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Electronic Servicing

A HOWARD W. SAMS PUBLICATION

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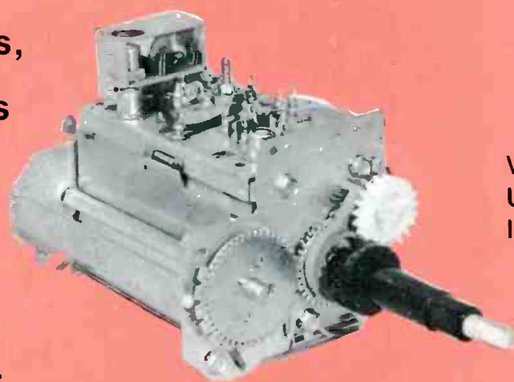

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California	Los Angeles, Ca. Central	90023	4184 Pacific Way	213-266-3728
	Sacramento, Ca. No.	95841	4611 Auburn Blvd.	916-482-6220
	San Diego, Ca. So.	92105	5111 University Ave.	714-280-7070
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	Miami, Fla. So.	33168	12934 N.W. 7th Ave.	305-685-9811
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Maryland	Silver Springs, Md.	20910	1105 Spring St.	301-565-0025
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	Springfield, Mass.	01103	191 Chestnut St.	413-734-2737
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Minnesota	Minneapolis, Minn.	55408	815 W. Lake St.	612-824-2333
Missouri	St. Louis, Mo.	63130	8456 Page Blvd.	314-428-1299
New Jersey	E. Paterson, N. Jersey	07407	158 Market St.	201-791-6380
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Ohio	Cinn., Ohio	45215	8180 Vine St.	513-821-2298
	Columbus, Ohio	43227	4003 E. Livingston Ave.	614-237-3820
	Parma, Ohio	44134	5682 State Rd.	216-845-4480
Oklahoma	Oklahoma City, Ok.	73106	3007 N. May	405-947-2013
Oregon	Portland, Oregon	97213	5220 NE Sandy Blvd.	503-282-9636
Pennsylvania	Pittsburgh, Pa.	15202	257 Riverview Ave. W.	412-761-7648
	Upper Darby, Pa.	19082	1742-44 State Rd.	215-352-6609
Tennessee	Memphis, Tenn.	38118	3614 Lamar Ave.	901-365-1918
Texas	Houston, Texas	77032	4324-26 Telephone Ave.	713-644-6793
	Longview, Texas	75601	Mopac Rd.	214-753-4334
Virginia	Norfolk, Va.	23504	3118 E. Princess Anne Rd.	804-625-2030
Washington	Seattle, Wash.	98108	432 Yale Ave.	206-623-2320
Wisconsin	Milwaukee, Wis.	53215	3509 W. National	414-643-8800

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1 YEAR GUARANTEE

NOT A FRANCHISE COMPANY

For More Details Circle (1) on Reply Card

December, 1975 □ Volume 25, No. 12

Electronic Servicing

in this issue...

DEPARTMENTS

ABOUT THE COVER

This color photo by Forest H. Belt of a GM **Astro** truck illustrates the article entitled "Installing CB Radios In Diesel Trucks".

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Robert E. Hertel, Publisher
INTERTEC PUBLISHING CORP.
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electronicscanner

news of the industry

Zenith reports a serious reliability problem with part number 22-7233, the four-lead capacitor associated with the horizontal-output transistor. Usually, the defect occurs only after many months of operation. But, when the failure begins, it proceeds rapidly, and the high voltage rises drastically. First symptoms might be a slight reduction of picture size along with intermittent arcing, but continued operation could cause failure of the horizontal-output transistor, tripler, vertical module, or the picture tube (cracked neck). **All** 22-7233 capacitors should be replaced whether defective or not. Out-of-warranty repairs will be paid by Zenith, but must be reported on Warranty Claim Form 3744C. **Zenith** chassis that are affected include: late 17EC35; late 17EC45; late 19EC45; 17FC35; 17FC45; 19FC45; 23FC45; and 25FC45.

Contact your Zenith distributor for more details. This capacitor was described and pictured on page 25 of the November, 1975 issue of ELECTRONIC SERVICING.

Stores of the Dunkin' Donut chain have been using a camera system that starts taking pictures of the cash register when the drawer is opened, and shuts off when the drawer is closed, reports the **Wall Street Journal.** An "unaccountable" sales increase of 10% occurred during the time the cameras were in operation! The kind of camera was not specified, but it seems a natural use for a video camera and video tape recorder.

Robert W. Sarnoff has submitted his resignation as Chairman of the RCA Board of Directors. At the end of 1975, when his resignation becomes effective, Mr. Sarnoff will have completed 10 years as President and as Chairman. Formerly, he was an executive with NBC, rising to become Chairman and Chief Executive Officer. Anthony L. Conrad, formerly President and Chief Operating Officer, has been named as President and Chief Executive Officer of RCA.

Admiral no longer plans to have one major introduction of a complete new product line each year. Instead, each individual product will be introduced as it is ready. Other manufacturers are said to favor keeping their traditional schedules, except for occasional extra presentations, such as RCA's showing of the ColorTrak system last summer.

Quadriphonic discs and tapes have had a small increase of sales lately. However, several articles in **Home Furnishings Daily** point out that most customers buy two-channel stereo systems, and many manufacturers are reducing the number of 4-channel models. Evidently, there will be no strong swing to quad sound in the near future.

The entire line of monochrome General Electric TV's now is all-solid-state. Six color and nine b-w models have been added to the line, bringing the total to 46.

(Continued on page 6)

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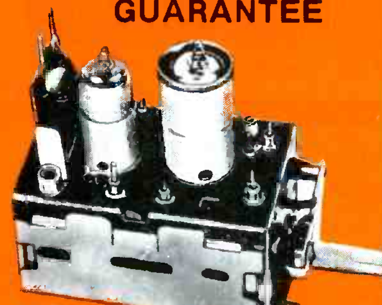

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- Send in your original tuner for comparison purposes to any of the Centers listed below.

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ARIZONA	TUCSON, ARIZONA 85713	1528 S. 6th Ave.	Tel. 602-791-9243
CALIFORNIA	NORTH HOLLYWOOD, CALIF. 91601	10654 Magnolia Boulevard	Tel. 213-769-2720
	BURLINGAME, CALIF. 94010	1324 Marsten Road	Tel. 415-347-5728
	MODESTO, CALIF. 95351	123 Phoenix Avenue	Tel. 209-521-8051
FLORIDA	TAMPA, FLORIDA 33606	1505 Cypress Street	Tel. 813-253-0324
	FT. LAUDERDALE, FLORIDA 33315	104 S.W. 23rd St., Bay 16	Tel. 305-524-0914
GEORGIA	ATLANTA, GA. 30310	646 Evans St. S.W.	Tel. 404-758-2232
ILLINOIS	CHAMPAIGN, ILLINOIS 61820	405 East University Street	Tel. 217-356-6400
	SKOKIE, ILLINOIS 60076	5110 West Brown Street	Tel. 312-675-0230
INDIANA	INDIANAPOLIS, INDIANA 46204	112 West St. Clair Street	Tel. 317-632-3493
KENTUCKY	LOUISVILLE, KENTUCKY 40205	2244 Taylorsville Road	Tel. 502-452-1191
LOUISIANA	SHREVEPORT, LOUISIANA 71104	3025 Highland Avenue	Tel. 318-221-3027
MARYLAND	BALTIMORE, MARYLAND 21215	5505 Reisterstown Rd., Box [illegible]624	Tel. 301-358-1186
MASSACHUSETTS	SPRINGFIELD, MASS. 01108	405 Dickinson St.	Tel. 413-788-8206
MISSOURI	ST. LOUIS, MISSOURI 63132	10530 Page Avenue	Tel. 314-429-0633
NEVADA	LAS VEGAS, NEVADA 89102	1412 Western Avenue No. [illegible]	Tel. 702-384-4235
NEW JERSEY	TRENTON, NEW JERSEY 08638	901 North Olden Avenue	Tel. 609-393-0999
	JERSEY CITY, NEW JERSEY 07307	547-49 Tonnele Ave., Hwy. [illegible] & 9	Tel. 201-792-3730
N. CAROLINA	GREENSBORO, N.C. 27405	2914 E. Market Street	Tel. 919-273-6276
OHIO	CINCINNATI, OHIO 45216	7450 Vine Street	Tel. 513-821-5080
	CLEVELAND, OHIO 44109	4525 Pearl Road	Tel. 216-741-2314
OREGON	PORTLAND, OREGON 97210	1732 N.W. 25th Avenue	Tel. 503-222-9059
PENNSYLVANIA	PITTSBURGH, PA. 15209	503½ Grant Avenue	Tel. 412-821-4004
TENNESSEE	MEMPHIS, TENNESSEE 38111	3158 Barron Avenue	Tel. 901-458-2355
TEXAS	DALLAS, TEXAS 75218	11540 Garland Road	Tel. 214-327-8413
VIRGINIA	NORFOLK, VIRGINIA 23513	3295 Santos Street	Tel. 804-855-2518
CANADA	ST. LAURENT, QUEBEC H4N-2L7	305 Decarie Boulevard	Tel. 514-748-8803
	CALGARY, ALBERTA T2H-OL1	448 42nd Avenue S.E.	Tel. 403-243-0971
		P.O. Box 5823, Stn. "A"	

IF YOU WANT TO BRANCH OUT INTO THE TV TUNER REPAIR BUSINESS, WRITE TO THE BLOOMINGTON HEADQUARTERS ABOUT A FRANCHISE.

For More Details Circle (5) on Reply Card

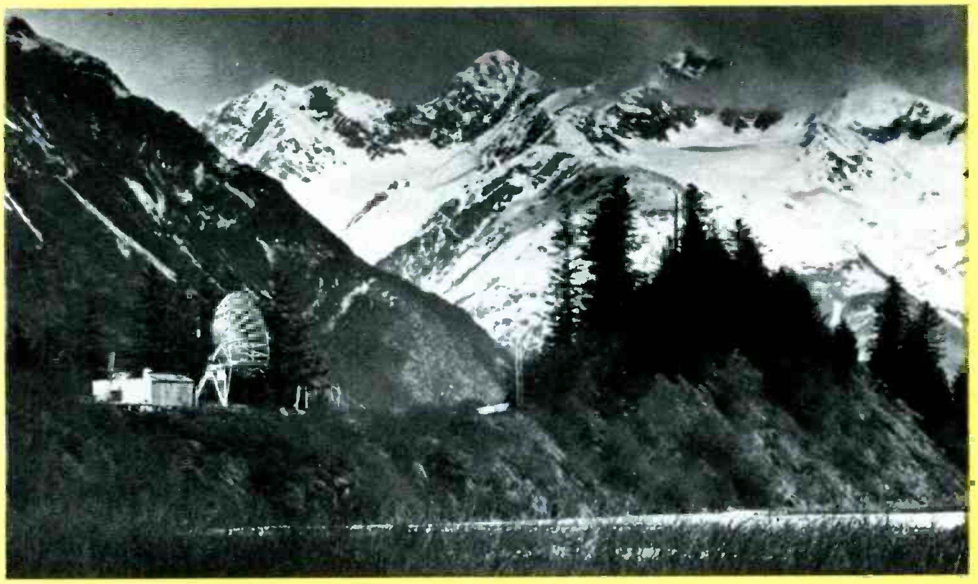
(*Continued from page 4*)

Stereo music on the standard broadcast AM band might be a possibility. At the first organizational meeting of the National AM Stereophonic Radio Committee (NAMSRC), officers were elected, and an announcement made asking all who have designs for broadcasting and receiving stereo with AM to submit the system to the committee for tests and evaluation.

The Pennsylvania Bureau of Consumer Protection has filed suit against a servicer operating near Waterford. Previously, the bureau had taken action against three TV technicians in Philadelphia, according to **Home Furnishings Daily.** In the suit, it's charged that Floyd Hartman of Hartman TV Repair Service defrauded customers by "performing repairs in an unworkmanlike manner, making unnecessary repairs, billing for non-existent repairs, and altering bills after consumers complained about charges."

Stop Alarm, a combination burglar alarm and door stop, **is offered by the Sunbeam Appliance Service Company.** Movement of the protected door activates a whistle powered by an aerosol can. Pressure of the aerosol is said to provide about 40 seconds of ear-splitting noise.

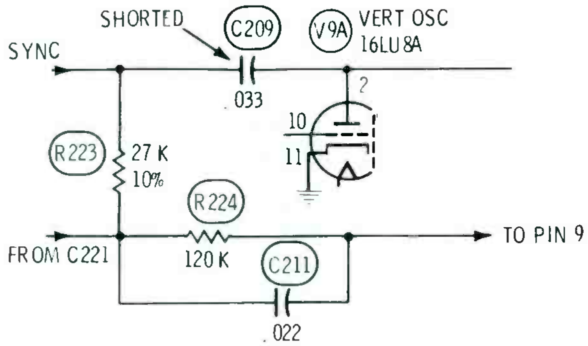
Reception of radio messages between ground stations located along the Alaska oil pipe line now is possible by using communications equipment in earth satellites. Mountainous terrain blocks direct signals. Five stations now are in operation. They are equipped with traveling-wave-tube power amplifiers, manufactured by Varian Microwave, and 33-foot-diameter parabolic antennas. Eventually, the system being set up by RCA Alaska Communications should have 100 smaller stations using 15-foot antennas, plus 28 more large stations with 33-foot antennas. At present, each amplifier and antenna can handle 612 phone calls. Television service might be added later. Signals are beamed to and from motionless satellites in geosynchronous orbits 22,000 miles over the equator.



symcure

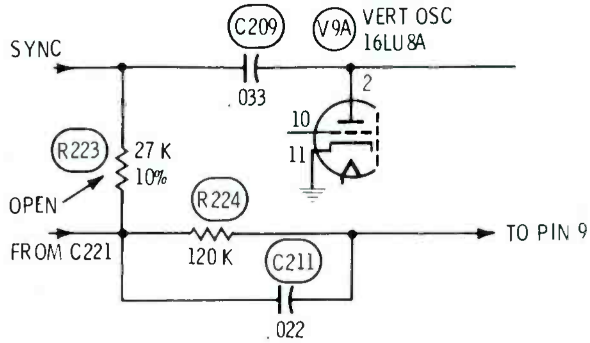
Symptoms and cures compiled from field reports of recurring troubles

Chassis—General Electric C-2
PHOTOFACT—1231-2



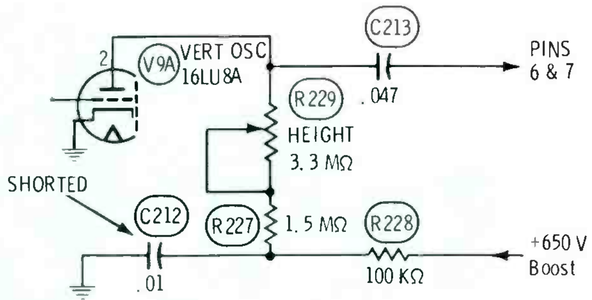
Symptom—Insufficient height
Cure—Check C209, and replace it if leaking

Chassis—General Electric C-2
PHOTOFACT—1231-2



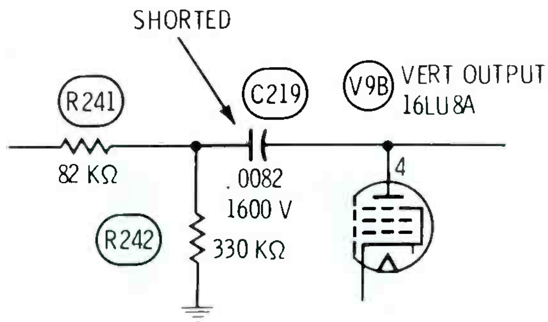
Symptom—Linearity stretched at top, insufficient height at bottom
Cure—Check R223, and replace it if increased or open

Chassis—General Electric C-2
PHOTOFACT—1231-2



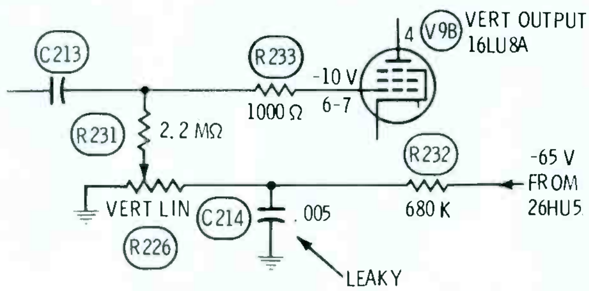
Symptom—No height
Cure—Check C212, and replace it if shorted or leaking

Chassis—General Electric C-2
PHOTOFACT—1231-2



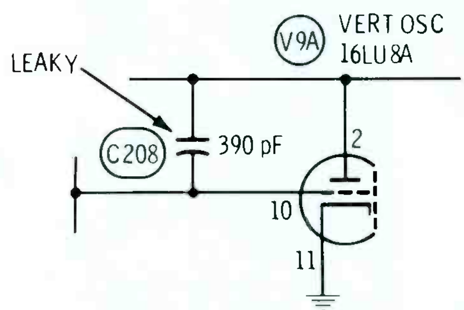
Symptom—Vertical cannot be locked (fast roll)
Cure—Check C219, and replace it if shorted

Chassis—General Electric C-2
PHOTOFACT—1231-2



Symptom—Linearity stretched at top
Cure—Check C214, and replace it if shorted or leaking

Chassis—General Electric C-2
PHOTOFACT—1231-2



Symptom—Insufficient height
Cure—Check C208, and replace it if leaking (even slightly)

reader's exchange

Needed: Complete service manual for Bell Imperial Model 1000B tuner/amplifier. Wish to borrow, or buy copy.

Dick's TV and Electronics
P.O. Box 5
Mt. Airy, Maryland 21771

Needed: Manual and schematic for Jackson Electrical Instrument Company Model 640 test oscillator, 100 kHz-32 MHz. Will buy, or copy and return.

Steven P. Czaikowski
1026-B Brixton Court
Sterling, Virginia 22170

Needed: Schematic and instructions for a Knight signal tracer KG-690. Will buy, or copy and return.

John H. Grumbling
9 Woodcrest Drive
Oroville, California 95965

Needed: A diagram for Model 520A regulated power supply made by Harrison Labs, Berkeley Heights, New Jersey.

Ritchie Electronics
P.O. Box N-7111
Nassau, N.P.
Bahamas

Needed: Schematic and operating instructions for Jerrold field-strength meter, Model TMT. Will copy and return.

Mike Costello
40 Whiteway Street
St. John's Newfoundland
Canada A1B 1K2

Needed: Schematic and service information for a 4-tube Crusader cathedral radio. Tube line up is 80, 47, 24 and 24A. Dial has 0 to 100 calibrations.

Lektro-Tek
4102 South Park Drive
Belleville, Illinois 62223

Needed: B&K CRT rejuvenator/tester Model 440, for reasonable price. Also, schematic and instructions for Hammarlund Model HQ105TR amateur radio receiver. Will pay for copies.

