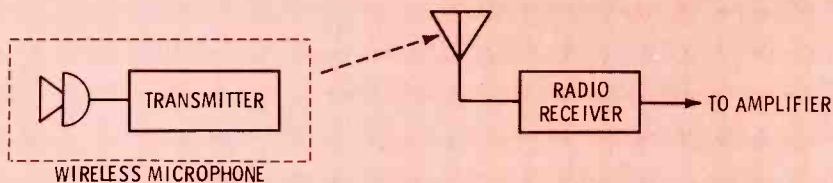


Fig. 25 Basic concept of wireless microphone system. Transmitter is inside microphone housing.

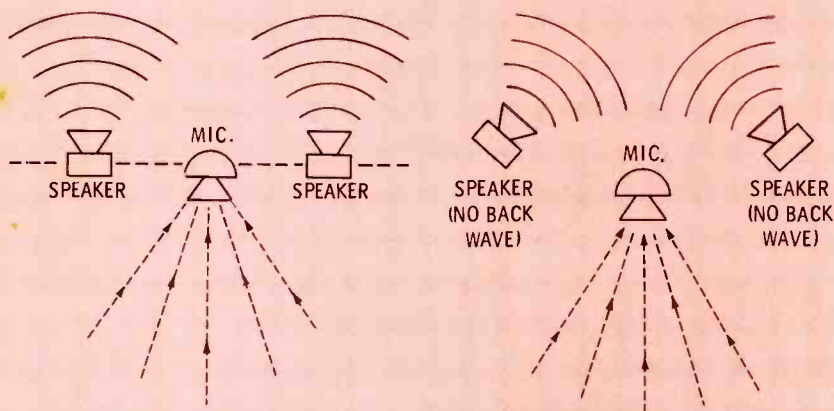


Fig. 26 Positioning of speakers to reduce the possibility of acoustic feedback is important (A) Speakers with some sound radiation from rear should be placed in line with mike and away from walls (B) Speakers with enclosed back or trumpet type should be positioned slightly forward of mike and pointed toward center of room.

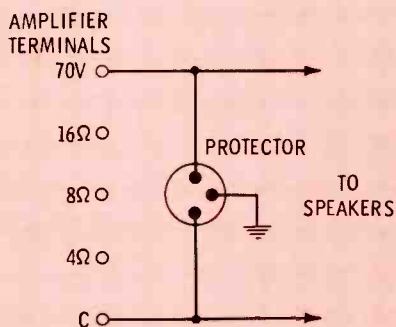


Fig. 27 Three-terminal gas tube can be used on 70- or 115-volt feed lines to protect amplifiers from "open line" defects.

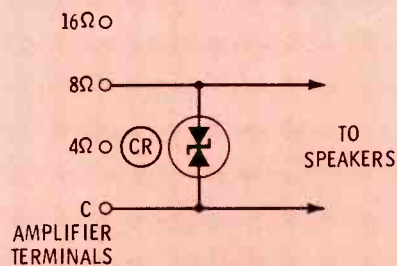


Fig. 28 Dual zener diode can be used to protect an amplifier feeding speakers at low impedance.

This feedback note will be at the frequency which is provided maximum overall gain by the system (electronic plus acoustic).

Two partial solutions will minimize this problem. First, the overall frequency response of the system—including microphone, speakers and acoustics—should be as flat as possible. This is an extensive and complicated subject, but use speakers that have almost flat response throughout their range, then try several types of microphones, and use the one that gives the best volume without feedback. At least, to minimize the feedback, the peaks in the response curves of the microphone and speakers should occur at different frequencies.

Second, the microphone must be prevented from "hearing" too well the sound from the speakers. Here are some suggestions:

- Do NOT point the speakers at the microphone.

- If the speakers have some sound radiation from the rear, they should be placed to the right and left side in line with the microphone, as shown in Fig. 26A, and not too close to a side or front wall, to prevent the rear sound from bouncing back to the microphone.

- If the speakers are trumpet type or have an enclosed back, they should be placed slightly forward of the microphone position (see Fig. 26B) and pointed toward the center rear of the room.

- Use a cardioid or other highly directional microphone which can discriminate between the direct sound and that reflected from the speakers.

