MARCH, 1970 ☐ 75 cents

A HOWARD W. SAMS PUBLICATION

Electronic Servicing

Formerly PF Reporter

Using the scope to...

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 for full details of this EICO 5-year GUARANTEE on factory-assembled instruments.)

Additional advanced features include: new functional design, new color-coordinated esthetics, new PC construction, new easier-to-build kit designs.

New EICO Solid-State Test Equipment

240 379 242 150 330

EICO 240 Solid-State FET-VOM $59.95 kit, $79.95 wired.
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 MΩ. Response 25 Hz to 2 MHz (to 250 MHz with optional RF probe). Ohmmeter reads 0.2 to 1 MΩ in 7 ranges. 4½" 200 μA movement. HWD: 8½", 5¾", 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 6½" 200 μA meter movement.

EICO 150 Solid-State Signal Tracer $49.95 kit, $69.95 wired.
Multi-purpose troubleshooter for TV/FM/AM & Audio Equipment. Independent RF Audio inputs. Speaker and meter output indicators. 400 mW continuous power output. Substitution amplifier, output transformer, speaker. Input for rated output: 1 mV RF, 63 mV audio. Hum 60 dB below 400 mW, 105-132 VAC, 50/60 Hz, 5VA. HWD: 7½", 8½", 5". 6 lbs.

EICO 330 Solid-State RF Signal Generator. $59.95 kit, $84.50 wired.
5 fundamental bands 100 kHz to 54 MHz. Vernier control 0-100%. Output 300,000 μV into 50-Ohm load. External signal modulation or internal 400 Hz, 0 to 100%. 105-132 VAC, 50/60 Hz, 1.7 VA. HWD: 7½", 8½", 5". 5 lbs.

EICO 379 Solid-State Sine/Square Wave Generator. $69.95 kit, $94.50 wired.
5 sine wave and 4 square wave bands. Low distortion Sultzer feedback FET circuit. Sine: 20 Hz to 2 MHz; 0-7.5V rms into hi-Z, 0-6.5V into 600 ohms Max. distortion 0.25%. Square: 20 Hz to 200 kHz; 0-10V p-p into hi-Z, pos. direction, zero ground. Rise time at 20 kHz less than 0.1 μ sec. 105-132 VAC, 50/60 Hz, 10VA. HWD: 7½", 8½", 8½". 9 lbs.

New EICO High Performance Instruments

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EICO 465 — Wideband Vectorscope/Oscilloscope $179.95 Kit, $249.95 Wired.
EICO 1025 — Solid-State Power Supply $79.95 Kit, $119.95 Wired.
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.

New EICO Probes for the Pros

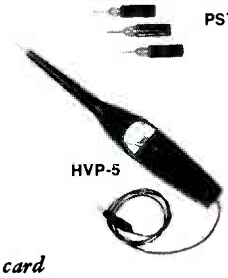
Hi-Voltage Probe HVP-5, Wired $19.95.
Convenient built-in voltmeter. Barrier sections isolate HV tip from handle and meter. Measures up to 30 KV. Lightweight, compact.

Solid-State Signal Injector Probe PSI-1, Kit $5.95, Wired $9.95.
Pen-size, 1-ounce, self-powered signal generator. Frequency range from 1kHz to 30MHz, with harmonics. Clip it to your pocket — ideal for signal tracing in the field.

Solid-State Signal Tracer Probe PST-2, Kit $19.95, Wired $29.95.
Flashlight-size, 2.2oz, self-powered. Hi-gain amplifier, 50Hz to 200MHz with demod tip. Input Z: 3500Ω, 35KΩ, 350KΩ; Output: 0.3 p-p volts. Noise −45dB. Distortion <5%. Complete with earphone, all probe tips, AA battery, pocket clip.

PST-2

PSI-1



HVP-5

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283 Malta Street, Brooklyn, N.Y. 11207
EICO Canada Ltd.
20 Millwick Drive, Weston, Ontario

Circle 1 on literature card

Who said B & K couldn't improve the only complete Television Analyst?

Now there is a new model... the 1077-B, with solid state sweep drive.

The B & K Television Analyst has become standard equipment in repair shops everywhere. And for good reason. It's the quickest, simplest way to test every stage of any TV.

But even classic instruments have to keep up with the times.

That's why we've added a solid state sweep drive in our latest model. It can check any new transistorized color set on the market today.

It's so easy, too. Because the unique B & K signal substitution technique eliminates the need for external scopes or wave-form interpretation.

Whether it's tubes or transistors, VHF or UHF, simply inject the appropriate test pattern or any other known signal. The new Model 1077-B, with its exclusive flying spot scanner, checks everything from the antenna terminals to the input of the picture tube.

Ask your distributor about the new Television Analyst. Only B & K makes it. And now B & K makes it even better.

Model 1077-B $389.95

B&K

Product of DYNASCAN CORPORATION
1801 W. Belle Plaine, Chicago, Illinois 60613

Circle 3 on literature card

March, 1970 • Volume 20, No. 3

Electronic Servicing

Formerly PF Reporter

this issue...

DEPARTMENTS

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ABP

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Robert E. Hertel, Publisher

Intertec Publishing Corp.
Subsidiary of Howard W. Sams & Co., Inc.

The BUSS HTA fuseholder measures only 1-25/32 inches in overall length and extends behind the face of the panel only one inch.

The holder features the popular bayonet type knob. A strong coil spring inside the knob assures good contact when the fuse is inserted into the holder. If a test hole in the knob is needed, a breakaway hole can be punched out to allow use of a test probe.

Rugged in construction to withstand vibration and shock, the HTA fuseholder can also be furnished with a special washer to make it drip-proof from the front of the panel. And the best feature of the HTA fuseholder is that it has *famous built-in BUSS quality*. You can't get it anywhere else.

For more information on the HTA fuseholder, or anything else in the complete line of BUSS small dimension fuses, fuseblocks, and fuseholders, write for BUSS Bulletin SFB.

Circle 4 on literature card

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ATLAS ELECTRONICS LIMITED
50 Wingold Ave., Toronto 19, Ontario

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St. Louis, Mo. 63107

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electronic scanner

news of the industry

TV X-Radiation Limits Set

The maximum amount of X-radiation emitted by b-w and color TV receivers manufactured after January 15, 1970 must be limited to .5 milliroetgen per hour measured at a distance of 5 centimeters from any point on the outside of the receiver, according to standards and regulations established by the Environmental Control Commission of the U.S. Department of Health, Education and Welfare.

Every receiver manufactured after January 15, 1970 must carry a label or tag certifying that the set meets the new X-radiation standard.

The new regulations also state that:

- Sets manufactured after January 15, 1970 must not exceed the established X-radiation limit even if the user adjusts the outside controls in a way that increases the capacity of the set to produce X-radiation.
- Sets manufactured after June 1, 1970 must not exceed the limit even though both external and internal controls have been misadjusted in a way that increases the amount of X-radiation emission.
- Sets manufactured after June 1, 1971 must not exceed the limits even if both internal and external controls are misadjusted and a component or circuit failure increases the ability of the set to produce X-radiation.

The regulations further require that the allowable amount of X-radiation not be exceeded even if the line voltage supplied to the set increases up to 130 volts.

Technician License Bill Filed in New York State

A bill to license both radio and television service technicians has been filed in the New York State legislature.

Requirements for application for a license, under the terms of the bill, are:

- at least 18 years of age
- good moral character
- a minimum of six months experience in the repair and maintenance of radio and TV, or has successfully completed a course of study in the repair and maintenance of radio and TV which has been approved by the advisory board of examiners.

After January 1, 1971, 18 months of experience would be required. Six months of credit toward the experience requirement would be allowed for those successfully completing a course of study approved by the advisory board.

NEA Shops Asked to Survey TV Fires and Smoke

Service shops belonging to the National Electronic Associations (NEA) have been requested by the National Commission on Product Safety to conduct a continuing survey to report incidents of fires or smoke originating in TV sets.

The reason for the NEA survey, according to Richard Glass, executive vice president of NEA, is because

9\underline{75}$

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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 are charged at cost.

24 hour service at our conveniently located service centers.

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

All tuners are cleaned inside and out, repaired, realigned and air tested.

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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
UHF Plug In
Universal Mounting
Hi-Gain Lo-Noise

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.

TSC

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(Home Office)

EAST . . . . 547-49 TONNELE AVE., Jersey City, New Jersey . . . . . TEL: 201-792-3730

SOUTH-EAST . . 938 GORDON ST., S. W., Atlanta, Georgia . . . . TEL: 404-758-2232

WEST . . . . SARKES TARZIAN, Inc. *TUNER SERVICE DIVISION*
10654 MAGNOLIA BLVD., North Hollywood, California . . . TEL: 213-769-2720

Circle 6 on literature card

the Commission on Product Safety is convinced that many fires and other incidents evolving from unsafe product designs are never reported to the manufacturer.

The commission reportedly believes that more accurate accounting of the incidence of fires in TV's can be obtained by a continuing survey of TV service shops.

Eastern Division of Castle Tuner Moves

The Eastern Division of Castle TV Tuner Service has moved from Long Island City, New York to 130-05 89th Road, Jamaica, N.Y. 11418.

The new facilities provide overhaul of TV tuners for the entire Eastern section of the U.S.

The main plant at 5710 N. Western Ave., Chicago, Ill. 60645 continues to provide similar service for the rest of the U.S.

NARDA Leader Proposes Union of Home Retail Sales and Service Associations

An alliance or merger of all retail trade associations whose members sell and/or service appliances, home entertainment electronics products, kitchens and furniture was proposed by Jules Steinberg, executive vice president of the National Appliance and Radio-TV Dealers Association (NARDA), at a meeting in Chicago of the American Institute of Kitchen Dealers, according to a report in **Merchandising Week.**

Included in the proposal as potential members of such a union were the National Alliance of Television and Electronic Service Associations (NATESA) and the National Electronics Associations (NEA).

Replying to the proposal, Frank Moch, executive director of NATESA, reportedly said, "There's a vast area of mutual interest worth exploring and investigating."

"But," cautioned Moch, "Uncle Sam might look at it with a jaundiced eye. It seems he's more interested in watching what the little guy does than what the big ones do."

NEA National Office to New Address

The National Electronic Associations' (NEA) national office has been moved to new facilities at the following address:

12 South New Jersey Street
Indianapolis, Indiana 46204
Phone (317) 636-9062

All administrative, legal and financial business will be conducted through the new national office.

Public relations information and materials relating to the NEA will continue to be handled by:

Jack Betz C.E.T.
2525 W. 4th Street
Waterloo, Iowa 50701

Montgomery Ward TV-Stereo Production Purchased by Admiral

Admiral has purchased Cortron Industries, the TV-stereo producing arm of Montgomery Ward.

Cortron reportedly will continue to supply TV and stereos to Montgomery Ward.

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.

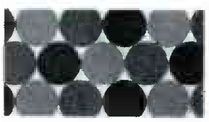
With a full 2-year warranty!

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.

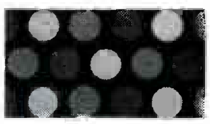
Before Chromacolor, every giant-screen color picture was made up of tiny dots on a gray background.

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

Simulated TV picture

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.

ZENITH®

CHROMACOLOR™

ONLY ZENITH HAS IT

Circle 8 on literature card

TV Service is Bargain Priced in Today's Economy

The shaded area in the chart indicates the level that TV service prices have followed, compared to other economic indicators.

The U.S. Department of Labor started keeping track of TV service rates in 1953. In that first year TV service rates were low. During 1954 through 1959 the TV service rate indicator climbed strongly. By 1959 the cost of TV repairs had caught up to the costs of other services and the indicator for wages of factory workers (per hour). In that year, TV service rates, at 103.5, exceeded the General Cost of Living Index, which then was only 101.5.

In 1960 the TV service index rose again, but had reached its peak. That year saw TV service rates at 105.0. Other services (less rent) went to 107.4. The index for hourly wages of factory workers rose to a similar 107.0. The general Cost of Living, at 104.2, was still a shade below the TV service indicator.

From 1960 through 1964 TV service rates froze at approximately 105 while the other indicators were continuing to rise.

In 1965 TV service rates actually dropped to 102.6, while the other indicators went on climbing.

The latest figures (November 1969) show TV service rates at only 101.0 while the other costs are now skyrocketing.

In an inflationary economy, when a cost indicator holds steady or drops off a bit, usually there is a good solid reason. The prices of transistor radios, for example, have dropped because of Japanese imports and automation.

However, the drop in TV service rates during recent years cannot be attributed to greater efficiencies or reduced costs of doing business. The cause seems primarily to be unrealistic service pricing.—Bear Facts, Calif. State Elect. Assoc. ▲

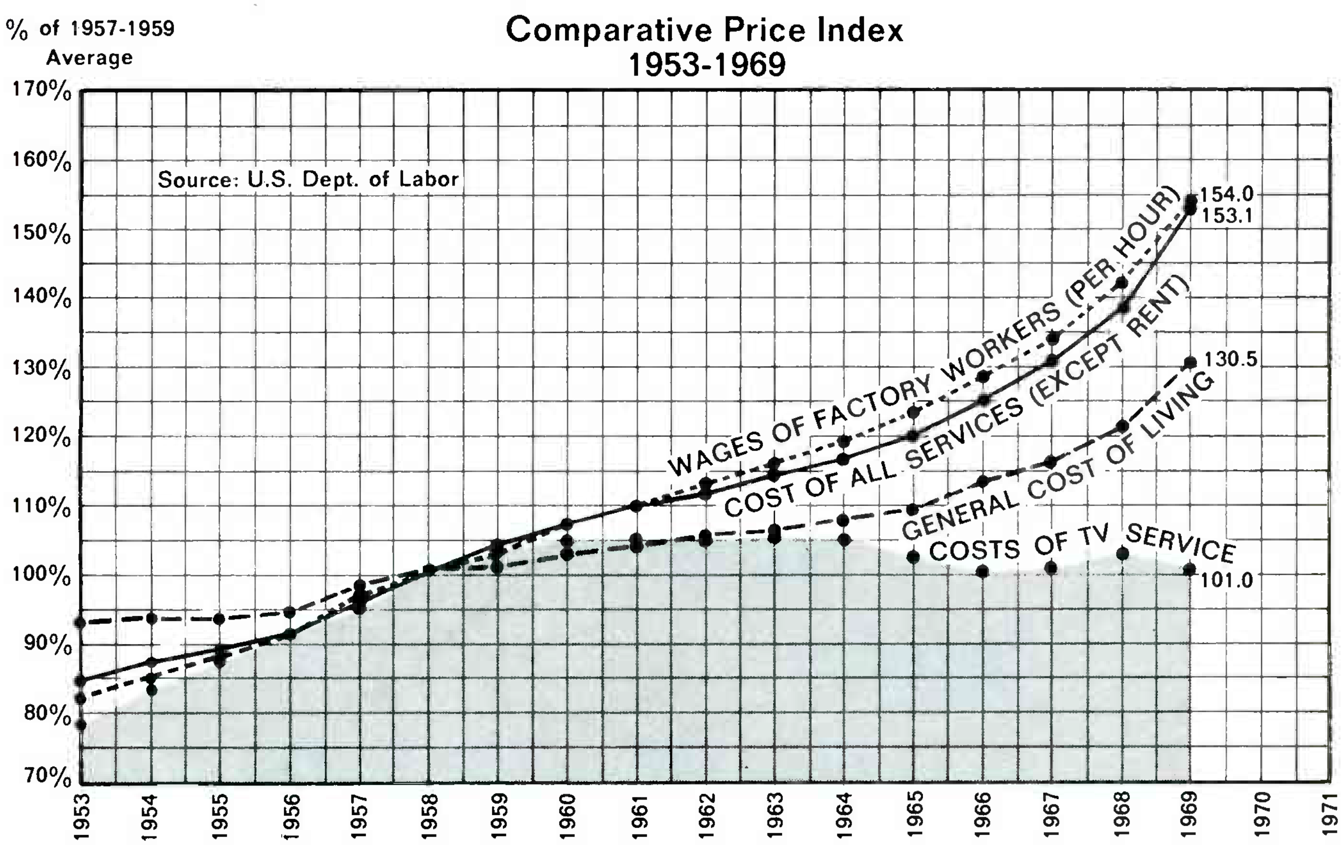
Service Training Schedule

Consumer electronic service training sessions conducted by TV manufacturers, distributors, service associations and universities which are open to all interested consumer electronic service technicians will be announced in this column. Send the dates, location and a brief description of the subjects to be covered to: Service Training, ELECTRONIC SERVICING, 1014 Wyandotte St., Kansas City, Mo. 64105. All information should be submitted two months prior to the date of the training session.

Iowa State University:

All-Day Classes March 9, 1970—Ottumwa, Iowa—Alignment
March 11, 1970—Ames, Iowa—Introductory Servicing Home Calls

5-Week Classes March 3, 10, 17, 24 and 31, 1970—Council Bluffs, Iowa—Transistor Sweep Circuits
March 5, 12, 19, 26 and April 2, 1970—Dubuque, Iowa—FM Stereo ▲



U S CITY AVERAGE — CONSUMER PRICE INDEX — 1957-59=100

Circle 9 on literature card →

letters to the editor

"For" Licensing

In regards to Mr. Norton's letter, which was in the December '69 issue of ELECTRONIC SERVICING, I would like to say that there is no reason for any oldtimers to be forced out of business because of licensing laws. If the oldtimer is a real technician, then he has been keeping up with advances in his field and he should be able to pass any test he might have to take, without even "boning up" beforehand.

If, on the other hand, he is a "seat-of-the-pants" repairman (well, that didn't help so let's replace this and see what happens), then perhaps it is better for all involved if he is either put out of business or, as is more likely, is made to attain an acceptable level of competence.

As for "servicing speakeasies", we already have them in California, and it takes only one irate customer or competitor to blow the whistle.

Licensing might not have eliminated all abuses among doctors and dentists, but even so I would not want an unlicensed doctor doing "major repairs" on me.

Joseph V. Breen
Sacramento, Calif.

"Against" Licensing

Three big cheers for Mr. Wolfson of Chicago, whose letter against licensing appeared in the January '70 issue of ELECTRONIC SERVICING. He states my views precisely, and I have been voicing them for over 30 years.

My hope is that the "silent majority" of service people will read this fine letter. Thanks for printing it.

Jack Watt
Ontonagon, Mich.

Comments on Antenna Installation

I have some comments regarding Bruce Anderson's article titled "Facts About Basic Home TV Antenna System Components", which appeared on page 50 of the January '70 issue of ELECTRONIC SERVICING.

I feel that mounting or grounding an antenna to any vent pipe or sewer stack is not only dangerous (sewer gas will explode) but also against the majority of the electrical codes. Also, in some areas antennas are not permitted on chimneys. Ground rods should be at least 8 ft. to do a good job. An installer should always check the state and local building codes, or he might find himself in court.

Burt's Radio & TV
Grand Rapids, Minn.

Tube Tester and Accessories for Sale

I have for sale a Hickok Model 6000 tube tester equipped with a Model CA-4 Universal Adapter, which enables the technician to test 5-pin, 7-pin and the new 10-pin Nuvistors, Novars and Compactrons.

I also am selling a CRT-1 Picture Tube Adapter accessory, which tests all picture tubes, including the new 110-degree deflection tubes. This can be used with all current Hickok manual tube testers.

All the equipment is in excellent condition. The latest set-up information and manuals are included.

For more information about these instruments, please contact me.

Bernard H. Serota
2502 S. Philip St.
Philadelphia, Pa. 19148

Touchy Horizontal Locking

This is in regards to Mr. R. G. Fruehauf's letter concerning the horizontal locking in a Zenith color set, which appeared in the Troubleshooter department of the December '69 issue of ELECTRONIC SERVICING magazine.

The factory modifications you gave for elimination of hooking left out the important change for increasing the filtering on the AGC line—changing the .033-mfd capacitor at test point E to a .1-mfd capacitor.

Because of insufficient filtering, the horizontal hold was erratic when switching from channel to channel. Once a channel was tuned in, the hold was very stable. A quick fix in the home can be accomplished by soldering the .1-mfd capacitor from test point E, which is clearly marked, to chassis ground, leaving the original .033-mfd capacitor in the circuit. This change is needed only in the "Y" series chassis.

Robert Corcoran
East Haven, Conn.

Service Labor Rates Should Reflect Your Cost of Doing Business

I was very impressed by your recent article on service pricing (Dec. '69 issue). However, I also was very upset by it.

After reading your article . . . I could not help stopping and daydreaming a little about what a fantastic life I would have if such service charges were realistic.

It might very well be true that the mentioned places, Electro-TV, and yes, even Wholesale TV, can charge such outlandish prices and get away with it, but what about such areas as I live in?

This is not to say that I live and work in a poor section of the country, but certainly not the kind that these two people live in.

The population of Skowhegan is around 5,000 people but the total for the servicing area is about 15,000.

When I started my business I obtained contracts for work through several department stores, two of which are national chains. Both of these left the service charges open to me for decision. Before I made up my mind about charges, I contacted several of the well-established businesses in this area to seek out *their charges. Then I made a service charge form (schedule of rates) which was turned over to these stores for approval.*

Needless to say, the charges that are my policy are far, far from the charges you listed as within sight of all. I can say only that if everyone who services in this area charged the outlandish prices that are mentioned in this article, there would be no service shops remaining.

The average charge for a home service call in this area is $7.00, and is for the first hour, *not 30 minutes. This is the price that I charge both to my customers and to the department stores. There is no additional charge for installing tubes, changing capacitors, etc. If this were the case, not many shops would remain in this area.*

My only comment to those who charge so much is that if such policies were to be national, the manufacturer would be forced to provide service since the average customer, and I mean average, not people who have five-figure incomes, could not afford such service.

As I glance down some of the charges, I can not help wonder why someone would pay a minimum charge of $58.50 to have repaired a transistor TV that could be bought new for slightly more than this.

The only thing accomplished by charging such prices is to further the sales end of the companies' income rather than the service end.

I guess I have said enough. The article really ticked me off, so I had to say my peace.

I enjoy reading your magazine and the articles are excellent. Do keep up the good work!

Edward B. Whittaker
Skowhegan, Maine

It is true, Mr. Whittaker, that the specific prices in the Dec. '69 issue of ELECTRONIC SERVICING probably cannot be applied to the economic conditions that exist in Skowhegan—and a lot of other towns and cities across the country. This was pointed out in the article. It also was pointed out that the purpose of the article was not to introduce specific service labor charges, but rather to present the philosophies and pricing methods of two shop owners who have attempted to develop service labor rates that are more realistic for their operations and market areas—service labor rates that enable them to provide their technicians adequate salaries and fringe benefits. That's what it takes to attract and retain good technicians. Consumers can benefit, because as the competence and efficiency of the service industry increases, better service will be rendered at a fair price.

The prices of products and services, if they are realistic, generally reflect what they cost the seller. Included in the price should be such costs as employee salaries and benefits, shop overhead—including taxes, lease, insurance and utilities—and depreciation of equipment.

The cost of some of these items—such as taxes, lease, utilities and employee salaries—can vary drastically from one area of the country, or state, to another. Consequently, the prices charged for services and some products also should vary.

An article titled "Soaring Cost of Living Seems Far, Far Away From a Town in Maine" appeared in the January 6 issue of the *Wall Street Journal.* The article described the low cost of living in Lubec, Maine, a town of 2,684 residents on the easternmost peninsula of the Maine coast.

According to that article, the 37-cent breakfast, the dime cup of coffee and the $7.00 motel room still survive in Lubec, and a husband and wife can live very comfortably on $4,500 a year. Houses that sell for $30,000 or more in New York and San Francisco can be purchased for $8,000 to $12,000 in this town, whose two police officers each receive $1.70 an hour.

Taxes also are low in Lubec. The municipal debt totals only a little more than $6.00 per resident, while in New York the municipal debt averages about $714 a resident.

The same article also mentioned that services are cheap in Lubec. For example, television technician Owen Wilson charges only about $9.00 labor for replacing a certain transformer in a TV. The typical labor charge for replacing this transformer in a TV set in Boston reportedly is $14.95.

Wilson has raised his fees for house calls to $3.50 in town and $4.50 outside of town—up 50 cents, or 14%, in 15 years. Compare this with the spiraling indicators in the national cost-of-living index.

Labor rates for television repair in Lubec, Maine are lower because the cost of doing business is less, and because a TV technician (and other residents) can live comfortably on less income than he could in many other areas.

A TV shop owner or technician in Los Angeles, Chicago or New York would starve to death if he charged the same labor rates that are charged by Owen Wilson in Lubec, Maine. Why? Because it costs more to produce the same service—and it costs more to live.

It is much more important that a shop owner know exactly what it costs *him* to produce the services he sells, than what the same services sell for out of his economic or market area. Also, he should not mimic the prices charged by his local competitors without knowing for sure that his cost of doing business is no more than theirs—differences in shop efficiency can make a big difference in what it costs different shop owners in the same city block to produce an hour of service labor.—The Editor.

PHOTOFACT Folders for Sale

I have Sams PHOTOFACT folders 1 through 905 for sale at reasonable prices. Please contact me for more information.

Ruben's TV
1006 13th St.
Green Bay, Wisc. 54304

Info on Imported Products

Your November '69 article on page 38 titled "Source Guide to Imported Consumer Electronic Products" indicates Sams coverage for Morse products but no Sams coverage for Electrophonic products.

The distributors for both products are one and the same. Morse and Electrophonic products are identical in all respects including model numbers and cabinetry.

The first two digits of their model numbers represent the chassis; therefore, Sams coverage for any Morse model will automatically cover any Electrophonic model bearing the same first two digits in the model number.

I hope this will help your readers.

Robert D. Sanford
Oxnard, Calif.

Diode Reversed

I recently had an RCA CTC24 chassis on the bench with convergence problems. Using PHOTOFACT folder 912-3, I located an open diode on the convergence panel.

I decided to replace the RCA diode module with GE 504 diodes, which I had on hand. I located the diodes on the schematic, and wondered about the biasing of X6A.

I then pulled out my RCA field service guide and located the diode identified by RCA as CR 801 E. It seems that the PHOTOFACT folder pictures this diode in the circuit backwards. Those who use this folder may want to note on the schematic that diode X6A should be reversed.

I am a very happy reader and subscriber of your magazine and a constant user of Sams PHOTOFACTs. However, since none of us can be expected to be perfect, it is handy to have other sources of servicing information in the shop.

Pat Pasco
Suitland, Md.

Help Needed

I recently purchased a used Simpson Electric Co.'s Model 330, Series 3538 tube tester. However, I cannot seem to find an updated roll chart or manual. I have written to the manufacturer and a tube data service company, but neither can help. I would appreciate any assistance in obtaining this information. Thank you.

M. C. McCready
7908 Riverview Ave.
Pittsburgh, Pa. 15218

I am in need of a diagram for a Pioneer Stereo Model SMB200A, No. M1179. Any information will be appreciated.

Bill Blackmore TV
22102 80th Ave. West.
Edmonds, Wash.

I recently purchased an old television sweep signal generator, Model No. Tele-Sweep TSW-50, but have been unable to contact the manufacturer to inquire about obtaining an operating manual, schematic, etc.

The manufacturer's name listed on the chassis is Vision Research Laboratories, P. O. Box 52, Kew Gardens, New York. I wrote to the address, but my letter was returned stamped "No Such Address."

If anyone could help me locate the articles noted above, I would gladly reimburse them for such information.

Jesse D. Mann
3728 Loomis St.
Lakewood, Calif. 90712

▲

Circle 10 on literature card

Circle 11 on literature card

Dale's service bench

by Allan Dale

Testing Stereo with Square Waves

The subject this month is a tried and proven method of testing stereo amplifiers. I've watched guys fumble around with one method and another, sometimes piddling with half a dozen different approaches to one simple service job. They waste a lot of time that way.