George V. Alvarado, Jr.
22 New Main Street
Haverstraw, New York 10927

troubleshootingtips

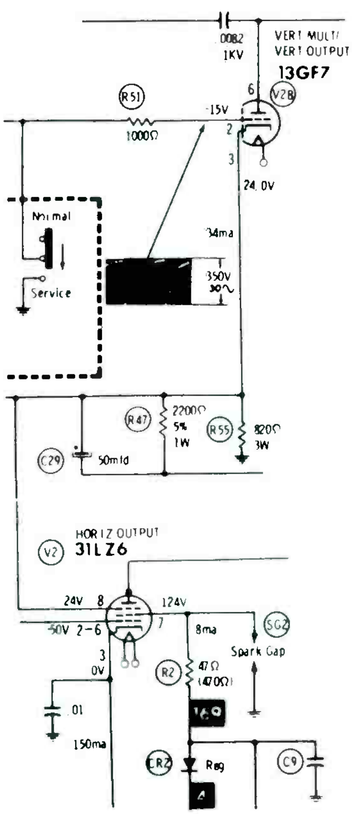
Send in your helpful tips—we pay!

Shrinking height
RCA CTC55 (Photofact 1203-2)

After periods of operation ranging from 15 minutes to several hours, the height of picture on this RCA would slowly shrink until it was only two or three inches high. Then the circuit breaker would trip. The vertical locking was not affected, and the linearity remained fairly good during the times the height would change.

R47, cathode resistor of the vertical-output tube, showed signs of having been overheated, and the 13GF7 tube had an intermittent short. Those parts were replaced and the TV returned to the customer.

Twice more the receiver was brought to the shop for the same complaint, and each time it operated fine.



During the last inspection, I carefully checked the schematic and discovered that the cathode of the vertical-output tube was connected directly to the suppressor grid of the 31LZ6 horizontal-output tube. Remembering the charred R47, I began to suspect that the problem might be coming from the horizontal tube.

As an experiment, I disconnected the wire between the vertical cathode and the horizontal suppressor, and connected an 820-ohm resistor from 31LZ6 suppressor to ground. I monitored the voltage at the suppressor, and after about 15 minutes, a DC voltage appeared, increased to +20, and then the breaker tripped. This proved the defect was in the 31LZ6 tube.

In my file of repair tips, I found that RCA suggested replacement of the 31LZ6 with a 36MC6. I restored the wiring, installed a 36MC6 tube, and the vertical problem was fixed.

J. M. Thurston
Fort Wayne, Indiana

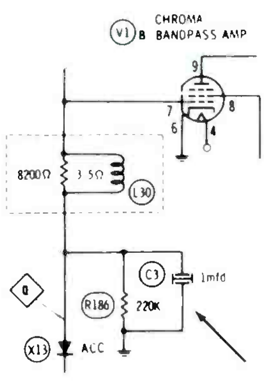
Excessive red in color
Zenith 18CC29
(Photofact 1225-3)

When the receiver was tuned to an unused channel, or when the color control was turned down, the raster had the normal white color. But with color, the pictures were predominantly red or red/orange.

Using a color-bar generator, I switched to the set-up position and found that the red horizontal line increased greatly in brightness, the blue line became darker, and the green line stayed about the same, when I tuned in the color pattern. This response definitely was abnormal.

DC plate voltages of V13 (6MN8) and the output voltages of the demodulator, IC1, also varied when the color signal was tuned in.

I replaced the demodulator IC first thing, but there was no improvement. All components around the IC checked okay. After exhausting those possibilities, I moved back to the chroma-bandpass stage, V1B, and found the plate and screen voltages changed from about +150 volts without signal to approximately 50 volts with color.



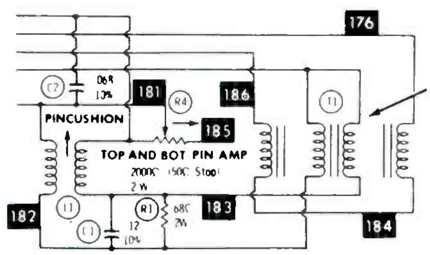
After some extensive testing, I replaced C3, a 1-microfarad nonpolarized electrolytic capacitor in the grid return of V1B. That cured the problem of excessive reds. Out-of-circuit, the capacitor tested leaky.

I don't quite understand how any defect in C3 could cause these symptoms, but replacement definitely solved the problem.

Jean P. Lash
Royal Oak, Michigan

Intermittent height
RCA CTC42XP
(Photofact 1112-3)

Occasionally, the height would flip to a small picture, with a loss of about 3 inches from top and bottom. Also, the raster was slightly trapezoidal. Careful moving and tapping of the various areas of the chassis showed the yoke assembly to be most sensitive.



I removed the convergence board, convergence yoke, and also the cover of the deflection yoke. With the power on, I moved components and connections, using a plastic rod, and soon located where the pincushion transformer had broken loose from the circuit board. A quick soldering of the transformer connections, replacement of the components, and the repair was completed.

Before rectangular color tubes were introduced, a trapezoidal picture **had** to be caused by the yoke. But, as pointed out in "Cures For Trapezoidal Pictures" in January, 1974 ELECTRONIC SERVICING, opens in certain pincushion components also can produce the effect.

Bob Plouf, CET
Gresham, Oregon

Needed: Wire for a wire recorder, new or used.
Andrew J. Pittek
222 Moye Place
Pittsburgh, Pennsylvania 15210

Needed: Delco power supply for servicing auto radios. Also, need late model VTVM or VOM, and all Rider TV manuals after Volume 13.
Arends Radio & TV Service
102 North Webster
Shenandoah, Iowa 51601

Needed: Manual for Hammarlund Model HQ-145. Will buy, or borrow for copying.
Joseph Carr
5440 South 8th Road
Arlington, Virginia 22204

Needed: Manual or schematic for Hughes Memo-Scope oscilloscope, Model 105A with dual-trace preamplifier 05-2 plug in. Will buy, or copy and return.
Jim Tyrrell
4714 N.E. 112th Avenue
Portland, Oregon 97220

Needed: Schematic or manual for Philco UHF sweep generator Model G8010. Willing to pay reasonable price, or copy and return.
M. N. Yoder
6512 Truman Lane
Falls Church, Virginia 22043

Needed: Old-type Mallory condensers, GEM 615, .05 MFD, 600 volts and, .25 MFD, 200 volts.
Orlando Ansehmi
R125 Second Street
Wyoming, Pennsylvania 18644

Needed: Instruction manuals or schematics for RCA Audio Chanalyst and Dumont 324R scope. Will buy, or copy and return.
Donald Wall
8 Mill Street
North Reading, Maryland 01864

For Sale or Trade: Transvision CRT tester-reactivator with high voltage sparker; also need Precision E400 sweep generator.
Al Crispo
159-3-90 Street
Howard Beach, New York 11414

Needed: Rider's manual #23 with index. Have volumes 1-5 abridged; and volumes 6-17 (excluding volume 11) for sale or trade.
J. Allen Call
1876 East 2990 South
Salt Lake City, Utah 84106

Needed: *Power transformer for a Model 620 Eico scope.*
J. C. Martin
1104 First Street
Natchez, Mississippi 39120

For Sale: *Early 1950s TV's and TV parts.*
Victor R. Engelhaupt
1111-1/2 Orizaba Avenue
Long Beach, California 90804

For Sale: *TL-D67 oscilloscope, brand new. Send self-addressed envelope.*
William D. Shevtchuk
1 Lois Avenue
Clifton, New Jersey 07014

For Sale or Trade: *Riders radio manuals Volumes 1-13, and Riders TV manual Volume 1, $130.00.*
Daniel Seidler
5827 South Campbell Avenue
Chicago, Illinois 60629

For Sale: *Sencore TV sweep analyzer, Model SS137. Never used, $60.00.*
B. Kutilek
17215 70th Avenue
Tinley Park, Illinois 60477

Installing CB Radios In Diesel Trucks

By Forest H. Belt

Here are practical suggestions to help you make topnotch CB installations in those $35,000-plus over-the-road trucks.

Installing a CB radio into a diesel tractor cab is not always easy. But don't shy away from these installations. The chief ingredient for success is **experience.** In case you lack that, I'll share some I gained developing my recent book "Easy Guide To CB Radio For Truckers", published by Howard W. Sams.

Truck Construction

First, realize that there are significant differences in the way various trucks are constructed. As an example, a **Peterbilt** cab-over-engine tractor has a large hollow crossbeam over the windshield. It's large

Fig. 1. In many trucks, a CB radio might interfere with movements of the driver's leg, if mounted under the dash in the usual way (left). Sometimes sufficient room can be found around the center console of a cab-over-engine model (right). Be sure the space isn't needed for something else, and that the driver can reach the CB controls and hear the speaker.

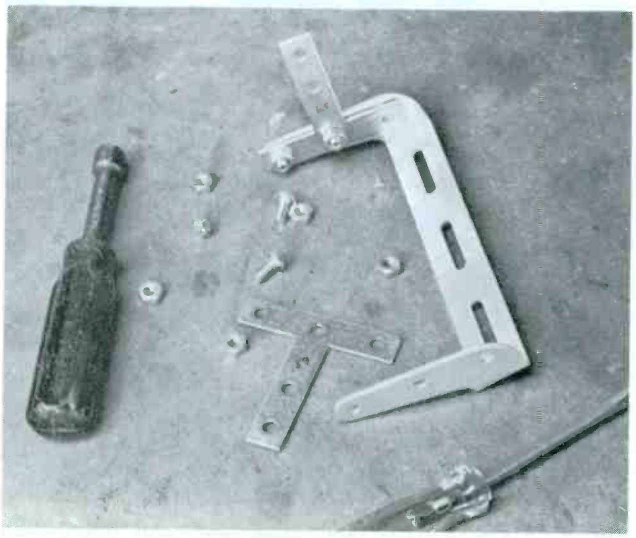


Fig. 2 "T" brackets (obtainable from hardware stores) added to the cradle permit mounting the CB radio upright, and with the speaker in the clear.

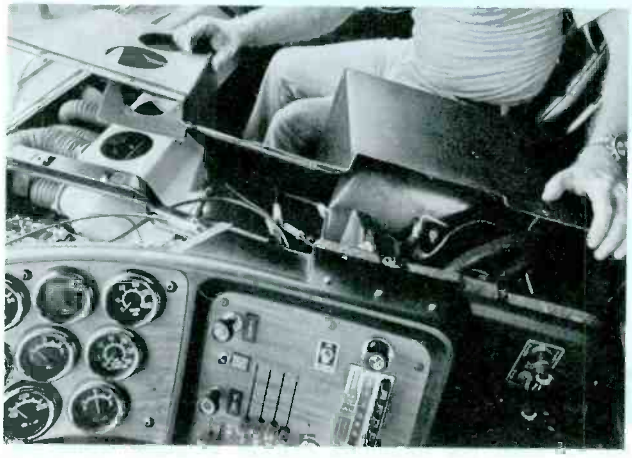


Fig. 3 Remove the self-tapping screws that hold the cover to the console. For total access, unclip the air-conditioner vents, and remove the cover. This allows you to trace good paths for the antenna and power cables, drill the holes and install the grommets, before replacing the cover.

enough to reach an arm into, and has large access panels. This space is perfect for running antenna cables. A GMC **Astro,** on the other hand, has a similar crossbeam, but the space inside is smaller, and access is more limited (a hand-sized hole in the center, and a small hole behind each sun-visor mounting bracket). What's more, padding covers the beam. So, until you remove the padding and visors, you can't even tell any access holes are there.

Construction oddities of different makes and models can complicate CB installations in trucks. To deal with these peculiarities, I suggest you visit various big-truck dealers in your locality. A few minutes talking with a body-shop foreman can save you hours of valuable time later. Either make notes, or record the conversation on a portable cassette machine.

Mounting The Radio

Most CB transceiver radios are designed to be hung under the dash, as shown in Figure 1. That's okay for tractors having conventional cabs, but it can be downright inconvenient in cab-over-engine tractors. Where you can't hang the unit overhead, such as from the crossbeam over the windshield, with the speaker aimed downward in the clear, you face limited alternatives.

One is to mount the unit in the kneehole beside the steering column. But that's not really a good place; long-legged drivers bump the unit with their right knee. You might hang the transceiver from the ceiling, but that tends to be a body-shop job. Units have been hung from the ceiling air-conditioner housing; but a metal plate should be installed inside the (usually plastic) housing for reinforcement.

The best answer, for cab-over-engine tractors, seems to lie in some sort of console mounting. Yet even that introduces two inconveniences.

For one thing, some CB models can't be bolted into the mounting bracket when the bracket has to fit **below** the transceiver; the bolt holes in the CB cabinet are not placed for over/under interchangeability. Worse, mounting that way faces the speaker down against the console, muffling the sound. You can combat that problem by installing an extension speaker nearby, or behind the driver. Virtually all modern CB transceivers have a miniature jack for plugging in an accessory loudspeaker.

Another alternative is to mount the transceiver upside-down on the console. That leaves the speaker facing upward. But few drivers want to operate a unit upside-down, even though it hurts nothing.

My solution to these multiple problems is to bolt short T-shaped extensions to the mounting bracket (Figure 2). That lets you put the transceiver right-side-up, even though the speaker still faces down. If the extra brackets raise the front of the radio high enough, an extension speaker won't be necessary; you can hear the internal speaker okay.

One other factor can waste your time unless you plan well. CB antennas, particularly the co-phased dual type so popular with truckers, differ considerably. Of course mountings vary, but it's the cable that can bring you difficulty. The way the cables are phased together determines where and how you begin the antenna installation. In next month's article on antenna work, I will explain different cable styles. I also show you where to start with each type. But for now... let's get back to the transceiver.

Connecting The Power

Once you've decided where and how you're going to mount the unit, study the truck further. First, figure out the DC power connection. Determine whether you'll have to add

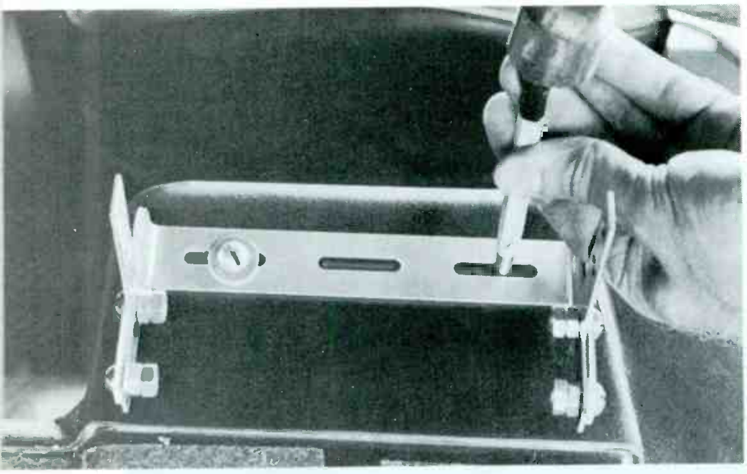


Fig. 4 Hold the mounting bracket in place while you mark the position for the first mounting screw. After drilling that one, use machine screw, nut, lock washer, and flat washers to secure the bracket as you drill for the second (and third, if needed) screw. This assures that the holes match.

Fig. 5 If you're lucky and observant, you might find screws already located where they can hold the radio mounting bracket solidly.

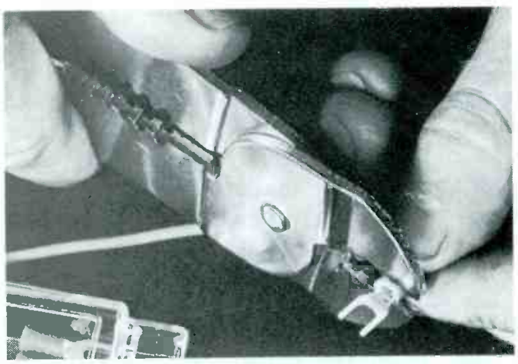


Fig. 6 Spade lugs assure dependable connections to the DC wiring of the truck. Strip off ¼-inch of insulation, twist the strands tightly and insert into the barrel of the lug, and then crimp (with the split side of the lug barrel in the cradle of the crimping tool). Use of the crimping tool gives a tight electrical connection without soldering.

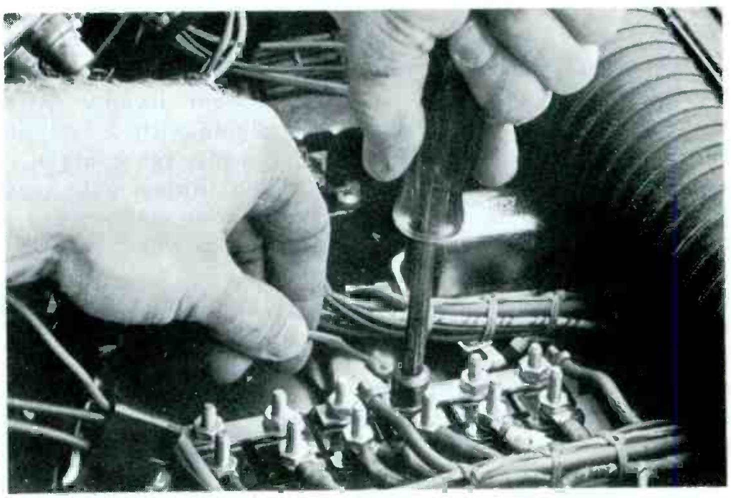


Fig. 7 With your test meter, find a DC-voltage bus that permits the driver to operate the CB rig even when power to the truck is off. Securely tighten the nut that holds the lug.

Fig. 8 Thumb nuts and an exposed fuse holder allow the driver to remove the CB rig quickly, if necessary to foil would-be thieves. Use grommets in every hole where wires must pass through.

wire or can hook up the transceiver as-is. The following paragraphs will help you plan.

Truck starting systems are 24-volt. But don't let that worry you. The battery system is tapped to provide 12 volts DC for lighting and for other accessories. Therefore the voltage you find at the power panel is 12 volts.

Polarity is crucial. Some CB transceivers can be hooked only to one polarity. Even those designed for either polarity can be damaged if you hook them up reversed. So, you have to ascertain whether the voltage measures positive or negative with respect to ground. Your portable digital or simple VOM works fine for this. The easiest place to check is right at the power buses. Or, if you want to know the polarity before you open the console, just pull out the cigar lighter and measure between the shell and the center of the socket.

Some radios have one DC hookup wire, others have two. The difference usually is this: the single-wire radio connects internally for one battery polarity only. A label on the set and a tag on the wire warns you. Hooking some sets incorrectly blows the fuse; a protective diode shorts wrong-polarity DC to ground, thus protecting costly transistors.

Two-wire radios are designed with a floating power bus inside. The radio can be hooked to either polarity. The trick is to connect the red DC wire to positive and the black DC wire to negative. You connect them that way whether positive is ground or negative is ground. The fuse is just as effective between the transceiver and ground as it is in the hot wire.