- Instruct the singers or announcers to move up within about six inches of the mike if they naturally talk softly, or within about one foot if they normally sing or speak loudly. The smaller the room where sound reinforcement is used, the more important position is.

- Large auditoriums with long reverberation decay times can be covered with less volume and clearer sound if trumpet speakers (which have little low-bass response) are used, or if the bass is attenuated with the amplifier tone controls.

- Do NOT adjust the treble tone control too low in a misguided attempt to reduce acoustic feedback.

More volume and reverberation but reduced clarity of sound will result.

- Identical speaker systems should be used on the left and right. This will make the source of sound appear to originate in the center at the location of the microphone.

- It is tiring for listeners to be forced to strain to hear weak sounds or cringe from deafening ones; adjust the equipment for a reasonable sound level.

Equipment Protection

PA system failures and equipment damage can be avoided or minimized by providing adequate system protection. For one thing, the amplifier chassis should be grounded, and the amplifier should be fused. If it is not, add a fuse. The speaker feed line of a solid-state amplifier should be fused if fuses are not provided in the amplifier itself.

To protect an amplifier delivering 70 or 115 volts to a speaker feed line, if the amplifier is not known to have built-in loss-of-load protection, a three-terminal gas tube protector can be added, as shown in Fig. 27. In case the speaker feed line opens and the amplifier output voltage increases excessively, the gas tube fires and shunts the amplifier output terminals until the load is restored. For this purpose, a T11-300, or equivalent, protector can be used.

A dual zener diode, connected as shown in Fig. 28, can be used to protect an amplifier feeding speakers at low impedance. The zener should avalanche when peak voltage becomes excessive because of loss of load. For example, if the amplifier is rated at 50 watts, the rms output voltage will be 20 volts to an 8-ohm load at full-rated output. A zener that avalanches at 30 volts will protect the amplifier, provided the zener is capable of handling the power.

Conclusion

No other facet of the electronics business is as simple technically as the public address field. All system components are available in grades from marginal to excellent. It is only a matter of correct selection of system components and common-sense installation. ▲

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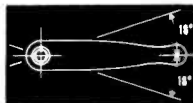
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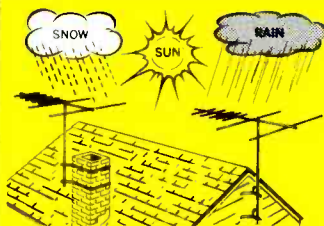


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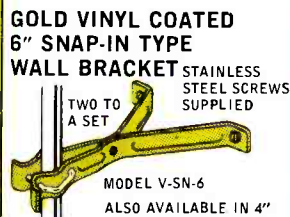
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troubleshooter

Repeated Burnout of B+ Resistor

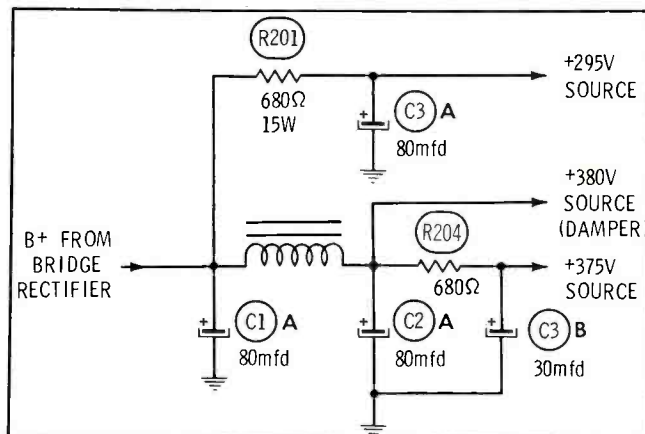
An RCA CTC19A color chassis (PHOTOFACT 823-3) produced sound but no raster. Tests revealed R204 (680 ohms, 1/2 watt) was burned open. This resistor supplies B+ to the horizontal oscillator and audio demodulator.

No short could be found in the B+ circuit; yet, when a new resistor was installed, it burned up just as soon as the high voltage started. Disconnecting the cap of the 6KM6 horizontal output tube stopped the resistor from heating. I increased the wattage rating of R204 to 2 watts, which gave me time enough before burn-out to test and find that C2A was open. A new C2 multiple capacitor cured the problem.