I like a square wave. It's easy to trace with a scope, and it tells you quite a bit about the amplifier, just at a glance. All you have to do is remember what a few waveforms look like. You can even make a chart, if you don't fix amplifiers often enough to remember the shapes.

You don't need a lab generator. An ordinary service-type is okay. Nor do you need a triggered scope (although that's what I use). But your scope must be a wide-band model, like you have for color TV work. A poor scope can distort a square wave seriously; if you're not careful, it'll fool you into thinking an amplifier is bad when it isn't.

Generator Versus Scope

Always use the same scope and generator. Get accustomed to them. If the scope response is poor at one end, you must allow for it. It happens I have an old scope with bad low-frequency response, and I've never bothered fixing it. That doesn't really hurt anything, as long as you know it's that way.

First thing to do is hook your square-wave generator directly to the scope. On my old scope, a 200-Hz square wave from my kit-type generator looks like Fig. 1A. I always set the scope sweep and sync to show three cycles of waveform.

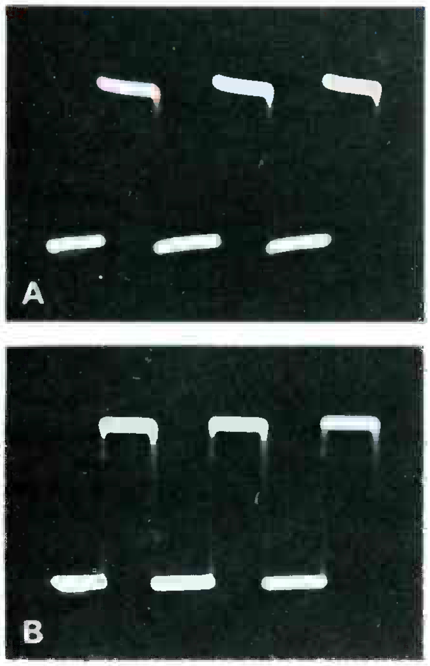


Fig. 1 Here's what the signal from a service-type square-wave generator may look like on your service scope. (A) At 200 Hz (B) At 4000 Hz.

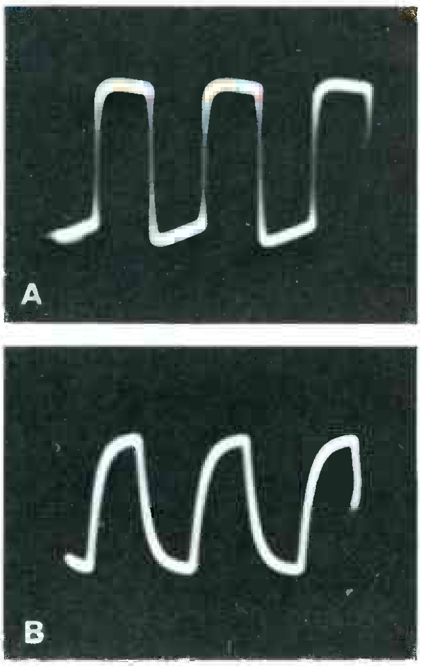


Fig. 2 Rounding of leading edges reveals rolloff of high frequencies; square-wave fundamental frequency and the amount of rounding are clues to which frequencies are lost. (A) At 2000 Hz (B) At 4000 Hz, same amplifier.

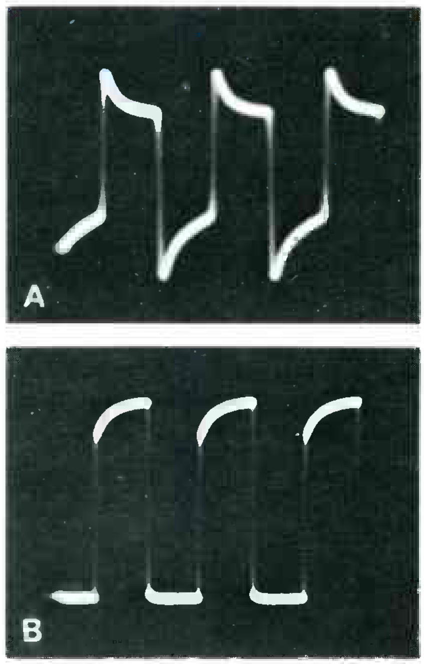


Fig. 3 More waveshapes you may see when servicing an amplifier with square waves. (A) Low-frequencies deficient, or highs overpeaked (B) Overload—increasing input doesn't give more amplitude.

I chose 200 Hz because that's a good frequency with which to start testing. A square wave tests an amplifier's low-frequency response down to about one-tenth of the square-wave frequency. Thus, a 200-Hz square wave is meaningful down to 20 Hz—about as low as a practical stereo amplifier needs to operate.

The flat-tops of the waveform in Fig. 1 are tilted and have a slight upward curvature near the leading edge. That's a sign the scope response is a bit poor down toward 20 Hz. You'll have to remember that when you test an amplifier.

Now set the generator dial for 4000 Hz. Set the scope sweep and sync to lock-in three cycles. My scope and generator make a display like Fig. 1B. The waveform is a true square at this frequency.

A square wave tests an amplifier's high frequency response up to about ten times the square-wave frequency. With 4000 Hz, you can tell how an amplifier operates up near 40,000 Hz. The waveshape in Fig. 1B is okay, so my scope's vertical amplifiers are okay up past 40 KHz.

Some stereo amplifiers are designed for flat response well above 50,000 Hz. That's far out of hearing range. But, if the manufacturer says the amplifier should respond that far, go ahead and test it. If you want to test it for response at 100 KHz, use a 10-KHz square wave. But always check how it looks on the scope first.

Square Wave in an Amplifier

What happens to a square wave in the stages of a stereo amplifier is the result of what a square wave is. You probably remember that a sharp, square-cornered waveform is composed of the fundamental sine wave plus odd-order harmonics out to infinity. As a practical matter, harmonics out to the eleventh or thirteenth are enough to keep a waveshape square.

The shape of a square wave in an amplifier depends on the frequency response of the stages. If harmonics are attenuated, the shape doesn't stay square. So studying the waveshape tells you how the amplifier performs.

The leading edge is the first place to look. If it's rounded off, the amplifier is rolling off some of the frequencies up toward the tenth harmonic of the square-wave fundamental. If it stays sharp, that means the amplifier is passing those harmonics okay. A 4000-Hz square wave that stays square all the way through an amplifier proves the high-frequency response is reasonably flat through at least 40 KHz.

If a 200-Hz square wave goes through okay, it means the frequency response of the amplifier is normal and reasonably flat down to 20 Hz.

If the leading edge is over-sharp, the response to subharmonics of the fundamental is deficient.

The waveforms in Fig. 2 both are from one of the amplifiers I recently had on the bench. They show poor frequency response.

The slight rounding of the leading edges of the waveform in Fig. 2A tells you the response isn't flat at high frequency. The input signal here is 2 KHz. The rounding means frequencies up toward 20 KHz are being rolled off, or amplified less.

The rounding looks worse in this amplifier if the square-wave fundamental is made higher. Fig. 2B was taken with the generator set for 4 KHz. Severe rounding tells you almost no frequencies up near 40 KHz are coming through. (This might not matter for listening, but the manufacturer claims flat response to 50 KHz.)

The trouble, I found, was in two transistors. One of them was pretty far gone with ICBO (collector-base) leakage—over 12 μA. The other one was slightly leaky, too, but it worked okay in a stage where it wasn't DC-coupled to another transistor stage.

The symptom of an opposite fault is pictured in Fig. 3A. The trailing edge is depressed, and the leading edge is abnormally high. The balance between highs and lows is wrong. This waveform was produced by an amplifier into which I fed a 200-Hz square wave. Frequencies down toward 20 Hz were being lost. I tracked this waveform backward from the output with my scope and found that the incorrect

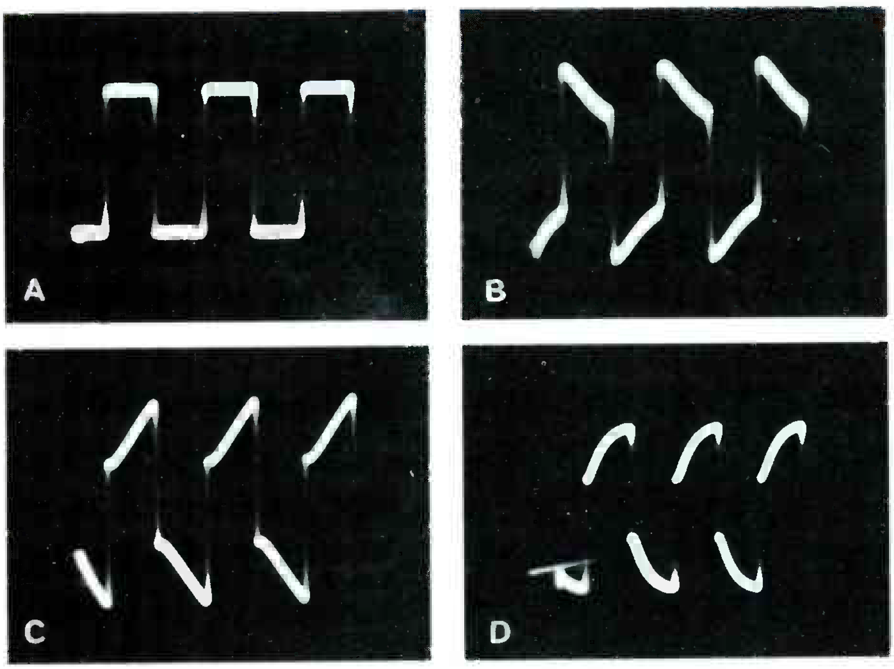


Fig. 4 Square waves reshaped by bass tone control. Effects are almost exclusively on trailing edges. (A) Normal waveshape when controls are at "flat" (B) Trailing edge low—bass reduced (C) Trailing edge high—bass boosted (D) Bass boosted even more.

shape originated in a pre-driver stage. From there on back to the input, the waveshape was square. A defective electrolytic capacitor was the cause.

I saw the waveshape in Fig. 3B several times while I worked on those amplifiers. One flat-top is rounded. It's one you'll see if you overload any stage with too much input signal. It can be cured by turning down the generator output.

It wasn't that easy in one amplifier, however. The square wave was normal through all the preamplifier stages. Beyond the level control, the waveform in Fig. 3B showed up. I made sure it was overload by turning the generator up higher. (If it is, the scope waveform doesn't get any higher at all—the tops and bottoms just get thicker. It was overload.) I could straighten out this one by turning the level control down. But the stages following the level control should be able to handle full-volume. So I hunted for trouble.

I turned the generator back down so the wave was square up to and past the level control. I found the overload in a driver. DC measurements revealed a bias upset that let the stage act like a limiter. Funny, but the real fault was the transistor preceding the driver. It handled the signal okay, but its DC collector current wasn't right—and that was part of the bias current for the driver.

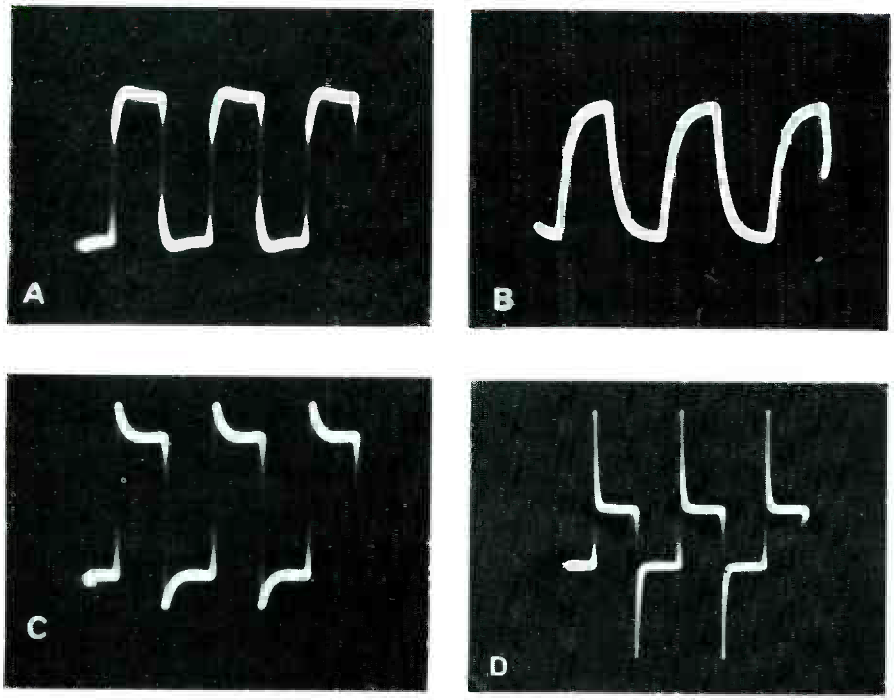


Fig. 5 Square waves reshaped by treble tone control. Effects are almost exclusively on leading edges. (A) Leading edge pulled down—treble reduced (B) Leading edge pulled way down—treble reduced severely (C) Leading edge raised—treble boosted (D) Treble boosted even more.

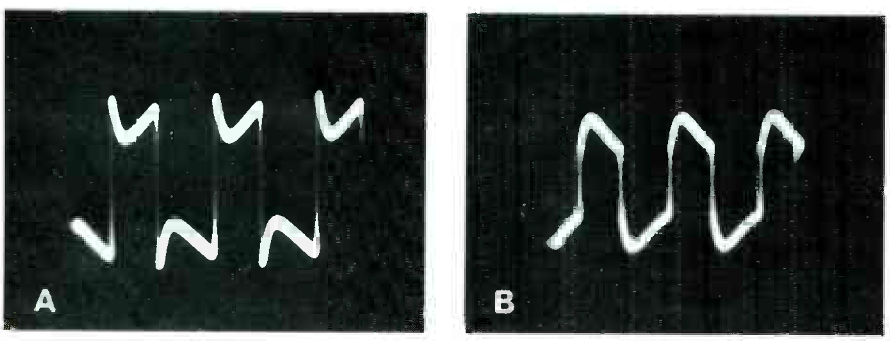


Fig. 6 Effects of adjusting both tone controls in the same direction. (A) Both turned up (B) Both turned down.

Effects of Tone Controls

One way to see how frequencies affect square waves is by testing the tone-control stages of a good amplifier. The series of waveform photos in Figs. 4 and 5 show the various results. A 1000-Hz square wave is good to try this with. It checks amplifier response from 100 to 10,000 Hz.

Make sure the preamplifier is operating normally. Feed in the signals, and connect the scope anywhere after the tone stages—the output of a predriver is fine.

Waveform A in Fig. 4 is the square wave when the tone controls are set for perfectly flat response. This is a good way to verify the **flat** setting of both controls.

Waveform B is with the **bass** control turned down. There are now fewer bass frequencies in the (former) square wave than treble. When frequencies are missing toward the low end—to and beyond 100 Hz in this case—the slope of the flat-tops from leading edge to trailing is **downward.**

Waveform C shows what happens when you turn up the bass control. Balance between treble and bass frequencies is upset, but without destroying high-frequency response. That's why there's no rounding at the leading edge. Boosting bass frequencies makes the slope of the flat-tops slant **upward** from leading edge to trailing edge.

Exaggerated bass boost is shown in waveform D of Fig. 4. This gives an amplifier that "juke-box" boominess. To an unpracticed eye, there seems to be a similarity between this waveform and the rounded one in Fig. 2B. But look at that leading edge. In waveform 4D, there's still a sharp corner. That means high frequencies are not being cut. The high trailing edge indicates only that bass is being boosted more than treble.

The waveforms in Fig. 5 show results of adjusting the treble control. In A the sharp corner of the leading edge is pulled downward, leaving the corner rounded. This shape is the result of turning the treble control down. Frequencies up toward 10 KHz are being rolled off (the test signal is still 100 Hz). Bass frequencies aren't bothered.

Waveform B of Fig. 5 shows severe rolloff at 10 KHz. Notice, however, that the trailing edges remain sharp-cornered, being neither raised nor lowered. That means low notes are still not bothered by this extreme effect on high notes.

Treble boost is shown in waveform C. Notice how the leading edge of the square wave is pushed upward sharply without affecting the trailing edge.

And waveform D of Fig. 5 shows extreme treble boost. The treble control is turned way up for this.

The secret of square-wave analysis must be obvious from these waveform photos. In case it isn't deeply impressed on you, here it is: Whatever is being done to high frequencies manifests itself at the **leading** edge of the otherwise square waveform. Whatever is being done to low frequencies shows up on the **trailing** edge.

Fig. 6 proves this dramatically. In Fig. 6A both bass and treble controls have been turned up. Extreme highs and extreme lows are both being boosted. The high leading edge shows emphasis on treble, and the high trailing edge shows emphasis on bass. Fig. 6B, on the other hand, was produced by opposite settings of these controls. The downturned leading edge shows treble is reduced, and the downslant to the trailing edge shows bass is reduced.

Distortion

Square waves make distortion obvious. Some distortions I found in the amplifiers I told you about are pictured in Fig. 7. These all happened to involve oscillations, too, which is a common cause of "peculiar" or "not right" sounds from stereo amplifiers.

The waveform in Fig. 7A first looks like a sawtooth. But a definite thickening in both slopes and the wavy triple lines at the peaks denote oscillation. As it turned out, there were two distinctly separate faults in this amplifier. The sawtooth was being shaped in a preamplifier stage, where a leaky capacitor had upset the bias. The oscillation was in the four-transistor output stage; I had to replace half the feedback network and redress some capacitors that had been moved by a "prober."

Fig. 7B is the result of parasitic oscillation. You can see its little RF "burst" riding at the bottom trailing edge of each cycle. This one also is creating some ringing oscillation at the top leading edges. Turning up the generator input made the major oscillation worse, as shown in Fig. 7C; it also revealed a very low overload factor in the amplifier. The trouble was in a driver section where part of the feedback system was bad. A resistor had changed value.

A badly oscillating stage in another amplifier produced the waveform in Fig. 7D. The cause was a bad transistor. Notice that the square shape is eliminated completely. The stage is producing its own RF signal, triggered by the square-wave input.

What's Next

All this information on square waves should, at least, put you on the track of troubles in stereo amplifiers. It's amazing how much information a square wave gives you, if you know where and how to look. Just be sure the test frequency fits what you want to test.

In my next column, I have a real goodie for you. If you work on car radios much, you've undoubtedly run into search-tuning jobs. They drive some technicians right up the walls.

If that happens to you, take next month's column up there with you. When you get back down to earth, you may know how to approach search tuners more confidently. ▲

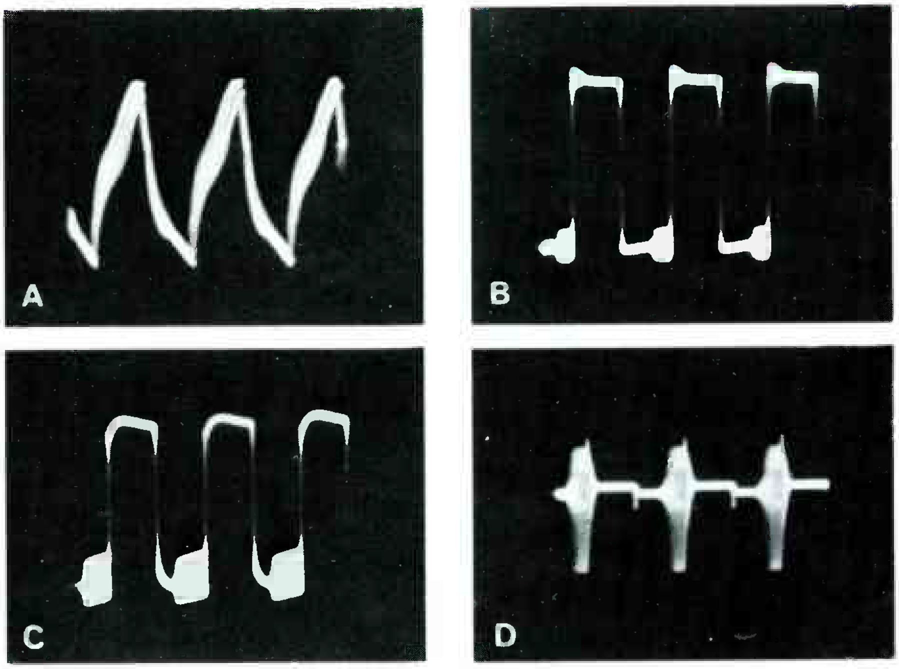


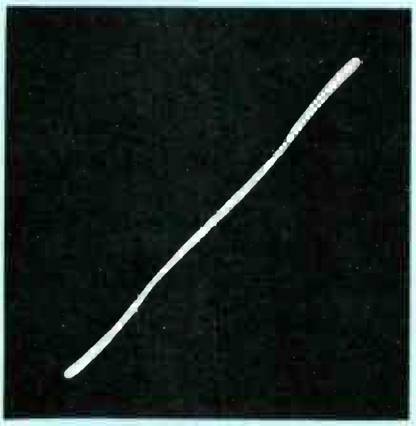
Fig. 7 Distortion as seen in square waves, with oscillations. (A) Two separate faults —waveform distortion plus oscillation (B) Parasitic oscillation in output stage (C) Same as B, except signal is overloading output stage (D) Stage self-oscillating, triggered by square-wave input.

VECTOR PATTERNS:

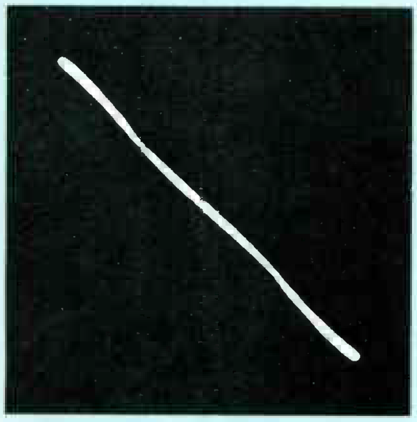
How the vector pattern is developed and what it can tell you about the performance of a color receiver

by Bruce Anderson

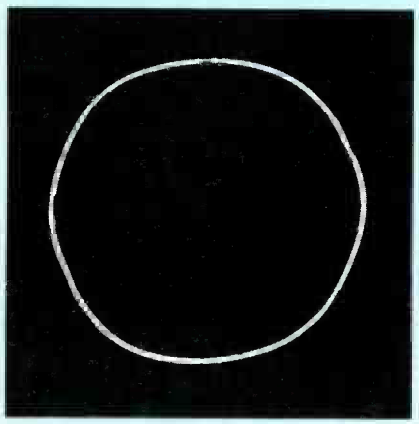
Fig. 1 Simple Lissajous waveforms.



A) In-phase signals



B) Out-of-phase signals



C) Signals in quadrature.

Simple Lissajous Patterns

The "daisy" or "starburst" pattern produced by a vectorscope is actually one of a group of patterns properly labeled "Lissajous figures". These are patterns which are generated when both the horizontal and vertical inputs of a scope are excited by signals which bear a simple harmonic relationship to each other.

The three Lissajous patterns in Fig. 1 are simple to explain and also are very easy to produce on any ordinary oscilloscope.

Fig. 1A shows the result of applying the same 60-Hz sine wave to both inputs of a scope. If the two signals are in phase, a diagonal line from upper right to lower left is displayed.

Fig. 2A illustrates how this type of pattern is developed. Since both the vertical and horizontal deflection voltages reach maximum positive at the same instant, T2, the spot on the CRT reaches its maximum upward deflection at the same moment that it is deflected to the right as far as it can go. At times T1, T3 and T5, there is no deflection, since both inputs are zero; when both inputs are maximum, at time T4, the spot reaches its maximum point of deflection to the lower left.

Fig. 1B shows the pattern produced if the polarity of one of the inputs to the scope is reversed—a 180° phase shift. Again a diagonal line is the result, but it extends from upper left to lower right. How this pattern is produced also can be deduced from Fig. 2A, simply by visualizing either of the inputs as being inverted.

How the circle in Fig. 1C, which is the result of inputs in quadrature, is produced, is shown in Fig. 2B. When the vertical-deflecting voltage is zero (times T1, T3 and T5), the spot is centered in the vertical plane; at times T2 and T4, the spot is centered in the horizontal plane. If only these points are plotted, it is not clear whether the pattern would be a square or a circle, so additional points must be considered.

At a point in time halfway between T1 and T2, both voltages are positive and .707 of their maximum values (sin 45° = .707), so deflection is upwards and to the right, .707 of maximum in each direction. Converting to polar coordinates by extracting the square root of the sum of the squares of the two inputs, we can prove that the **total amount** of deflection remains the same, but that the **direction** of the deflection is 45° to the right from vertical. If all the instantaneous values of the deflection voltages were calculated in the same fashion, it could be proved that the deflection always would be the same amount and that the direction would continuously change.

An RCA Model WO 91 oscilloscope was used to produce the waveforms of Fig. 1; however, the patterns may be duplicated using any make of scope. To produce Fig. 1A, the vertical input selector of the WO 91 was set to **CAL,** which supplies a .3-volt signal to the vertical amplifier, and the horizontal selec-

Generation and Interpretation

tor was set to **LINE,** providing a sample of the filament voltage to the horizontal amplifier. By changing the settings of the vertical gain control, the polarity reversing switch and the horizontal gain and phasing controls, the pattern can be varied at will.

Fig. 3 shows some of the patterns which may be generated by feeding into the two scope inputs two signals which are harmonically related. Waveforms of this type are useful for measuring frequencies; for example, in checking a remote-control transmitter. In Fig. 3A the vertical-input frequency is twice the horizontal-input frequency; in Fig. 3B the opposite is true. Fig. 3C was generated by using a vertical-input frequency equal to the third harmonic of the horizontal-input frequency. Fig. 3D results when the vertical input has a frequency of ⅔ of the horizontal input. Notice that, in every case, the ratio of frequencies is the same as the ratio of the number of loops (or "humps") at the top and side.

The Vectorscope Pattern

Having seen how the basic Lissajous patterns are formed, it is not too difficult to visualize a way of "making a daisy vector pattern." To do this, we must start with the fundamental circular pattern and then cause the deflection in both planes to fall to zero at regular intervals. In other words, the inputs must be "chopped". Of course, the chopper must operate at some exact multiple of the signal frequency, so that the deflection will drop to zero at the same points as each succeeding circle is formed. If the chopper were to operate at twelve times the frequency of the signal, the pattern will have twelve loops. If two of these are gated off, a waveform very similar to the vectorscope "daisy" will result.

A keyed-rainbow color generator produces horizontal sync pulses at a nominal rate of 15,750 pulses per second, and it also generates a color subcarrier which is 15,750 Hz less

Fig. 2 Formation of Lissajous patterns.