If you don't know for sure where the power panel is, now's the time to open the console cover. A large panel underneath contains rows of automatic-resetting thermal breakers and a series of switched and nonswitched 12-volt buses. The photos in Figure 3 show how to open the console of a GMC **Astro.** Other truck builders make the power panel equally accessible. You loosen a few screws and lift a cover forward of the console.

Once you find the power panel, you can figure how to run the hot wire—whether it be black or red—from the transceiver to the panel. If you mount the radio on the console, as I do in this demonstration with a Johnson **Messenger** 123SJ, you can drill a hole for the hot wire right beside the mounting bracket, or just behind it. **Concealed wiring always marks the professional installation.**

Probably, you can use a single hole to carry both power wire and antenna cable. For the DC power wires alone, you need only a small hole, into which you insert a small grommet before you run the wires through. If your dual-antenna cable design (next month) brings both coaxial cables to the transceiver, you'll need two holes, both with grommets. Rubber grommets not only make the installation dressier, they prevent chafing of the wires and cables.

Having pinned down a location for the power wire, drill the hole for it. If you plan to run both cables through the same grommet, drill a half-inch hole. Heavy-duty grommets with a quarter-inch inside hole do an excellent protective job. They're sometimes called **rubber bushings** at hardware stores.

Go ahead and attach the bracket (Figure 4). Mark one hole first, centerpunch the spot, and drill. Then with one bolt holding the bracket in place, punch and drill the second hole. Mark, punch, and drill another, if you feel a third bolt would hold the bracket more solidly.

Install all three (or both) bolts. In trucks where you mount on the console, use flat washers on both sides and a lockwasher on the side with the nut. Many truck consoles today are constructed of high-impact plastic. Without the flat washer, vibration and strain eventually crack the material around the holes, and the mounting shakes loose.

This kind of mounting precaution is wise even if you're fastening to a metal console. You may be tempted to use self-tapping (sheet-metal) screws. Unless you get underneath and back them with Tinnerman nuts, self-tapping screws tend to vibrate loose. Holes they're in become oversize, and eventually you have to switch to bolts anyway.

You should also consider the matter of **grounding.** If the radio has a metal case, you'll find that it picks up less ignition noise if you ground the case well. You can't make direct ground when you bolt to a plastic console. But you can install a metallic-braid bonding strap between one mounting bolt and some metal frame member beneath the console cover. Use your ohmmeter to be sure the bracket is actually grounded by the bonding braid. Measure for zero ohms between the bracket and the skin of the tractor—say around the door.

With one-wire DC connections, this metallic bond is crucial. **Never depend on the shield of the antenna cable to provide the ground for DC power.** With two-wire systems, a ground for the metal cabinet is not so important, although as I said, it does stop some ignition interference. Certain CB transceivers have plastic housings. A two-wire power connection and the antenna cable shield furnish all the grounding considered necessary.

Occasionally, as happened to me in one GMC tractor, you can find screws already in a good location for mounting. The ones you see in Figure 5 are self-tapping types that screw into fixed Tinnerman clips underneath. One clip had in fact been dislodged by mechanical work done before I even saw the truck. Nevertheless, I replaced it to assure a solid mounting for the CB transceiver bracket.

I also take the precaution of measuring the voltage again, using the bracket as the ground point. I clip the meter ground lead (negative, in my demonstration installation) to the bracket and touch the hot test lead to the DC power bus where I intend to make the DC connection. If I obtain a proper 14-volt reading, I know the radio will have the DC power it needs.

Grommets and splices

Okay, the bracket is fastened. Now run the free end of the radio's hot wire through the grommet you put into the hole drilled beside the bracket. Dress the wire neatly over to the DC power block.

If you mount the unit overhead, drill a hole so you can poke the DC wire through a grommet into the hollow crossbeam over the windshield. Then you can bring the wire down the channel that divides the windshield, or you can run it across and down the doorpost and behind the dash panel. Either way is okay, as long as the wire is hidden. Do not poke any wire or cable into an access hole, because when you replace the cover you pinch the wire. Sooner or later the insulation wears through and the wire shorts out.

Keep the fuse outside the hole, near the transceiver for easy access. More important, with metal dashes, you need the fuse for protection in case of a short where you take the wire inside the console. Without fusing, a short there could trigger a disaster.

If you run the wire down one of the doorposts, you might have to splice. Twist the ends together securely, **solder them,** and wrap the splice with several turns of plastic tape.

You should know there is only one right way to make the connection to the power panel. That's with a spade lug. Figure 6 shows the method. You can buy spade lugs very inexpensively at any electronic supply house, and a low-cost crimper sells for only a dollar or two.

Connect the hot DC wire under a nut (and washer, if there is one) on the DC power panel (Figure 7). Most truckers prefer that you select an unswitched bus, so the CB unit stays on, even with the key switch off. Do not hook through any of the thermal circuit breakers; as you know, the CB transceiver has its own fuseholder in the DC hot line. Tighten the nut securely, and make sure it hasn't squeezed the terminal lug out from under.

Finishing The Job

Finally, you mount the radio in its bracket. Even here, I like to add a small extra. Rings of thieves seem bent on stealing every CB radio they can find in a truck. Consequently, many truckers take the radio out and carry it with them into their motel or eating place, whenever they stop.

At the hardware or radio-TV store, you can buy cadmium-plated wing nuts, or thumb bolts (Figure 8). Install these, instead of hexhead nuts, to simplify removing and reinstalling the unit without tools. And make sure the coax antenna lead has sufficient slack to prevent crushing during these times.

Restore the console covers, and you're done with the transceiver. If you're reasonably familiar with the truck, the elapsed time should be no more than an hour.

Next Month

Next month, I'll show you how to do a fast and good antenna installation, also explaining the two most common truck-antenna-cable formats and how to deal with them. □

OFTEN-USED TUBES

By Gilbert J. Grieshaber

The list of tubes that follows is my recommendation for the shelf stock of a small TV/radio service shop. It is based on careful records kept for several years in my own operation, covering the servicing of all brands, but without warranty replacements which could distort the figures.

Local conditions, such as the percentage of carry-in portables or unusually-high sales of one brand in the area, can change the demand somewhat. Therefore, you should adjust your buying, after a trend becomes apparent. Larger shops should expect to stock multiples of these quantities.

Tubes listed for a large quantity should be stocked in tube caddies for use during service calls. An arrow pointing upward beside a quantity indicates that the sales have increased within the past year, and a downward arrow marks decreased sales of the tube.

TUBE Type	Quantity
1G3/1B3	1
1V2	3
2BU2	2
2BV2	1
3A3	30
3AT2	4
3AW2	2 ↑
3BS2/3BT2/3BW2	2 ↓
3BZ6	1 ↓
3CA3	1 ↓
3CN3	2 ↑
3DB3	3 ↓
3DF3	1
3DG4	1 ↓
3DH3	1
3DJ3	1
3HA5	1
4BZ6	1 ↓
4DT6	1
4EH7	1
4EJ7	1
5AQ5	1
5CG8	1
5GH8	2 ↑
5LJ8	1 ↓
5U4	2 ↓
6AD10	1 ↑
6AF9	1
6AG9	1
6AL3	1
6AL5	1
6AM8	1 ↓
6AQ5	4 ↓
6AS5	1 ↑
6AU4	1 ↓
6AU6	2
6AW8	2
6AX4	1 ↓
6B10	1
6BA11	4 ↑
6BE3	1
6BK4	25
6BL8	3 ↓
6BN6	1
6BN8	1 ↓

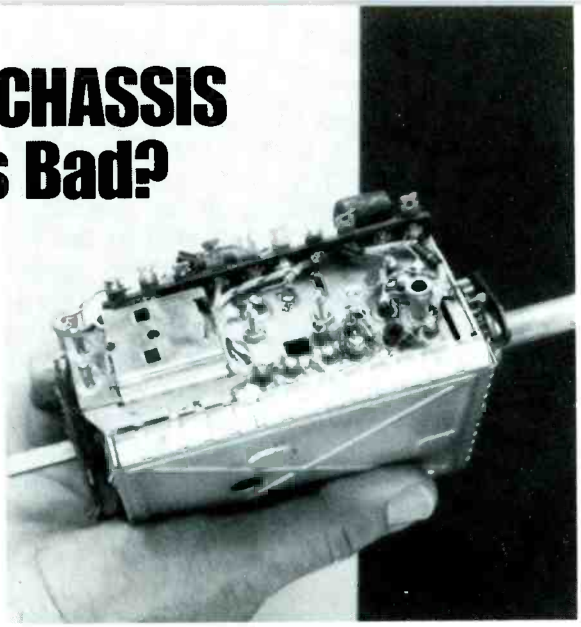
TUBE Type	Quantity
6BQ5	1 ↓
6BQ6	1 ↓
6BQ7	1 ↓
6BS3	1 ↓
6BZ6	2
6CB6	2
6CG3/6CD3 /6CE3/6DT3	4 ↑
6CG3/6BW3/6DQ3	3 ↑
6CG8	1 ↓
6CJ3	8
6CL3	15 ↑
6CL8	1 ↓
6CM3	1 ↓
6CS6	1
6DR7	1
6DS4	1
6DQ5	1 ↓
6DT6	1 ↓
6DW4	20 ↓
6DX8	1
6EA7/6EM7	2
6EA8	2
6EB8	1
6EH7	1
6EJ7	2 ↓
6EM5	1
6EN4	1 ↑
6EW6	4
6FM7	1
6FQ7	10 ↓
6GE5	1 ↓
6GF7	4 ↓
6GH8	20
6GJ7	1
6GM6	6
6GN8	1
6GU7	6
6GW6/6DQ6	2 ↓
6GX6	use 6HZ6
6GY6	use 6HZ6
6GX7	1
6HA5	3 ↓
6HB6	1 ↓
6HB7	2

TUBE Type	Quantity
6HF5	1
6HL8	1
6HQ5	2
6HS5	5
6HS8	1
6HV5	6
6HZ6	4 ↓
6J10/6Z10	3 ↓
6JB5	3 ↓
6JB6	1
6JC6	6
6JD6	1
6JF6	1 ↓
6JG6	1
6JH6	2
6JH8	1
6JS6	5 ↓
6JT8	1
6JU8	2
6JW8	2
6JZ8	1
6KA8	2
6KD6	5 ↓
6KE8	3
6KM6	1 ↓
6KN6	1 ↓
6KT8	3 ↓
6KY8	1
6KZ8	3
6LB6	10
6LE8	1 ↓
6LF6	1 ↑
6LF8	2
6LH6/6LJ6	2 ↑
6LJ8	1
6LQ6/6JE6	20
6LR6	2
6LR8	1 ↓
6LU8	2 ↓
6LY8	1 ↓
6MD8	2
6ME8	2
6T8	1 ↓
6T10	1
6U10	3 ↑

TUBE Type	Quantity
6V6	1 ↓
6X9	1
8B10	1
8FQ7	1
8JV8	1
8LT8	1
10CW5	1 ↓
10GF7	1 ↓
10GK6	1
10JA8	1 ↓
11MS8	1 ↓
12AU7	2 ↓
12AX7	2
12AY3	1 ↓
12AZ7	1
12BY7	3 ↓
12CL3	1
12DW4	1
12GW6/12DQ6	1
12HG7/12GN7	3 ↓
12HL7	3 ↑
13GF7	1 ↓
15KY8	1 ↓
17AX4	1 ↓
17BS3	1 ↓
17CT3	2 ↑
17JZ8	1 ↓
17KV6	1 ↓
19CG3	1 ↓
21GY5	1
21HB5	1
21LR8	1
22JR6	1 ↑
23JS6	1
23Z9	1 ↓
24LQ6	1 ↓
26HU5	1
31JS6	1
33GY7	1
34CE3	1 ↓
35LR6	1
35W4	1 ↓
36MC6	2
38HE7	1
40KD6/36KD6	2
50C5	1 ↓

Note: ↑ *indicates sales are increasing*
↓ *indicates sales are decreasing*

TUNER OR CHASSIS ...Which Is Bad?



By Max Goodstein

Is the tuner defective? Or is a chassis problem simulating a tuner malfunction? Answers to those questions can be important, for a mistake can cost both time and money. In this timely article, some guidelines and tips are given for determining the source of "tuner" problems.

In this age of tuner substitutors, it seems impossible for technicians ever to make a wrong diagnosis about a tuner problem. Yet, it happens. The fact that mistakes do occur is no reflection on the technique of tuner substitution, for the method is excellent when done correctly. No, the solution is to cross-check, making certain there are no loopholes in the procedure.

Basic Problems

Some of the problems that can originate either in the tuner or in the chassis are:

- no picture or sound;
- low sensitivity, perhaps with little snow off channel;
- snow on channels that usually have none;
- overload of strong signals, might be associated with low sensitivity;
- intermittent white or black horizontal bars on some channels; and
- wrong fine tuning. This can give several different symptoms, such as no color, interference, or beat patterns.

Signal Injection

When injecting a test signal from a tuner substitute or generator into the IF's, it's best to connect at the tuner end of the shielded IF cable.

Many technicians remember the serious problems with some old Motorola TS-908 and TS-917 color receivers. Only stronger stations could be received, and the color was terrible. A test signal applied directly to the grid of the first IF tube gave good results, so they concluded the tuner was defective. Unfortunately, a bad run of tuner-to-IF cables was the problem; the tuners were normal. A test that included the cable would have prevented much wasted time.

By using that test, I have found many intermittent connections and poor soldering joints at the tuner plugs. If I had not included the cable, I probably wouldn't have found those problems, and would have blamed the tuner for erratic operation.

Tuner Voltages

If the symptoms point to a tuner problem, first measure all B+ voltages at the tuner. It's likely every technician has blamed a tuner when the defect later proved to be an off-value resistor, an open B+ resistor, or a shorted capacitor outside of the tuner.

Measuring voltages is easy and quick except in those models, such as some import portables, where the tuner is completely buried. Sometimes it's necessary to dismantle the set completely to clean the contacts or measure voltages on the tuner.

For that reason, I look for tie points on the main chassis where the B+ or AGC voltages originate, and then measure them there. Of course, in some cases it's necessary to pull the tuner when the defective component is on top of the tuner. But, a wrong voltage at the chassis usually means the tuner is okay, and the defect is in the chassis.

Tuner substitutes

Remember that the tuner substitutes have their own power supplies and gain-control voltages built in. So don't expect such a test to find problems involving those two voltages. **Check the tuner voltages before you finish the diagnosis.**

Wayne Lemons wrote in ELECTRONIC SERVICING about a tuner that received some channels but not others. The conclusion was: the tuner had to be defective. But it wasn't; instead, the B+ supply to the tuner was too low.

AGC Voltages

AGC defects are easier to analyze in tube-power receivers than in solid-state models. With tubes, negative voltages are **always** used to reduce the gain. We could short the AGC terminal on the tuner to ground, and if the picture became less snowy, it was a cinch the negative AGC voltage there was excessive.

That test won't work with bipolar-transistor tuners. Shorting the RF AGC to ground removes all forward bias from the RF-amplifier transistor, causing a lot of snow. In addition, the overload might zap the transistor that supplies the RF AGC.

Typical AGC voltages

After examining many schematics, I've discovered that almost all RF-amplifier bipolar transistors used in present receivers are of the NPN type, with AGC voltages ranging from about +1.4 volts to +3.5 volts. To reduce the gain, the positive AGC voltage is increased over the no-signal value.

If you believe a wrong AGC voltage is giving insufficient gain, or poor AGC action, you can **disconnect the AGC wire from the tuner and connect an external adjustable bias supply.** Just remember that both too much and too little forward bias reduces the gain.

Tuners with MOSFET RF stages have about +7 volts with little or no signal and perhaps -2 volts on a strong channel. Most of the tests ordinarily used with RF tubes can be used here, including the one of grounding the AGC to check for less snow.

Many tuners have feed-through capacitors connected to both MOSFET gates, regardless of whether the FETis above or below the case (see Figure 1). These make excellent test points.

General Electric, in the service notes for the MA chassis, suggests that interference resembling sound bars on strong signals (but normal on weaker signals) might be caused by a shorted gate #2 in the RF MOSFET. To check for this possibility, disconnect the RF AGC wire at the tuner, and measure the DC voltage at the tuner AGC terminal (with power on). There should be zero DC volts. Any higher voltage indicates a leaky or shorted gate in the MOSFET (see Figure 2).

Mixer voltages

Mixer base connections often are tied to feed-through capacitors, making them accessible from the outside, as shown in Figure 3.

The feed-through connections are good test points for voltage measurements, RF signal injection, or sweep injection for IF alignment.

One tube-equipped tuner gave me a lot of trouble. The snow was weak without signal, and on strong signals there was overload. These symptoms can be from AGC problems. But in this case, I finally found a mixer-grid test point that was shorted to chassis by a solder blob.

Case History #1

This RCA CTC38 chassis had good sound but absolutely no video. Usually the tuner is working if the sound comes through okay. So, I injected a video signal from a color-bar generator at various points of the video circuit until I found that L212 (4.5-MHz trap) was open.

Unfortunately, after I replaced the coil, the video would come in and then fade away in a kind of motorboating. Sometimes, the point having maximum voltage variation will indicate the origin of a defect, even in closed-loop circuits such as AGC. This time, maximum variation seemed to be at the base and emitter of the AGC transistor, but replacing it didn't help.

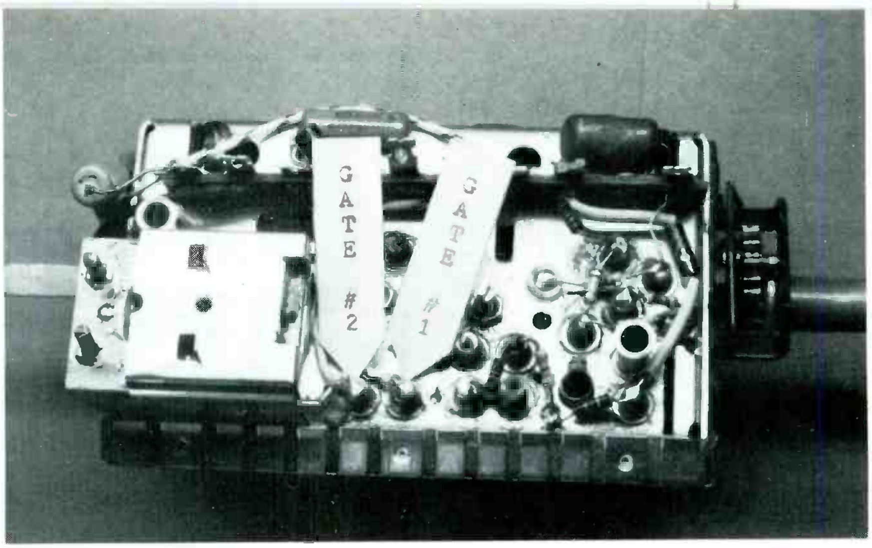


Fig. 1 Both gates of some MOSFET RF amplifiers are connected to feedthrough capacitors that can be used as excellent test points.