R204 can only heat because of an increase in the current through it. Where is this extra current coming from?

Raymond Richer
Woonsocket, R.I.

The extra current is caused by an AC voltage where none should be. The AC voltage is a horizontal waveform from the damper feeding into the +380-volt



source. It is normally bypassed to a very low amplitude by C2A, but not if this capacitor is open, as in the case you described. C3B acts as a filter of this waveform, but the AC current must go through R204. Or to state it another way, C3B acts as a dead short to the horizontal voltage, so the full AC voltage is across R204 and causes extreme heating.

I have repaired several receivers in which C1A opened. This caused C3A to function as the input capacitor, and the capacitor charging current passed through R201, the 15-watt 680-ohm resistor, and burned it up—about the same as your problem, except the AC was 120 Hz instead of 15,750 Hz.

Hum Bars

A Penncrest Model 2881-87 color TV exhibits 120-Hz hum on the screen during both b-w and color reception. I checked all tubes and the filters in the low-voltage power supply, but have not been able to determine the cause of the hum.

Also, a Philco Model G3050B portable b-w TV has a 2-inch dark horizontal bar that moves from the bottom of the screen to the top. Again, all tubes and filters checked normal.

What could be causing the hum in these two receivers?

R. B. Ulmer
Baton Rouge, La.

There are two common types of interfering horizontal bars that float from bottom to top of a TV screen during reception of a broadcast signal.

One, caused by direct hum modulation of the CRT, is characterized by rounded top and bottom edges. Typical sources of such direct hum modulation are cathode-to-heater leakage in tubes, which causes 60-Hz (one bar) hum, and a defective decoupling capacitor in the B+ source of a tube or a defective low-voltage power supply filter, both of which can cause either 60-Hz or 120-Hz (two bars) hum, depending on the exact defect and whether the rectifier circuit is half wave or full wave. If the source is in the video amplifier stages, the hum bar can be seen on a blank as well as active channel. However, if it originates in the IF or tuner, no bar will be visible unless the set is receiving a broadcast or test signal through the tuner.

The other common type of hum bar is caused by radiation of the silicon rectifiers in the receiver, and is characterized by well defined top and bottom edges and relatively even shading between. The radiation

usually is picked up by the antenna or antenna lead-in, and, consequently, the resultant bar can be seen only when the receiver is tuned to an active channel. Since such radiation amplitude-modulates the received signal, the horizontal bar usually will be significantly lighter or darker than the rest of the screen. The effect is more noticeable during reception of weak signals.

Hum-type interference caused by radiation of silicon rectifiers can be eliminated by shunting one or both silicon rectifiers with .001-mfd ceramic capacitors, or by placing a .05-mfd capacitor across the 120-volt AC input. Twisting the antenna lead-in wire and dressing it away from the power supply components, or using an outside antenna instead of rabbit ears also can help reduce the possibility and/or effects of such interference.

Recurring Failure of Detector Diode

The video detector in a General Electric MXT chassis must be replaced every 4 to 6 weeks. Can you offer any suggestions for curing this problem?

Alvin Jeffery
Bensonville, Ill.

It is likely an intermittent screen-to-grid short in the video tube is destroying the diodes. From our experience with other brands and models, we suggest you replace the 6AF11 video tube the next time you replace the diode. ▲

TeleMatic NEW LOOK

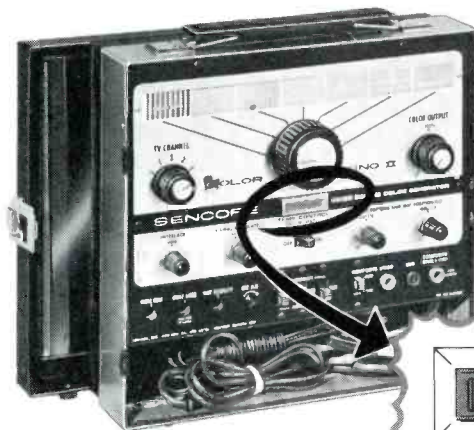
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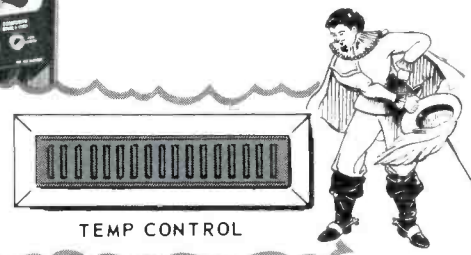
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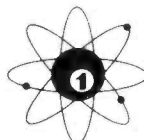


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audio systems report

Compact Hi-Fi Speakers

The availability of a new compact-sized, all-weather high-fidelity speaker has been announced by the Magitran Company, division of the ERA Corp.