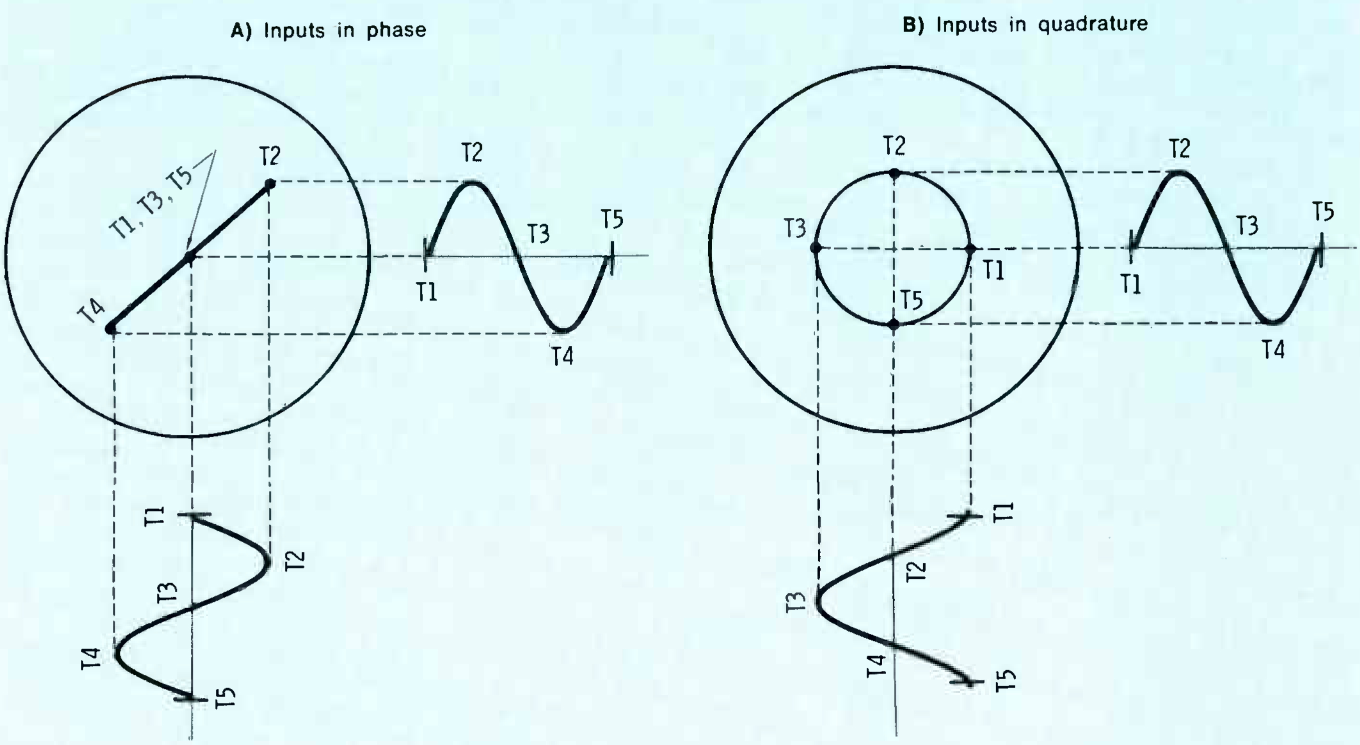
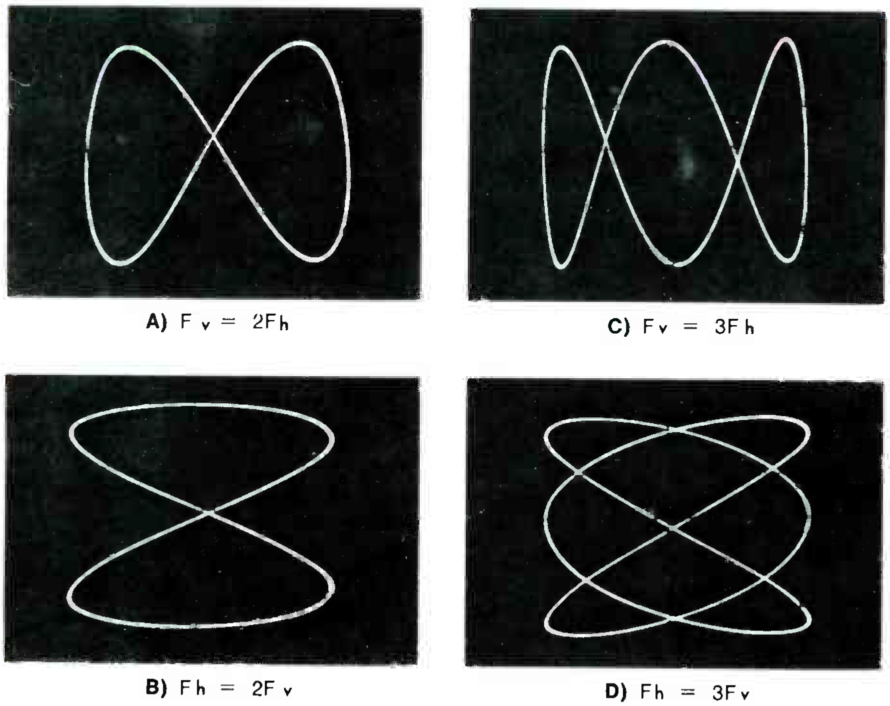


Fig. 3 Lissajous figures resulting from harmonically related frequencies.



than the frequency of the reference oscillator in a television receiver. As a result, the difference-frequency between the color subcarrier from the generator and the output from the reference oscillator in the receiver is exactly equal to the scan rate. (During broadcast reception, the scan rate is reduced to approximately 15,734.29 Hz.)

Because of these frequency relationships, the output from each demodulator is a sine wave having a frequency of one cycle per scan interval. Since the demodulators (or perhaps some other circuit in the chroma system) are cut off during horizontal-retrace time, a portion of this sine-wave output is blanked, and only about 300 degrees are visible. Thus, two of the petals of the daisy are lost.

As we have just discussed, each chroma demodulator produces a sinusoidal output which is blanked for about 60°. Since the color-bar generator is keyed on ten times during the unblanked interval, there remain a total of ten petals in the vectorscope pattern.

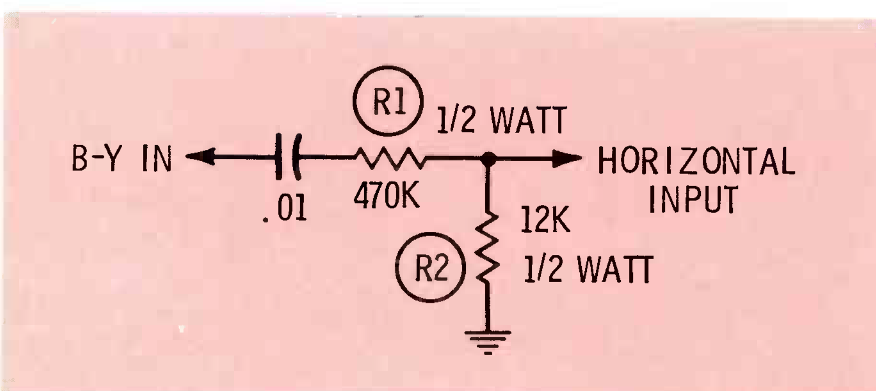


Fig. 4 B-Y attenuator probe to prevent saturation of scope horizontal amplifier.

Depending on the exact axes of demodulation, the vector pattern may be a circle or an ellipse. In receivers using R-Y and B-Y demodulation, the axes of demodulation are separated by 90°, and the pattern is circular. If X and Z axes are used, the pattern will be ellipsoidal, with the major axis inclined upwards to the left.

How Characteristics of Test Instruments Can Affect the Pattern

The Lissajous waveforms described in the preceding section can be displayed on nearly any scope; no special features are required. Much the same is true of the vectorscope pattern, but it is important to remember some of the effects which the characteristics of the oscilloscope and other test equipment can have on the display.

Most television receivers currently in production have at least 500 KHz of response to each chroma sideband, a total chroma passband of at least 1 MHz. In some receivers, response to colors in the fleshtone region is extended somewhat in the lower sideband. Although the I-axis modulation of the transmitter extends to about 1.5 MHz, it has been determined (at least in part by empirical methods) that extending the response of the chroma circuits in a receiver beyond about 500 KHz often degrades performance rather than enhancing it, because of the added noise which is produced.

The color-difference signals produced when a standard broadcast is being received extend no further than 500 KHz, except perhaps in the fleshtone region, but the sidebands produced by a keyed-rainbow generator can extend above this limit (although reduced in amplitude by the response characteristics of the receiver), unless the instrument is designed to limit the sidebands. Thus, the test signal may differ significantly from the signal which the receiver is designed to receive. This may preclude the use of the color-bar generator and vectorscope as a means of analyzing bandpass problems. Before relying on a specific generator and scope, make a few "trial runs" on receivers known to be out of alignment; then perform vector analysis of each after they have been aligned, to be certain of the test equipment.

The scope used for observing the vector pattern need have response only up to about 1 MHz to display color-difference signals properly. This is no problem in the vertical-deflection system, but many scopes have horizontal amplifiers with quite narrow bandpass. Because of this, the scope itself can distort the display. This can be remedied, if necessary, by decreasing the plate-load resistors in the horizontal amplifier of the scope, or by connecting the B-Y signal directly to the horizontal deflection plates of the CRT. The manufacturer's specifications should tell the frequency response of the horizontal amplifier; it can be verified by a simple frequency response check.

If the response of the vertical amplifier of the scope is much wider than the response of the horizontal amplifier, the greater delay of the vertical amplifier will cause a phase shift of the vector pattern. This is the same situation which exists in any color television receiver, and is the reason for the luminance-channel delay line. For this reason, it is desirable to use a scope with a relatively narrow bandpass in the vertical amplifier.

Referring once more to Fig. 1C, the circle will be produced only if the gains of the horizontal and vertical amplifiers are such that the respective inputs produce the same amount of deflection. Since both scope amplifiers have gain controls, it is a simple matter to adjust them to produce a circle, but unless the gains are calibrated, the fact that a particular receiver produces a circular pattern is meaningless. Adjusting the gain controls to produce a circular pattern is possible, even if one color-difference signal has much less than its specified amplitude.

Most modern oscilloscopes have provisions for calibrating the vertical amplifier, but few have means to calibrate the horizontal amplifier. The horizontal gain can be determined by injecting some known voltage and marking the horizontal-gain control, so this really is no big problem.

Oftentimes, the B-Y signal at the picture-tube grid will drive the horizontal amplifier of the scope into saturation. This may be prevented by constructing a simple attenuator probe for the B-Y input. Usually a 30:1 to a 50:1 voltage divider (Fig. 4) will do the job. A blocking capacitor should be used between the receiver and the divider to prevent loading the B+ supply to the difference amplifier. The circuit shown in Fig. 4 is suitable for many scopes and can be modified for others. If it will not function properly with a particular scope, the attenuation may be increased by increasing the value of R1, or it may be decreased by increasing the value of R2.

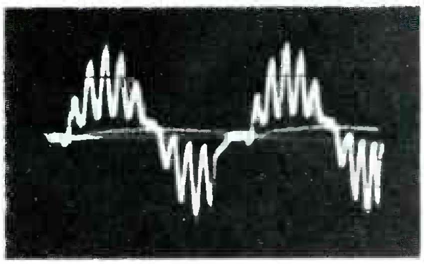
Interpreting the Pattern

As a basis for this discussion, we shall assume that the receiver being serviced is one using R-Y and B-Y demodulation. These demodulation axes are at 90° and 180° with reference to the burst signal. Fig. 5 shows the waveforms viewed at the difference-amplifier outputs, using both normal techniques and the vectorscope approach. These waveforms were photographed after the receiver was aligned carefully and checked for satisfactory operation.

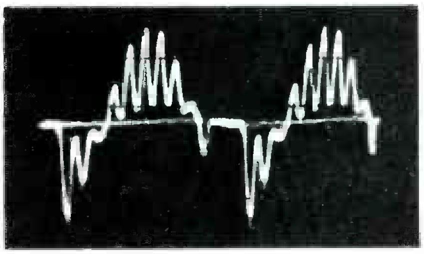
Fig. 5A shows the output of the R-Y amplifier. The tint control was set so that the sixth bar was at null (zero output point), although this position of the control did not give the best possible flesh tones when viewing an actual colorcast. Without changing the tint control, the outputs of the B-Y and G-Y amplifiers were observed; these are shown in Fig. 5B and 5C, respectively. When observing the G-Y signal, the vertical gain of the scope was increased so that all three waveforms would have about the same amplitude.

After the outputs of the difference amplifiers were viewed with a linear time base, the scope was connected to produce the vector pattern of Fig. 5D. The R-Y signal was connected to the vertical amplifier and the B-Y signal was used for horizontal deflection. The excursions of the sweep in the vector pattern normally are counted clockwise from blanking time; hence, the vertical petal which extends upwards is the third pulse and corresponds to the third pulse in the waveform of Fig. 5A. It also corresponds

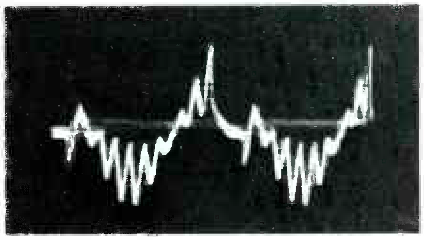
Fig. 5 Normal color-difference signals.



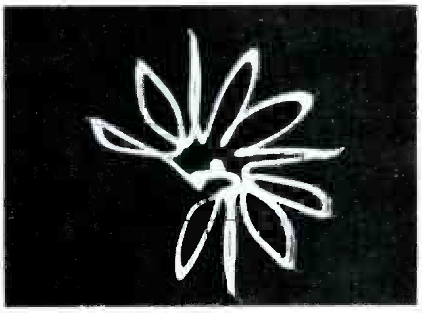
A) R-Y signal



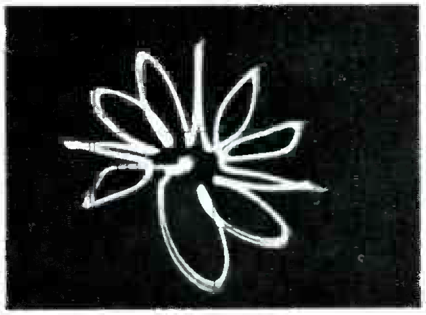
B) B-Y signal



C) G-Y signal



D) R-Y vertical, B-Y horizontal



E) B-Y vertical, R-Y horizontal

to the third bar (red) displayed on the picture tube.

The broadening of the trace in the fourth, fifth, seventh and eighth petals was attributed to a small amount of instability in the color-bar generator rather than to any malfunction of the receiver. This was verified by checking several other receivers, all of which showed the same effect. This jitter also was noticeable on the scope when observing the signals in Figs. 5A, B, and C, but it could not be photographed. This is a "plus" for the vectorscope technique—jitter is more easily spotted.

The leads to the scope were reversed for the next experiment, and the pattern in 5E resulted. The order of the positions of the petals is reversed (petal 1 of Fig. 5D is petal 10 of Fig. 5E, etc.), but more important, the **shape** of the individual petals is greatly modified. Since none of the receiver controls were changed between the times when the two photographs were taken, it must be assumed that the scope itself, or the test leads and probes used with it, must be responsible. This suggests, but certainly does not prove, that the particular scope used to observe the vector pattern of any receiver might be a significant factor in shaping the pattern.

It is obvious that receivers which use three chroma demodulators (some models of RCA, Motorola, and General Electric, to name three) cannot be completely checked by observing the R-Y/B-Y vector pattern. In servicing these receivers, it is necessary either to observe one of the vector patterns which uses G-Y as an input, or to resort to conventional, time-base displays, such as the one in Fig. 5C.

There are four possible vector patterns which incorporate the G-Y input. These are:

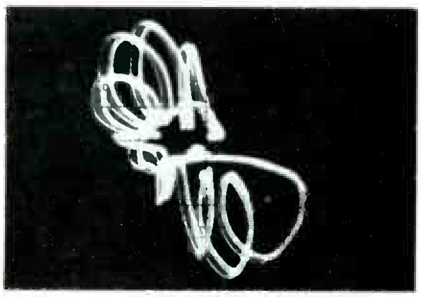
1. G-Y to horizontal input and R-Y to vertical input,
2. G-Y to horizontal input and B-Y to vertical input,
3. G-Y to vertical input and R-Y to horizontal input, and
4. G-Y to vertical input and B-Y to horizontal input.

The first and second of these possible waveforms are shown in Figs. 6A and 6B, respectively. These waveforms are much less convenient to analyze than those in Figs. 5D and 5E since the input signals are not in quadrature and the patterns are not circular. This must be considered as a "minus" for the vectorscope technique. Naturally, the other two possible patterns which include the G-Y input also can be used, but these have the same disadvantage.

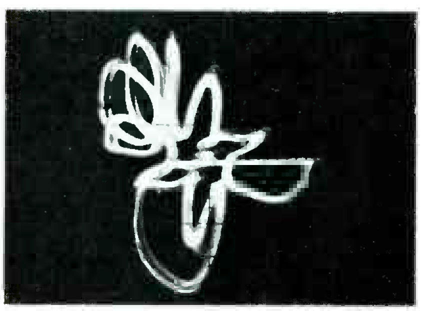
Even in receivers which use only two demodulators, it is possible to encounter malfunctions which are not indicated by the single, familiar vector pattern of Fig. 5D. In general, any circuit problem which occurs in the G-Y difference circuits beyond the point of matrixing will have no effect on this pattern. Therefore, it must be concluded that no receiver can be checked completely without using either a second vector pattern or resorting to time-base observations.

In checking the relative merits of the techniques using vector and time-base waveforms, it was assumed that most service problems can be divided into four broad categories: 1) complete or partial loss of signal in one or more color-difference channels, 2) phase shift in the axes of both demodulators, 3)

Fig. 6 Vector patterns using G-Y signal

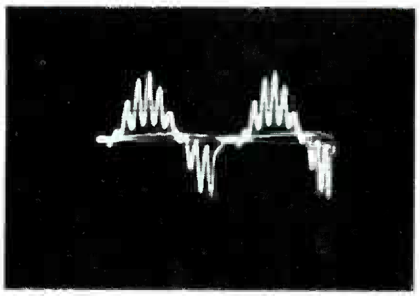


A) G-Y horizontal, R-Y vertical

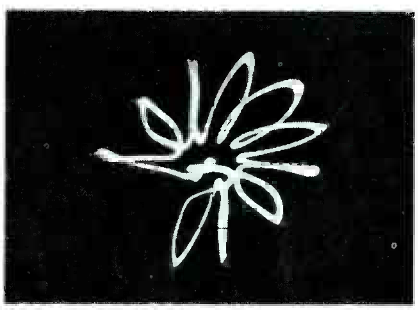


B) G-Y horizontal, B-Y vertical

Fig. 7 Waveforms with R-Y axis shifted

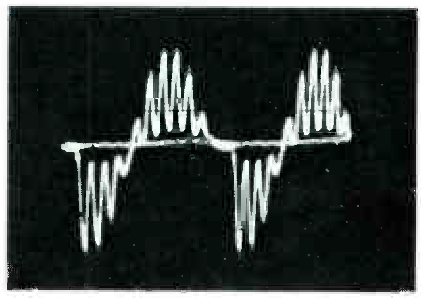


A) Time-base waveform of R-Y

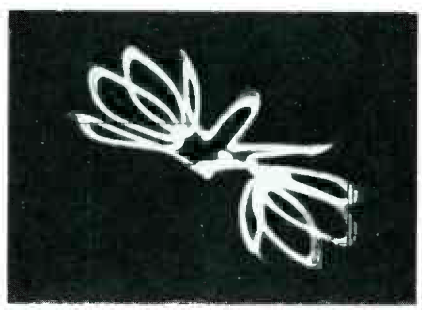


B) Vector waveform

Fig. 8 Waveforms with B-Y axis shifted



A) Time-base waveform of B-Y



B) Vector waveform

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phase shift in the demodulation axis of one demodulator, and 4) problems caused by incorrect bandpass of the receiver.

The first of these types of troubles could be analyzed about as well with either technique, since amplitude of the signals was the item of concern. We found the time-base waveforms somewhat more convenient, since the scope being used had no ready method of calibrating the horizontal gain; but this might not be true of the vectorscopes used in many shops. Troubles in the second category, phase of both demodulation axes shifted in the same direction (as when the tint control is misadjusted or the AFPC circuits are out of alignment), were analyzed about as easily with either technique. It made little difference whether we checked to see that the third petal was vertical or that the sixth bar of the R-Y signal was nulled.

For the next comparison, the phase-shift network between the reference oscillator and the R-Y demodulator was "bugged" so that the phase was shifted about 30° from normal. When the time-base waveform was observed, it was noted that the null was at approximately the seventh bar instead of the sixth. When the vector patern was viewed, the pattern had become elongated along an axis extending from the upper right to the lower left. Photographs of these two waveforms are shown in Figs. 7A and 7B. The B-Y demodulator was "bugged" in the same fashion; the resulting waveforms are shown in Figs. 8A and 8B.

As a final comparison, the patterns produced by a misaligned receiver were observed. The receiver first was misaligned by turning the core of the chroma take-off coil about two turns. The waveforms which resulted appear in Fig. 9. By comparing these time-base waveforms with those in Figs. 5, 7, and 8, it can be noted that the distortions produced by misalignment are similar in appearance to those which result from demodulator phase shift. Such is not the case with the vector patterns. Note particularly the appearance of the third, sixth, and ninth petals.

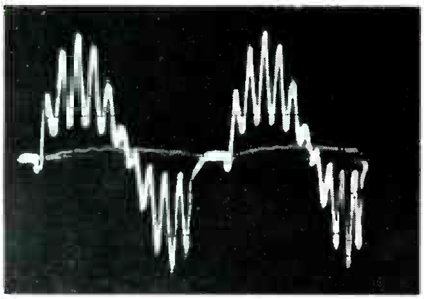
After the receiver was realigned, the 41.25-MHz trap, located in the input circuit of the first IF amplifier, was tuned deliberately into the receiver passband. This produced the series of waveforms in Fig. 10. Again, we found that the vector pattern gave a more definitive indication than did the time-base waveforms. Also, it was noted that both the chroma take-off coil and the trap could be returned to the correct frequency by observing the vector pattern, but not by watching the time-base waveform. Of couse, it is unlikely that a receiver with several tuned circuits out of adjustment could be aligned using only the vector pattern.

Summary

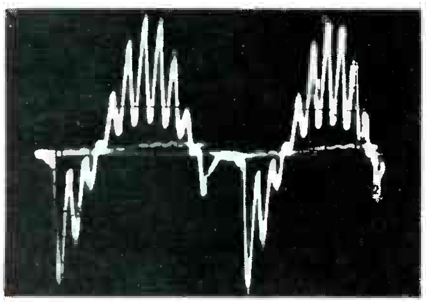
From the series of tests made in preparing this article, it appears that several servicing routines can be simplified by use of vector analysis techniques, although the same problems can be solved by conventional methods.

If a vectorscope is to be used, it is mandatory that its characteristics be thoroughly learned to get the most benefit from it. It is suggested that the experiments described here be duplicated as a first step in this familiarization, and that a little extra time be taken to use both techniques, vector and time-base waveform analysis, on a number of receivers before the vectorscope and the technician decide to "go steady". ▲

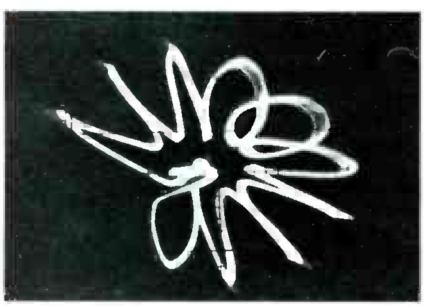
Fig. 9 Waveforms with chroma misalignment



A) R-Y waveform

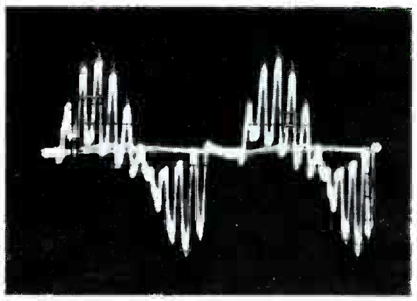


B) B-Y waveform

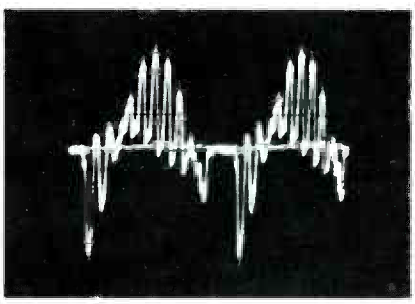


C) Vector waveform

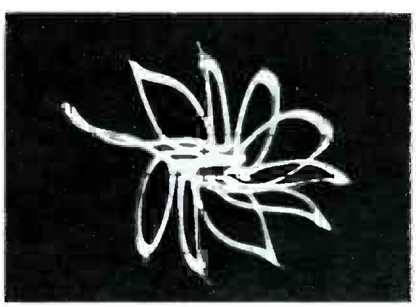
Fig. 10 Waveforms with IF misalignment



A) R-Y waveform



B) B-Y waveform



C) Vector waveform

Our hot ones are the last to go.

The last thing you need is to be called back a day or two after you've replaced the sweep or high voltage tubes in somebody's color TV.

But, they're usually the first to go.

Because they get so hot.

So we figured out how to cool them.

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Well, we've given it special patented radiator fins that first absorb the heat and then radiate it out of the tube.

Now it runs cooler and lasts longer.

Same for our 6JS6C.

Or take our 6BK4C/6EL4A. That's the shunt regulator that eliminates runaway high voltage. We gave this one a whole new anode and shield design to improve heat transfer and stability.

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Using the Scope and HD to track down distortion

by Robert G. Middleton

It is difficult, and sometimes impossible, to evaluate harmonic distortion with only a scope. For example, consider the sine-wave patterns illustrated in Fig. 1. Although no industry standards have been established, it is generally agreed that a hi-fi amplifier should have less than 1% harmonic distortion. The harmonic distortion in the waveform in Fig. 1A is within acceptable limits for a hi-fi amplifier; the other five waveforms are not within acceptable limts. Note that you cannot distinguish visually the difference in distortion between Fig. 1A and Fig. 1B.

Although a scope by itself cannot accurately indicate whether a sine-wave pattern has hi-fi charac-

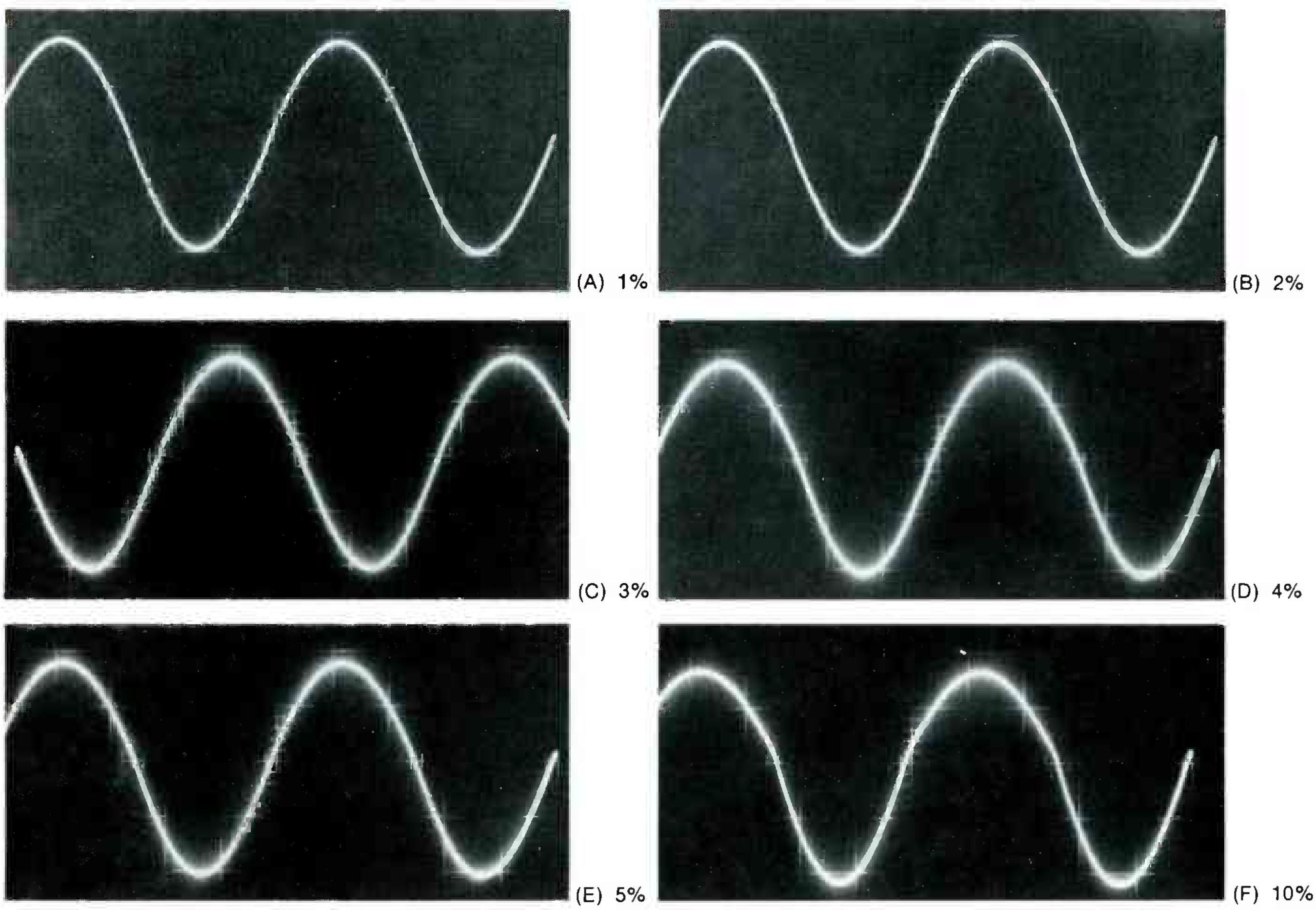


Fig. 1 Examples of harmonic distortion in sine waves.