A 1-microfarad capacitor added from tuner AGC to ground stopped the motorboat, but the AGC settings for best results were different for each channel.

Next, I tried a tuner substitutor. There was no motorboating, but again the AGC settings were critical for various channels.

Perhaps the Nuvistor RF stage was oscillating, so I tried neutralizing the stage. There was no improvement. A thorough cleaning of the tuner contacts helped nothing. Finally, I was forced to conclude that the tuner was not the problem.

Swallowing my pride, I called an RCA factory technician. At my mention of motorboating, he immediately said to change the second IF transistor. I changed the transistor, and to my amazement the pulsations stopped.

That was the first time I ever encountered an IF transistor causing motorboating, although it has happened many times with audio-output transistors. Such output transistors showed base/emitter leakage, when tested, and the motorboat probably was produced by a difference of time constant causing an overshoot when the circuit attempted to supply the extra base current needed.

Figure 4 shows the first two IF stages. Notice that the two transistors are in series between +80 volts and ground. Also, the base voltages are supplied from a single voltage divider. Although the AGC operates to change the emitter voltage of Q1, it also changes the bias of Q2, because of the series connection of the transistors. The circuit compensates nicely for normal drift, but perhaps the extra correction for the defective transistor overshoots the mark before the emitter and collector voltages can stabilize.

Advice

When the set was motorboating, I tried bridging a filter across various points of the circuit. Unfortunately, I first connected it to the +270 supply; then, without thinking about the consequences, I immediately touched the lead to the +18-volt supply on the tuner. Yes, you guessed it! I zapped all three transistors in the tuner, adding that problem to the original one.

Advice: if you connect a filter or other large capacitor to the transistor circuit, **discharge it before bridging another terminal.**

Case History #2

The only symptom of a 14Z8C50 chassis Zenith was overloading on the lower channels. I adjusted the AGC so channels 2 and 4 didn't weave and overload, but then the higher channels had low contrast. No one setting of the AGC would bring in all channels correctly.

Neither changing the IF module nor substituting the IF AGC voltage helped at all. But by chance, I

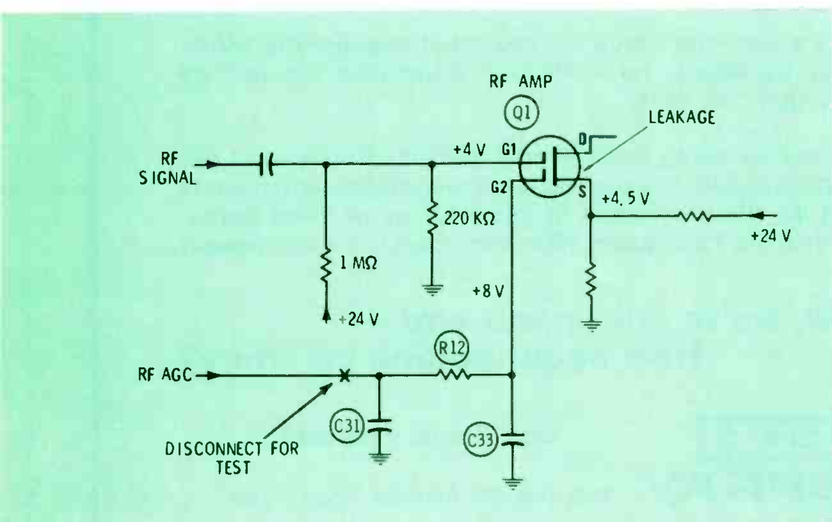


Fig. 2 Check for internal gate leakage of a MOSFET by disconnecting the AGC wire to the RF stage, and then measuring the voltage at the tuner side. The correct voltage should be zero; any other voltage indicates leakage because of a defective MOSFET.

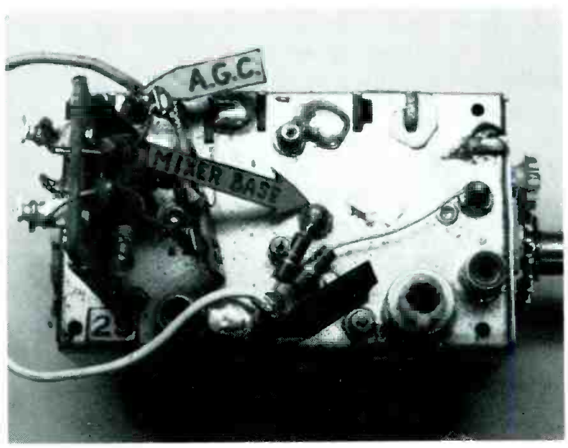


Fig. 3 Leads of mixer transistors often connect to feedthrough capacitors. Test signals can be injected there, and DC voltages measured.

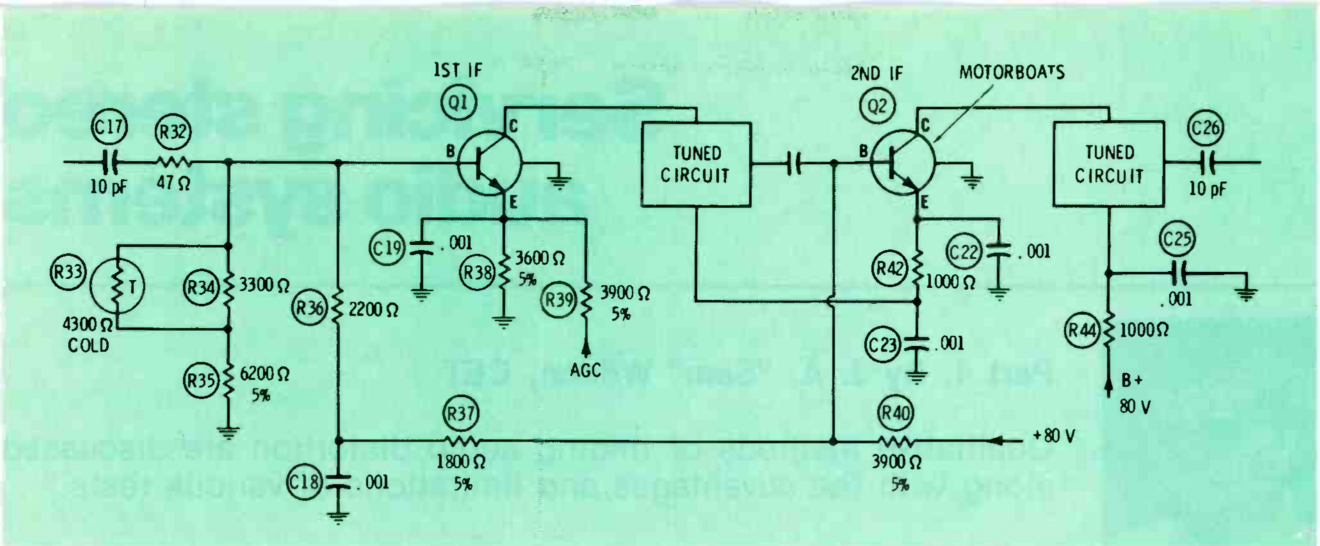


Fig. 4 This partial schematic of the IF stages in RCA CTC38 chassis shows both transistors are in series with the supply voltage, and the bases come from a common voltage divider. A leaky 2nd IF transistor causes a motorboat of the video.

replaced the 6HA5 RF tube and the AGC operated normally. The tube tested some grid leakage, showing that my mistake was in not measuring the RF AGC voltage.

Case History #3

To replace a filter capacitor in a CTC59 RCA chassis, I had to remove the entire vertical chassis. After the set was reassembled, I found the high channels were dead and the others snowy.

Using signal injection technique, I fed an IF signal and also a color-bar pattern into various points of the tuner. The results were confusing. Replacement of the MOSFET RF amplifier and Q2 mixer transistor gave no improvement.

All the DC voltages tested fine, until I finally recognized that the +15 volts at the IF-output socket on the tuner was missing. A visual examination disclosed a broken R21 (see Figure 5). Probably the resistor broke either when I wiggled the plug to remove it or in reinserting it after the filter repair. Apparently, the closeness of the broken ends fed a small amount of signal to the IF cable.

Case History #4

Excessive B+ supply voltage to the tuner can destroy some or all of the tuner transistors, as I discovered with a Zenith 4B25C19 chassis. After I found two of the tuner transistors shorted, I remembered the advice given during a Zenith factory seminar, and measured the supply voltage. It was too high, and further testing proved the zener diode, X26, that's used for regulation (Figure 6) was open. Replacement of the transistors and the diode brought the voltage back to normal, and the job has not had a callback.

Conclusions

The use of a tuner substitutor in Case #1 might have been misleading if I had failed to make additional tests. As it was, a useless trip to the tuner overhaul facility was avoided.

Case history #2 was misleading because it didn't appear to be a tuner trouble.

Substitution of the tuner would have pointed correctly to the tuner of Case #3.

An excessive supply voltage, as in Case #4, does not necessarily destroy transistors immediately. the new replacements might operate for days, but I recommend that you measure the supply voltage every time you find a dead transistor, as insurance against an early failure. □

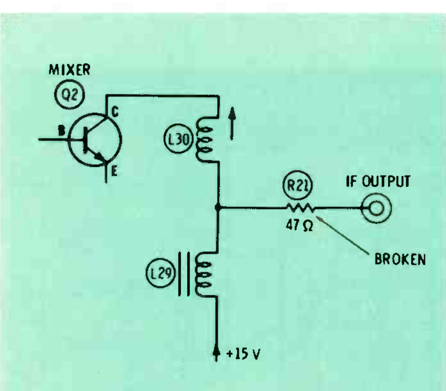


Fig. 5 A broken resistor decreased the gain of a tuner in an RCA CTC59. It might have broken when the IF cable was removed; use care in handling all cables.

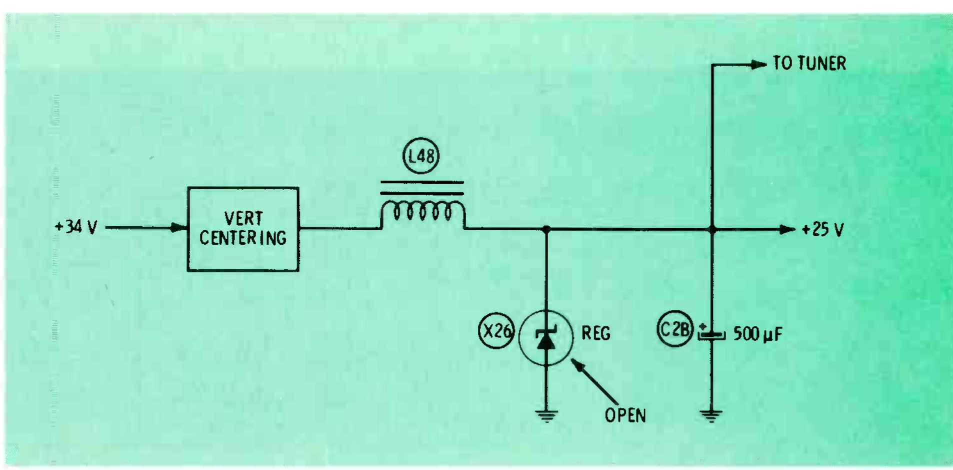


Fig. 6 High supply voltages can zap tuner transistors. An open X26 zener raised the tuner voltage in this 4B25C19 Zenith chassis.

Servicing stereo audio systems

Part 4, By J. A. "Sam" Wilson, CET

Qualitative methods of finding audio distortion are discussed, along with the advantages and limitations of various tests.

In my dictionary, quantitative means the subject can be measured, and qualitative refers to features that give the subject its basic nature or character. For example, when you buy a new suit of clothes, the size is quantitative, while the style is qualitative. As we use the terms in electronics, **quantitative** measurements produce definite readings. **Qualitative** measurements give general indications which must be interpreted.

Qualitative measurements usually can be made quickly, giving approximate answers. In audio work, the human ear and a scope are the two instruments most often used. A technician listens to reproduced music and thinks to himself, "That tone quality sounds distorted." Or, he looks at a scope pattern and decides that it is abnormal.

Most quantitative measurements require time, care, and test instruments. Whether qualitative or quantitative tests are best depends on the conditions and what you are trying to prove.

Speed Or Precision?

Sometimes the difference between qualitative and quantitative tests is in how you operate the test equipment. Figure 1 shows a universal connection of equipment for testing an amplifier by either method. In fact, it's often helpful to alternate between the types of tests.

Waveforms first

It's worse than useless to measure the power output or run a frequency-response curve (quantitative) on an amplifier that has parasitic oscillations, or any large amount of distortion. Therefore, a few quick listening and scope (qualitative) tests should be done first.

Figure 2 shows examples of right and wrong waveforms. Small amounts of distortion are difficult to identify on a scope. Therefore, **any** indication of distortion means the amplifier performance is unsatisfactory.

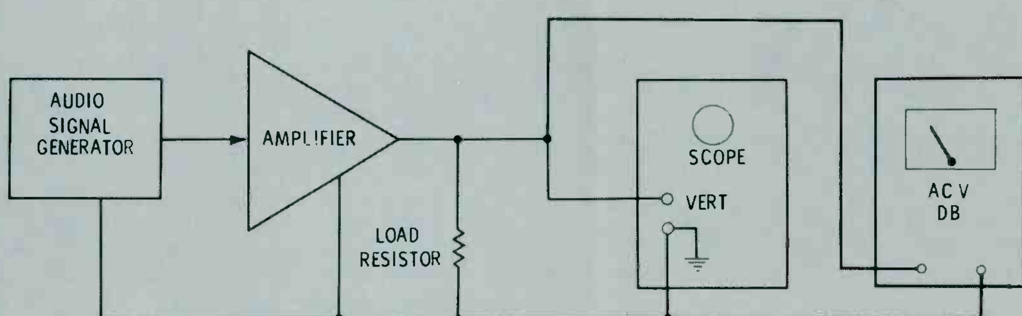
Clipping and crossover distortion were discussed last month, so that information will not be repeated. However, every amplifier will clip when called on to supply more than its maximum wattage. You must decide whether or not the output power is sufficient, for it is possible for a defect to cause the overload to occur at less than the rated wattage.

If clipping of either or both peaks happens at insufficient output wattage, the amplifier should be repaired. And, of course, it's useless to run a response curve when there is clipping, because the curve will seem flatter than it actually is.

Parasitic oscillations

Parasitic oscillations are pro-

Fig. 1 Many qualitative and quantitative tests can be made by connecting equipment and amplifier as shown



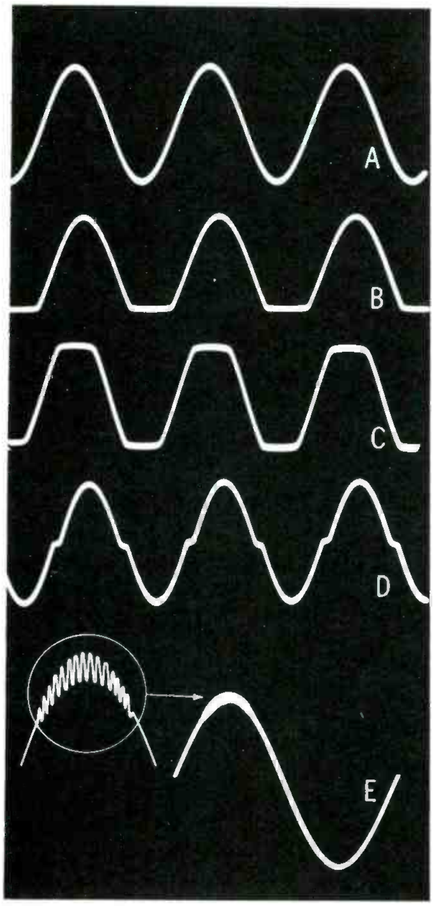


Fig. 2. These are some possible distortions of sine waves: **(A)** normal sine wave for reference; **(B)** clipping of just one peak usually indicates wrong bias; **(C)** clipping of both peaks might mean the amplifier has insufficient power, but it could show excessive input to a normal amplifier; **(D)** loss of some amplitude near the center of sine waves from solid-state amplifiers is caused by insufficient forward bias of the output transistors. It's called crossover distortion; and **(E)** a thickening of a sine wave near one or both peaks might indicate parasitic oscillations. Increase both the vertical and horizontal gains of the scope to see if the thicker part of the line is really supersonic sine waves.

duced by an amplifier that, under certain conditions, also becomes an oscillator. There are two basic kinds. The one shown in Figure 2 is triggered by a low-frequency signal, and usually occurs only near one or both tips of the triggering waveform. To find it, use a low-frequency sine wave from the generator (say 60 or 80 Hz) and run the amplifier gain up and down as you watch the scope waveform of the output signal. There should be no envelopes of RF on the sine waves.

Other defects can cause the amplifier to oscillate continuously, with nearly full power, and usually at a super-sonic frequency. These parasitic oscillations do produce high distortion that can be measured on distortion meters, but a scope identifies the oscillation faster and more accurately than is possible with any other instrument.

Input and output leads of an amplifier operated too near each other can cause parasitic oscillation. However, the usual culprit is a combination of incorrect output load on the amplifier and internal negative feedback of marginal stability. By definition, negative feedback has the correct phase to reduce the gain (which should guard against oscillation). But combinations of circuit reactances, stray capacitance, and borderline loading can change the phase of the negative feedback signal so it becomes **positive** feedback at some extreme frequency, such as the supersonic range (above audibility). Positive feedback can change the amplifier into an oscillator.

If the frequency is supersonic, an ear test merely tells you that the amplifier will produce only faint volume before distortion becomes excessive (it's already running full power on supersonics).

Finding and repairing the source of parasitic oscillations is not always easy. One test is to double the value of the negative feedback resistor (if it's 24K, try 47K). Elimination of the oscillation proves the negative feedback is involved. If it's worse, it means the feedback is not the cause, and the extra gain from the resistor change is making the oscillation more intense.

Many amplifier designs have resistor/capacitor filters to limit the high-frequency response of the amplifier. Those filters are there to minimize parasitic oscillations, and the components should be tested carefully.

Motorboating

Parasitic oscillations of a low-frequency nature usually have a "put-put-put" sound that bears the name "motorboating". The most likely cause is defective decoupling of the power supply feeding several stages. Poor filtering of a multistage amplifier allows the stages to act as a multivibrator at a low frequency.

Best Waveforms For Tests

No one generator waveform is best for all tests. Clipping or overload is easiest seen on triangular, sawtooth, or sine waves. Square waves and sawtooth waveforms indicate relative frequency response. We'll show some specific examples.