The mini-Poly-Sonic uses Magitran's Poly-Planar loudspeaker for



the acoustical driver. It measures 6 in. X 10 in. X 1 3/8 in. and weighs 1 lb. Its power rating is 5 watts and

it has a frequency range of 70 Hz to 20 KHz.

Each unit comes with attachable legs, mounting hardware and audio wire, and sells for under \$15.00.

Circle 55 on literature card

"Packaged" Sound Systems

Four new pre-engineered, packaged sound systems, designed for use in industrial, institutional and outdoor high-noise areas, have been announced by Bell P/A Products Corp.

The "Simple Sound Systems", designed for direct user application, cover areas from 30,000 to 90,000 sq. ft., or reach crowds of up to 25,000 persons. The group of four systems includes two standard (75- and 110-watt) and two solid-state (90- and 200-watt) systems. Each system consists of a microphone, amplifier, and a sufficient number of weatherproof horn-type speakers to cover the prescribed area and audience ranges.

The amplifiers are provided with various inputs for the attachment of tape deck or record player, microphone or tuner. All microphones



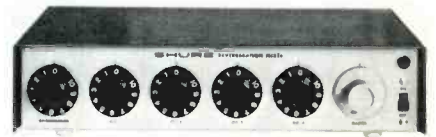
are equipped with touch-talk press bar and locking features. All four systems are pre-wired, with components pre-matched, and include lengths of cable. Installation reportedly is easy and quick.

List prices range from \$420.00 for the "Standard 75" 75-watt system with four speakers to \$775.00 for the "Deluxe 200" 200-watt system with six speakers.

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Four-Channel Microphone Mixer

A new microphone mixer with adjustable, built-in reverberation has been announced by Shure Brothers, Inc.



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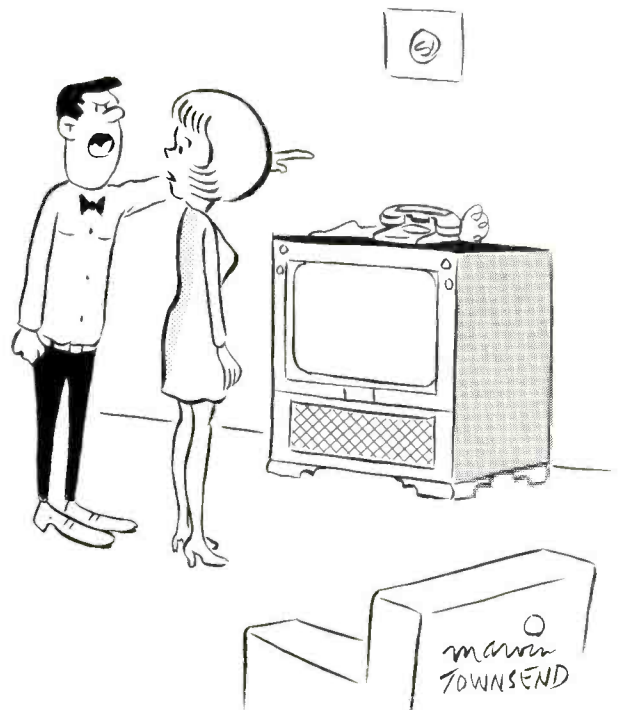


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Other features include a jack that accepts a remote on/off switch, female Cannon-type connectors on all four microphone inputs, and a facility for "stacking" two or more mixers to obtain additional input capacitance.

Battery power supply, output cable kit, locking panel, phono pre-amplifier, rack panel kit and stacking kit are available as optional accessories.

List price is \$180.00.

Circle 57 on literature card

Phone "Extension"

A new device which allows two persons to listen in on a phone call has been introduced by Robins Industries Corp.