Meter in Audio Amplifiers

teristics, do not jump to the conclusion that a scope is useless in tracking down distortion. You will find that a scope is the most useful supplementary instrument to use in conjunction with the basic hi-fi test instrument: the **harmonic distortion** (HD) **meter.**

The basic design of a harmonic-distortion meter is shown in Fig. 2. It contains a tunable frequency-reject filter, an amplifier, and a meter calibrated in percentage of harmonic distortion. In operation, the audio oscillator is set to the desired test frequency, such as 1 KHz, and the output from the amplifier is fed to the meter. An attenuator (not shown in Fig. 2) is then set for the reference calibration by bringing the meter pointer to full-scale indication. We are then ready to measure the percentage of harmonic distortion in the audio signal.

First, the function switch of the HD unit is thrown to the **Test** position. This places the reject filter in series with the signal path. When the filter is tuned to reject the fundamental component of the test frequency, the meter indicates a minimum value because only harmonic voltages then can pass through the filter. The amplifier in the HD unit can be adjusted for 100%, 30%, 10%, 3%, or 1% full-scale indication on the meter. This amplification of the harmonic signal permits an accurate reading, just as the lower voltage ranges on a VOM or VTVM permit accurate reading of small voltages.

Although the test procedure is relatively simple, there are certain technical points to be observed:

1. The audio oscillator should have considerably less distortion than the amplifier under test. Good service-type instruments have less than 1% HD, and lab-type instruments may be rated for as low as 0.05% HD.
2. An audio oscillator may be checked for distortion as shown in Fig. 3. As in most electronic units, tubes are the most common troublemakers, followed by defective capacitors. Remember that the HD meter itself can become defective and require servicing.
3. If an audio amplifier is being tested, as shown in Fig. 2, a power resistor of suitable value should be connected across the amplifier output terminals, and the output from the audio oscillator should be advanced to drive the amplifier to maximum-rated power output.

Distortion Characteristics of Scope Vertical Amplifier

A scope that is used in tracking down audio distortion should have a vertical amplifier with high-fidelity characteristics. Some service-type scopes have hi-fi response, and virtually all lab-type scopes employ vertical amplifiers with less than 1% harmonic distortion.

It is easy to check a vertical am-

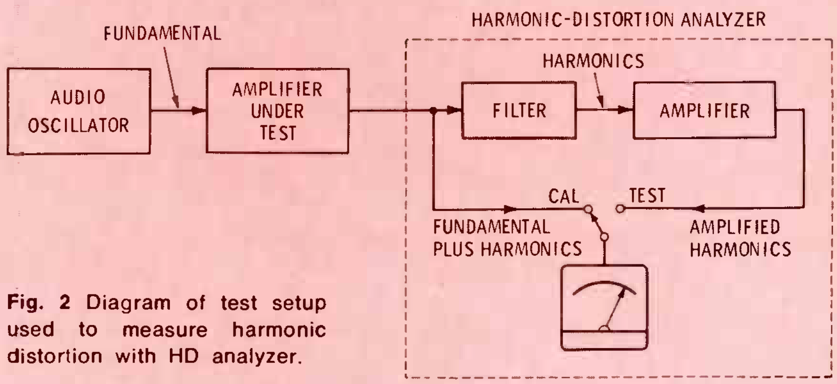


Fig. 2 Diagram of test setup used to measure harmonic distortion with HD analyzer.

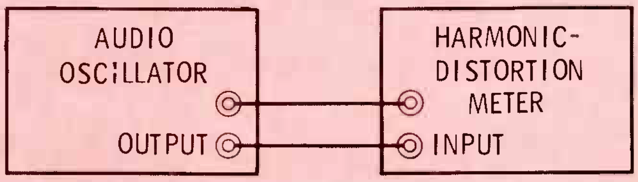


Fig. 3 Test setup for checking distortion of audio oscillator.

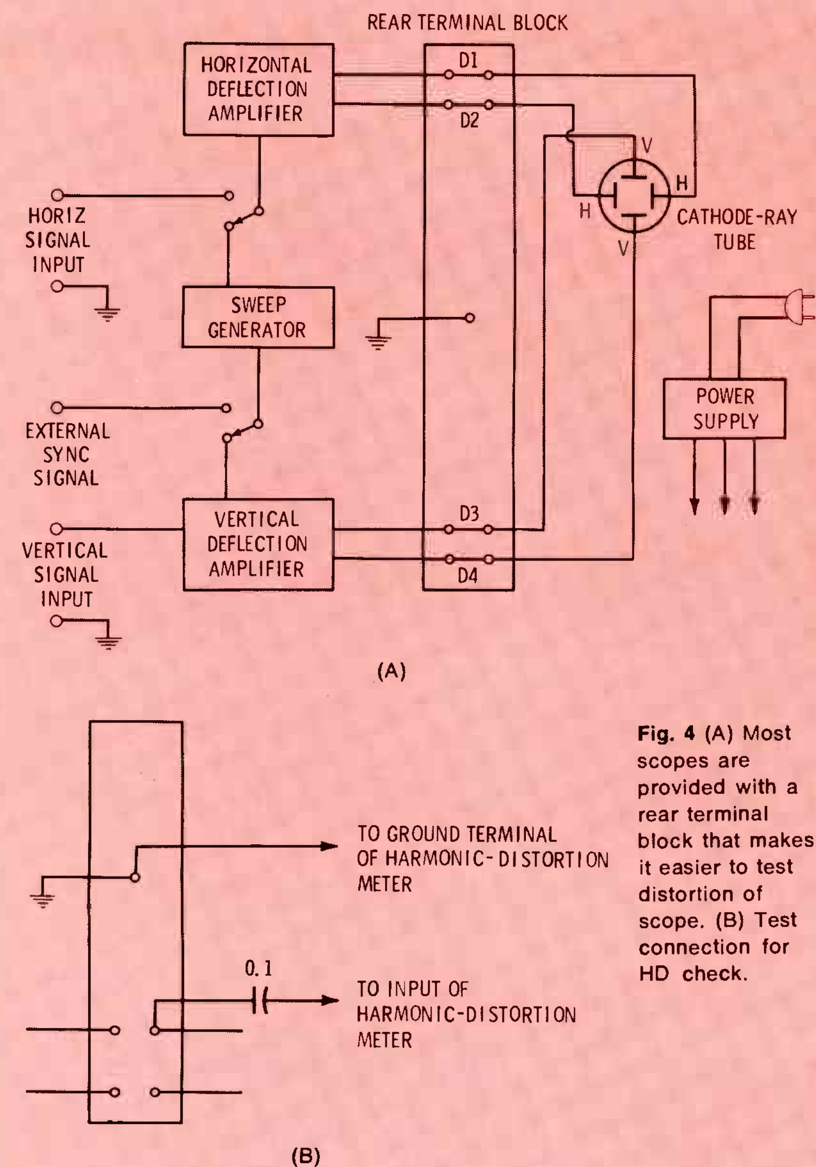


Fig. 4 (A) Most scopes are provided with a rear terminal block that makes it easier to test distortion of scope. (B) Test connection for HD check.

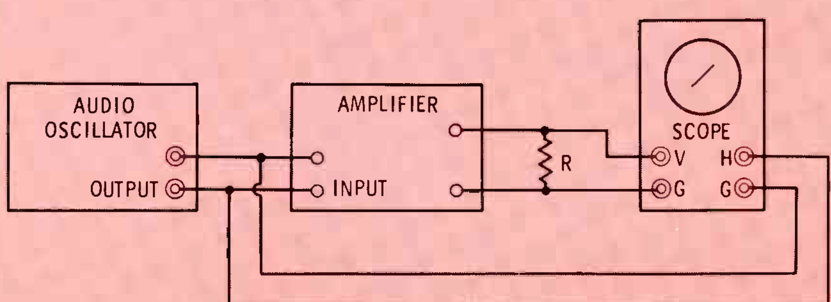


Fig. 5 Setup for input-output Lissajous scope test of harmonic distortion.

plifier for harmonic distortion, as illustrated in Fig. 4. A rear terminal block commonly is provided on the scope, which makes it easier to connect the scope to a harmonic-distortion meter.

Note that practically all scopes have double-ended (push-pull) drive to the CRT, whereas most HD meters have single-ended input. Therefore, couple **one** of the vertical-amplifier output terminals to the input of the HD meter, and ground the case of the scope to the case of the HD meter, as shown in Fig. 4B.

A low-distortion audio oscillator should be used to drive the scope in this test. The vertical-gain control of the scope is set to display the sine-wave pattern at normal height on the screen. The percentage of harmonic distortion is measured with the HD meter.

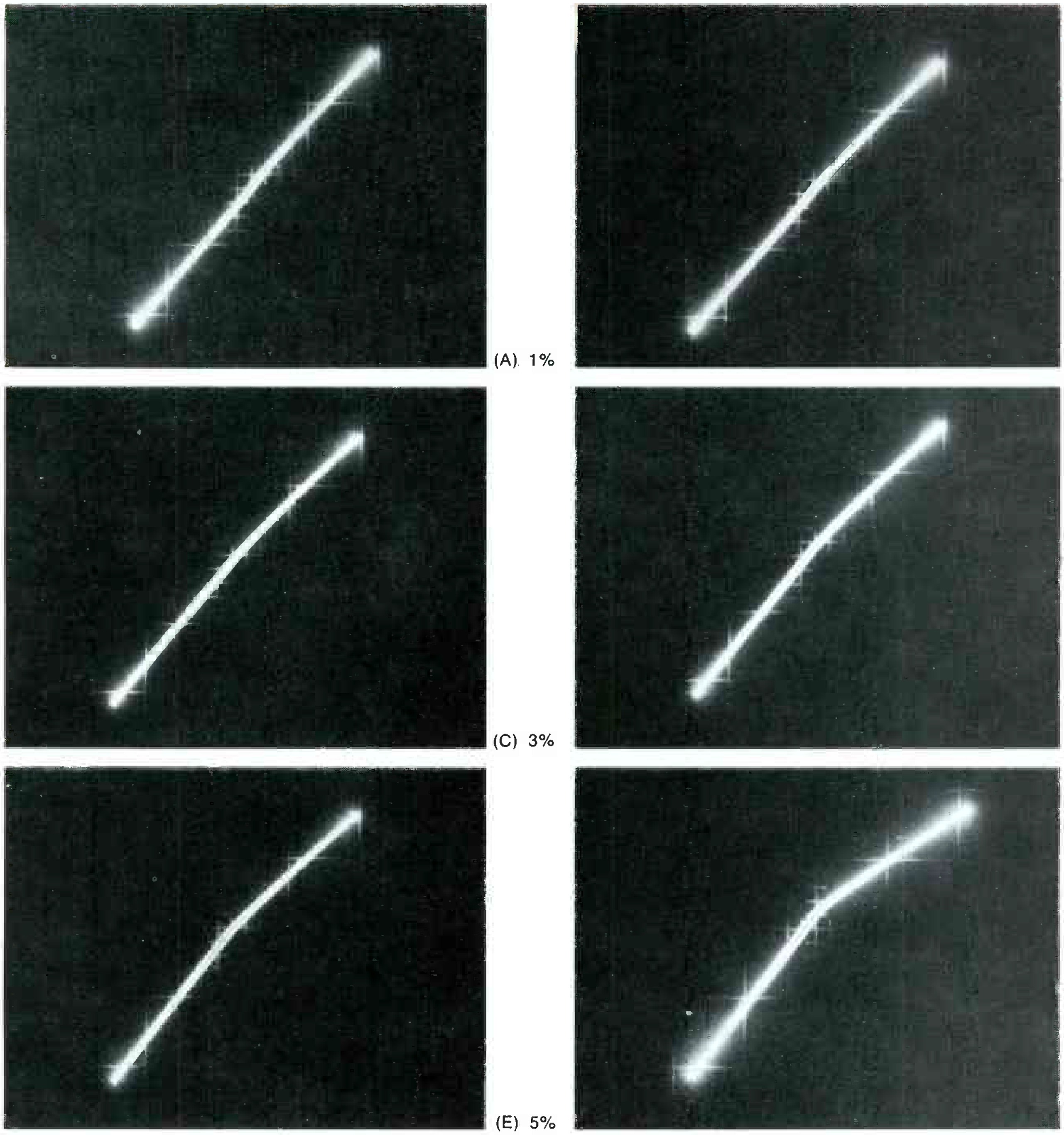
The foregoing procedure can also be applied to terminals D1 and D2 in Fig. 4A to measure the harmonic distortion in the horizontal amplifier of the scope. If you find that both the vertical and horizontal amplifier have very low distortion, the scope can be used to considerable advantage in tracking down distortion, as we shall discuss next.

Input-Output Lissajous Patterns

The test setup in Fig. 5 provides an input-output Lissajous pattern. That is, the input signal is fed to the horizontal amplifier, and the output signal is fed to the vertical amplifier. Examples of how harmonic distortion is indicated by Lissajous figures are shown in Fig. 6. Notice that small percentages of harmonic distortion show up more clearly in this method than in the patterns illustrated in Fig. 1. For example, it is practically impossible to detect that the waveform in Fig. 1C has 3% distortion, whereas the line pattern in Fig. 6C shows definite curvature when examined closely.

The chief disadvantage of the test method depicted in Fig. 5 is that few service-type scopes have hi-fi vertical **and** horizontal amplifiers.

A perhaps unexpected advantage of the test method shown in Fig. 5 is that it drastically reduces the effects of any harmonic distortion in the audio oscillator. In other words, the **shapes** of the patterns in Fig. 6 will be the same, whether the audio oscillator has 0.05% distortion or 30% distortion. The reason for this independence is that the audio oscillator applies the same waveform to the amplifier under test and to the horizontal-input terminals of the scope (Fig. 5). The practical result is that distortion from the audio oscillator does not change the shape of the Lissajous figure, but merely causes various changes in **brightness** along the trace.



(A) 1%
(B) 2%
(C) 3%
(D) 4%
(E) 5%
(F) 10%

Fig. 6 Examples of harmonic distortion in Lissajous figures.

Use of Scope With Harmonic-Distortion Meter

Because the vertical amplifier of a service-type scope generally has much better characteristics than the horizontal amplifier, a scope is commonly used with a harmonic-distortion meter in the manner shown in Fig. 7. (Again, if the speaker is disconnected from the amplifier, a power resistor of suitable value should be substituted for it.) Measurement of harmonic distortion is usually made while the amplifier is driven to maximum rated power output. Most HD meters contain a built-in voltmeter for convenience in measuring the level of the audio voltage. Since power in watts is equal to E^2/R, if an amplifier is rated for a maximum power output of 10 watts, and works into a load of 8 ohms, the voltmeter of the HD unit will read approximately 9 volts at maximum power output.

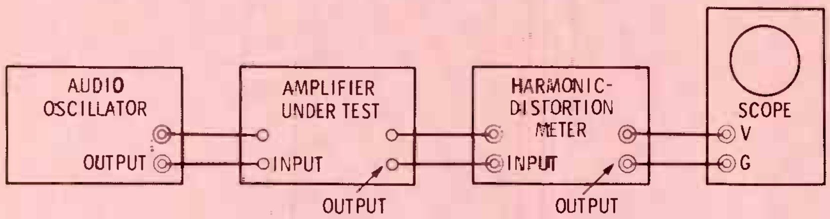


Fig. 7 Test setup for distortion measurement using oscilloscope and HD meter.

When the HD meter is set to its **Set Level** position in the test setup shown in Fig. 7, the scope pattern will be similar to the examples shown in Fig. 1. However, when the HD meter is switched to read the percentage of harmonic distortion, the scope will display the distortion components in the amplifier output waveform because the fundamental has been removed. Examples of such scope patterns are shown in Fig. 8. If the audio oscillator is tuned to 1 KHz, for example, 60-Hz or 120-Hz hum voltages will appear with the distortion products. When the audio oscillator is tuned to 60 Hz, any 60-Hz hum voltage would be rejected along with the fundamental frequency in the signal. If the scope is swept at a comparatively high rate, such as 500 Hz, hum voltages will show up as a thickening of the trace.

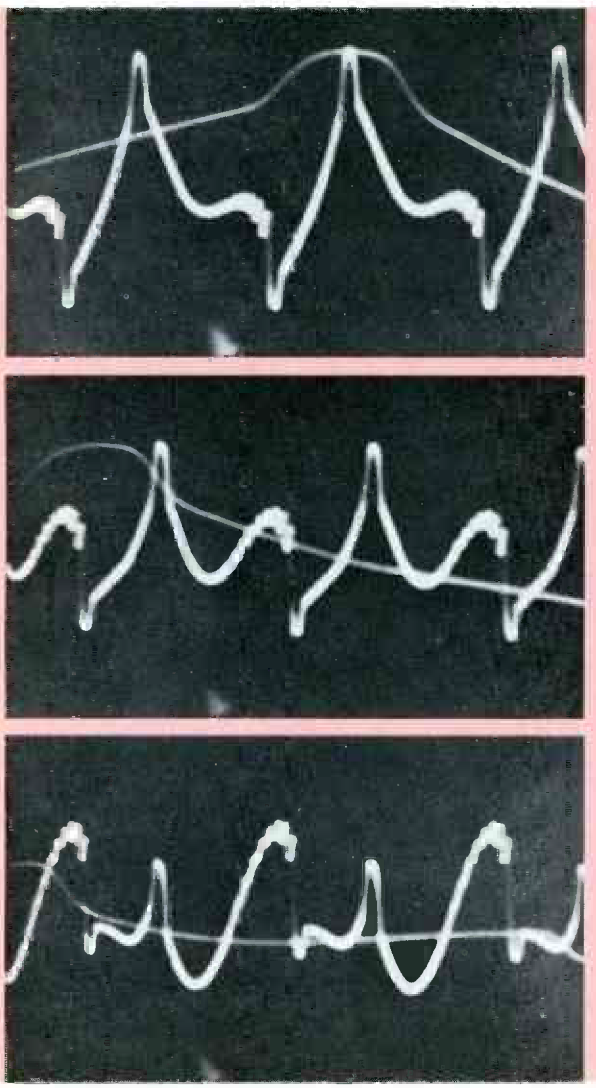


Fig. 8 Typical change in shape of a harmonic-distortion waveform as the harmonic-distortion meter is tuned through the null point.

Note the **peaks** in the patterns in Fig. 8. These peaks in the waveform are an important clue to one source of distortion: grid-current flow. Possible causes are a leaky coupling capacitor in the amplifier, or an equivalent defect that would cause low grid bias.

Also note the "wiggles" in the patterns in Fig. 8. These usually are caused by parasitic oscillation. Parasitic oscillation is often associated with grid-current flow. In other words, when a bias defect is corrected so that grid current does not flow, the parasitic oscillation is generally cleared up at the same time.

Distortion can be predominantly second-harmonic or third-harmonic. Consider the distortion-product waveform in Fig. 9. The sweep rate of the scope has been adjusted to display two complete cycles of the audio test signal (as shown in Fig. 1). The HD meter indicates 2% harmonic distortion. The distortion-product waveform has four peaks, compared with two peaks in the audio test signal; this indicates second-harmonic distortion. However, there also is some third-harmonic distortion present, which becomes more evident when the test signal from the audio oscillator is applied to the horizontal amplifier of the scope, the next procedure we shall discuss.

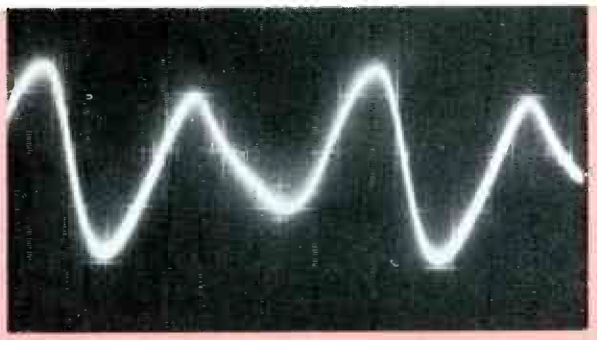


Fig. 9 A distortion-product waveform.

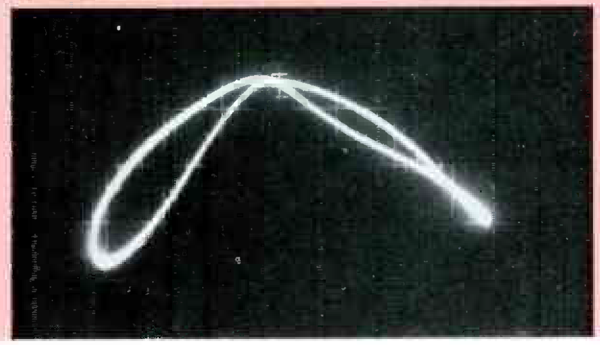


Fig. 10 A Lissajous distortion-product waveform.

Fig. 10 shows the Lissajous distortion-product pattern that is displayed when the scope is swept with the audio test signal. Observe that there is a crossover near the center of the pattern, and that there is another crossover near the right-hand end of the pattern. The rule of crossovers states that a second harmonic produces one crossover, and a third harmonic produces two crossovers. Therefore, we know that both second- and third-harmonic distortion products are present in the waveform in Fig. 10. (A lab-type scope was used in this test, to insure that the distortion indicated in the pattern was actually from the amplifier under test, and not from the scope.)

The basic Lissajous figure with one crossover is shown in Fig. 11. In this example, the two waveforms start at the same instant, and the "bow-tie" pattern is symmetrical. However, a distortion-product waveform is generally shifted considerably in phase with respect to the fundamental. In turn, a "bow-tie" pattern may assure the sequence of shapes depicted in Fig. 12. For example, compare the basic curvature in the pattern of Fig. 10 with the curvature in the pattern of Fig. 12B. Always evaluate all distortion-product patterns with respect to phase shift, as well as noting the number of peaks or the number of crossovers in a pattern.

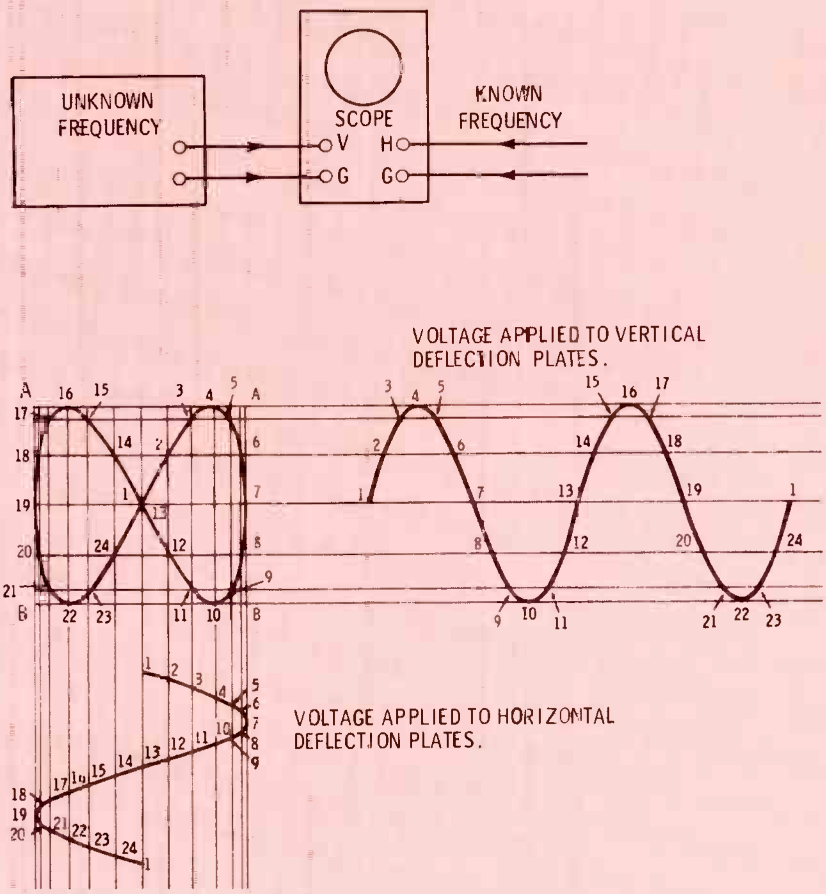


Fig. 11 Generation of Lissajous patterns.

Signal-Injection Tests

The test setup shown in Fig. 7 is an over-all harmonic-distortion test. To isolate the specific source of distortion is an amplifier, signal-injection tests often are very helpful. For example, an over-all test of the two-stage amplifier in Fig. 13 might indicate an excessive amount of harmonic distortion. It then must be determined whether the distortion is being caused by a defect in the first stage, in the second stage, or possibly in both stages.

The logical procedure is to couple the audio oscillator to the base of the second transistor, and measure the harmonic distortion produced by the second stage. (The output from the audio oscillator should be coupled to the base of the second transistor through a 5-mfd capacitor, to avoid DC voltage drain-off.)

The result of the foregoing signal-injection test can be evaluated as follows:

1. If the percentage of distortion produced by the second stage is almost the same as the over-all value, the source of the trouble probably will be found in the second stage.
2. If the percentage of distortion produced by the second stage is tolerable, such as 1% or less, the source of the trouble probaby will be found in the first stage.
3. If the percentage of distortion of the second stage is a substantial fraction of the over-all value, there is a defect in each stage (such as leaky capacitors), or a defect common to both stages (such as subnormal supply voltage).