Square waves

Square waves have no even

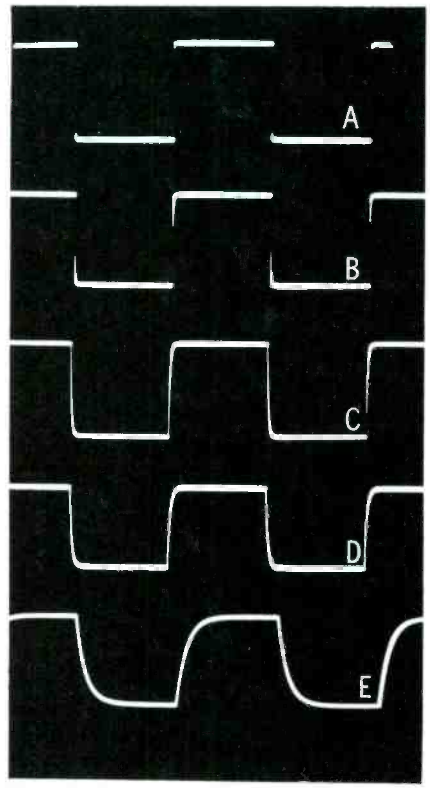


Fig. 3 Analysis of square waves can show the approximate high-frequency response. Waveform **(A)** is the output of an audio generator (B&K Model E-310B); **(B)** an amplifier, whose response was only -.5 dB at the 9th harmonic and -2 dB at the 50th, rounded two corners and made the rise and fall sides barely visible (in the original picture); **(C)** 9th harmonic was -.8 dB and 50th was -7 dB; **(D)** 9th harmonic was -1.8 dB and 50th was -12 dB; and **(E)** 9th harmonic was -9 dB and 50th was -24 dB. The rising edge now resembles the classic capacitor-charge curve, and the falling side approaches the capacitor-discharge curve.

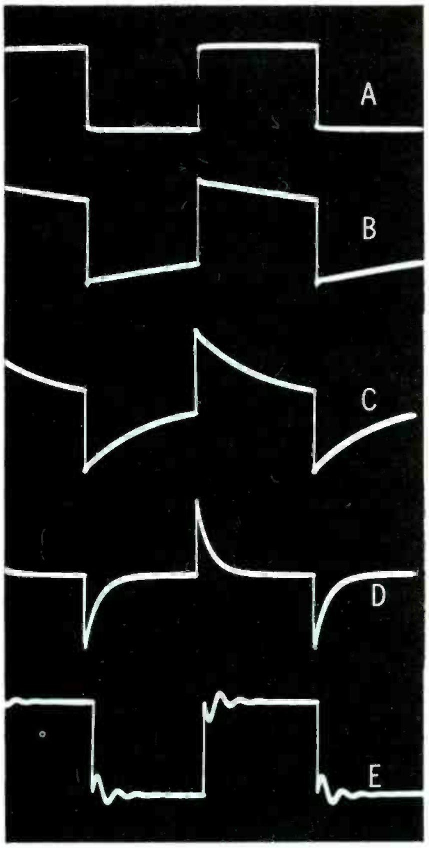


Fig. 4 Square waves can show approximate low-frequency response. Waveform **(A)** is the generator output for reference; **(B)** a slight tilt is caused by response of 0 dB at the fundamental and -4.3 dB at 1/9th frequency; **(C)** a curve is added to the tilt when the fundamental is -1 dB and 1/9th is -14 dB; **(D)** mostly pulses remain when the 3rd harmonic is -4 dB, fundamental is -8 dB and 1/9th frequency is -26 dB; **(E)** ringing is added to the tops and bottoms by a peak in the response curve at several times the fundamental frequency (repetition rate).

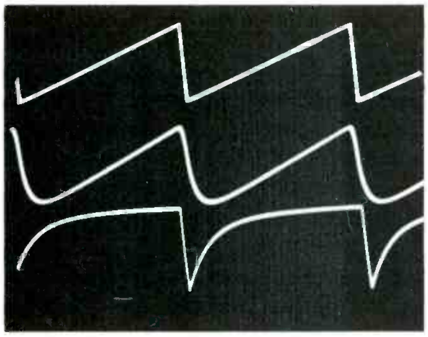


Fig. 5 Sawteeth waveforms also exhibit some changes because of poor frequency response. The top trace shows the generator sawtooth waveform for reference; in the middle is the result of high-frequency attenuation (the same as in Figure 3E); and the bottom trace is the result of low-frequency attenuation (as in Figure 4D). These waveform changes are not so distinctive as those with square waves.

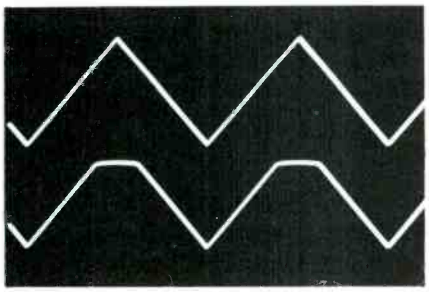


Fig. 6 Triangular waveforms can be made by severe high-frequency filtering of square waves. Therefore, the high frequencies are very low in amplitude, making this waveform not acceptable for frequency analysis. However, the straight sides and sharp tips are excellent for showing nonlinearity (causes slopes to be curved) and clipping, as shown in the trace at the bottom.

harmonics, but consist of a fundamental and odd harmonics up to perhaps the 99th. The 3rd harmonic is 33% of the fundamental, 5th is 20%, the 7th is 14%, and so on. But the formula is not important for this test. The value of square waves, for evaluating frequency response rapidly, lies in the definite change of waveshape when the upper harmonics are attenuated.

There is no universal agreement among audio experts about how many harmonics represent a satisfactory square wave. Perhaps the waveforms of Figure 3 will prove that a generator with sharp square waves displayed on a wide-band scope will show even a small loss of higher harmonics. For example, waveform (B), the first one below the standard, had a response of -.5 dB at the 9th harmonic and only -2 dB at the 50th. Yet, the dual-trace scope screen showed a definite difference. Not only were two corners rounded slightly, but the rising and falling lines were visible, where they could not be seen on the generator signal.

Low frequencies

Surprisingly, the shape of a square wave can give an approximate idea of the frequency response **below** the fundamental frequency. There are two factors at work. First, the flat tops and bottoms simulate DC voltages, which cannot be held unless the amplifier has good response below the fundamental. Also, when the low-frequency attenuation is severe enough to reduce the amplitude of the fundamental and the lower harmonics, only the upper harmonics (which are present mainly at the rising and falling sides) remain.

Figure 4 shows the effects of various amounts of low-frequency attenuation. In summary, attenuation below the fundamental, but with the fundamental not reduced, tilts the tops and bottoms (trace "B"). But more loss of lows—that also reduces the fundamental—makes curves of the tops and bottoms (trace "C"), and large attenuation of the fundamental with some loss of 3rd and 5th harmonics makes the tops and bottoms curve so much that only positive-going and negative-going pulses of high frequencies remain.

Ringing

Another strong point of square waves is in showing ringing or overshoot. A moderate amount of ringing is shown in Figure 4E. The strong harmonics present at the vertical edges of the square waves shock excite any resonant circuits or near-oscillating conditions in the amplifier, and this "oscillation" produces a damped wavetrain of sine waves on the top and bottom plateaus.

If the wavetrain disappears after a half cycle or one cycle, it is called **overshoot.** More than one cycle is called **ringing.**

Frequency-response curves will show the peaks that trigger the ringing or overshoot, but they take time and often must be extended outside the audible band. Square waves identify ringing faster than any other method.

Square waves have only one drawback: they cannot show clipping because both tops and bottoms are clipped already.

Testing With Sawteeth

Sawteeth waveforms, sometimes called ramps, give some of the advantages of square and sine

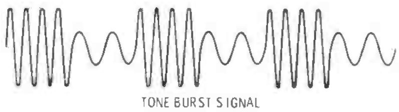
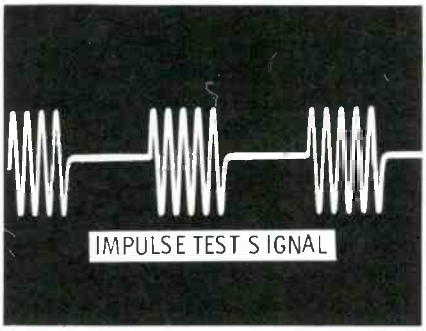


Fig. 7 Several types of non-continuous test signals are used. The drawn waveform above illustrates a burst of high-intensity high-frequency sine waves, followed by low-amplitude low frequency sine waves, etc. The genuine scope waveform below shows an impulse signal having bursts of several cycles of sine waves with no signal between; and it was produced by feeding a sine-wave gating signal into a Tektronix Model FG-502 function generator.



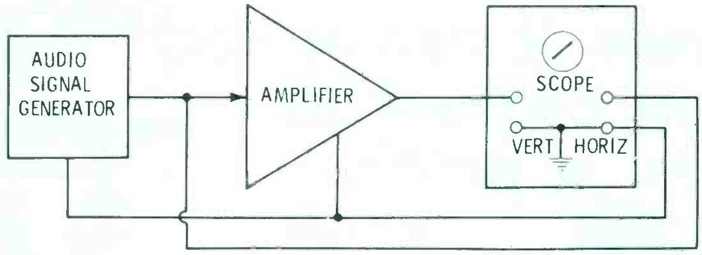


Fig. 8 Lissajous patterns can be produced by using the same generator signal as input for the amplifier being tested and also as the source of horizontal sweep for the scope. Usually, the vertical and horizontal gains are adjusted for equal deflection, say 4 centimeters each.

waves, but also have limitations. Examples of ramps whose waveshapes were changed by attenuated high frequencies and low frequencies are shown in Figure 5. As you can see, it is more difficult to evaluate them than square waves, even when the amount of frequency attentuation is the same.

Few generators provide sawteeth waveforms, and that limits their use in testing.

Triangular Waves

Another waveform often included with function generators is the linear triangular waveshape (Figure 6).

Perhaps the triangle is best for showing any clipping or nonlinearity of the amplitude. It also changes waveform according to the frequency response of the amplifier, but the discrepancies are more difficult to see than with ramps or square waves.

Tone-Burst And Impulse Tests

Two on-and-off test signals are important for testing transient response, especially with speakers which are far more prone to overshoot than amplifiers are.

Tone-burst tests (Figure 7) have several cycles of a high-amplitude high-frequency signal, followed by a low-amplitude low-frequency signal, etc. **Impulse** test signals have several cycles of the desired frequency in a burst, then an equal time with no signal, etc.

Both these signals test the ability of the amplifier or speaker to start the tone with full amplitude (rather than building up gradually), and to stop without overshoot or ringing. They are harder to analyze than sine, triangle, ramp, or square waves.

Lissajous Patterns

Harmonic distortion, amplitude distortion, and phase distortion can be observed by the use of lissajous patterns on a scope, as shown in Figure 8. The same sine-wave generator signal supplies input to the amplifier that is under test, and drives the horizontal sweep of the scope.

Many different waveforms are possible (Figure 9). If the amplifier output is identical to the input and the vertical and horizontal gains of the scope are adjusted for the same sensitivity, a straight line at a 45° angle is formed. Non-linearity curves the line, and clipping makes a horizontal end. Phase differences changes the line into an ellipse, or into a circle when the phase difference is near 90°.

This is the only one of the qualitative tests that can show phase changes. If the phase shift is the same for all frequencies, it can be

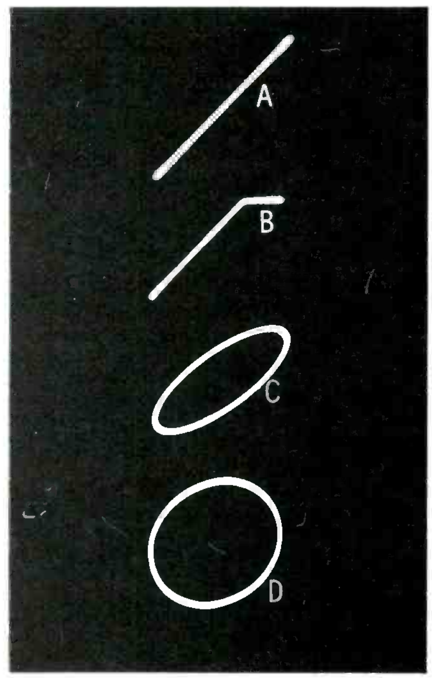
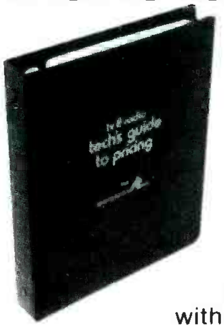
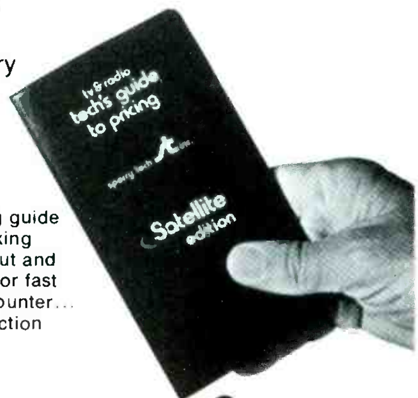
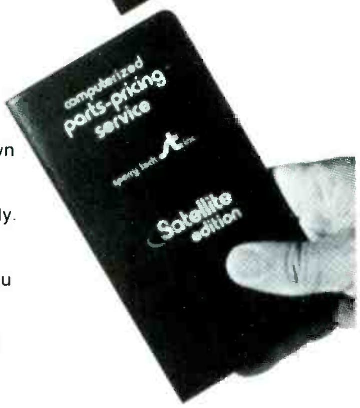


Fig. 9 These lissajous patterns were created by an equipment hookup as described in Figure 8, and using sine waves. Perfect linearity and zero phase shift gives the 45° line of **(A)**. Clipping of the positive peak **(B)** bends the top into a short horizontal line. Clipping of both peaks would have that plus a horizontal line to the left at the bottom. **(C)** is an oval waveform caused by phase shift (about 45°), and a phase difference of almost 90° gives a circle **(D)**. Lissajous patterns are the only ones described in this article which can show phase differences.







disregarded. But various phases at different frequencies is a warning of possible instability, increased distortion, and self-oscillation.

Comparative Tests

Stereo systems offer convenient comparison tests between the two identical channels. If just one channel has distortion, you can compare voltages and waveforms a stage at a time until you find the source of the problem.

Quantitative Tests

Many tests giving definite figures about amplifier performance can be done using the same setup as shown in Figure 1. For example, a **Bode plot** is a point-by-point method of establishing a frequency-response curve by measuring the amplitude of each frequency and entering it on logarithmic graph paper. A sine wave of constant amplitude must be supplied by the generator, and the output AC voltage from the amplifier usually is measured in decibels. The graph shows frequency versus amplitude.

A Bode plot takes considerable time to finish, but it is the most-accurate method of testing frequency response.

With the addition of a distortion meter to the amplifier output, total-harmonic distortion or intermodulation distortion can be measured at any wattage desired. Also, the signal-to-noise ratio can be tested.

Summary

Fast qualitative tests, such as waveform analysis or comparing stereo channels, are most valuable for finding defects that produce gross degradation of amplifier performance. In many cases, it is not necessary to employ tests of any higher accuracy.

Quantitative tests measure the exact characteristics of an amplifier, and are used often to determine if the specifications are being met.

Next Month

Quantitative methods of testing distortion, frequency response, hum and noise will be explained next month. ☐

bookreview

Study Guide For Associate CET Examinations
Author: J. A. Wilson, Dick Glass, Ron Crow
Publisher: Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis, Indiana 46268
Size: 320 pages, book number 20972
Price: $7.95 paperback

This book provides a thorough review of the basic electronics fundamentals needed for passing the associate-level CET exam. It is intended to provide an overall view of basic electronics that will enable working technicians to "fill in the gaps" in their understanding of basics. The book can serve as a comprehensive review for students and recent graduates of electronics schools. Practice tests are at the end of each chapter; answers are in the back of the book.

Contents: Scope of the Associate CET Examination; Mathematics; DC Circuits; AC Circuits; Electronic Components; Basic Electronic Circuits; Instruments; Tests and Measurements; Analysis and Troubleshooting of Basic Circuits; Practice Test; Color Codes; Basic Logic Circuitry; Answers to Practice Tests; Index.

Know Your VOM-VTVM, Third Edition
Author: Joseph A. Risse
Publisher: Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis, Indiana 46268
Size: 176 pages, book number 21134
Price: $5.50 paperback

The third edition of "Know Your VOM-VTVM" uses a simple, nonmathematical approach to explain volt-ohm-milliammeters, vacuum-tube voltmeters, solid-state electronic voltmeters, and analog and digital VOM's. The major features of the various types are covered, and the advantages and disadvantages are described. Some subjects discussed are: design principles, calibration, testing, troubleshooting and repair, and maintenance of VOM's and VTVM's. The book is designed for either self-study or classroom use. Review questions follow each chapter; answers are at the end of the book.

Contents: Uses of VOM's and VTVM's; VOM's; Inside the VOM; Putting the VOM to Work; Use, Repair, and Maintenance; The VTVM: How It Works; Using and Caring for the VTVM; Solid-State Analog VOM's; Digital VOM's; Answers to Questions; Index.

photofactbulletin

PHOTOFACT BULLETIN lists new PHOTOFACT coverage issued during the last month for new TV chassis.