"Twinfone" has no moving parts and requires no batteries or electricity. One end of the device slips over the telephone earpiece, while an ample length of tubing carries the sound to the device's earpiece,



permitting a second person to take part in the conversation. The device also can be used by the hard-of-hearing, who can use both earpieces at the same time to "amplify" the sound. "Twinfone" reportedly can be kept on the phone when not in use without interfering with cradling the receiver, and can be removed or replaced easily.

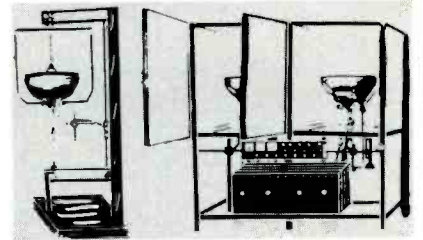
The list price is \$4.98. ▲

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productreport

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

Service Extensions

A complete line of Molex service extensions has been introduced by the Telematic Division of the U.X.L. Corp.

These service extensions are designed to speed servicing of TV



sets, high-fidelity equipment and appliances equipped with Molex interconnectors. All Telematic Molex service extensions are 36 in. long, and are available in 15-, 9-, 6-, 3-, 2-, and 1-contact configurations.

The prices range from \$5.80 for the 15-contact cable to \$.50 for the 1-contact cable. A kit, containing four popular cables, costs \$9.95.

Circle 60 on literature card

"Work Holders"

A complete system of "work holding" precision tools is announced by PANAVISE Division of Colbert Industries.

The system consists of: four dimensionally related bases, with compound rotation and tilt action; seven types of adjustable workholder vise heads and attachments



with variations; and three "up and down" universal positioner assemblies.

Shown here is the Model 380 "vacuum base" (\$15.95) and the Model 315 circuit board holder (\$14.95) with 10-in. cross bar. Prices of other bases and attachments range from \$1.50 to \$22.95.

Circle 61 on literature card

Statement-Ledger System

New England Business Service, Inc. has made available a simple "ONE-WRITE" statement-ledger system. This system, useful to many types of businesses who need to keep accurate records of all transactions, consists of the customer's statement folded over the account ledger card. Entries made either daily or weekly on the statement automatically appear on the ledger card by use of NCR carbonless paper. When bills are due, the stub is removed and the statement is ready to mail.

The NCR statement forms range in price from \$9.95 for 250 statements to \$75.00 for 4000. The



NCR ledger forms range from \$5.95 for 100 to \$29.95 for 1000. The statement-ledger posting files sell for \$21.95 each and the index guides are priced at \$3.95 per set.

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Soldering Iron

A lightweight, balanced soldering iron suited for radio and TV repairmen and light industrial applications is made by Ersa of Germany and is now being distributed in the U.S. by Edsyn Inc.

The weight of this soldering iron reportedly is less than 5 oz. including the line cord. An added feature



is the long life tip which, according to the manufacturer, requires no filing or shaping during its life.

The Ersa 30 is available in either 30- or 40-watt sizes and sells for \$5.75.

Circle 63 on literature card

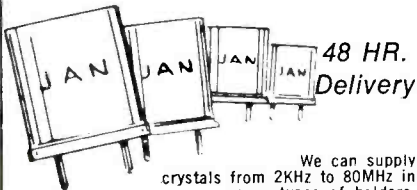
Line Protector

Damage to electronic equipment resulting from high line-voltage surges reportedly is prevented by Telecommunications Industries' Model 300 Protectors.

Equipped with a gas tube, the



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Any CB crystal, TR. or REC. except synthesizer crystals	\$2.25
Any amateur band crystal (except 80 & 160 meters)	\$1.50 or in FT-243 holders
	4 for \$5.00
Any marine frequency (HC6/U)	\$2.85
80 meter—FT243 holders	\$2.50

We have in stock over six million crystals which include types CR1A/AR, FT243, FT241, MC7, FT249, HC6/U, HC13/U, HC25/U, HC18/U, etc. Send 10¢ for our 1970 catalog with oscillator circuits, listing thousands of frequencies in stock for immediate delivery. (Add 10¢ per crystal to above prices for shipment 1st class mail, 15¢ each for air mail.)