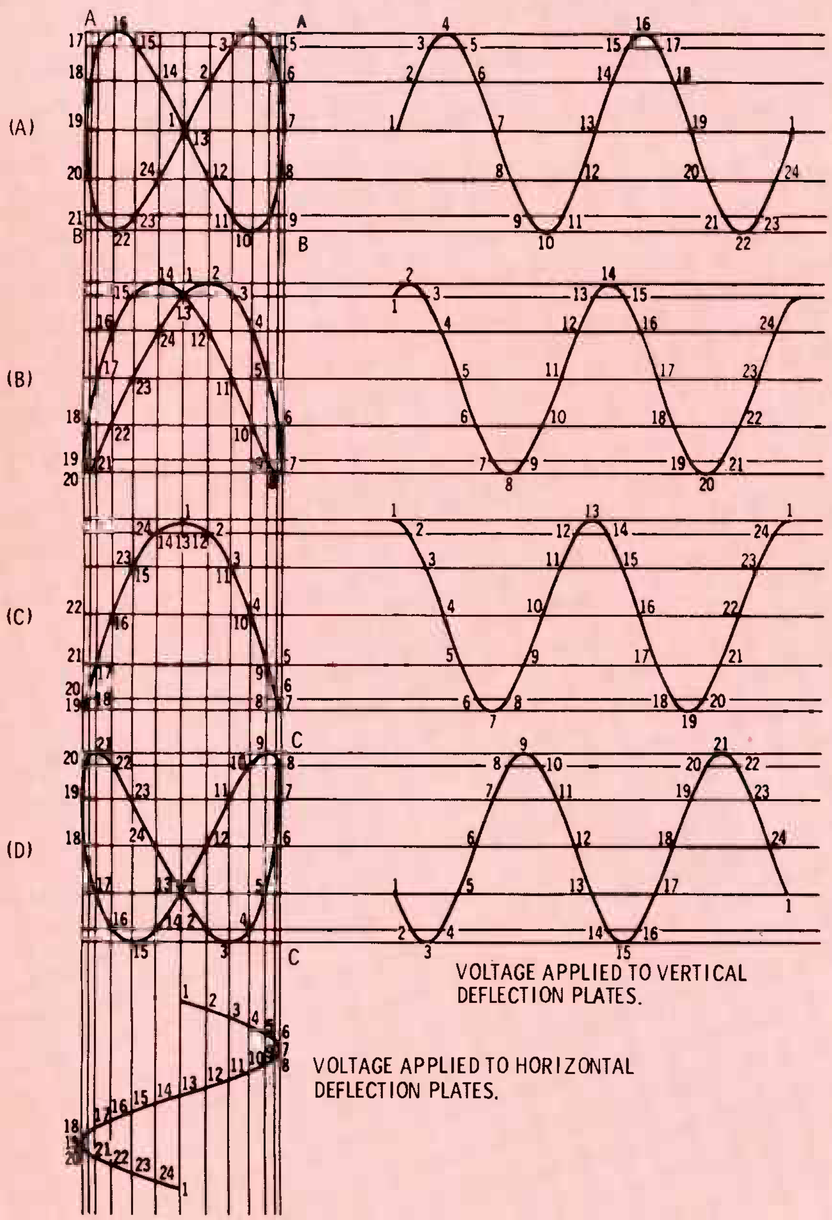


Fig. 12 Effect of phase variation on aspect of a "bow-tie" Lissajous pattern.

Signal-Tracing Tests

Some technicians prefer to make signal-tracing tests, instead of signal-injection tests. Signal-tracing tests are feasible in most cases, because the input resistance of a harmonic-distortion meter is fairly high (300,000 ohms is typical).

To measure the distortion produced by the first stage in Fig. 13, the HD meter can be connected to the collector of the first transistor. In this example, a blocking capacitor is not required, because only a slight amount of current is drawn by a shunt resistance of 300,000 ohms. However, when testing tube-type amplifiers that operate with comparatively high plate voltage, it is good practice to connect a 0.25-mfd blocking capacitor in series with the input lead to the HD meter.

Tracking down distortion in a circuit like the one in Fig. 13 is relatively simple because there is no feedback loop from the output stage to the input stage. On the other hand, when a negative-feedback loop is present, such as in the circuit in Fig. 14, the signal applied by the feedback loop to the input stage might need to be taken into account when the test results are evaluated. For example, when an over-all test of the circuit in Fig. 14 shows that

an objectionably high percentage of harmonic distortion is present, a single measurement will not be sufficient to track down the specific cause of the distortion.

If distortion occurs in either the first stage or the second stage in Fig. 14, the output signal from Q2 will be distorted accordingly. Since a sample of the output signal is fed back to the emitter of Q1, the collector output from Q1 will contain distortion products, whether the source of distortion happens to be in the first stage or the second stage. Therefore, a harmonic-distortion measurement at the collector of Q1 is meaningless, by itself. However, if you also make a harmonic-distortion measurement at the emitter of Q1, you then can conclude whether the source of the distortion is in the first stage, or not. The evaluation can be made as follows:

1. If the HD meter indicates practically the same percentage of distortion when connected to the emitter and when connected to the collector of Q1, the Q1 stage is not causing the distortion. That is, the trouble will be found in the second stage.
2. If the HD meter indicates substantially more distortion when connected to the collector of Q1 than when connected to the emitter of Q1, the circuitry of Q1 is causing the distortion.

Another method of localization also can be employed: Make the configuration in Fig. 14 equivalent to that of Fig. 14, opening the feedback loop between the collector of Q2 and the emitter of Q1. Although the system distortion is thereby increased, the process of tracking down the source of the distortion becomes simpler because there is no interaction between the output and input stages. With the audio-oscillator signal applied to the first stage, connect the HD meter to the collector of Q1 in Fig. 14 to determine whether the trouble is in the first or second stage. Since the feedback loop is open, the evaluation can be made as follows:

1. If the HD meter reads a low value, such as 1% or less, the first stage is operating acceptably, and the source of the trouble probably will be found in the second stage.
2. If the HD meter reads an objectionably high value, there probably is a defect in the first stage.
3. In case the HD meter reads an appreciably higher value at the collector of Q2 when there is an objectionably high value of distortion at the collector of Q1, defects are present in both stages.

Capacitors are the most common causes of distortion; collector leakage in transistors also can cause dis-

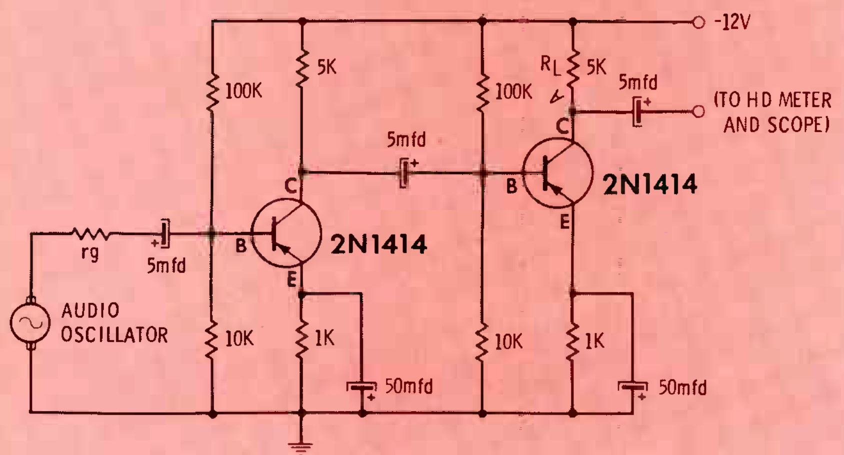


Fig. 13 HD measurement in a simple two-stage audio amplifier.

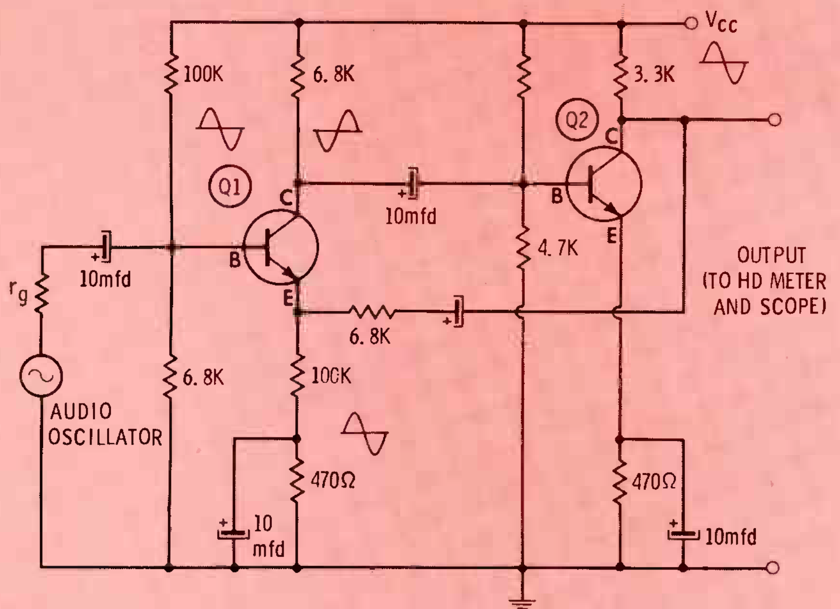


Fig. 14 A more complex two-stage audio amplifier with a negative-feedback loop.

tortion. Leaky capacitors usually can be isolated by DC voltage measurements. On the other hand, open capacitors are isolated either by signal-tracing with a scope, or by bridging the suspect with a known good capacitor. Collector leakage in a transistor causes a change in DC voltage distribution, and in case of doubt whether abnormal voltages are caused by a defective capacitor or by a defective transistor, it is advisable to disconnect one end of the capacitor for test. After the defective component has been replaced, do not forget to re-connect the feedback loop, so that the amplifier operates normally with minimum distortion.

Tests in Push-Pull Stages

Tracking down distortion in transformer-coupled push-pull stages is complicated by the interaction of the two circuit sections. If the upper push-pull transistor in Fig. 15 has excessive collector leakage, and is producing distortion, a distorted waveform will appear initially at the collector of this transistor; however, it is then coupled via the primary of the output transformer to the collector of the lower push-pull transistor. Consequently, distortion measurements at the collectors of the individual transistors will give practically the same reading, regardless of the location of the defect.

In this type of circuit, it is advisable to make an overall HD test first. If the reading is excessively high, first check the driver stage by connecting the HD meter at the collector of the driver transistor (Fig. 15). If a satisfactorily low reading is observed, the trouble probably will be found in the push-pull section. The best approach is to make DC voltage measurements in the push-pull stage, and to compare the values with those specified in the receiver service data. This procedure will pinpoint a transistor with collector leakage, or an off-value bias resistor. As noted previously, suspected open capacitors in the feedback loop or in the supply circuit are easily checked by means of a scope, or by bridging with a new capacitor.

Conclusion

This article has considered the use of a harmonic distortion meter, supplemented by the scope, to track down distortion in audio amplifiers. The HD meter is one of the least-understood basic audio instruments. Its utility is obvious when we attempt to evaluate small percentages of distortion in audio signals; even the most experienced technician cannot detect the presence of 2% or 3% distortion in a sine wave displayed on a scope.

We have discussed the fact that oscilloscope amplifiers might not have hi-fi response. Unless the scope amplifiers are better than the hi-fi unit under test, it is pointless to try to track down distortion by means of input-output Lissajous figures. It also has been pointed out that the harmonic distortion present in a scope amplifier can be measured with an HD meter.

It is very helpful to supplement an HD meter with a scope, because you then can observe whether the distortion is principally second-harmonic, third-harmonic, or a mixture of both. If distortion is being caused by grid-current flow in a tube, this fact shows up as peaks in distortion-product waveforms. Parasitic oscillation in a stage will show up as "wiggles" or "bulges" in a distortion-product waveform.

The utility of both signal-tracing and signal-injection tests in tracking down distortion has been reviewed. It has been observed that signal-tracing procedures are more desirable when analyzing distortion produced within a negative-feedback loop. In other configurations, signal-tracing and signal-injection procedures are equally applicable. As a further diagnostic aid, a feedback loop often can be opened for test purposes.

Push-pull amplifiers with transformer coupling require a somewhat indirect approach, because a distorted signal from one side of the circuit is coupled into the other side of the circuit. Since AC defects often are accompanied by localized abnormal DC voltages, it is usually helpful to make systematic DC voltage measurements. ▲

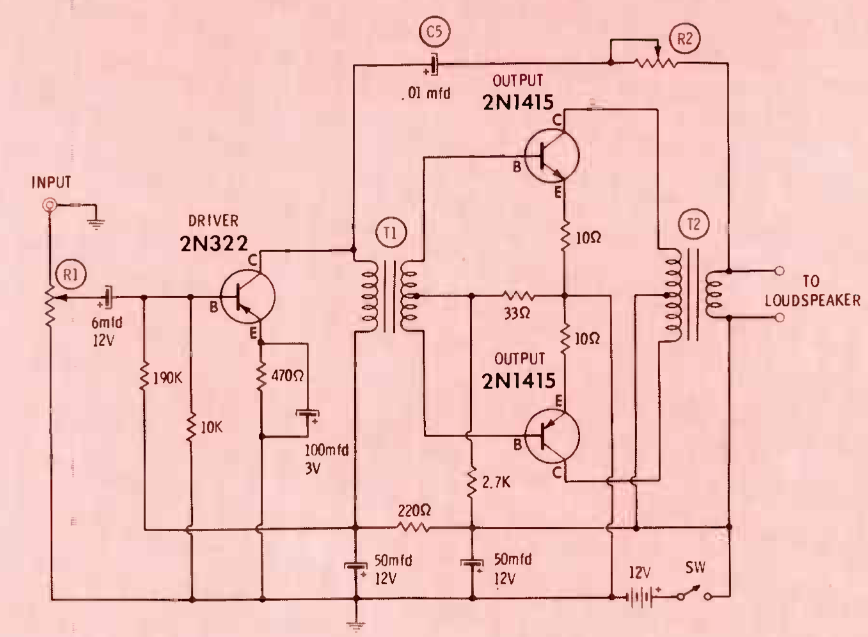
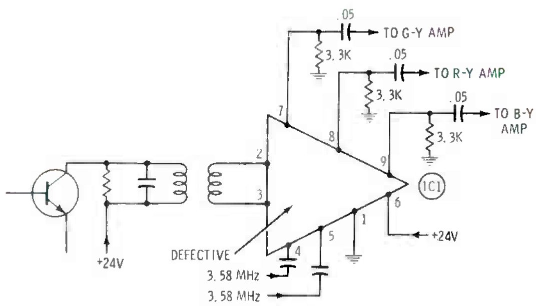


Fig. 15 Audio amplifier with a push-pull output configuration.

symcure

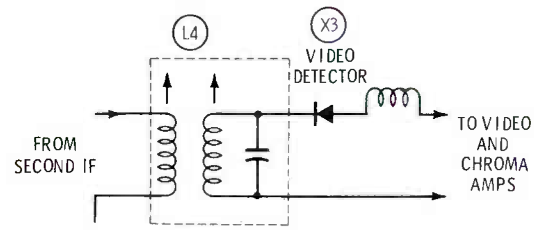
Symptoms and cures compiled from field reports of recurring troubles

Chassis—Zenith 12A10C15
PHOTOFACT folder—1067-2



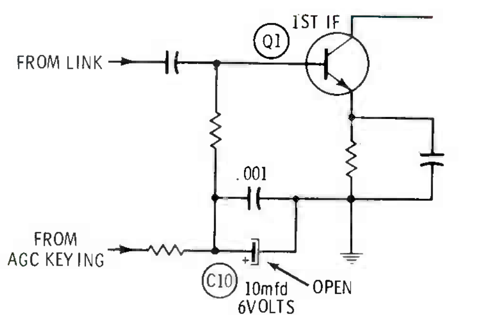
Symptom—raster is reddish when burst is received
Cure—replace integrated circuit IC1

Chassis—RCA CTC36
PHOTOFACT folder—1012-2



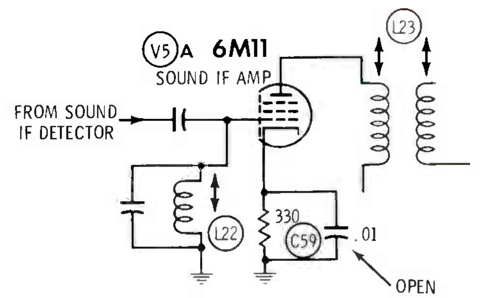
Symptom—AGC overload; very little snow off channel
Cure—check and, if defective, replace the video detector diode, X3

Chassis—Packard Bell 98C19
PHOTOFACT folder—1019-1



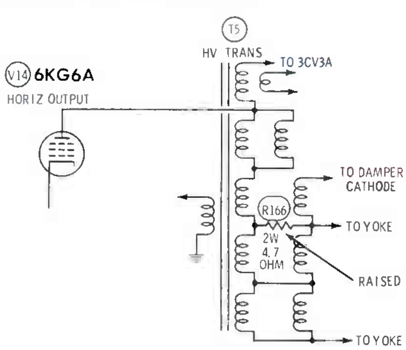
Symptom—vertical shimmy or poor vertical locking
Cure—replace C10, if it is open or has poor power factor. Use only a tantalum type capacitor

Chassis—General Electric KE
PHOTOFACT folder—1028-1



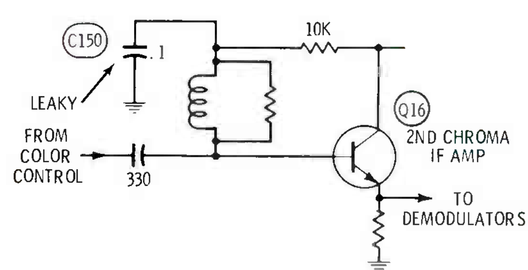
Symptom—intermittent audio buzz and distortion
Cure—replace C59

Chassis—Electrohome C5
PHOTOFACT folder—1044-1



Symptom—picture off-center toward the right
Cure—R166 increased in value; replace

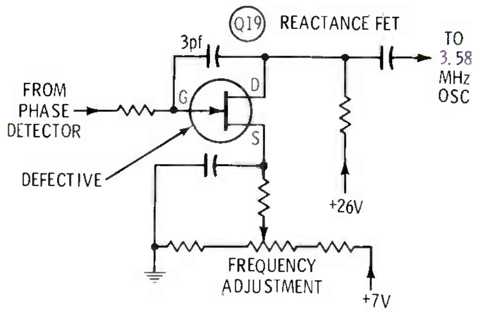
Chassis—Admiral K10
PHOTOFACT folder—1022-1



Symptom—weak or no color; base voltage low on Q16
Cure—replace shorted or leaky C150

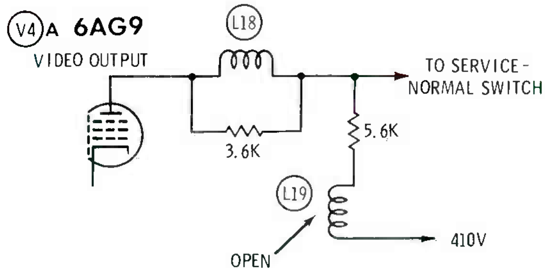
symcure

Chassis—Admiral K10
PHOTOFACT folder—1022-1



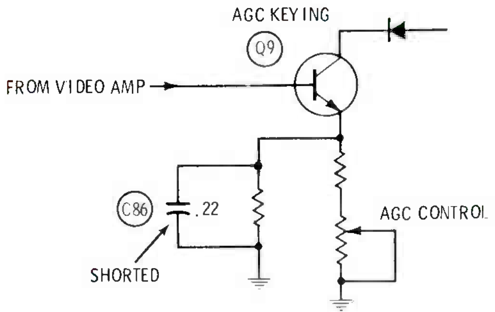
Symptom—no color locking
Cure—check or replace the reactance FET, Q19

Chassis—General Electric KE
PHOTOFACT folder—1028-1



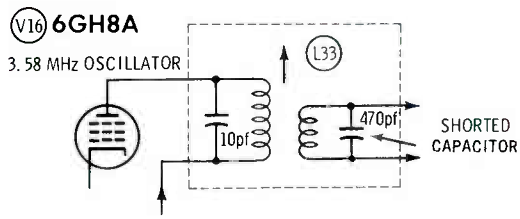
Symptom—high voltage decreased; picture blooms out, returns if CRT socket is removed
Cure—check for open L19; also, high-voltage rectifier might be damaged

Chassis—Admiral K10
PHOTOFACT folder—1022-1



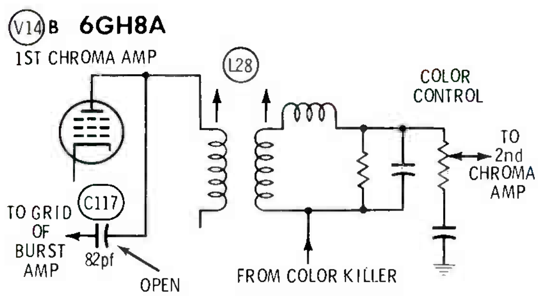
Symptom—no color; excessive AGC; no emitter voltage on Q9
Cure—replace shorted C86

Chassis—Philco 19QT87
PHOTOFACT folder—1026-3



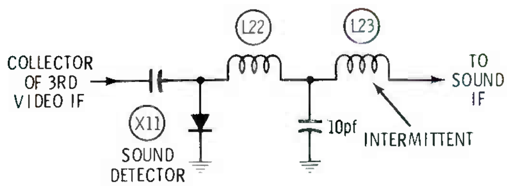
Symptom—weak green produced in place of all other colors
Cure—check for a shorted 470-pf capacitor across the secondary of L33. Remove the old one, but do not replace it

Chassis—Philco 19QT87
PHOTOFACT folder—1026-3



Symptom—poor color locking
Cure—check and, if open, replace C117

Chassis—Philco 19QT87
PHOTOFACT folder—1026-3



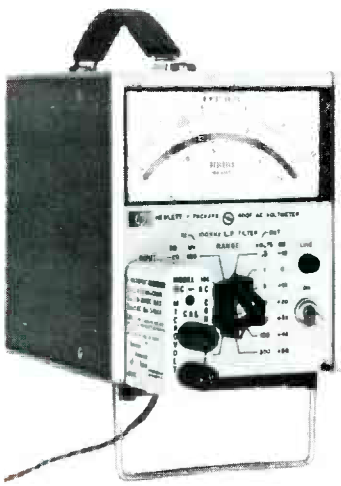
Symptom—volume of sound varies intermittently; picture normal
Cure—replace L23 ▲

testequipment

notes on analysis of test instruments, their operation and applications

Microvolt DC Meter

Electronic Applications Co. has announced the availability of their new Model 100 DC microvolt converter. This instrument will transform any AC millivolt meter into a



direct-reading DC microvolt meter with zero drift and 1 microvolt resolution, it is reported.

The manufacturer states that 1% accuracy is accomplished by the use of an ultra linear DC to AC converter.

Other features include 10-megohm input impedance and automatic polarity. It is stated that use of the Model 100 requires no AC millivolt meter modifications.

The price of Model 100 is $49.50.

Circle 50 on literature card

FET-Equipped Tube Tester

Instant readings without the need for tester warmup time reportedly is one new feature of SENCORE's updated version of their Mighty Mite Six tube tester, Model TC154.

Immediate readings after turn on and tube warm up are made possible by the use of a field-effect transistor (FET) in place of the vacuum tube previously used in the circuitry of the tester, according to the manufacturer.

Other changes include replacement of the function switch with push buttons, and the addition of another socket (bringing the total to 13) to enable technicians to check the most recent types of tubes, as well as tubes that were seldom used in the past but recently have become more popular.

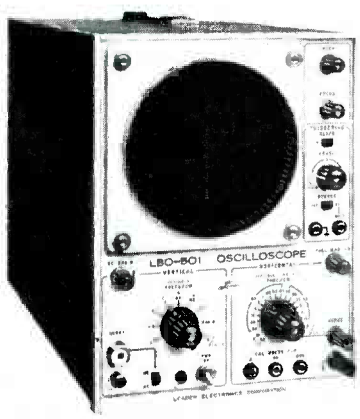
One other advantage realized from the use of an FET in place of the vacuum tube is that it eliminates the possibility of the leakage test being affected by the leakage of the tube used in the tester itself, according to Herb Bowden, president of SENCORE.

Model TC154, housed in a brushed steel and vinyl case, is priced at $89.50.

Circle 51 on literature card

Solid-State Triggered Scope

Leader Instrument's latest entry into the solid-state triggered-sweep oscilloscope field is the LBO-501. The 5-in. scope has a bandwidth of DC to 10 MHz. Features include triggered sweep, calibrated vertical



input and calibrated time base. A size and weight reduction has been effected by the extensive use of semiconductors, including a new solid-state high-voltage power supply, according to the manufacturer.

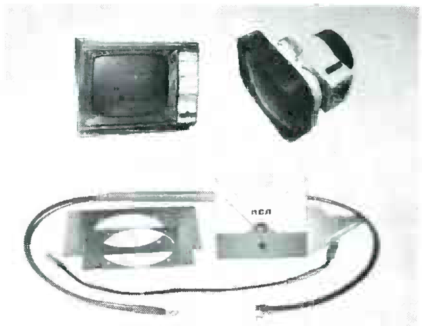
DC coupling enables the user to make precise measurements in the DC millivolt region where a meter cannot be used. The triggered sweep makes it useful for viewing complex waveforms, according to Leader. Special sweep positions for viewing horizontal and vertical TV are provided. Among the conveniences offered are a lighted graticule, sharp rise-time square waves for calibration, and a tilt stand for easier viewing. The vertical sensitivity is 20 mv pp/cm, and bandwidth is DC to 10 MHz. Triggered sweep range is from 0.2 us/cm to over 0.2 sec/cm.

Model LBO-501 measures 10½ in. X 8 in. X 16½ in. and weighs 20 lbs. The price is $339.50.

Circle 52 on literature card

High-Voltage Meter Kit For Color Test Jigs

A high-voltage meter kit that is designed for direct installation in RCA color test jigs and adaptation



to other brands of test jigs is announced by the Parts and Accessories Division of RCA.

The kit, No. 10J110, consists of a 3½-in. rectangular 50-μa meter calibrated for a range of 0 to 35 KV DC, with 70 scale divisions; a meter multiplier and cable assembly comprised of a special high-voltage resistor which reportedly is precisely calibrated under operating conditions and double encapsulated with insulation to withstand voltages as high as 50 KV DC; a meter ground lead for grounding the meter to the ground connection of the test jig; and mounting hardware and instructions for installation of the meter in RCA Color Test jigs Models 10J102, 10J103, 10J104, 10J105, and 11A1015A, or universal mounting in other brands of jigs.

Price is $24.95.

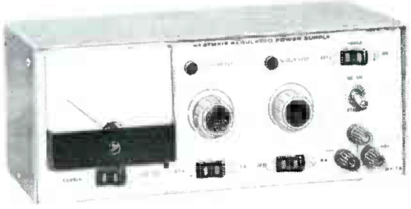
Circle 53 on literature card

Regulated Low-Voltage Supply

The new Heathkit Model IP-28, 1- to 30-volt, regulated, current-limiting, solid-state power supply, will deliver up to 30 volts DC at 1 amp maximum load with less than 50 mv variation. For more critical circuits in which the voltage drop across the supply leads is an important consideration, the Remote

Sensing feature of the IP-28 reduces the voltage variation at the load to less than 20 mv.

A front panel rocker switch selects either 1-10 volts DC or 1-30 volts DC ranges, and the output is continuously variable. Variable current limiting in two switch-selected



ranges from 10-100 ma or 10 ma-1 amp is also included to protect the load.

A 3½-in. meter can be switched to read either voltage or current, and two pilot lamps indicate which function is being monitored. For extra convenience, a DC On/Standby switch on the front panel removes voltage from the load for making circuit changes without having to disconnect leads. External AC and DC programming terminals for special applications are provided on the rear panel.

The new IP-28 reportedly can be assembled in about eight hours, with circuit board-wiring harness assembly. Price of the kit is $47.50.

Circle 54 on literature card

Push-button Multimeter

Olson Electronics Inc. has introduced Model TE-235, a push-button multimeter. It incorporates taut-band meter suspension; large push buttons are used for function and

range selectors. The expanded scale meter has a built-in mirror for parallax correction.

Characteristics

- Sensitivity: 30K ohms/volt
- DC Volts Range: 0-1, 2.5, 10, 50, 250, 1000 volts
- AC Volts Range: 0-2.5, 10, 50, 250 volts
- dB Range: −10 to +36 dB.
- Resistance: 0-5,000, 50K, 500K, 5 meg ohms
- DC Current: 0-5 μa, 100 ma, 250 ma, 500 ma, 10 amps.