ADMIRAL
Chassis T2K8-/T3K8-/T8K6-/T9K6-1A/-1B/-2A/-2B 1521-1
Chassis 2M10CA, 3M10C, 4M10C 1522-1

BRADFORD
1071A15/B15/B25/C35/D24/F35 (WTG-80408, WTG-90894/902/910/928/951) 1519-1

CATALINA
122-5316A, 122-5319A 1518-1

CORONADO
TV6-2045A 1521-2

HITACHI
Chassis CRX 1516-1

JC PENNEY
MODEL 2121 (855-2291) 1512-2
2915 (855-2366) 1513-2

MAGNAVOX
Chassis T985-01-AA/-BA thru T985-04-AA/-BA, T986-02-AA/-02-BA/-04-AA/-04-BA 1516-2

PANASONIC
Chassis ETA-12 (Late Prod.) 1511-1

RCA
Chassis CTC68UB/UD/UE/UH/UJ/UK 1517-1
Chassis CTC72C/D/M/T/V 1518-2
Chassis CTC76L/P/T 1519-2
Chassis KCS201A/B 1520-1
Chassis KCS202A/P 1523-1

□SANYO
91V87S 1522-2
Chassis SF-60000, SF-61000, SF-70000 1525-1

SEARS
528.41940500 1525-2

□SHARP
C-1941, C-1942 1520-2
2K-39/-40/-41 1521-3
2W-52 1522-3
C-1940 1523-2
C-1340, C-1341 1524-1

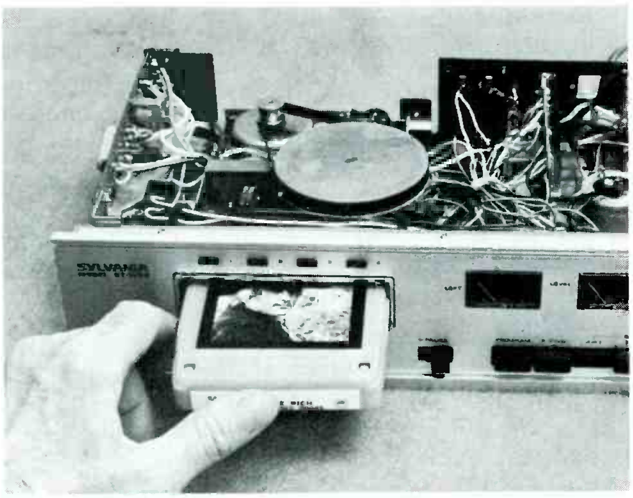
SONY
Chassis SCC-41A-E 1524-2

WARDS AIRLINE
GAI-12635A 1517-2

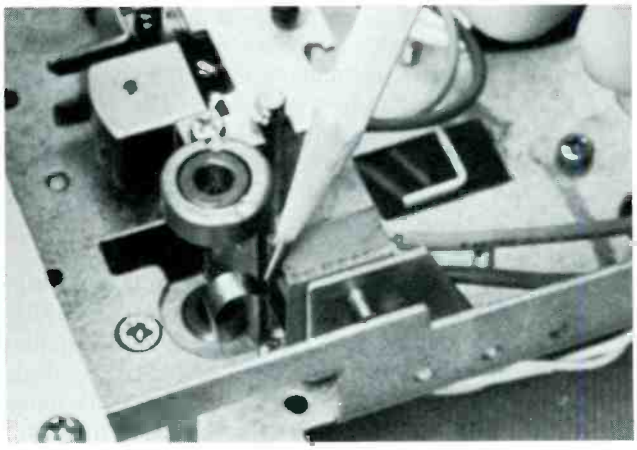
Forest H. Belt's
EIGHT-TRACK WORKSHOP

Session 3/Conducted by Dewey C. Couch

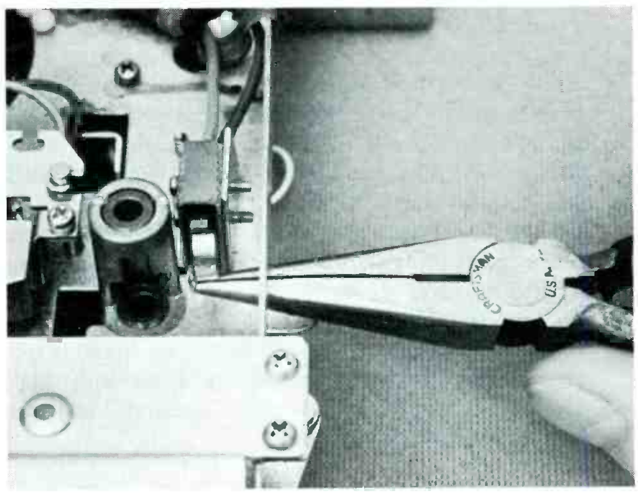
Session 1 explained thorough cleaning and inspection, and you saw in Session 2 how testing speeds your diagnosis, and adjusting cures certain symptoms. Now, in conclusion, the various functions of a typical eight-track machine are shown step-by-step, along with symptoms and cures. It's quite likely you will see comparable assemblies in other models.



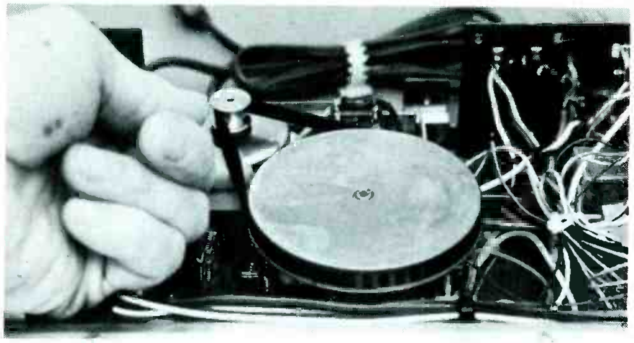
Step 1. When you push a cartridge into an eight-track machine, a switch closes, furnishing power to the motor and to the amplifier. The operation after this should be automatic, with a change to the next pair of stereo tracks occurring where the tape has been spliced together to make it endless. Removing the cartridge switches off the power. Some general symptoms of defects include: slow or erratic movement of the tape; no tape movement; broken tapes or tapes pulled out of the cartridge; tapes that stretch or wear out too fast; and excessive mechanical noise. Of course, bad tapes and cartridges also can cause most of these symptoms, so you should always have a test tape for comparison.



Step 2. As the cartridge seats fully into the slot, it presses an actuator which closes a microswitch (leaf switch in some machines), applying power to the motor. The acutator slides in a groove in the capstan housing assembly. The actuator may mount on the chassis or on the microswitch bracket and simply bend against the switch when the cartridge presses on it. I've removed the flywheel so you can see the actuator.

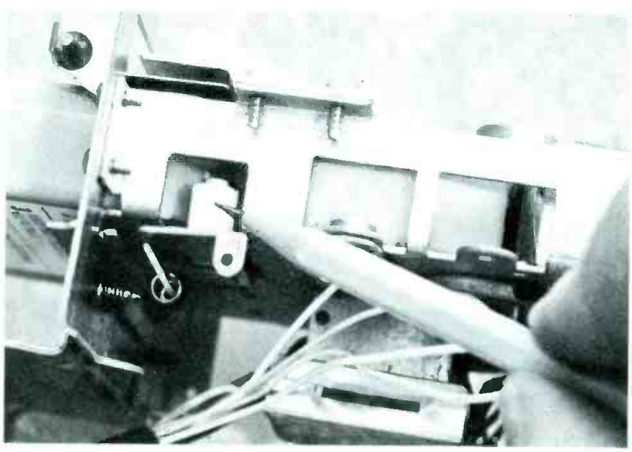


Step 3. Regardless of how the actuator mounts, if it gets bent out of shape, it might not close the motor-power switch. Sometimes you can reshape the actuator with long-nose pliers. But it's safer to install a new one. You can check the switch with your VOM to see if the contacts are okay. Push the switch with a pencil eraser to close its contacts. Check for voltage at both terminals.



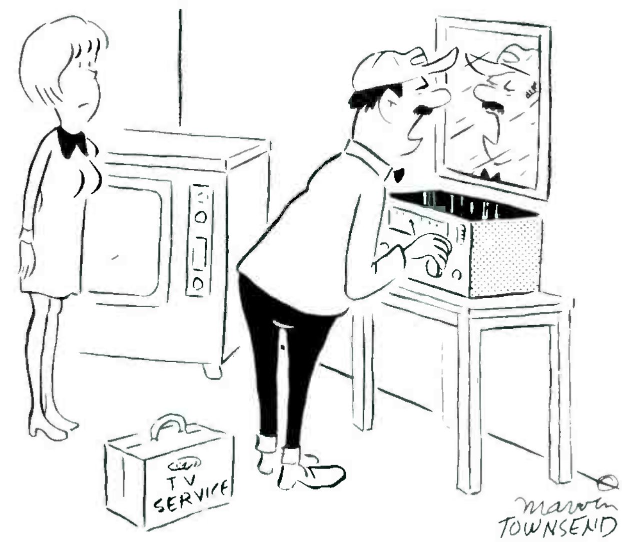
Step 4. The motor pulley drives a rubber belt (usually flat). The belt wraps around and spins the heavy, speed-smoothing flywheel. If the belt is dirty, worn, or stretched, it can slip on the motor pulley and allow slow or erratic tape movement. Severe looseness might prevent the belt from turning the flywheel at all. If the belt is dirty, clean it with isopropyl alcohol. If it's worn or stretched, replace it.

Step 5. The flywheel, driven by the drive belt, spins the capstan. If the flywheel binds or rubs against anything, it can produce the same symptoms as a dirty or defective drive belt. Remove the belt and try turning the flywheel by hand,. It should spin easily and smoothly. If you notice any trace of binding, remove the flywheel and clean the capstan shaft and bearing thoroughly with alcohol. While you're at it, inspect the capstan. If it's rough or scored, it might twist the tape and break it. Or, the roughened shaft could bind in its bearing. The only solution is a new flywheel assembly and capstan bearing assembly. Never replace one without the other.

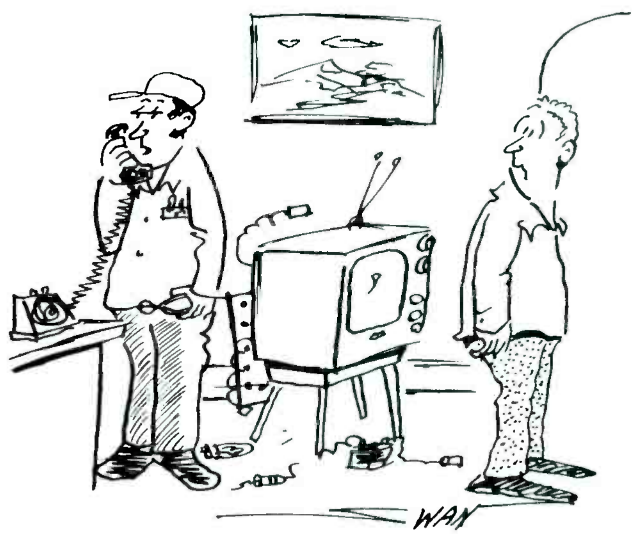


Step 6. When you push a cartridge into a machine, a small plastic roller, mounted on a spring-loader lever, rolls into a detent notch in the cartridge edge. The roller pressure forces the cartridge to seat fully in the slot, so the pinch roller inside the cartridge presses firmly against the capstan. If the detent roller or lever binds, or if the spring comes loose or stretches, pinch-roller pressure might not be sufficient to maintain steady tape speed. (How to check cartridge pressure was explained in Session 2 of this Workshop.)

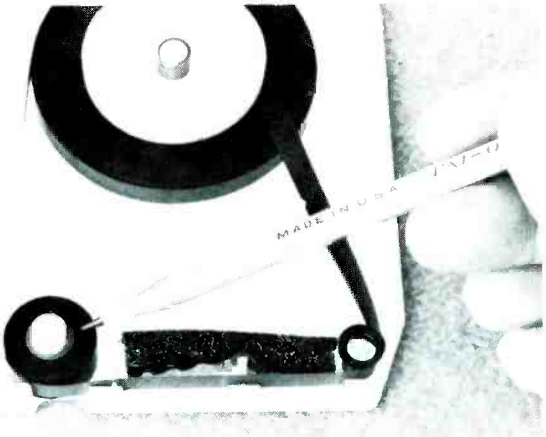
"Oops! Quitting time. Just leave everything where it is and I'll try to get back tomorrow."



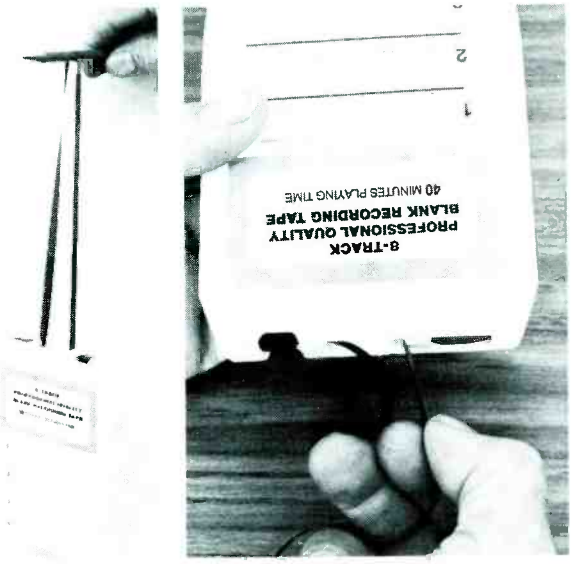
"I'm afraid you've called me for nothing, Miss! There's nothing wrong with this picture."



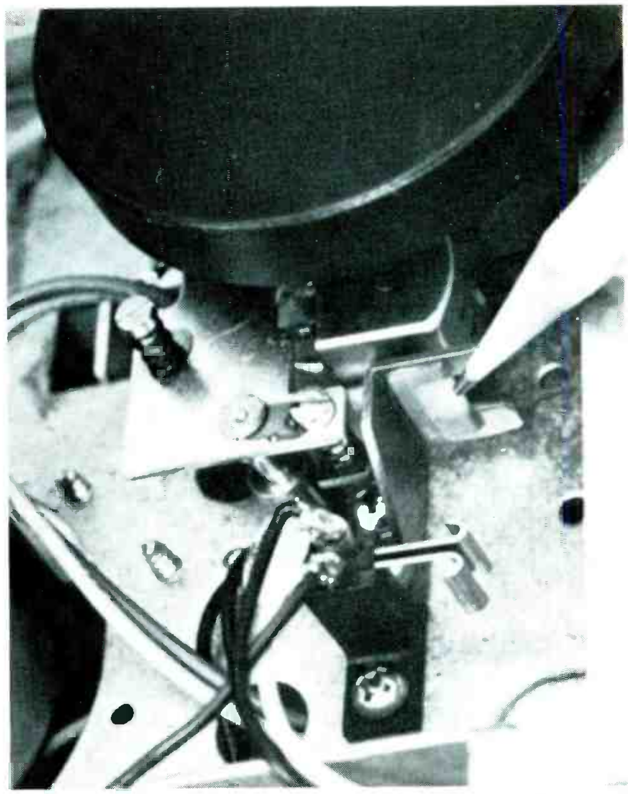
"Dear, look in my TV repair manual on page 36, and tell me what step 4 is."



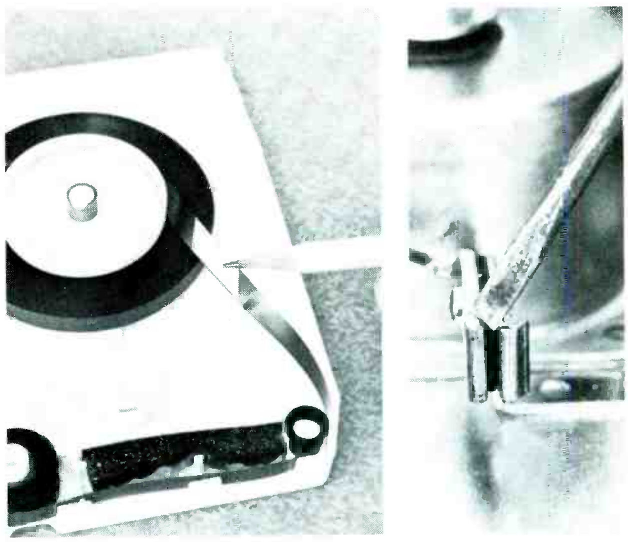
Step 7. Normal tape speed also depends on condition of the cartridge. A defective cartridge can produce many of the same symptoms as a malfunction in the tape-drive assemblies. The position of the pinch roller varies from one brand of cartridge to another. Occasionally, a pinch roller is located too far back in the cartridge to press adequately against the capstan in certain machines, even though the cartridge is fully seated in the slot. Slight readjustment of the detent lever might cure this. But don't carry it too far or you'll have too much pressure for other cartridges (and thus break tapes repeatedly).



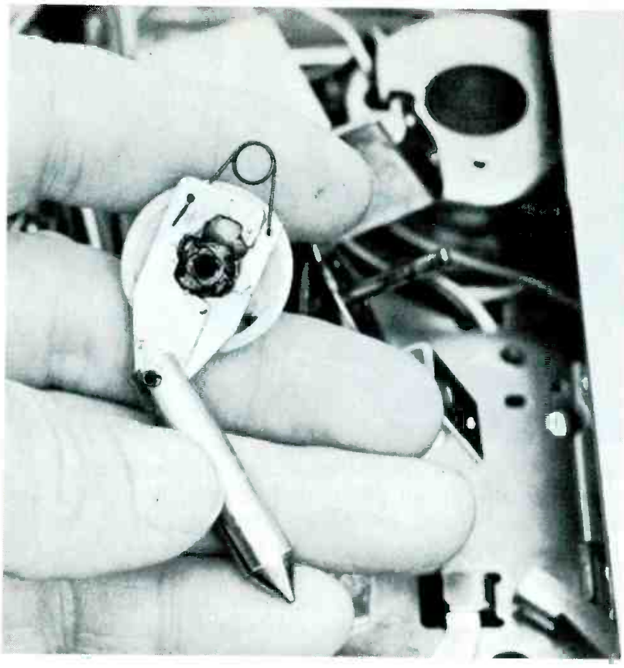
Step 8. Tape tension also varies among cartridges. If the tape has been wound too loosely, the capstan and pinch roller may pull it out of the cartridge faster than it can wind back onto the spool. If it was wound too tightly it strecthes, or sometimes puts too much load on the capstan. Either way, you'll notice excessive wow as you listen to the tape. A simple test tells you if the tape is wound properly. Stand the cartridge on end, open end up. Slip a pencil under the tape, at the center. Raise the pencil until the cartridge lifts off the bench. Measure the distance between cartridge and pencil. Single-album tapes should reach 7 to 14 inches; double-album tapes, 14 to 24 inches. Less than 7 inches of slack means a tape is wound too tightly; more than 14 inches, it's too loose. To rewind the tape into the cartridge, hold the cartridge open-end-down. Grasp the tape near the side away from the pinch roller and pull down briskly for an instant, then let go. The tape should rewind itself completely. Repeat if necessary.



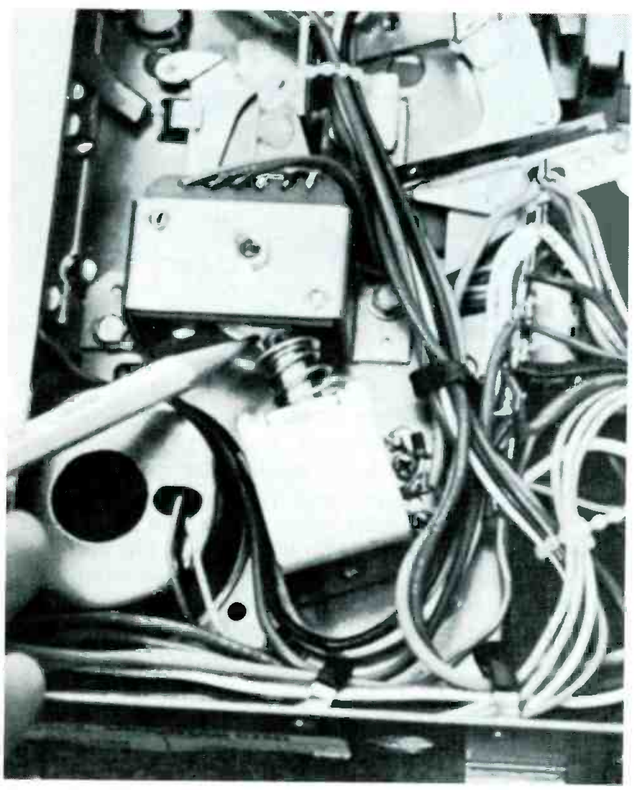
Step 9. In operation, as the tape moves across the head, a guide holds the tape at the correct height to match the tracks with the head gaps. To reduce friction, you often find a plastic insert in the slot of the tape guide. Should this insert come loose, tapes wear excessively. Some inserts can be replaced. On other machines, you have to replace the entire tape-guide assembly.