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Circle 38 on literature card

units operate in less than one microsecond, withstand repeated high surge currents, do not introduce noise into the line they protect, are available in either single or multiple arrangements, operate thousands of times without requiring replacement, and are designed for indoor or outdoor mounting, according to the manufacturer.

In the event of a sustained over-voltage condition, a fusible spacer actuates a shorting bar in the unit and permanently connects to ground both sides of the line.

The 1-pair unit is priced at \$8.50 for quantities of 1-99; the 2-pair unit is priced at \$15.00 for quantities of 1-99.

Circle 64 on literature card

Auto Alarm System

A device intended to scare off would-be thieves of automobile accessories has been introduced by Regency Electronics, Inc.

The device, designated the "Squealer", sounds the automobile horn at the rate of 1/2 second on/1/2 second off, if a thief attempts to remove any electronics accessory to which it is attached.

The alarm reportedly will operate on any automotive product

Stop Thievery of Auto Electronics
\$9.95

"The Squealer"
frantically sounds your horn if a thief attempts to steal accessories from your auto.

Easy to install yourself!
Operates on any car with horn relay
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Stop that thief from taking...
Tape Deck
AM/FM
Citizens Band
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Regency ELECTRONICS, INC. Indianapolis, Indiana MADE IN U.S.A.

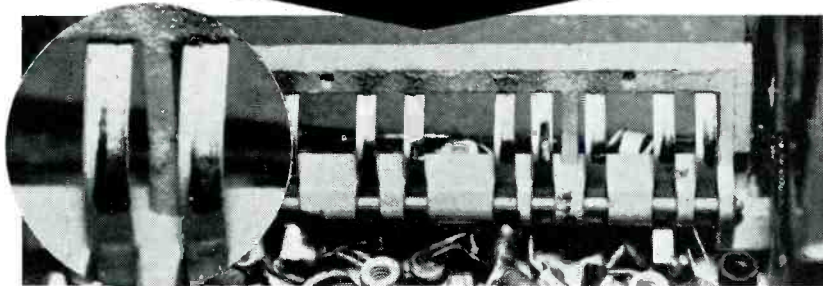
equipped with a 6- or 12-volt battery and horn relay. The unit is installed by connecting one wire to each side of the horn relay and a third insulated wire to the accessory on the auto's interior.

Price is \$9.95.

Circle 65 on literature card

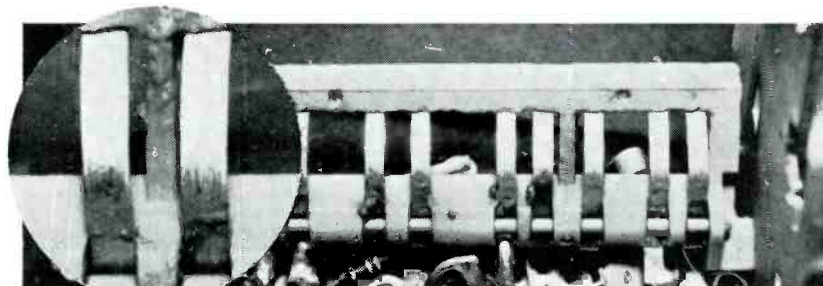
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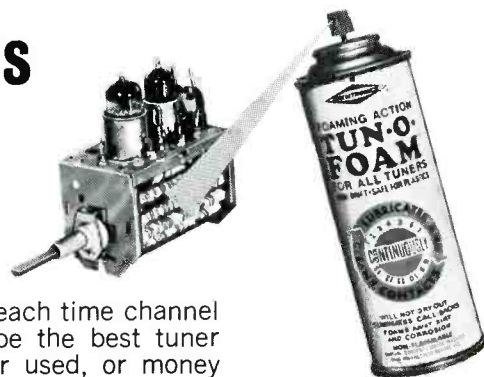


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Circle 45 on literature card

ANTENNAS

100. *Telrex Communication Engineering Laboratories* — has announced the availability of Catalog PL70, which describes Telrex's new "Challenger" line of

communication antenna systems, as well as other Telrex systems.

101. *Vikoa, Inc.* — has released an illustrated, 63-page catalog featuring wire, cable and electronic products for internal distribution system uses and needs. This IDS/MATV equipment catalog includes a "thumb-thru" index as well as a complete alpha-numerical index.