The size of the Model TE-235 is 8½" x 5⅛" x 2 13/16". Batteries and test leads are included in the $39.98 price.

Circle 55 on literature card

Pin Tip Plugs

Four new pin tip plug models have been made available by Pomona Electronics Co., Inc.

Model 2072 Shorting Bar is used as a connecting link with equipment having pin jacks. Model 2192 Component Mounting Double Pin Tip Plug features set screws to secure leads; recess in body for mounting small components. Model 2953 adapter converts a Single Pin Tip Jack to a binding post. Model 2978 adapter converts a Double Pin Tip Jack to ¾-in. spaced binding post.

Shorting bar resistance less than 1.5 milliohms; current rating of

5 amps continuous, 10 amps intermittent. Tip Jacks are beryllium copper, gold flashed. Pin Tips are 0.080 in. diameter, nickel-plated brass.

Prices are: Model 2072, $0.75; Model 2192, $1.85; Model 2953, $1.35; and Model 2978, $2.25. ▲

Circle 56 on literature card

antenna systems report

UHF Amplifiers

UHF frequency amplification problems often found in large all-channel/on-channel MATV systems

desired in apartment buildings, schools, etc., reportedly have been met and solved by The Finney Company (FINCO), with their new M-174 and M-175 solid-state UHF amplifiers.

According to the manufacturer, the M-174 single-channel UHF amplifier offers a 30 ±3 dB gain with a 1-volt output on a single UHF channel, whereas the M-175 broadband UHF amplifier offers a 30 ±3 dB gain with a 1-volt composite output on all UHF channels. Both amplifiers have a 75-ohm single output, The Finney Company reports.

Model M-174 lists at $145.00, and Model M-175 sells for $160.00.

Circle 60 on literature card

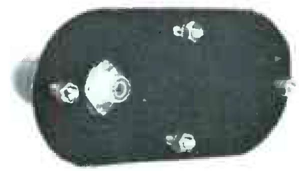
Vehicular Antennas

Now available from the Antenna Specialists Co. are two low-silouette, high-performance communications antennas for VHF and UHF frequencies.

Circle 32 on literature card

According to the manufacturer, the special-environment antennas are intended primarily for buses, trains, trucks, squadrols and similar vehicles operating in areas where communications are vital and antenna security may be a problem.

Encased in high-impace molded plastic and secured with heavy bolts from the inside, the antennas may be mounted in either vertical or



horizontal position. Model ASP-572 operates in the 450-to-570-MHz range, while Model ASP-571 operates in the high bands. The power ratings are 100 watts and the VSWR is 1.5/1 or better, Antenna Specialists reports. The radiation patterns are essentially omni-directional.

The cost of Model ASP-572 is $19.25, and Model ASP-571 sells for $29.95.

Circle 61 on literature card

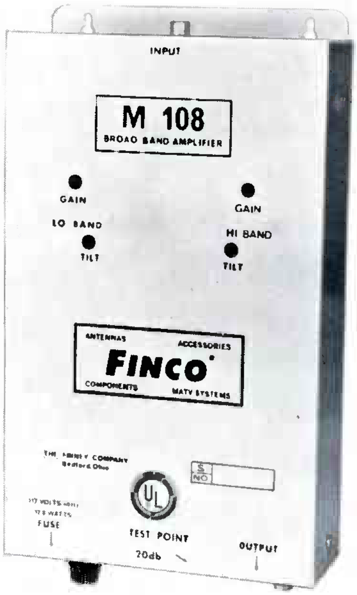
VHF Distribution Amplifier

Finco solid-state deluxe VHF distribution amplifiers (Models M-108 and M-109), designed for use in large hotel and apartment installations, are now available from the Finney Company.

The high-output, broad-band amplifiers offer a minimum gain of 40 dB on both high and low bands with individual gain control on both bands. Silicon overlay transistors in the driver and output stages provide a high-level output with very low intermodulation. Silicon transistors are used to eliminate temperature problems.

A variable slope control with a range of 6 dB is fitted in each band to compensate for the very long cable runs which the amplifiers can handle. A test point at –20 dB is provided at the amplifier output.

Electrical specifications are the same for both models, with the exception that Model M-109 has sep-



arate low-band and high-band input at 75 ohm. Both come with all matching connectors.

The price of Model M-108 is $165.00, and Model M-109 sells for $171.00. ▲

Circle 62 on literature card

Fig. 1 Sony portable color receiver using 12-inch Trinitron picture tube (11 inches viewable diagonal). It's all-solid-state.

The Sony One-Gun Color CRT

Design, theory of operation and convergence procedures

by Forest H. Belt

The Sony one-gun Trinitron* color picture tube often is confused with a different color CRT called the **chromatron,** which never got into a commercial set. But they're definitely not the same. Nor even much alike. To end any mixup, here's a thorough description of the Trinitron, how it works and what its advantages are.

Sets with 7- and 12-inch Trinitrons are already being sold in the U.S., and 16- and 18-inch versions are due later. One 11-inch (viewable diagonal) model is pictured in Fig. 1. For the most part, this little portable looks and operates much like any other color set.

That is, it does until you open it up and look for the adjustments.

*A Sony Trademark.

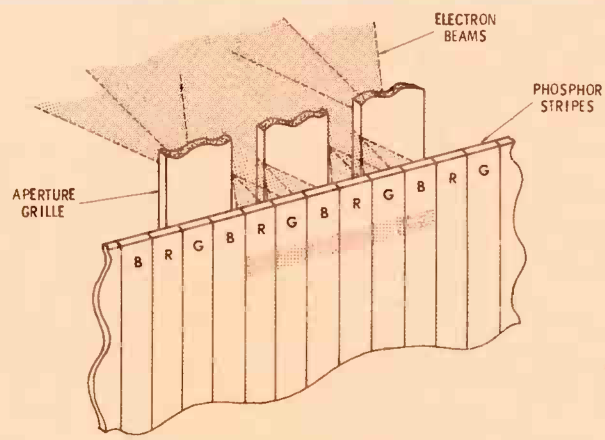


Fig. 2 Phosphors are deposited on screen in vertical stripes. Aperture grille is really a vertically slotted shadow mask.

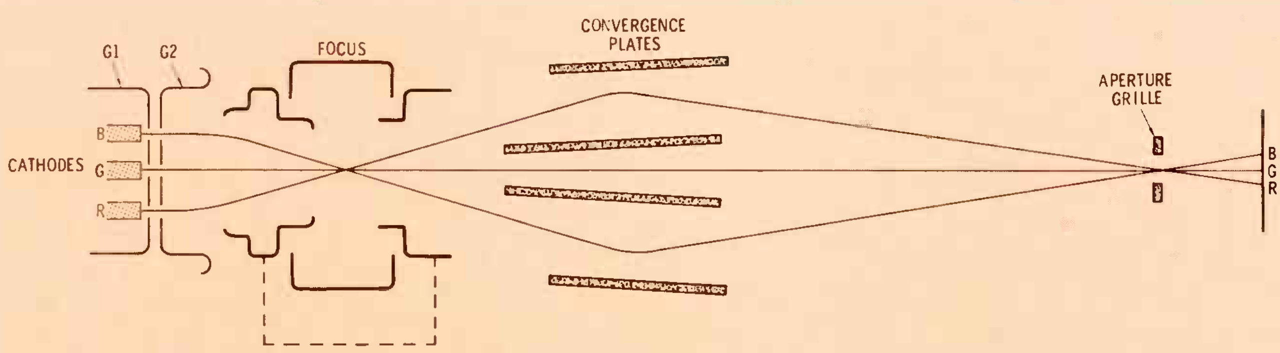


Fig. 3 Structure of Trinitron electron gun, which produces three beams. Simplicity makes surrounding circuits very simple.

Then it's a different story. There are so few—only a half-dozen, including convergence. That's a far cry from the couple dozen a conventional picture tube needs.

Color by Vertical Stripes

The first odd thing you notice about a Trinitron picture tube is its color phosphors. There are three primary colors—red, green, blue—just as in a regular color CRT. But these in the Trinitron are deposited on the tube face in vertical stripes, side by side. There's a red, then a green, then a blue; then another red, another green, another blue, and so on, as shown in Fig. 2.

The second unusual thing is the Trinitron shadow mask. It doesn't have holes like a conventional one. It has **slots.** It's not even called a shadow mask; it's called an **aperture grille.**

You can see its relationship to the phosphor stripes in Fig. 2. It's just behind the stripes, between them and the guns. The vertical slots line up with the green phosphor. Each slot is only as wide as one stripe. You can see from the sketch, the slots and stripes are both much narrower than the beam of electrons from the electron gun.

One Gun, Three Beams

To understand how the aperture grille works, you need to know what the electron gun of the Trinitron does.

Conventional color CRT's have three guns. The Trinitron has only one. But it puts out three beams. How that's done is illustrated in Fig. 3.

There are three cathodes. Each one emits a bunch of electrons that are gathered roughly into a beam when they go through a hole in the control grid, or G1. The three cathodes are in line horizontally—side by side—and so are the three holes in G1. Green is in the middle.

Another grid, G2, is an accelerating anode. It's also called the **screen** grid. It speeds up the electrons in the three beams as they

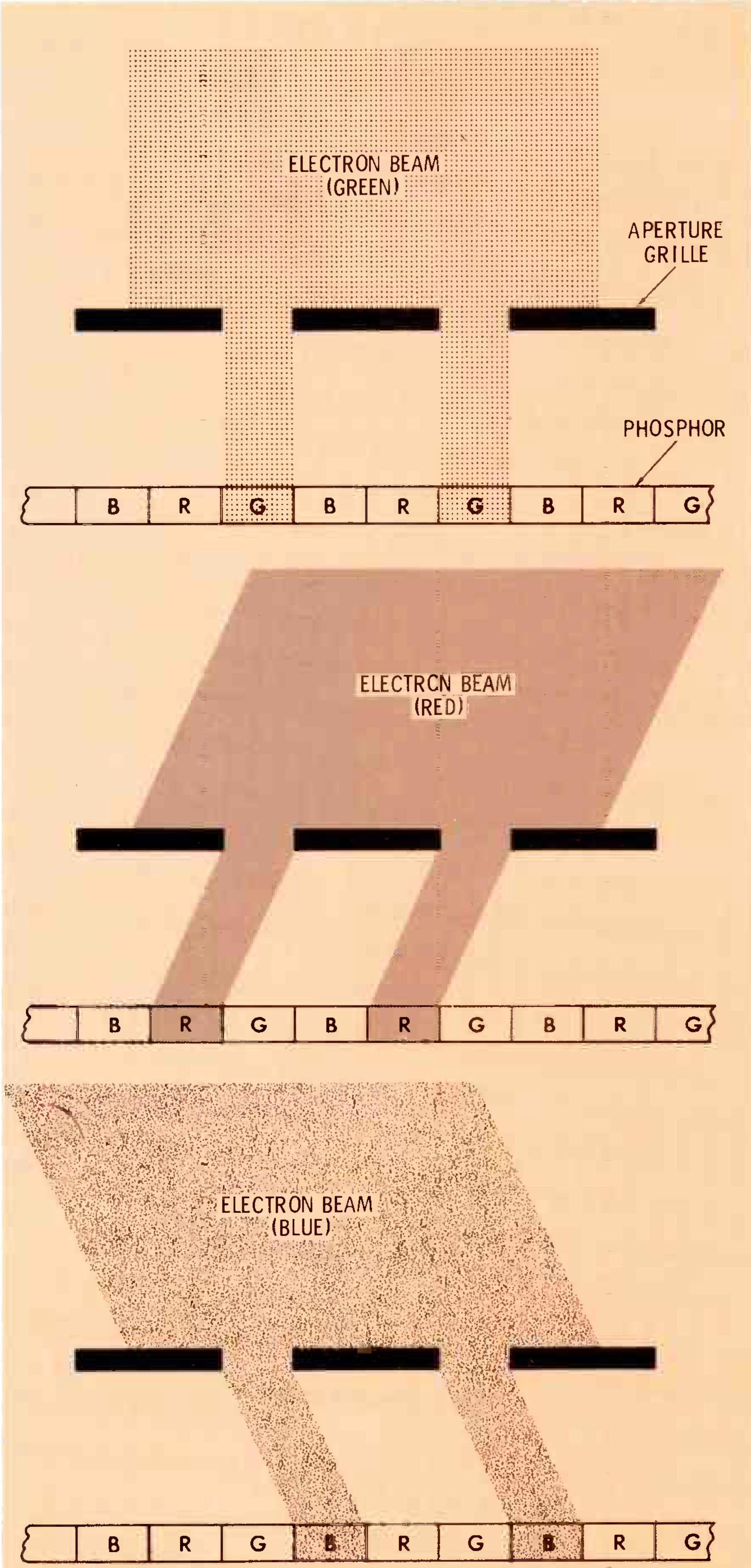


Fig. 4 Masking effect of aperture-grille slots. Angles of beams are adjusted so they illuminate only the phosphor for their own color.

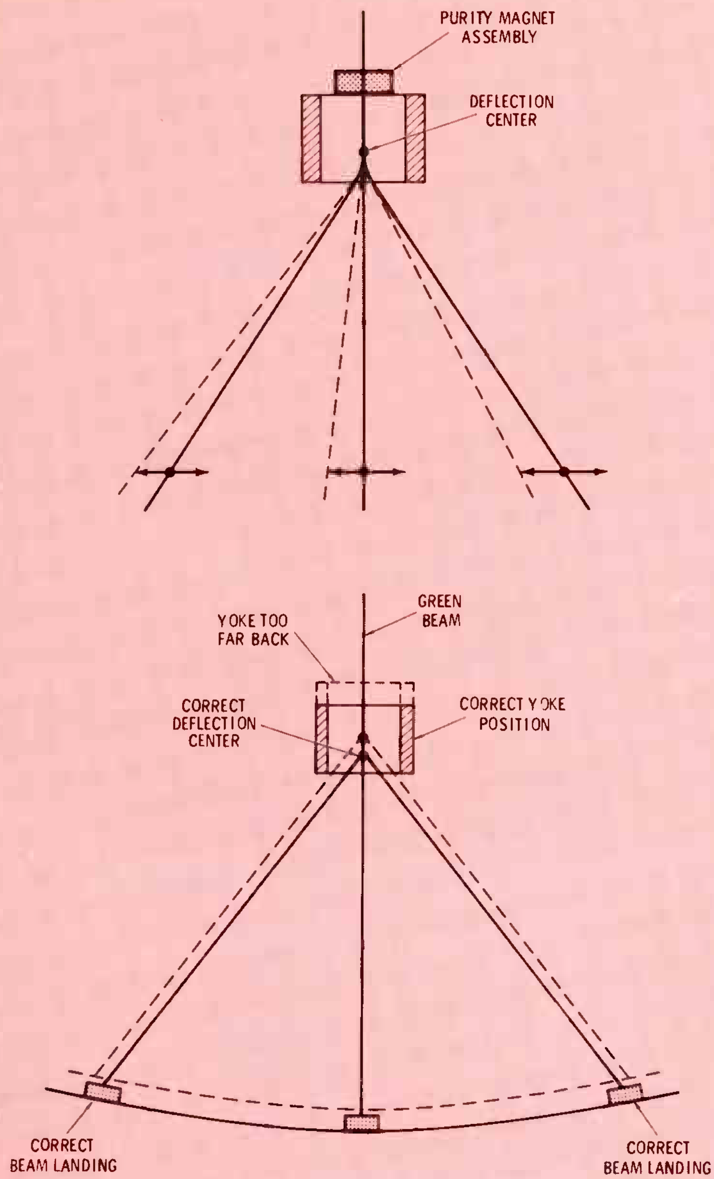


Fig. 5 Purity adjustment for center is with purity magnet; edge purity is adjusted by sliding yoke. Best to check green and red for purity.

pass through the three holes in the G2 structure.

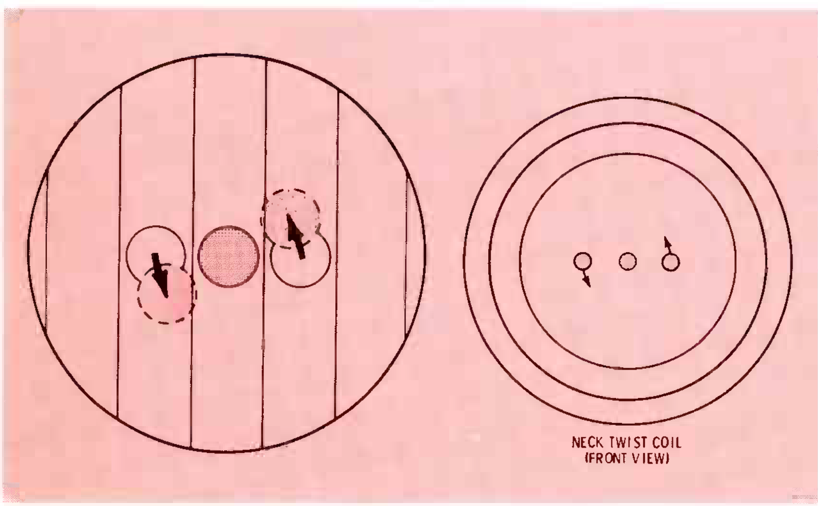
The beams, now with plenty of energy, enter the first of a set of focus elements. A DC field bends the blue and red beams toward the middle. At one spot inside this focus assembly, they cross over each other and the green beam. In the same process, each stream of electrons is concentrated into a tight, round beam. Green continues straight ahead. The red and blue beams angle off, aimed toward opposite edges of the screen.

Before they've gone very far, all three beams pass through an array of convergence plates. Those plates carry the same 19 KV supplied to the second anode. The static field and the shape of the plates bend the red and blue beams back toward each other and the green beam. If the voltage is exactly right, all three beams meet again (converge) right at the aperture grille.

One Color Per Beam

The aperture grille and its relationship to the deflection yoke are the key to color purity and easy convergence in the Trinitron.

First, look at Fig. 4 and how the aperture grille masks each of three beams. It allows each beam to hit



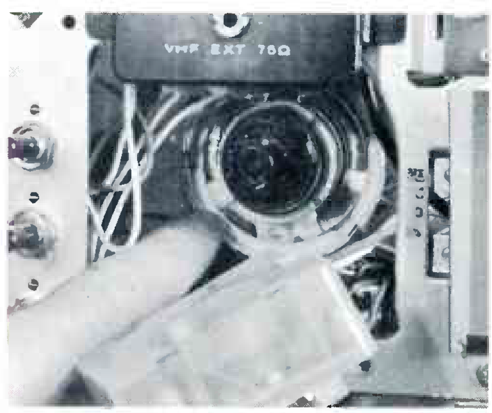


Fig. 6 Neck-twist coil is rotated to improve green purity. DC flowing in it keeps the three CRT beams lined up horizontally.

only the phosphor it's supposed to excite.

Each beam covers at least two of the slots in the grille. The green beam, coming straight in, hits green phosphor stripes. The red beam comes into the slots at an angle set by the convergence plates. It strikes two red stripes, but can't hit blue or green—the grille prevents it. Likewise, the blue beam, coming through the grille slots from the opposite angle, can't hit red or green stripes—only blue.

Getting purity in the center is easy. But when the yoke sweeps the beams, they could easily land wrong. The yoke has to be in just the right position along the CRT neck so the point of deflection (called **deflection center**) is correct. Fig. 5 illustrates this.

A purity magnet (Fig. 5A) mainly affects how the beams land near the center of the screen. The arrows show how shifting the magnet moves beam relationships. If you're adjusting the purity magnet, you try for best purity in the center. Use a green raster.

Fig. 5B illustrates yoke positioning. If it's too far back on the neck, the deflection center is out of position. Out near the edges, the beams don't go through the slots like they're supposed to. You adjust for best purity all over the screen by sliding the yoke forward or backward on the neck of the CRT.

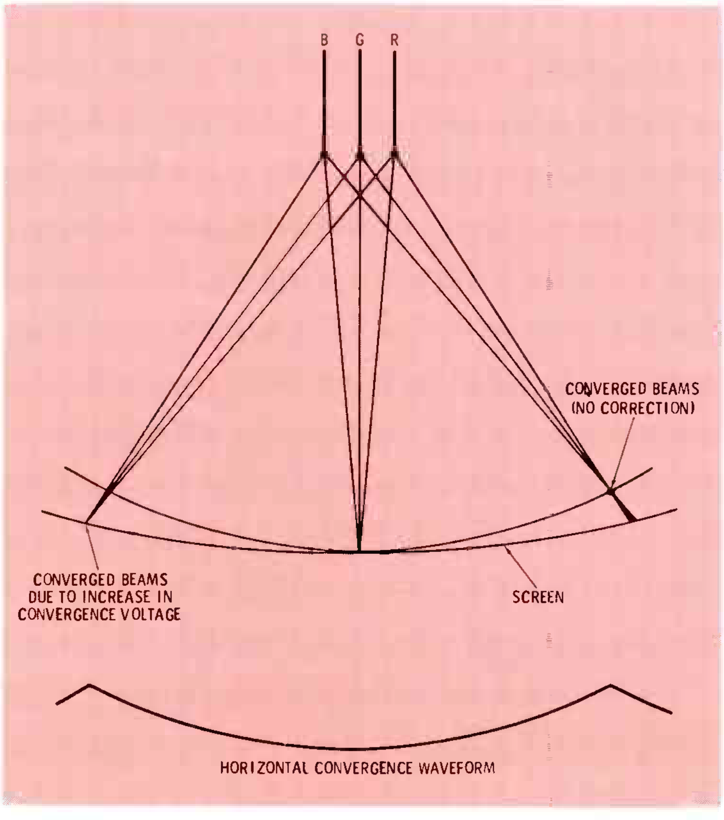
There's one more adjustment to assure that each beam lands on only its intended color. It's called the **Neck-Twist Coil.** Slight misalignment in the gun may keep the three beams from lining up horizontally. The effect is shown above the photo of the coil, in Fig. 6. The red or blue beam may spill over onto some green stripes. Turning the neck-twist coil corrects this. During adjustment, watch a red raster; this adjustment doesn't affect green.

Converging at the Edges

With purity as good as you can get it, turn your attention to keeping the beams going through the slots together all the way across the screen. The face of the Trinitron is only slightly convex. The angle of beam deflection inscribes a much shorter radius.

Fig. 7 illustrates what this does to the beams. The deflection point is further from the screen at the edges than at the center. If the beam crossover point stays the same distance from the gun, out near the edges the beams cross before they reach the aperture grille. That's misconvergence.

What's needed is something to lengthen their focal distance at the beginning of each line, let it return to normal as the beams sweep



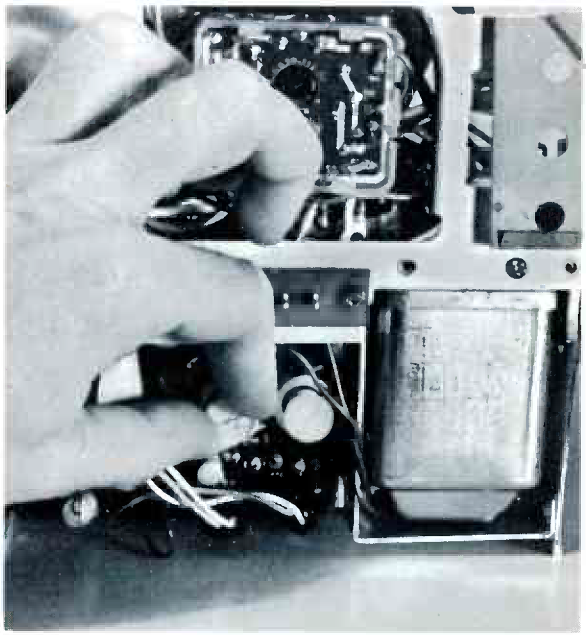
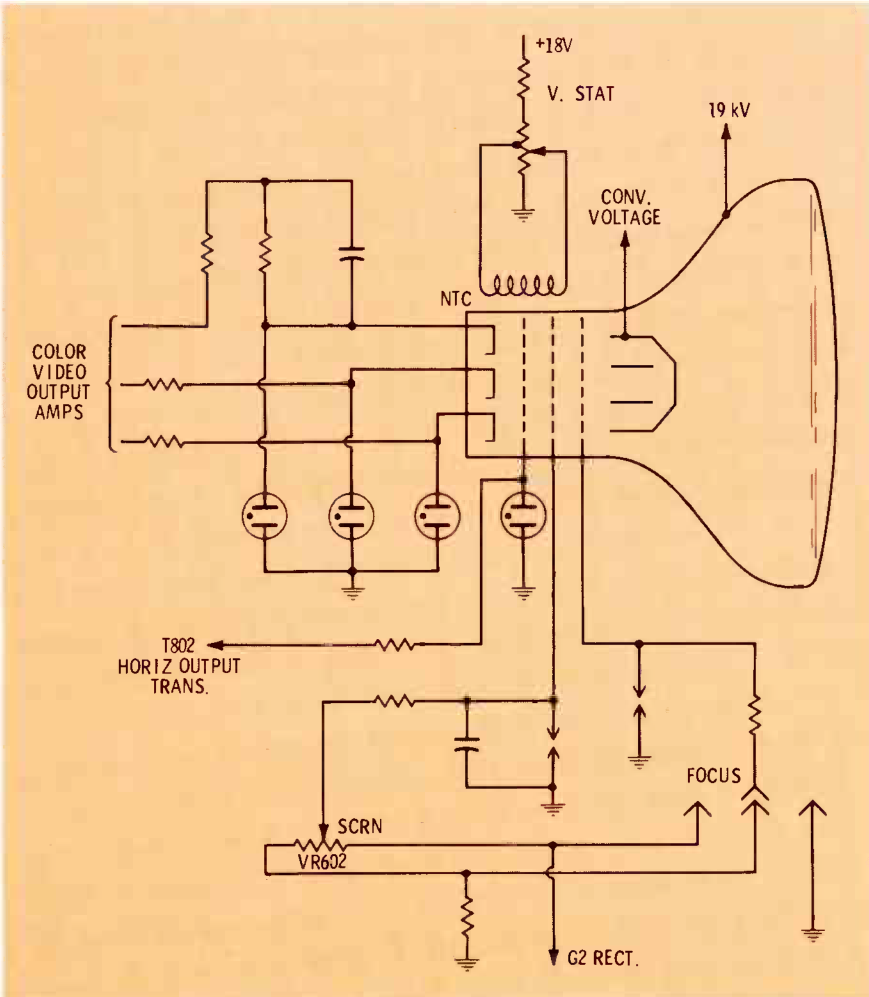


Fig. 7 Sketch shows how parabolic waveform added to convergence plates lengthens focal point of beams as they sweep toward edges. The controls in the photo are the only convergence adjustments you normally will make.