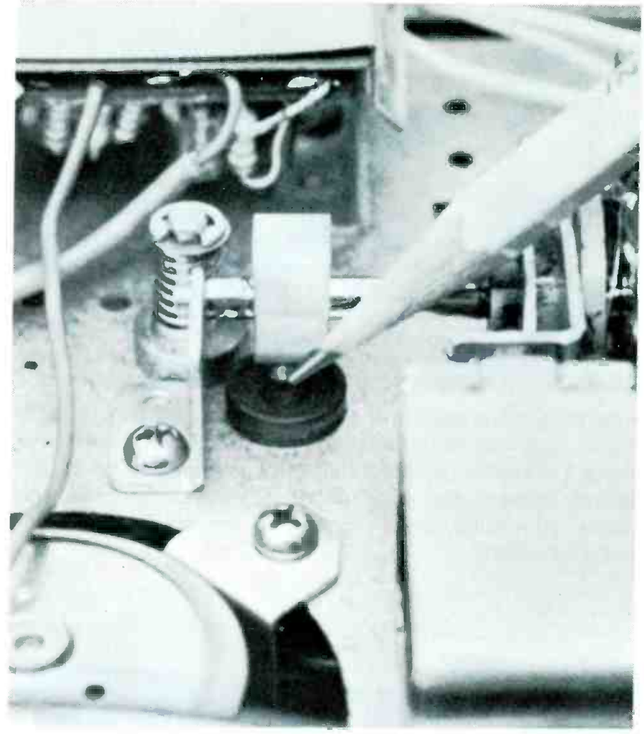
Step 10. To form the tape into a continuous loop, the ends of the tape were spliced together on the dull (oxide) side by a short strip of conductive metal foil. When you play a cartridge past the end of the program, the foil shorts across the contacts of a sensor switch, which applies power to a track-change solenoid. If the solenoid doesn't actuate, use a screwdriver or test lead to short across the sensor switch. Then try the program-advance switch. If neither causes a track change, the solenoid is bad or there's no voltage to it. Use your VOM to find the problem.



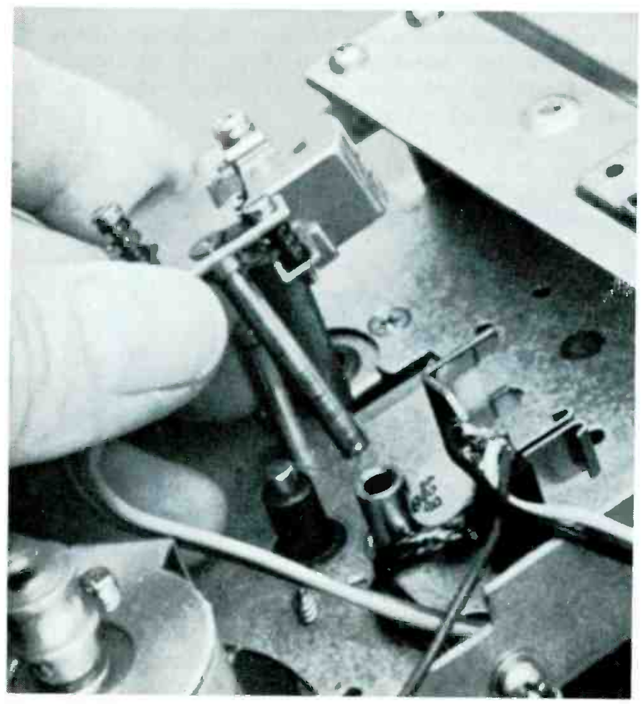
Step 11. Power reaching the coil of the solenoid produces a magnetic field that pulls in the plunger. Two spring-loaded pawls (one for pull and one for push) mount on the plunger (sometimes on a lever pulled by the plunger). The two pawls straddle a ratchet gear on the track-change cam assembly.



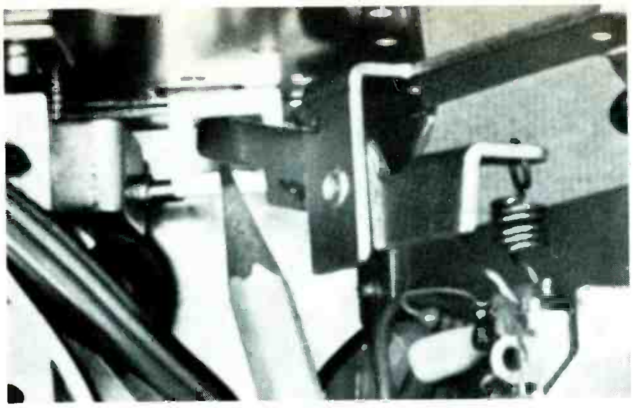
Step 12. When the solenoid moves the plunger, one pawl tugs on the ratchet gear, rotating the cam assembly 1/8 turn. Then power ceases to activate the solenoid, and a heavy spring returns the plunger. The other pawl pushes the ratchet gear, rotating the cam assembly 1/8 turn further. If the cam assembly doesn't rotate when you actuate the solenoid electrically or manually, check the ratchet gear and pawls for wear. Make sure they're lubricated. The pawl spring may be weak or even missing.



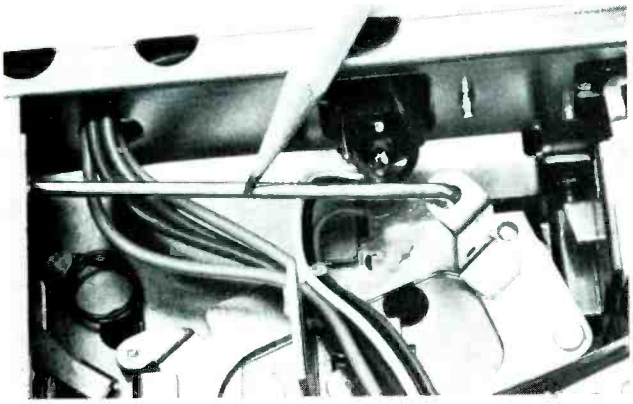
Step 13. The track-change cam has four graduated steps —one for each program. A lift rod extends through a bushing between cam and head plate. The rod rides the steps as the cam rotates. Program 1 takes the highest step, placing the head at the top of the tape tracks. Cam steps for programs 2, 3 and 4 drop the head sequentially downward. From program 4, the head is raised back up to the program-1 position. A spring holds tension on the head plate, keeping the lift rod firmly down against the cam steps in each position.



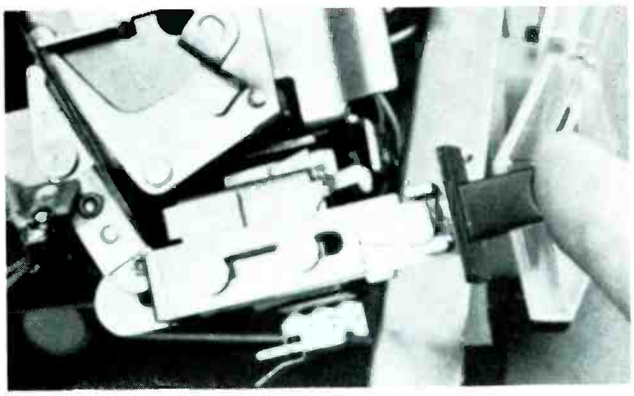
Step 14. The head plate mounts at the top end of the lift-rod shaft. Its alignment keeps the head at the proper angle to the tape. If the rod binds, the head can't change tracks properly when the cam rotates. The head-tension spring is another suspect; it might be weak or missing.



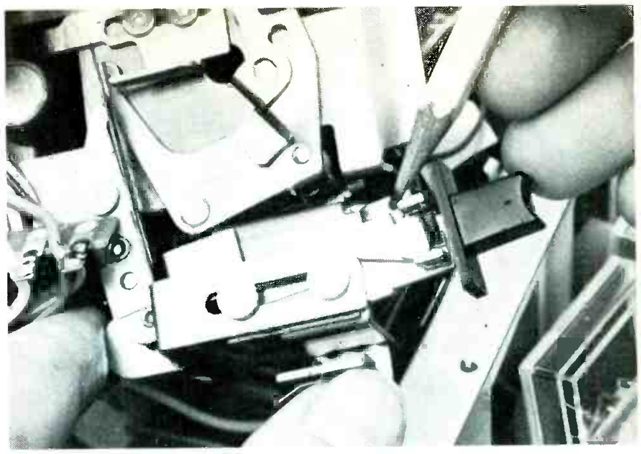
Step 15. On the machine shown here, a switchover lever that's mounted on the printed-circuit board protrudes through a slot in the recording slide. When you press the Record button, the slide pivots the lever to move the handle of a slide switch, changing the electronics from play to record.



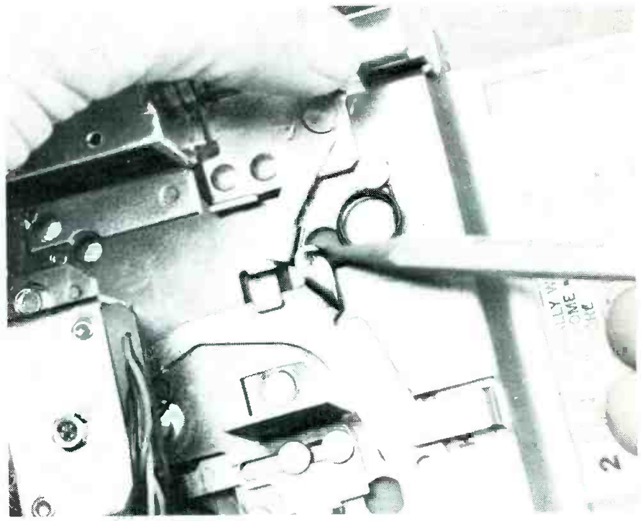
Step 16. For recording, you hold the Record button down and then insert the blank cartridge tape. A large pin, pushed by the cartridge pressure arm, protrudes through the recording-slide bracket, holding the switchover lever and slide in the recording mode. Eject the cartridge and the pin retracts, releasing slide and lever. The machine reverts to the play mode.



Step 17. When you depress the Pause button, a slide moves forward, pivoting a pause lever. A heavy leaf spring, mounted on the pause lever, pushes on the ejection slide, moving it slightly to the rear. A tab on the end of the ejection slide protrudes up through a cutout in the baseplate. This tab shoves the tape cartridge, moving it backward sufficiently (about 1/8 inch) so the pinch roller is clear of the capstan. If the cartridge doesn't move back, check the tab on the ejection slide; it might be bent or broken. Check the slides and levers for binding.



Step 18. A latching assembly catches the pause slide and holds it in the pause position. But when you push the Pause button again, the mechanism releases the slide, allowing all assemblies to return to whichever mode the unit was in. If the pause slide doesn't latch or release properly, check the latching assembly. Make sure it's free of caked lubricant and grime, and that its springs haven't slipped out of position or broken.



Step 19. When you press the Eject button, voltage goes to the eject solenoid. The solenoid plunger pushes a small curved lever which pivots the cartridge-pressure lever slightly. At a certain point, a spring takes over and pivots the curved lever fully, moving the cartridge-pressure roller out of the detent notch in the cartridge. In the same motion, the pressure lever shoves the eject slide, which moves the cartridge to the rear. If the cartridge doesn't eject properly, try moving the solenoid plunger by hand. Binding brought on by dirty levers and slides, or a loose pressure spring, accounts for most faults here.

***This concludes** the Eight-Track Workshop series. You should by now have a broad overview of eight-track operation. The servicing procedure outlined in these Workshop sessions, and your pictorial tour through the mechanics of a typical machine, should permit you to service eight-track players and recorders with confidence.* □

Servicing RCA XL-100 part 2

By Gilbert J. Grieshaber

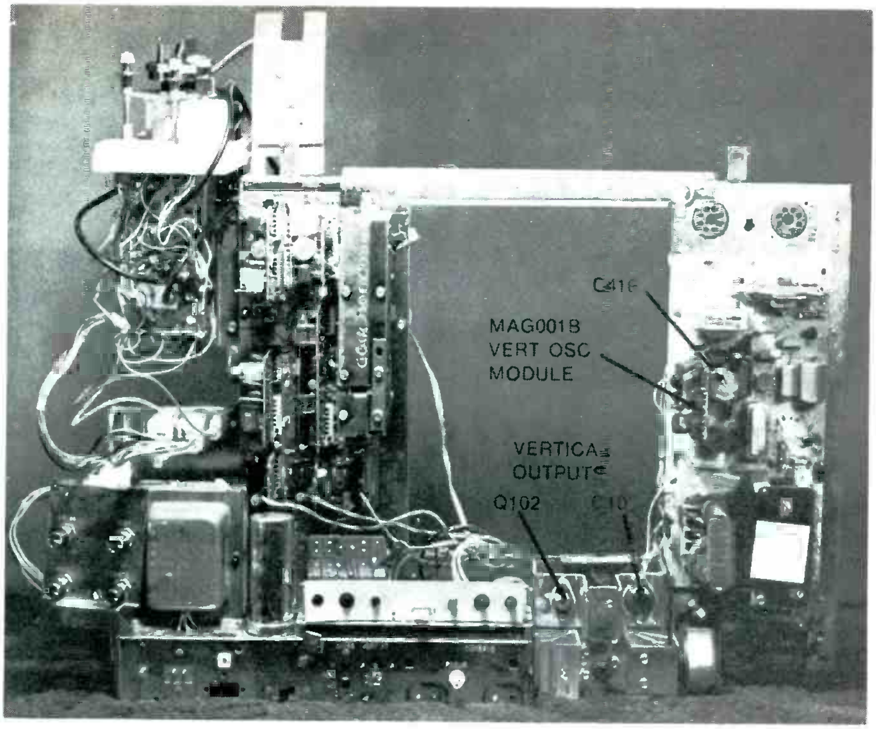
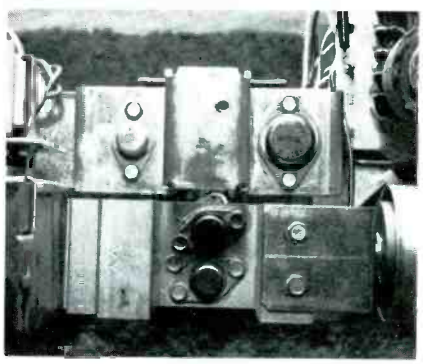


Fig. 1 Components for vertical deflection are located in several areas of the RCA CRC58 chassis.

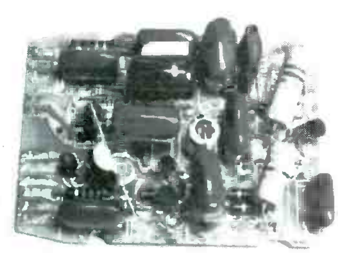
A thorough explanation of the RCA CTC58 vertical-sweep circuit is presented, with numerous waveforms and many troubleshooting tips.

Many of the vertical-deflection circuits in the various models of all-solid-state color TV receivers appear to be very similar. No transformers are used (except for pincushion correction), and the output signal from the complementary-symmetry emitter-follower output transistors either is direct coupled or coupled through a large blocking capacitor to the vertical yoke coils. Few of the circuits have linearity controls.

Despite these general similarities, all the details are different. In fact, neither the circuit analysis nor the troubleshooting procedures will work for more than one model.



Q101, NPN vertical-output transistor, is at the right above, and PNP Q102 is at the left. Both are bolted into sockets, and require mica insulating washers and silicone grease for proper installation.



Most of the vertical components, including Q1, Q2, Q3 and Q4 are on the MAG001B plug-in module. The driver transistor, Q3, is the larger one with the heat sink. Pin 1 is the top connection, numbering down to pin 12 at the bottom.

Locations Of Vertical Components

As explained last month, we have chosen the RCA CTC58 chassis as being representative of the XL-100 series, even though there are minor variations in other vertical circuits.

Vertical-sweep components are widely scattered. The output transistors are located on a heat sink underneath the yoke (Figure 1). A few components, including some in the pincushion-correction circuit, are on the PW400 board (usually called the horizontal board), and four transistors plus the remainder of the oscillator and driver stages are on module MAG001B, which plugs edgewise into PW400. Also, the emitter fuse/resistors of the output transistors are on the front side of the chassis, opposite the high-voltage section.

Of course, this gives plenty of test points, so you usually can pinpoint any parts failures in short order.

Block diagram

Figure 2 contains a block diagram of the entire vertical-sweep system. Most of the components are on the vertical module, MAG001B. However, even if you have a replacement module and intend to substitute it as a test, you should conduct some preliminary measurements first, otherwise the new module might be ruined.

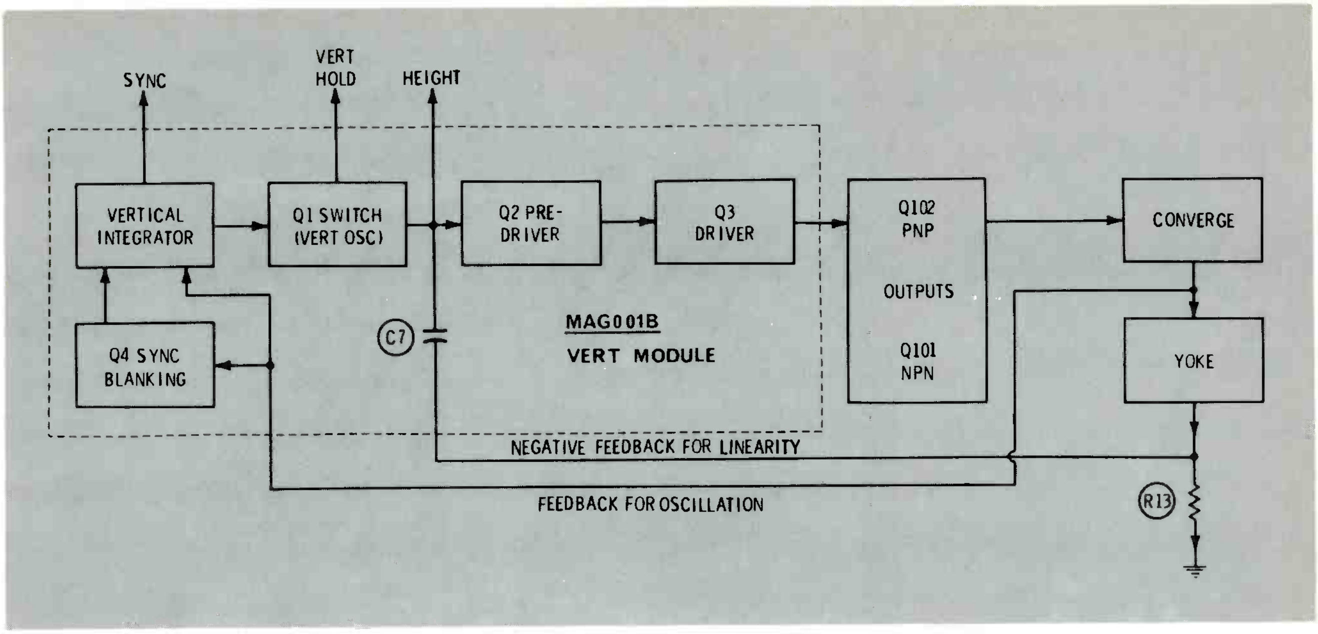


Fig. 2 This block diagram shows the general layout of the vertical deflection, including whether the stages are on the module or the chassis. One exception is R13. It is on the module, but has been drawn to make clear that all of the vertical yoke current goes through it.