AUDIO

102. *University Sound, Div. of LTV Ling Altec*—has issued a 1970 comprehensive PA systems catalog covering their complete line of audio products.

SERVICE AIDS

103. *Mueller Electric Co.*—has made available an illustrated, 8-page Catalog No. 350, which gives complete specifications for their line of electric clips and insulators.

TECHNICAL PUBLICATIONS

104. *Howard W. Sams & Co., Inc.*—Literature describes popular and informative publications on radio and TV servicing, communication, audio, hi-fi and industrial electronics, including 1970 catalog of technical books on every phase of electronics.*

TEST EQUIPMENT

105. *Sencore, Inc.*—has issued its 12-page 1970 catalog, Form No. 517, which describes the company's complete line of test instruments and features 5 new instruments, with performance data and prices included.*

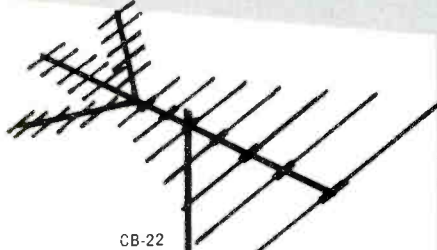
TOOLS

106. *Upson Tools, Inc.*—has released Catalog No. 171, which describes 44 new tools manufactured by the company, as well as containing conversion tables applicable to the hand tool industry.

*Check "Index to Advertisers" for additional information. ▲

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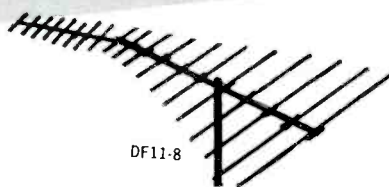
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Durable all-aluminum weather proof construction for long installation life!



CB-22

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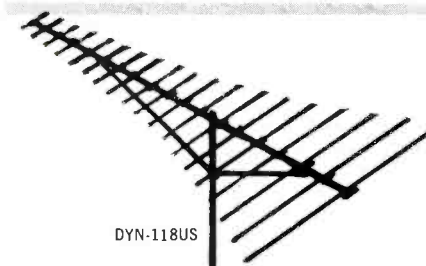
Model	Number of elements			Range of Reception	
	VHF	UHF	Total	VHF up to	UHF up to
CB-22	7	5	10	22	50 miles
CB-28	11	7	10	28	60 miles
CB-34	15	9	10	34	80 miles



DF11-8

DIRECTION-FINDER SERIES

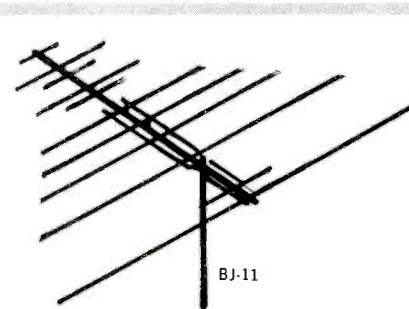
Model	Number of elements			Range of Reception	
	VHF	UHF	Total	VHF up to	UHF up to
DF3-3	3	3	6	30 miles	20 miles
DF5-4	5	4	9	45 miles	40 miles
DF7-8	7	8	15	50 miles	75 miles
DF7-11	7	11	18	50 miles	100 miles
DF11-8	11	8	19	75 miles	75 miles
DF11-11	11	11	22	75 miles	100 miles
DF15-8	15	8	23	100 miles	75 miles
DF15-11	15	11	26	100 miles	100 miles
DF19-8	19	8	27	125 miles	75 miles
DF19-11	19	11	30	125 miles	100 miles



DYN-118US

DYNERGY SERIES

Model	Number of elements			Range of Reception	
	VHF	UHF	Total	VHF up to	UHF up to
DYN-33US	3	3	6	35 miles	20 miles
DYN-54US	5	4	9	60 miles	30 miles
DYN-66US	6	6	12	65 miles	50 miles
DYN-88US	8	8	16	125 miles	75 miles
DYN-118US	11	8	19	125 miles	75 miles
DYN-158US	15	8	23	150 miles	75 miles



BJ-11

BIG SHOT JR. SERIES

Model	Number of elements	Area Used
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BJ-11	11	Metropolitan and Suburban
BJ-12	12	Semi-Fringe

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