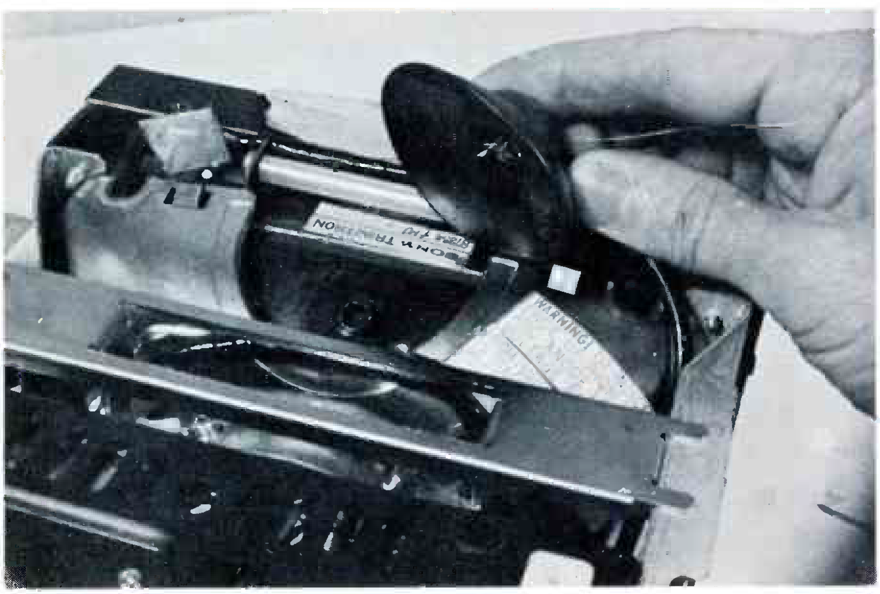


Fig. 8 Circuitry surrounding Trinitron picture tube stresses simplicity, compared with shadow-mask-tube circuits. Photo shows second-anode cap at top of tube instead of at side of bell as in conventional CRT's.

across center, and lengthen it again as they move on toward the right edge.

DC voltage on the convergence assembly determines the crossover point in the first place. So, logically, a parabolic voltage that's perfectly in step with the horizontal sweep can be added to it; the resulting voltage variation alters the focal length as needed.

The parabolic voltage waveform is shown in Fig. 7, below the sweep sketch. Applied to the convergence plates, the parabolic voltage adds to the 19-KV DC that's already there. Rising and falling, it stiffens the beams during the start and finish of each line—moving the focal point out and back to conform exactly with aperature-grille curvature.

That's all there is to horizontal convergence. The circuit is simple. A parabolic signal is taken from the horizontal-yoke return circuit and fed through a capacitor to the convergence plates.

Vertical convergence is even simpler. Slight vertical misconvergence doesn't show up anyway; if a beam lands a little high, it's still on the same color stripe so there's no visible error. Whatever slight correction is needed is designed into the vertical output stage and deflection coils.

There are only two convergence adjustments (Fig. 7). One is the **Vertical Static** adjustment. You make it first. Just put horizontal crosshatch lines on the screen and adjust the control to converge them. The other, the **Horizontal Dynamic** adjustment, primarily affects vertical crosshatch lines. It makes one end or the other of the parabolic signal higher in value, in case a little extra beam-stiffening is needed toward one side of the screen. There's also a capacitor you can change to improve convergence if a replacement Trinitron cannot be set up correctly.

Powering the Trinitron

Supply circuits for the Trinitron are diagramed in Fig. 8. The photo shows the second-anode button and the 19-KV high-voltage connection.

As mentioned earlier, there are three cathodes. They are the driven elements in the Trinitron. Color video signals, to which the Y or brightness components have already been restored, are fed to the cathodes. They control how many electrons get into the beams, and thus determine average scene brightness and the mixture of primary colors that make a color scene. About 70 peak-to-peak volts of video are applied to them.

The control grid (G1) is common to all three beams. With the cathodes driven, G1 stays at ground (zero volts) potential most of the time. Average bias is set by whatever average DC is on the cathodes—about 100 volts DC. However, horizontal and vertical blanking pulses are fed to the grid, driving it deeply negative for those short intervals when they are present.

The efficiency of Trinitron phosphors is closely matched for all colors. Also, because of the common G1, transconductance for each beam is about the same. There's no need for complex gain adjustments, so the screen (G2) is common to all beams, too. No gray-scale tracking is necessary. There's no series of screen adjustments—just one. It varies the DC voltage applied to G2—between 300 and 400 volts.

Focus voltage can be varied from zero (ground) potential to the full voltage that's available for G2. I have already indicated the voltage on the convergence plates; it's 19 KV, plus the parabolic dynamic-convergence signal.

A Step Toward Easier Servicing

The Trinitron is simpler than picture tubes of the three-gun shadow-mask variety. There's less to go bad inside and outside a Trinitron.

The Trinitron color portables I've seen in operation produce a satisfactory picture. Convergence was good, and colors seemed warm and true. Color pictures are bright enough to be viewed comfortably under strong flourescent lighting, but they don't seem any brighter than (if as bright as) pictures on the new black-surround color CRT's in some U.S. brands.

Whatever its other advantages, the Trinitron is unique and easy to set up. ▲

troubleshooter

Excessive Brightness

I have a Zenith 23XC38 color chassis with too much brightness. Even with the brightness, brightness range, CRT bias and screen controls at minimum, there is still a lot of brightness.

The CRT, all controls, resistors 193 and 194 and the 12HL7 video output tube have been checked, but no defect found. All the voltages on the CRT are normal except the cathode voltages, which are 25 to 35 volts low. I presume this is my trouble. How do I correct this problem?

Ed Anderson
Gonvick, Minn.

When you are troubleshooting direct-coupled video circuits, the "no-signal" DC voltages on most schematics can be very misleading. CRT cathode voltages that are only 20 to 30 volts low will make the picture brighter, but not as much as you indicate. Remember, the CRT cathode voltages will be at least 20 volts more positive on station. Also, you have indicated that the brightness, brightness range and CRT bias controls all have been misadjusted to produce minimum brightness; this will increase the CRT cathode voltages nearer to normal. Consequently, the CRT cathode voltages you measured are not merely 20 or 30 volts low. You must add to the no-signal voltage on the schematic another 20 volts because a station is tuned in, plus approximately 30 volts because the controls have been adjusted. Thus, the CRT cathode voltages are about 80 volts low—enough to make a huge difference in brightness.

Don't depend entirely on a tube tester when evaluating the video tubes; better replace them to be sure.

DC voltage analysis is your best bet to pinpoint the cause of this brightness problem. I suspect that the cathode and grid voltages on the 12HL7 have been interchanged on the schematic, because the collector of Q2 is marked 11 volts, while the grid of V5 (with zero resistance between) is labelled 15 volts and the cathode 11 volts, which would cause the grid of the tube to be positive with no signal applied.

The source of this brightness problem probably is in the video stages.

No High-Voltage Regulation

A Curtis-Mathis CMC26 color chassis (PHOTOFACT 921-1) has no regulation of the high voltage. The high voltage at times reaches 30 KV, as though the 6BK4 regulator were not in the circuit. Any suggestions?

Pete Gonzales
Gallup, New Mexico

Yes, we have a few suggestions, Pete. One of the parts failures that occur most often in any high-voltage regulator circuit using a 6BK4 is the 1K cathode resistor (R152 in this set), which may be burned open by a shorted or gassy 6BK4. Even after a new tube is installed, there will be no regulation if the cathode circuit is open. This resistor is checked best with an ohmmeter.

If R152 is burned, C93 (.01 mfd capacitor connected from 6BK4 grid to cathode) may be shorted, too; these two parts often fail at the same time when the 6BK4 arcs or shorts. With C93 shorted, the regulator will draw excessive high-voltage current after a new R152 is installed. The excessive load may even kill the high voltage.

The other general cause for loss of high-voltage regulation is excessive bias on the 6BK4. Only about −13 volts on the grid, measured from the cathode (with a VTVM), will cut off all regulator current. The cathode voltage is clamped by its connections to B+, and the grid is supplied by a voltage divider from the B-boost. Adjustment of the high-voltage control changes this grid voltage to set the regulator current and the amount of high voltage. If the bias is greater than −13 volts, unsolder the resistors in the grid circuit of the 6BK4, and carefully check them on an ohmmeter; their value is critical for proper regulator action.

Inadequate Stereo Separation Produced by Multiplex Adapter

I have a Webcor stereo Model WC1068-1B, which did not include multiplex, so I purchased a multiplex unit to use with it. (The tuner is covered in PHOTOFACT folder 522-13 and the multiplex unit is in folder 644-12.) My problem is that I do not have good stereo on FM. I have tried to align the multiplex unit, but it didn't help. Is this normal with this type of adapter, or is there something that I can do to achieve better stereo FM?

John C. Leahy
Lenanon, Pa.

The Webcor Model A-1946 FM-stereo adapter is one of the "first-generation" types, in which the separation is around 15 dB, or about half that of later ones with the diode-switching bridge circuit. In the earlier types the 38-KHz injected carrier phase is very critical, so L2 (A1) and L3 (A2) may have to be set with the aid of a multiplex generator. If you do not have access to a generator, you may be able to adjust the phase satisfactorily by moving to a position where the right and left speakers are near your right and left ears, respectively, and then make these two adjustments carefully for best stereo effect.

IF response curves are more critical for stereo reception, so it may be necessary to perform sweep alignment for a broader, flat-topped response.

According to the picture in the PHOTOFACT, the speakers in the cabinet of your unit are not separated very far apart; this will reduce the area where acoustic separation is possible. If the speakers are 3 feet apart, the position of the listener for best directional stereo effect will be in front of the center of the cabinet and just 3 feet from each speaker.

Be sure the multiplex adapter is connected correctly to the tuner. For example, there is an outlet on the tuner for normal FM with de-emphasis and another for multiplex with only an IF filter. Use the one marked "multiplex".

Also, determine if the separation is satisfactory using the input from the phonograph. FM-stereo will never exceed the amount of separation obtained from the phonograph. ▲

Hot and Cold Approaches to Solving Thermal Intermittents

Heat from lamps and cold from coolant sprays help pinpoint temperature-sensitive defects.

by Lon Cantor

Two of the most effective aids for locating intermittent defects also are the simplest: a 100-watt lamp and an aerosol can of cooling spray.

The Basic Technique

Intermittent defects that are triggered by heat often disappear when the chassis is removed from the warm cabinet to the cooler environment of the test bench. Normal operating temperature can be obtained best by using a 100-watt bulb in a socket-reflector fixture equipped with a padded spring clamp for easy attachment to the chassis. Place the lamp about a foot from the circuit which you believe is the most likely source of the intermittent. Check occasionally to make sure the lamp is not warming any of the parts too much.

After the heat from the lamp has triggered the defect into activity, individually spray with coolant each component in the suspected circuit. Use an extension tube connected to the nozzle of the spray can to confine the spray to only one component or small area at a time, as shown in Fig. 1. Watch the picture or listen to the sound, depending on which is affected by the intermittent. When the defective component is cooled with the freeze spray, the trouble will disappear almost immediately. In some cases, the suspected part can be heated slightly with a soldering iron to trigger the defect, then cooled again as additional proof.

Solid-State Problems

Defective solid-state components, especially transistors, are often the cause of a complete loss of signal when they reach normal operating temperature. The actual defect in such cases is apparently an open circuit at the point where the leads are attached internally. Output transistors in auto radios often are offenders in this way. Warm up the circuit until the sound cuts out, then spray the transistor with coolant. Before you can shut off the spray, the sound will be back, if the trouble is caused by an intermittent thermally sensitive defect.

Detector diodes are good suspects when an overload or AGC problem appears after the receiver has become warmed thoroughly. Before the cooling sprays were marketed, we had to replace the diode, and hope. Now a whiff of spray will help pinpoint the defect. **One warning:** Diodes with glass bodies can be

Fig. 1 Test setup shown here is for checking leakage of capacitor with low voltage rating. Leakage is indicated in form of voltage by FET VOM. If leakage drastically decreases when capacitor is sprayed with coolant, defect is heat sensitive, or thermally intermittent. Plastic tube attached to nozzle of can enables the technician to confine the coolant to one component or small area of circuit.

cracked by a direct application of coolant. Therefore, spray just the leads, or wrap a small piece of paper around the diode before you spray it.

Sometimes very little cooling is necessary. I remember well the time I replaced an output transistor in a portable stereo amplifier only to find the new one apparently just as sensitive to heat as the original, and just as easily restored to normal operation when cooled. A more careful investigation showed that a small amount of the spray had been bouncing onto the driver transistor, which was just behind the output stage. Replacement of the driver transistor permanently cured this intermittent.

Intermittent Capacitors

In many cases, it is easier to find the bad component by its reaction to the cooling spray and explain later what caused the symptoms. This was true of a Magnavox T922 color chassis that fluttered vertically after it was thoroughly warm. At first it appeared to have rapidly changing height, but a closer examination revealed the entire raster was bouncing up and down at an erratic rate. When the 25-mfd capacitor across the vertical centering control (C2, Fig. 1) was cooled, the picture suddenly became steady. This test was repeated several times, both before and after a new capacitor was installed. Apparently the defective capacitor shorted intermittently when a critical temperature was reached.

Other capacitor defects may be present when the set and components are at room temperature but disappear when operation of the receiver has raised the ambient temperature inside the cabinet. Such was the case with an RCA CTC19 chassis in which random horizontal areas of the picture jerked sideways (almost like an arc, but with more movement) during the first five minutes of operation. After five minutes, the picture became very steady. Because of the rounded edges of the intermittent disturbance, the problem seemed to originate in the horizontal AFC circuit.

Heat and cold were applied alternately to the horizontal oscillator

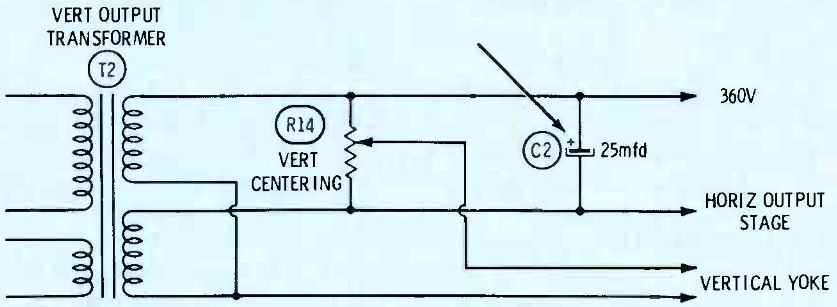


Fig. 2 Quick-repeating intermittent short in capacitor (C2) across vertical centering control caused rapid vertical movement of picture displayed by Magnavox T922 chassis.

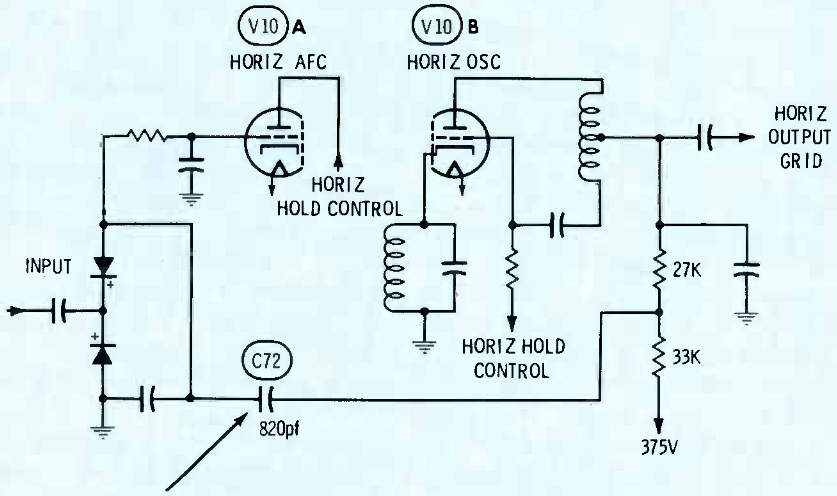


Fig. 3 Intermittent leakage of capacitor C72, in feedback loop between horizontal AFC and oscillator stages of RCA CTC19 chassis, caused random horizontal strips of the picture to jerk to one side.

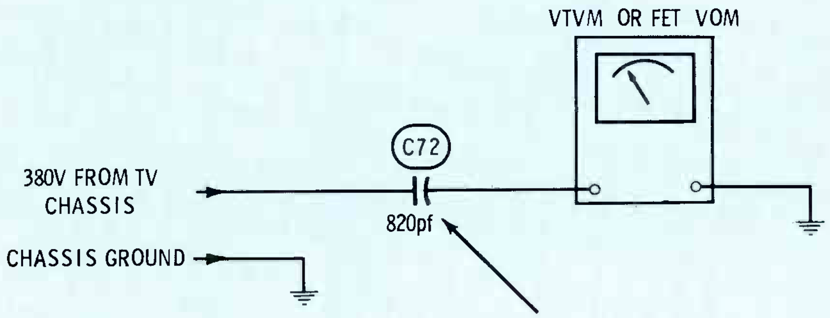


Fig. 4 Test setup for detecting extremely temperature-sensitive leakage in capacitor. DC voltage of about ¾ rating of capacitor is applied to one end of capacitor and VTVM or FET VOM is applied to other. Leakage will be detected in most capacitors. After capacitor is charged fully, a slowly changing or erratic reading indicates a defect.

and AFC circuits, with no results after the first five minutes of operation. The heat lamp and cooling spray apparently failed in this case, yet chassis heat seemed to have a definite effect on the problem.

After many hours of analyzing the trouble symptom and the schematic, it was decided the defect was C72, which perhaps was intermittently leaky. The capacitor was replaced and the trouble disappeared.

To prove to ourselves that the old C72 was intermittently defective, that night, before closing the shop, we connected the old capacitor between the 380-volt DC source of the chassis and VTVM, as shown in Fig. 3. The next morning, while the shop was still cool (it was summer), the VTVM and receiver were turned on. The meter reading quivered erratically. Occasionally the pointer would go up to +360 volts and stay there long enough to read, then would swing back to zero. The lamp was positioned to warm the capacitor: it was only a few minutes before the indication of intermittent leakage stopped. We succeeded in making it intermittent again by alternate cooling and heating, but the temperature was very critical—just a little too much heating or cooling and the trouble was cured temporarily. **Moral: Not every part needed maximum heating or cooling during diagnosis. Apply heat or cold sparingly at first.**

Heat can also make a leaky capacitor much leakier. Sometimes, heating with a soldering iron the leads to a suspected capacitor will produce the trouble symptom and pinpoint the source of the trouble. In other cases, it is better to heat the whole general area with the lamp, then cool just one part at a time. The latter method was used to find the loss of color in an Admiral G11 chassis.

The color on the screen of this chassis disappeared after 15 minutes of normal operation. A negative voltage was measured on the plate of the killer tube, which should be one of the first suspects in such a case of missing color. Each of the parts in the killer and bandpass amplifier stages were sprayed individually. When C109 (.1-mfd grid bypass capacitor in Fig. 4) was cooled, fully saturated color was restored.

Tubes Can Be Temperature Sensitive

A part-time serviceman brought in a chassis that displayed vertical rolling during the first 15 minutes of operation. He explained that changing the tubes had not cured the trouble symptom. We sprayed all the vertical components. No results. We changed the vertical oscillator-output tube and the trouble disappeared. The old tube was reinstalled to double check the diagnosis. The rolling returned. As an experiment, we sprayed the bottom of the tube (spraying the glass will usually crack it). The picture started rolling, confirming that the tube was temperature sensitive.

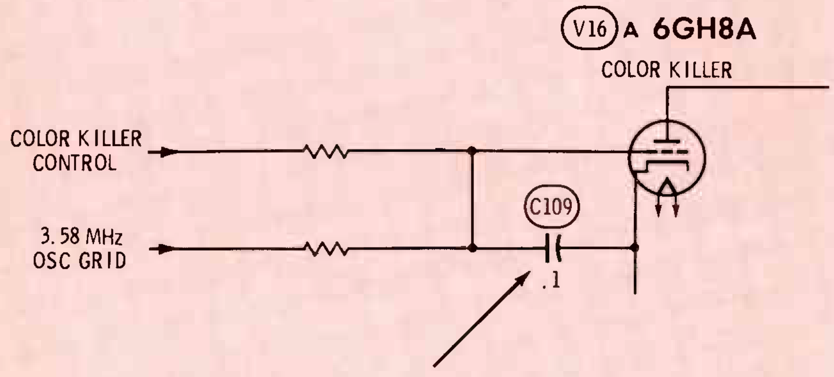


Fig. 5 Leakage of bypass capacitor (C109) in grid circuit of color killer caused all color to disappear from screen of Admiral H12 chassis after 15 to 30 minutes of normal operation.

Other Uses for Cooling Spray

Heat damage to a transistor during installation need never concern you if the transistor is cooled until it frosts before you solder it to the board. Incidentally, higher-pressure sprays are available that can cool down to –50°F.

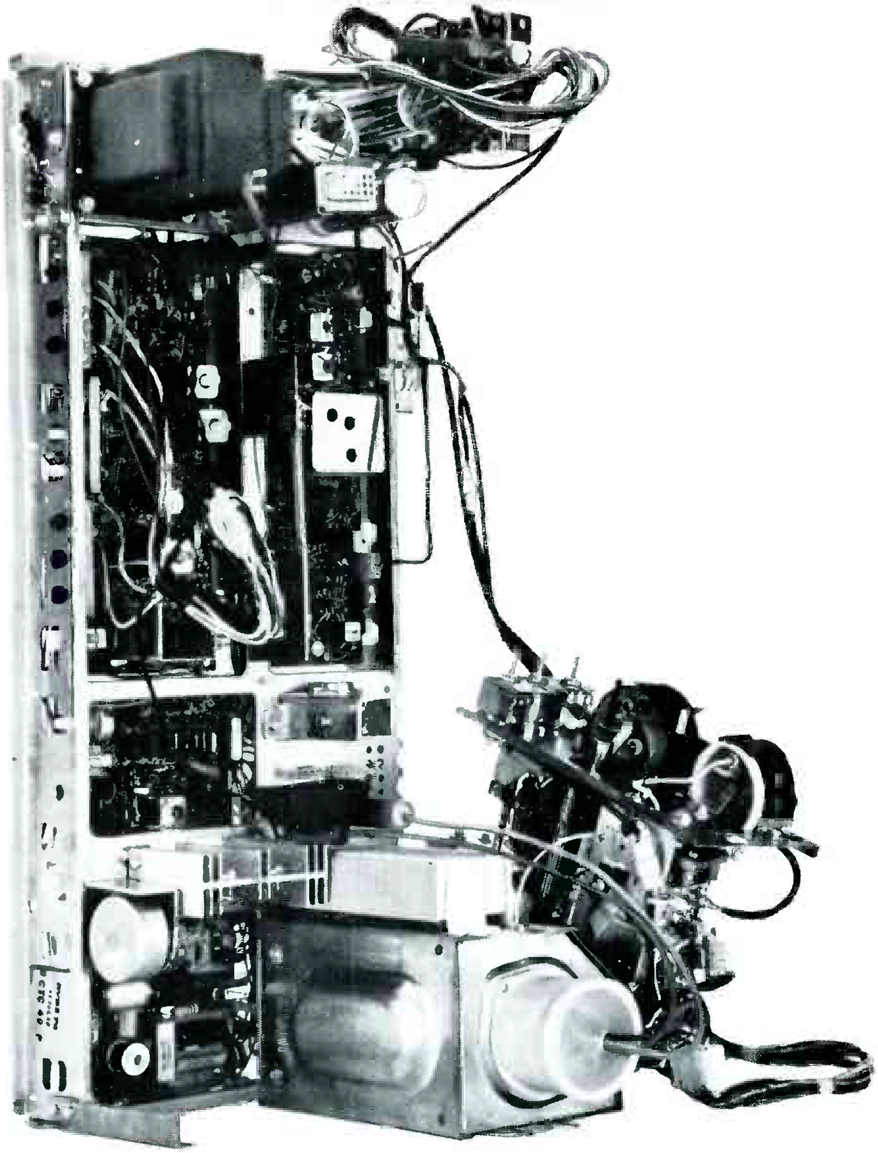
Have you ever had trouble soldering mike, or coax, cable or even plastic-covered wire because the plastic was softened by the heat and was deformed or caused shorts? This will not happen if you spray the plastic with coolant just before soldering.

Hard-to-find cracks in circuit boards or burned resistors often can be uncovered if the suspected area is sprayed until frost is formed.

Tests in ELECTRONIC SERVICING's laboratory indicate that high-value small-wattage resistors can be raised to an out-of-tolerance value by only slightly more heat than is normally used in soldering. To prevent this, cool the body of such resistors shortly before they are soldered, and they will stay at their original value.

Conclusion

Any tool, instrument, chemical or technique that will reduce the time needed to isolate the cause of a temperature-sensitive, intermittent defect should be considered an essential part of an electronic technician's working inventory of tools, test instruments and service-aids. Because of their effectiveness, pointed out in the techniques described in the preceding paragraphs, heating devices and cooling sprays have earned their places in the select inventory of valuable service-aids that save diagnostic time—and in the business of servicing consumer electronic products, time is spelled m-o-n-e-y. ▲



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*one tube rectifier

RCA

Auto reverb units / Operation, Installation and Servicing

by Joseph J. Carr

The function of an auto reverberation unit is to delay the sound to the rear seat speaker by a factor of a few milliseconds (usually 25-30 ms) to create an illusion of being in a concert hall. In an actual concert hall, sound bounces off the walls as well as traveling to the listener in a direct line. The incident, or reflected, sound wave arrives at the listener's ear a few milliseconds later than the direct wave because it has a longer path to travel. This split-second delay is the basis of reverberation. Although the artificial version found in automobile sound systems adds a few embellishments of its own, these reverberators can offer the listener much realism and added enjoyment.

Basic Design

There are two main sections in reverberator units: the audio amplifier (Fig. 1) and the spring delay unit (Figs. 2A and B). The amplifier is usually a three-stage unit similar to those found in the audio sections of regular car radios. Although this type of amplifier offers considerable gain, the overall gain of the entire system is approximately one. This is because of the high attenuation produced by the delay line.

The delay unit is an electromechanical device that uses springs to accomplish the delaying function. The input is an electrical-to-mechanical transducer that is similar in operation to a permanent-magnet loudspeaker. The delay spring(s) is connected axially to a rotating permanent magnet. This magnet, in turn, is placed coaxially inside an electromagnet coil. This design is similar to a permanent-magnet (PM) loudspeaker; however, in the PM loudspeaker the coil is the movable piece, while in the reverberator delay unit the coil is fixed and the magnet moves.

Signal applied to the input coil creates a magnetic field that alter-

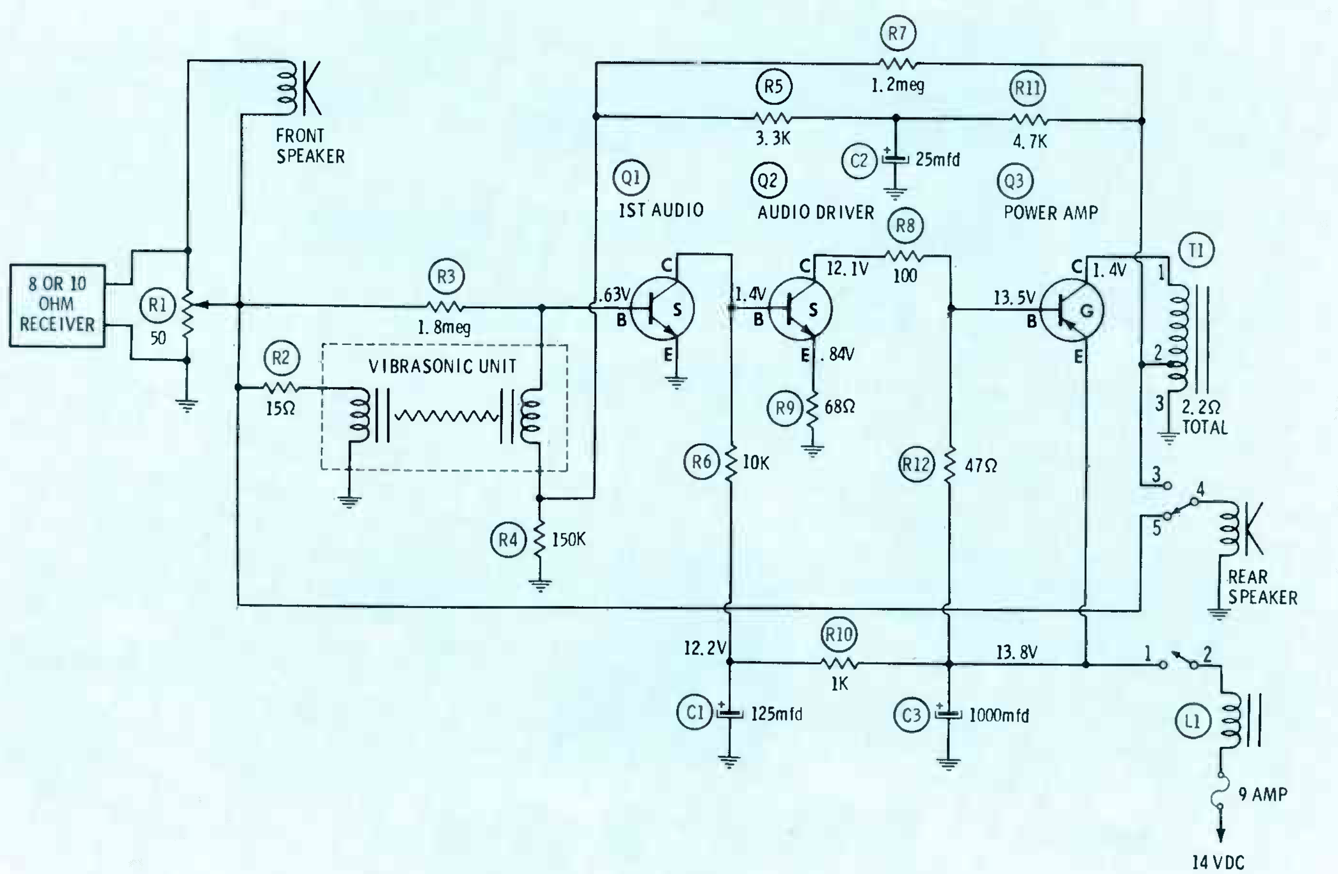

Fig. 1 Schematic diagram of Motorola reverb amplifier.

nately adds to and subtracts from the field about the permanent magnet. This action causes the magnet to move in step to the applied audio signal. The signal, which at this point is a series of mechanical vibrations, drives the permanent magnet in the output transducer.

The output transducer is like the one at the input, except in some cases the impedance of the coil is different.

The mechanical vibrations transmitted along the spring cause the permanent magnet in the output transducer to vary its relative position inside the coil. The signal current thus induced in the output coil is the input that is applied to the audio amplifier chain.

Some reverberators use a one-spring delay line, while others use a twin-spring arrangement. It is common for the two-spring design to have one spring designed to produce a 25-millisecond delay and the other to give 27 milliseconds.

Typical Installations

There are two basic designs of reverberator systems available for automotive use. One system houses the entire control circuit, delay line and amplifier chain inside one unit that is designed to hang beneath the automobile's dashboard. The lower-priced Motorola reverb and most of the reverbs imported from Japan are of this type of construction, and are usually mounted to the lower lip on the underside of the dashboard, with small "L" brackets for support. A one- or two-conductor wire is run beneath the floor mats or carpeting to the rear-seat speaker. There are also usually two other pairs of wires; one to hook to the front speaker and one to the radio output.

The other basic reverberator design has a control head mounted either in or under the dashboard. This control head is connected via a four- or five-conductor cable (similar to antenna rotor wire) to the delay/amplifier unit in the trunk. The control head usually is wired to function as a regular rear-seat speaker control when the reverb is not in use.

The delay/amplifier unit is housed inside a rectangular box. It should be mounted so that the long axis of this box runs fore and aft along the center line of the automobile, as shown in Fig. 3. This technique is supposed to lessen the "chiming" effect that occurs when the car is driven over rough roads. Secure the unit to the trunk interior with both sheet metal screws and star washers. Proper installation is critical to the functioning of the reverberator unit.

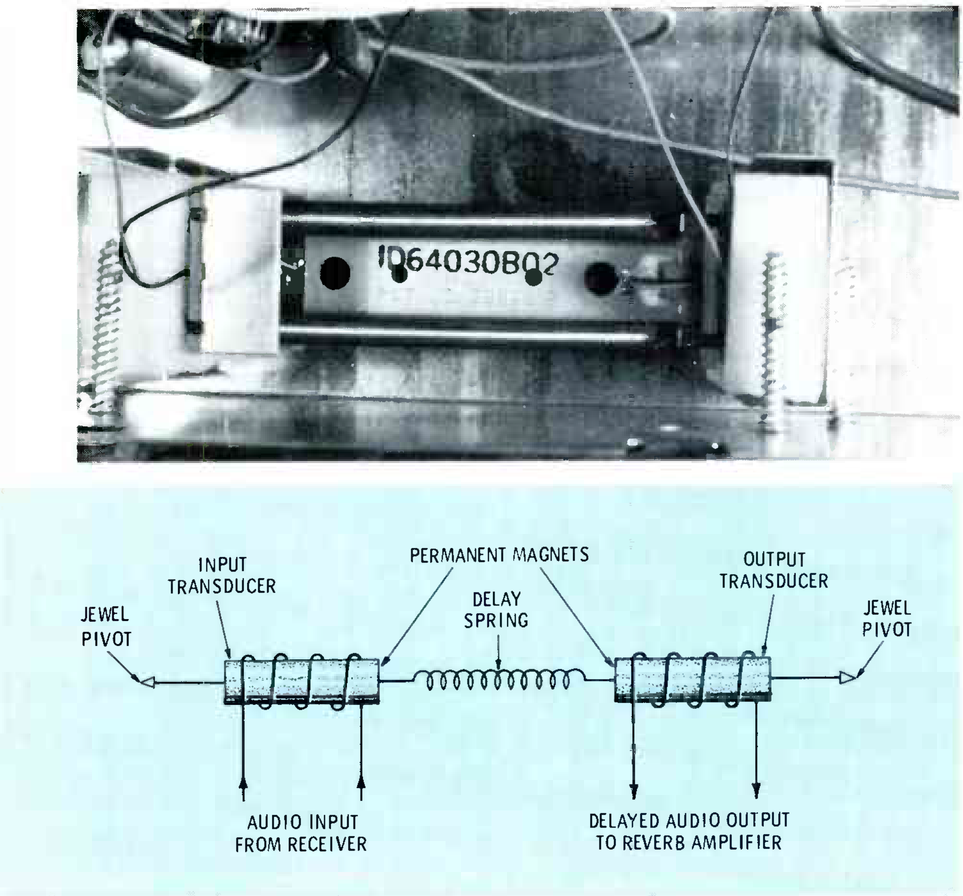

Fig. 2 Photo and drawing show physical construction of delay line employed in Motorola reverb unit.

In-Car Troubleshooting

A majority of the troubles encountered in reverberators are caused by improper installation. A common complaint is weak reverberation. The fader pot usually operates poorly in both reverb and normal RSS modes, or it doesn't operate at all. This problem often is found to be caused by reversal of the two pairs of wires leading from the control head to the radio output and front speaker. This reversal can be either a case of mistaking one pair for the other, or a case of the two wires within one pair being reversed.

Another common problem results when the installer mistakes one of the other wires for the power "A" lead. The symptoms are weak and/ or distorted sound usually accompanied by the acrid odor of burning electronics parts. Unless the error is caught in time, it will cause the control pot and the input coil of the delay unit to burn out.

Another all-too-common trouble that will cause weak and distorted sound is a short in the wire harness to the unit in the trunk. Often, when the trim and carpets are repositioned, a screw will puncture the insulation on the wire harness. If the screw rips through the power lead it will cause the fuse to blow. If it punctures the audio lines, however, weak and distorted audio will be the result.

Deciding whether to pull the reverb for bench service is simple: Determine whether both the audio input signal and DC power are reaching the unit. A VOM (or 12-volt pilot lamp with alligator clip leads attached) is all that is necessary to confirm the presence or absence of DC power. A small test speaker will check out the audio input. If both power and signal are reaching the reverberator, and it is known that the rear speaker is in good shape, it is a safe bet that the reverberator should be pulled for bench diagnosis.

Bench Troubleshooting

Before attempting to troubleshoot a reverberator on the bench, determine which terminals on the input plug go to power, audio, etc. If power is applied to the input coil by mistake, it will burn out the transducer before the error can be realized. The proper connections should be identified either by consulting the schematic or by tracing the wires.

There is one quick and simple check that will prove out the entire audio amplifier chain and the output side of the delay line: Very gently and carefully touch the delay line springs with a screwdriver or similar tool. If a loud, resounding crash comes blaring through the speaker as this is done, then the output transducer and the amplifiers are working. If there is no sound or only a very weak sound, the most probable source of the trouble is in these sections.

If the preceding check proves the sections from the springs through to the speaker are operating normally, the trouble is likely to be in the input wiring or the input transducer on the delay unit. A low-impedance audio source, such as a radio speaker output, is required to properly check out the input side of the reverb. Disconnect the high side of the input transducer coil and apply an audio signal to it. A healthy output from the reverberator speaker indicates that the entire delay line and amplifier chain is functioning normally, and the trouble must be elsewhere in the input circuit. An ohmmeter will tell if the input coil is open, but the method just mentioned is necessary to detect a shorted coil. This is because of the low impedance of this coil (just a few ohms).

"Chiming"

One of the more common complaints heard from reverberator owners is the tendency of these units to produce a "BOING" sound whenever the car is driven over rough roads. The name for this problem is "bongo effect" or "chiming". The cure, or at least as much of a cure as is possible, is absurdly simple. The only materials required are two short pieces of electrical or masking tape and one small-size rubber band.

The rubber band is cut at one point and then the two ends passed through the eyelets that fasten the two halves of each spring in the delay unit. The ends of the rubber band are then fastened to the delay line housing with the pieces of tape, as shown in Fig. 4.

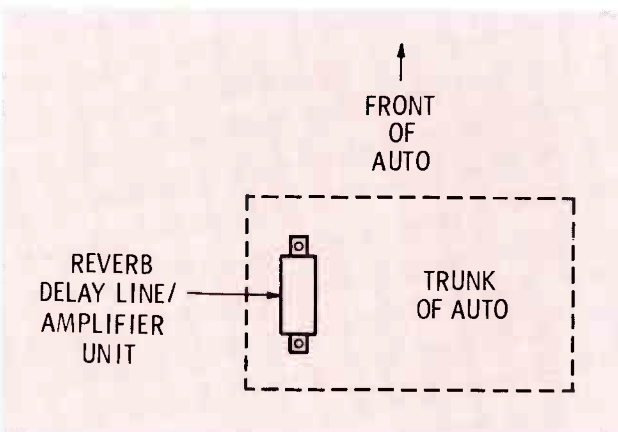

Fig. 3 Diagram showing proper positioning of reverberator unit in trunk of auto.

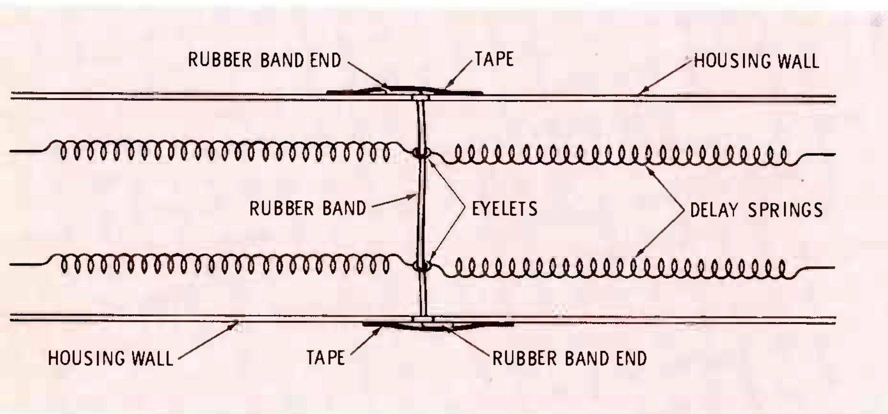

Fig. 4 Rubber band passed through delay spring eyelets and taped to housing wall, as shown, eliminate "chiming".

Interference and Noise

Alternator whine and ignition noise generally can be suppressed in reverberator systems by the usual methods employed on the engine to suppress radio interference. Occasionally, however, the reverberator will pick up noise when the radio is free of such interference. When this occurs, usually no amount of suppression equipment in the engine compartment will eliminate the noise.

Two possible causes for this type of interference are: 1) inadequate grounding of the reverberator, and 2) the position of the rear seat harness relative to the wiring in the automobile.

The first case can be taken care of by scraping the paint from around the mounting holes of the delay line/amplifier unit and using star washers between the mounting tabs and the car body.

The second cause usually can be cured by rerouting the reverberator wire harness to the other side of the car. (It is good practice during original installation to run these wires down the opposite side of the car from the normal automobile wiring harness.) ▲

photofact bulletin

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

ADMIRAL

Chassis TK2-1A 1082-1
Chassis 1K10-1A 1083-1

AIWA

75T-01 1086-1

BRADFORD

WTG-60061A,
1105D30 1078-1
CMAT-89243 1080-1

BROADMOOR

6912 1088-1

CATALINA

122-742B 1081-1
AM-FM Chassis used with
Model 122-742-B 1081-1-A
122-743A, 122-749A,
122-750A 1082-2
AM-FM-FM Stereo Radio
used with Model
122-750A 1082-2-A

CHANNEL MASTER

6100A, 6104A,
6120A (Ch. 918) 1078-2
6130, 6134 1087-1

CORONADO

TV2-6628A, TV2-6629A,
TV2-6630A 1084-1
TV2-6631A, TV2-6632A ... 1088-2

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10M113 1082-3

DELMONICO

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AM-FM Radio Chassis
TC-773 .... 1079-1-A

EMERSON

Chassis 120918, 120920A/B,
120956 1089-2

GENERAL ELECTRIC

TR100TEB-5 (Ch. T-5) ... 1080-2

MAGNAVOX

Chassis T944-01-AA/-02-
AA/-03-AA/-04-AA 1085-1

MOTOROLA

Chassis 16TS-930A/B 1086-2
Chassis E/F/G/J19TS-
597C/D 1087-2

"I'm taking the gamble out of operating a small business, Fenton—you're fired."

PANASONIC

AN-109N, AN-309D,
AN-409T (Ch. N-93) 1077-1
TR-415B, TR-415BC 1086-3
Chassis N-93A 1087-3

PENNCREST

2363A, 2364 1089-3

PHILCO-FORD

S1040WH, S1042BK
(Ch. 19HT15) 1078-3
R1252WA (Ch. 18CT24) . .1084-2

RCA

Chassis CTC36M/N/
XAA/XU/XW 1077-2
Remote Control Receiver
CTP18, Transmitter
CRK11E 1077-2-A
Chassis KCS156AA/
AD/AH 1088-3

SEARS

Chassis 562.10420/421/
422/423 1079-2

SEARS SILVERTONE

Chassis 528/529.72940 thru
528/529.72948 1081-2

SONY

TV-92OU 1083-2
KV-701OUA 1085-2

WARDS AIRLINE

GEN-11760A (63-11760) . .1089-1

ZENITH

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14Z43 1080-3
Chassis 13A12, 13A12M,
13A12S, 13A12S1 1084-3

PRODUCTION CHANGE BULLETIN,

ADMIRAL

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19H1073-11,
19H1073-14 1081-3

GENERAL ELECTRIC

Chassis D1 1079-3

MOTOROLA

Chassis TS-924B/C,
E14TS-/F14TS-924D 1077-3

SEARS

Chassis 564.80081 1077-3
5034 (Ch. 562.10461) 1081-3

TRUETONE

EIS2885A-86/85B-86/
85C-86, EIS2887A-86/
87B-86/87C-86, EIS2889A-
86/89B-86/89C-86 1087-4

ZENITH

Chassis 12A10C15 . . . . .1085-3▲

book review

The Semiconductor Data Book, Fourth Edition: Motorola Semiconductor Products Inc., Phoenix, Arizona 85036; 2160 pages, $4.95.

This book includes specifications for all discrete semiconductors registered by the EIA at publication time, as well as many Motorola-numbered types.

Numerical listing of the important parameters of all semiconductors registered by the EIA (those with 1N-, 2N- or 3N- prefixed), presented in a 185-page section, is provided. It gives the information needed to identify and characterize any registered device and find recommended replacements for obsolete, hard-to-obtain or nonpreferred devices.

The majority of the book is devoted to data sheets giving information on all Motorola discrete semiconductor devices. The data sheets are arranged in alphanumeric order for easy location.

Also included are: selector guides for all categories of discrete semiconductors; case outlines for semiconductors; selector guides for digital and linear integrated circuits; and application notes explaining how to use the devices described.

An updating service, with a minimum of two supplementary books published in 1969, is also available for an additional $2.00.

Color TV Waveform Analysis: Robert G. Middleton, Howard W. Sams & Co., Inc., Indianapolis, Ind. 46206, 1970; 125 pages, 5½ in. X 8½ in., paperbound, $3.50.

This book is written for technicians who are familiar with basic scope operation and with the general principles of color-TV receivers. It provides a theoretical presentation of waveform processing along with a practical application of waveform analysis.

Waveform analysis in RF and IF sections is covered in Chapter 1, while Chapter 2 deals with waveform analysis of the video and bandpass amplifiers. Chapter 3 is concerned with chroma-demodulator waveforms and Chapter 4 is titled "Analysis of Matrix Waveforms." Analysis of color-sync waveforms and circuit actions and color TV waveforms are presented in the final two chapters. ▲

product report

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

Solid-State Intercoms

The Bogen Division of Lear Siegler, Inc. has announced the availability of three new series of solid-state intercoms.

The IM series seventeen-station and nine-station master units reportedly feature 6-watt peak output power and private operation with optional hands-free reply when called by other master units. Both the IM-17 and the IM-9 masters may be employed in either an all-master system, a single master-multiple remote system or an "intermix" system–multiple masters and remotes in any combination. Bogen states that the IM systems afford 100% trunkage. The IM master (with a Bogen paging accessory) can be tied into any existing public address system to provide high-level

paging for noisy areas, and to receive hands-free replies from the P.A. loudspeaker or horn. Non-interlock station selector buttons enable the master to simultaneously call one, several or all of the stations in the system.

There are several types of remotes than can be used in the IM system, including selective and non-selective units, styled to match the masters. These feature a privacy switch which permits them to operate either in a private mode or non-privately. Wall-mounted remotes are also available for indoor or outdoor use.

The IE series solid-state intercoms may be employed in either an all-master system, a single master-multiple remote configuration or a master system which employs either one or two non-private remotes. The IE-13 and IE-7 masters have 12 and 6 station-selector buttons, respectively, all of the non-interlock type, which enable the master station to call several or all of the stations simultaneously.

In the IE-13 all-master system as many as six separate conversations may be held at the same time. By adding a Bogen TBR-1 relay accessory to an IE system, paging through any P.A. system is possible, with hands-free response from loudspeaker or horn. The RIE-1 remote may function either non-privately or privately. IE systems are operated from a 120-volt AC power source, 50/60 Hz, but can easily be adapted for a 12-volt DC battery supply, according to the manufacturer.

A special solid-state two-station package, the IE-4S, has also been introduced by Bogen, with one master and one remote. The master incorporates three selector switches, permitting the addition of two more remotes. It is reported that the master can call one, two or all remotes simultaneously, and that remotes can originate calls to the master station. Bogen states that unique magnetic annunciators identify the calling remote and, in the event that the master is unattended, do not clear until the master station replies. Remotes are also equipped with a privacy switch. The IE-4S can either be placed on desk top or wall-mounted and can operate on either 120 volts AC or 12 volts DC.

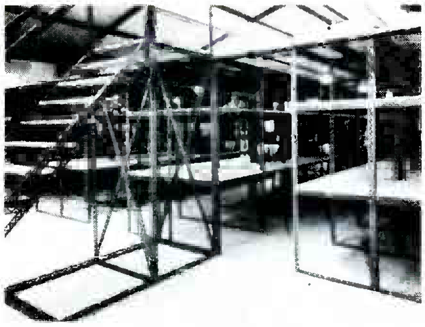
The cost of Model IM-17 is $222.40; the IM-9 sells for $182.40. Model IE-13 is priced at $77.40 while the IE-7 is priced at $62.45. The solid-state IE-4S sells for $74.90.

Circle 63 on literature card

Slotted Angle

Chevron Slotted Angle has made available a new slotted angle size called "Triumph" which is said to provide greater strength for building multi-tiered storage racks and bays, conveyor systems, etc.

"Triumph" is 2½ in. X 1½ in. X .08 in. and is manufactured from cold rolled steel of 64,000 to 70,000 lbs. tensile strength, it is reported. The pattern features what Chevron calls "infinite boltability" which enables it to be "mated" to



any other type of slotted angle. It is rustproof by a phosphate granodizing process and finished in a medium-gray baked-on enamel.

Chevron's "Triumph" is available in either 10-ft. (CA 150/10) or 12-ft. (CA. 150/12) lengths and weighs 90 lbs. per package. Each package, complete with 72 bolts with washers and lock nuts, costs $29.00.

Circle 64 on literature card

Picture Tube ID Card and Vacuum Spark Tester

General Electric's Tube Department has announced the availability of two service aids for TV service technicians.

GE's Picture Tube Identification Card, designated ETRO-5199, offers a method of visually inspecting and identifying the type of screen on color picture tubes. Colors shown

Circle 24 on literature card

Circle 25 on literature card

on the card approximate the appearance of the "unexcited" color screen, it is reported. The card is offered at no charge.

The General Electric Vacuum Spark Tester, ETRS-5198, reportedly provides an effective method of determining the cause of picture-

tube failure. A high-frequency arc generator in the tester generates about 50,000 volts at a frequency of 3 to 4 MHz, with adjustable voltage. GE cautions the user that the tester should not be used to check known good picture tubes because its high-intensity spark may damage the cathodes of the tube.

The Vacuum Spark Tester sells for $10.95.

Circle 65 on literature card

Desoldering/Soldering Tip

Now available from Techni-Tool, Inc., the #4918 D.I.P. desoldering/soldering tip can be inserted in a standard ⅜-in. screw-type soldering gun of 35 watts or more.

Grooved and channeled for 10-, 14- or 16-lead, dual inline packages, the tool will effectively desolder a complete 16-pin D.I.P. in one pass, according to the manufacturer. In addition, the #4918

tool has end tips shaped for straightening bent connector pins.

The #4918 desoldering/soldering tool is priced at $1.95. ▲

Circle 66 on literature card

Circle 26 on literature card

catalogs literature

COMPONENTS

100. *Allied Electronics Corp.*—has released a 56-page supplement to their 1970 industrial catalog No. 700. The supplement, catalog No. 701, includes a revised semiconductor and integrated circuit directory, plus digital display equipment, oscilloscopes, power supplies and other industrial products.

SPECIAL EQUIPMENT

101. *Raytheon Co.*—has made available an 8-page illustrated catalog which covers Raytheon's Regency series of control knobs.

102. *Seton Name Plate Corp.*—has issued Seton Catalog 70-B, which describes and illustrates their line of self-adhesive, weather-proof emblems.

TECHNICAL PUBLICATIONS

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

TEST EQUIPMENT

104. *Simpson Electric Co.*—has published a 32-page 3-color catalog, Bulletin 2081, which describes over 1,500 stock ranges, sizes and type of Simpson's panel instruments and includes a panel instrument characteristics chart, a glossary of terms and a quick-reference index.

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

Coming in ES next month . . .

- Using the VOM in Tube and Solid-State Circuitry
- Theory of Operation of AM & FM Signal-Seeking Auto Radios
- Common Causes of Drift in Stereo FM Tuners
- A Detailed Look at Chroma Waveforms
- Flat-Rate Pricing and an Incentive Pay Plan

advertisers' index

The brilliance of our new color replacement tube is matched only by the sharpness of its pictures

RCA MATRIX

Now it's easier to sell up to the best. RCA has added brightness without sacrificing sharpness! Here's how and why:

To produce the brightest color picture tube in RCA's history, we developed a new phosphor-dot screening process that incorporates a jet-black matrix. But we didn't stop there. We wanted a tube that could deliver sharp, vivid pictures even in strong room light. So, we added the brilliance of new phosphors and deposited each red, green and blue phosphor-dot within the black matrix. Result: brighter pictures with no loss of contrast. Thanks to the matrix technique, combined with our new high resolution gun and greatly improved phosphors, the Matrix is also the *sharpest* color picture tube in RCA's history. Matrix owners can turn up brightness *without* "turning down" color!

Will your customers see the difference? You bet! What's more, they'll be pre-sold on the difference—every time they see the 1970 big-screen color sets people are talking about! So when they need a replacement tube, satisfy their appetite for brighter, sharper pictures. Don't replace their old tubes with another "old" tube. Give their sets new brilliance and more vividly detailed pictures with RCA Matrix. The Matrix Tube is 100% brighter than any previous color picture tube manufactured by RCA.

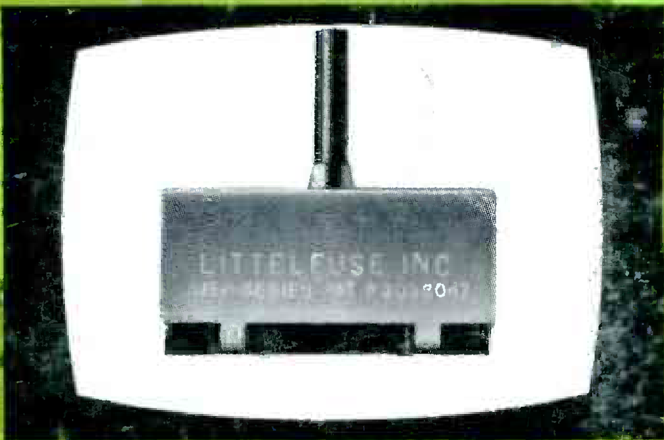
For complete details, call your RCA Distributor.

RCA Electronic Components,
Harrison, New Jersey

RCA

The RCA 25BCP22 Matrix Tube can directly replace 25XP22, 25BAP22 and also the following types: 25ABP22 25AFP22, 25ANP22, 25AP22, 25AP22A, 25AQP22, 25BMP22, 25CP22, 25CP22A, 25GP22, 25GP22A, 25SP22, 25WP22, 25XP22/25AP22A and 25ZP22.

THE SAFEST SETS YOU'LL EVER SERVICE HAVE LITTELFUSE CIRCUIT BREAKERS.



Standard Catalog Part No.	Hold Rating (Amps.)	Standard Catalog Part No.	Hold Rating (Amps.)
815.650	.490	8152.75	1.92
815.800	.600	815003	2.1
815001	.650	8153.25	2.2
8151.25	.930	815004	2.5
81501.5	1	81504.5	3
8151.75	1.2	815005	3.25
815002	1.4	815006	3.9
8152.25	1.5	815007	4.14
81502.5	1.65		

Littelfuse TV set circuit breakers are the safe, reliable, money saving short-circuit-problem-solvers . . . 17 available models—exact replacements—cover the entire range of domestic television sets.

Littelfuse circuit breakers are available from your distributor—singly or in bulk.

Super-simple in operation—the sensitive breaker flips open under current overloads protecting the circuitry. Reset by merely pressing the red reset plunger. A built-in "trip free" feature of Littelfuse breakers prevents forced closing when dangerous overload currents are present.

Nothing's more reliable than a Littelfuse circuit breaker. Thermal-responsive Littelfuse breakers are dual operated bi-metallic devices providing temperature compensation over a wide range of ambient temperature variation. Molded phenolic construction eliminates warping and distortion of the base, maintaining exact factory set calibrations. The unit is completely enclosed to protect critical moving parts from dirt and other foreign matter.

Any TV set you're likely to service will take Littelfuse circuit breakers.

They'll flip for safety.

You'll flip for satisfaction.

LITTELFUSE

DES PLAINES, ILLINOIS 60016

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