For that reason, and the possibility that you might want to repair the module rather than replacing it, we will give a brief rundown on the circuit operation.

A Strange Multivibrator

The large schematic of Figure 3 shows the entire vertical-sweep circuit. As you follow the wiring, remember that emitter followers have a slight loss of gain and do not invert the signal polarity. In other words, they are not counted when you visualize it as oscillator.

Q2 and both output transistors are emitter followers. Therefore, the output of Q1 feeds Q3 driver, and the output of Q3 (through the output transistors) feeds the base of Q1. This last path is the one marked "positive feedback for oscillation".

Inside the module, the feedback path is not easy to follow. From MAG001B terminal #5, the signal goes through R1, C4, R6, and C3 before reaching the base of Q1. Some of those components do double duty as the integrator.

To summarize, the circuit functions as though the output of Q1 were directly coupled to the input of Q3, and as if the output of Q3 (through the positive-feedback network) were coupled to the input of Q1. They are the only two transistors that have gain.

When you look at it that way, the circuit is comparable to the multivibrators using a two-section tube.

Sync blanker

The sync-blanker transistor, Q4, appears to be part of the positive feedback loop. However, its collector has no DC voltage, so it functions only as a switch to ground all sync signal just following the start of the vertical sync.

Here's the way it operates. Sync comes in to MAG001B terminal #12 (Figure 4), where it is integrated by R2, C2, R4 and C1, then it goes through C3 to the base of Q1. Just as the integrated sync pulse reaches maximum amplitude, it triggers the switch (or oscillator) transistor, Q1, into starting retrace. The same positive-going signal from the output just triggered also is brought to the base of Q4, where it acts as forward bias, decreasing the C/E resistance nearly to zero ohms, and shorting out all the sync signal at C2 until the pulse portion of the feedback waveform has passed. Figure 5 shows how a bite is taken from the right side of the vertical sync.

The purpose of this action is to prevent any possibility of noise mixed with the sync from causing "second triggering" instability. With a snow-free signal, grounding the base of Q4 to defeat this circuit made no change of performance.

Triggering the oscillator

A portion of the same kick-back pulse at terminal 5 also is filtered slightly by R1, C5 and L1 (see waveforms of Figure 6) before going through C4 and R6 and joining the partially integrated sync at the junction of R4 and R6. From there, the two signals go through C3 to the base of Q1. If no station is tuned in, the filtered pulse from the yoke triggers Q1 into conduction. But the time constant of C3 and R7 plus the vertical-hold control is such that the vertical-sync pulse triggers Q1 just preceding the positive-feedback pulse. That's correct locking.

C3 and the base/emitter junction of Q1 form a shunt rectifier that produces negative voltage. So, the base measures about -.35 volt, even though the positive pulse temporarily forward biases the base, causing a narrow negative-going pulse at the collector (Figure 7). After the base pulse has passed, the base is negative, which is reverse bias to shut off all collector current.

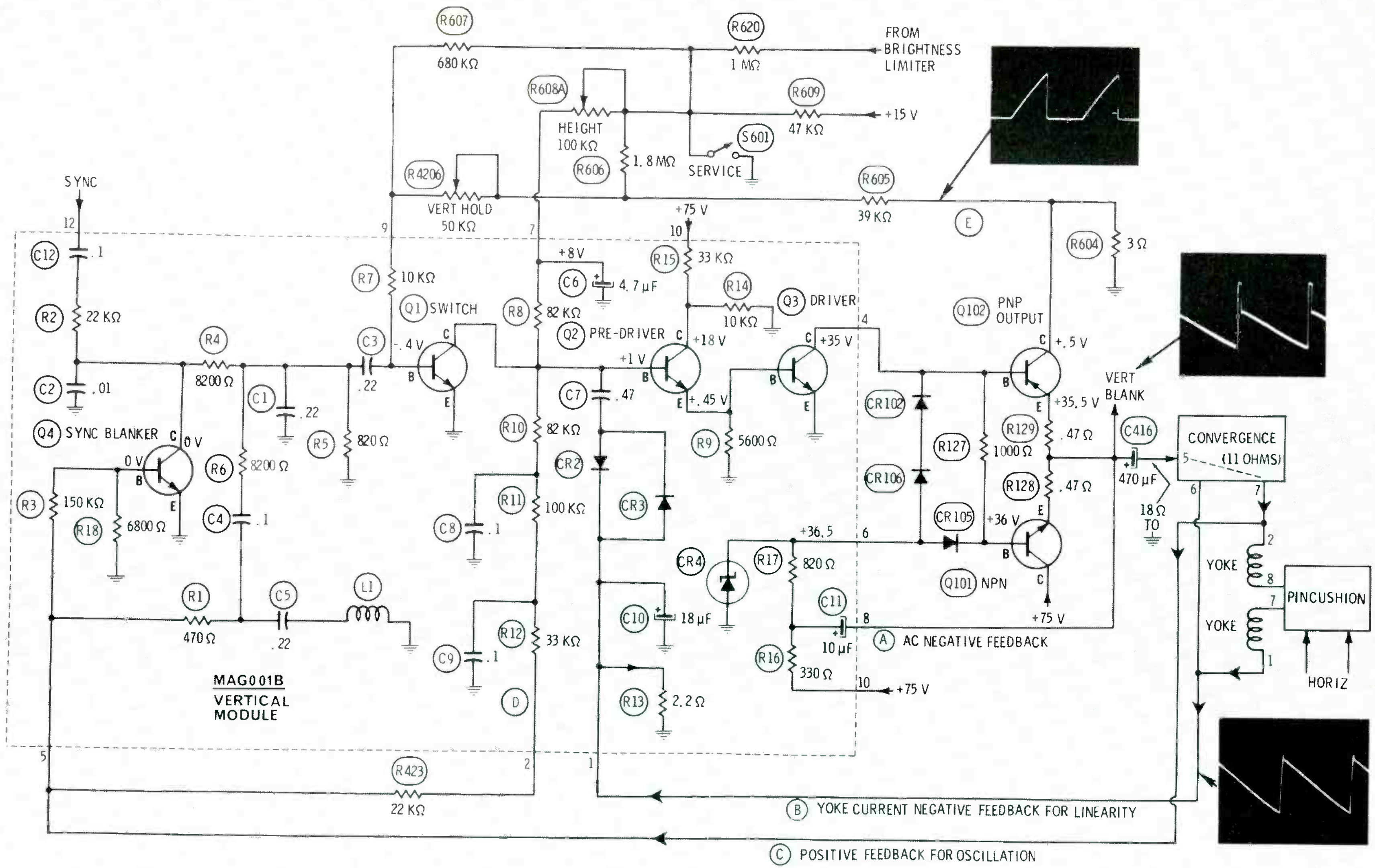


Fig. 3 A complete circuit analysis is keyed to this complete schematic of the CTC58 vertical-deflection system. If the emitter followers (Q2, Q101, and Q102) are ignored, then it's clear that Q1 and Q3 form a multivibrator oscillator. Three feedback paths are marked. Two others, (D) and (E), affect the linearity and frequency.

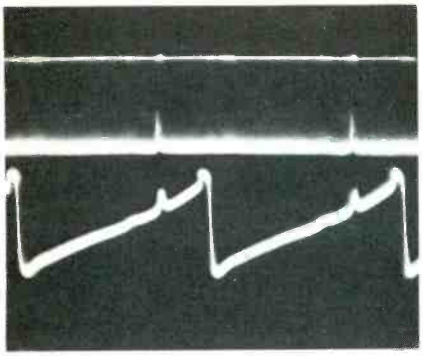


Fig. 4 At MAG001B pin 12, 28 volts PP of sync enters the module (top trace). After integration of the sync, both it and the positive-feedback signal are applied to the base of Q1. For the lower trace, the vertical was given a slow roll to separate the small sync pulse from the larger feedback signal (2 V PP).

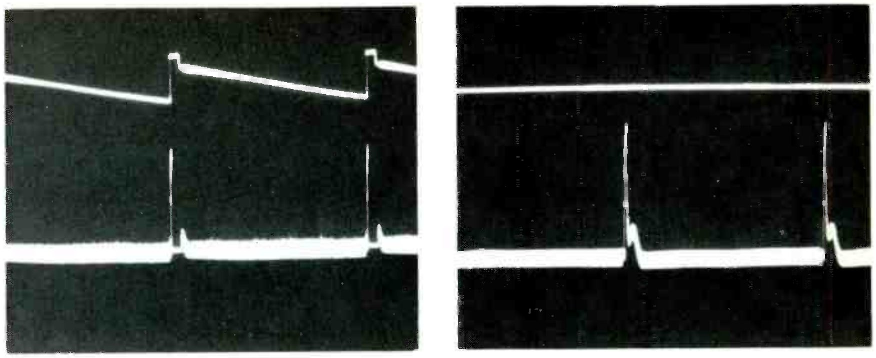


Fig. 5 To prevent second-triggering instability of the vertical locking, the vertical sync is shorted to ground by Q4 just as soon as the vertical retrace pulse begins. The top trace of the left picture is the waveform at the base of Q4, and at the bottom is shown the collector waveform with the piece missing at the right of the rising edge of the sync. For the waveforms in the picture at the right, the base of Q4 was shorted to ground, removing the sweep signal (top trace). Complete sync then was found at the collector (bottom trace).

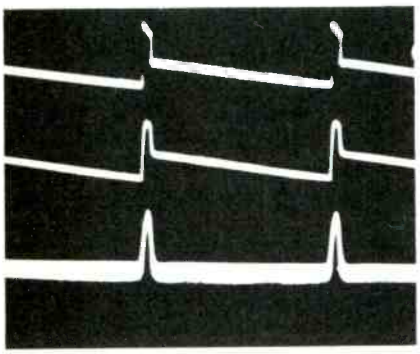


Fig. 6 These waveforms show the changes of the positive-feedback signal (from path "C") to the oscillator, Q1. Top trace is the sample of sweep voltage at MAG001B pin 5; the center waveform is at the junction of C5 and C4 (slightly rounded by R1 and C5); and the pulses at the input side of C3 are shown by the bottom trace.

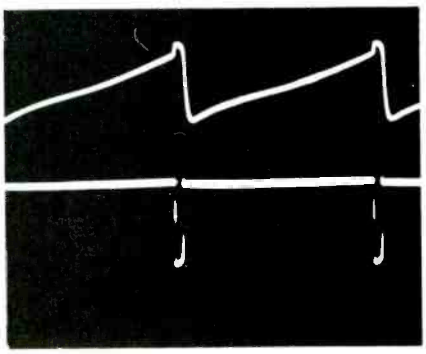


Fig. 7 At the base of Q1 switch transistor (top trace), there is -.34 volts DC and 2 volts PP. The collector (bottom trace) has +.98 volts DC and 1 volt PP. The signal at the base of Q2 is identical to that at the collector of Q1, and the emitter signal has the same waveform, but only about half the amplitude.

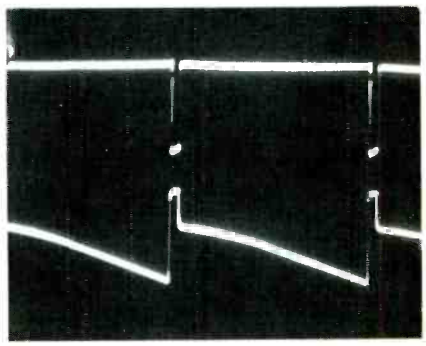


Fig. 8 Q3, the driver transistor, has these signals: at the base (top trace) there is +.5 volt DC at 1.5 volts PP; and the collector has +35.5 volts DC and 48 volts PP (bottom trace). Because the output transistors are emitter followers, the collector waveform of Q3 is nearly the same as the output signal from Q101 and Q102.

Height and linearity

Collector voltage of Q1 is adjusted by the height control. At the collector, the minimum voltage is nearly zero when the transistor conducts. When there is no collector current, the collector voltage is equal to the maximum determined by the height control. Therefore, adjusting the height control for a higher voltage gives a pulse of larger amplitude, which is amplified by the succeeding stages to produce increased height.

There are some interesting details about how a waveform that appears to be only a pulse can produce a sawtooth of deflection. But to avoid an interruption let's finish the basic circuit functions, and then take up linearity.

Driver stages

The base of Q2, pre-driver transistor, is connected to the collector of Q1; therefore the signal is the same as the lower trace of Figure 7. tips of the negative-going pulses there are at zero voltage, so the nearly-flat top of the waveform is the forward bias.

Q2 is wired as an emitter follower (input to the base, and output from the emitter), and the emitter is connected to the base of Q3, the vertical driver. That's why the signal at the base of Q3 is slightly smaller in amplitude, but otherwise identical to that at the collector of Q1. Figure 8 gives base and collector waveforms of Q3.

Q3 appears to have a gain of about 100, based on the pulse portions of input and output signals However, that's a little misleading, as we shall see. Q4 actually has a much-higher gain.

Output stage

The output transistors are used as emitter followers, giving a power

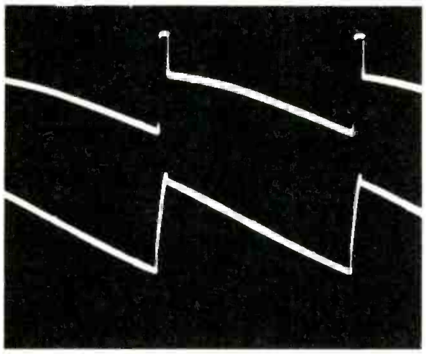
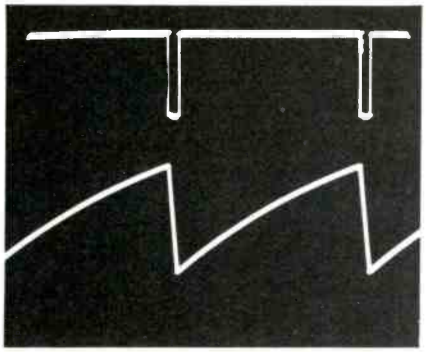


Fig. 9 The 48 volt PP vertical deflection signal from the emitters of Q101 and Q102 is shown by the trace at the top, and the 2.4 volt PP waveform of the bottom trace is the waveform of yoke current, which is obtained by routing the cold end of the yoke through R13 on MAG001B.



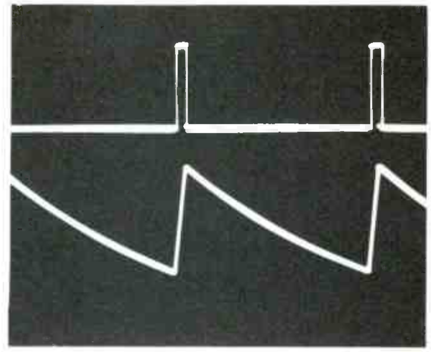


Fig. 10 The paradox of Q3, driver transistor, being driven by pulses and having an output of mainly sawteeth needs clarification. A test simulating the waveshaping values at the collector of Q1 produced good 60-Hz sawtooth waveforms. as shown here. If these two polarities of sawteeth had been added, the result would have been near zero because of phase cancellation. So, the conclusion is that the yoke-current sawtooth is cancelling most of the sawtooth that should have been formed by C7.

gain but no voltage gain. This gives the strange sight of the output signal being almost identical to the output of the driver. Because the output transistors have opposite polarity and no bias, except the drive signal from Q3, Q102 draws current to deflect the top part of the picture (while the other is cut off from reverse bias), and then Q101 draws current to sweep the bottom part of the picture.

Figure 9 shows the vertical sweep waveform at each end of the deflection yoke coils.

To minimize crossover (or notch) distortion, three diodes and one resistor are included between the bases of Q101 and Q102. This gives a smooth transition between the currents of the two transistors.

A single +75-volt power supply is provided for the outputs, making the common emitters operate at about +36-volts DC. Therefore, a large coupling capacitor (C416) feeds the AC signal to the yoke circuit and blocks the DC. Many audio-output stages use a similar circuit.

From the high side of the yoke coils, a sample of the sweep voltage is brought back to terminal 5 of the MAG001B module (see Figure 3) through the path marked (C) POSITIVE FEEDBACK FOR OSCILLATION. After being filtered and mixed with the vertical sync signal, it reaches C3 and the base of Q1, as explained before. The phase is correct for positive feedback, and the circuit oscillates. That's the end of one cycle.

On the schematic are **four** negative-feedback paths. Together they provide nearly-perfect vertical linearity at any height, making a linearity control unnecessary.

Yoke-Current Feedback

A correction signal labeled (B) YOKE CURRENT NEGATIVE FEEDBACK FOR LINEARITY provides most of the vertical linearity. The ultimate goal of any sweep circuit is to produce a near-perfect sawtooth of **current** through the yoke coils. **Voltage waveforms at the yoke are of little value.** Therefore, the best type of linearity correction should come from the yoke current.

Now, if you want to obtain a voltage waveform of a signal current, you need only place a low-value resistor in series with the current. A perfect voltage waveform of the current will appear across the resistor.

In the CTC58 circuit, the yoke current returns to ground through R13, which is on the MAG001B module. A sample of the voltage waveform (Figure 9, bottom trace) is slightly modified by the paralleled diodes CR2 and CR3 (to improve the linearity) and applied to the bottom end of C7. The main task for C7 is to create a linear sawtooth. In fact, it is the most-important component in the entire circuit for producing good linearity.

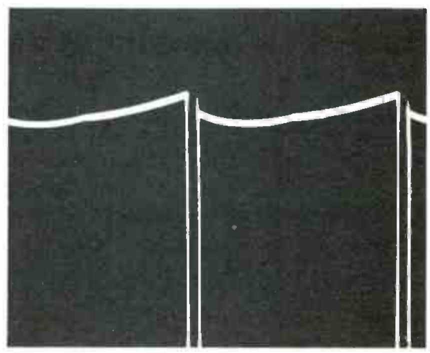


Fig. 11 A rounded sawtooth waveform between pulses can be seen at the collector of Q1, if the scope gain is increased enough to deflect the tips below the bottom of the screen. Most of the pulse amplitude is in the cut-off region of both Q2 and Q3, therefore Q3 amplifies the tiny sawtooth that actually reaches its base. Any deviation from the desired yoke-current waveform changes the shape of the small sawtooth at the base of Q3, and corrects for any non-linearity.

However, the side of C7 that's connected to the collector of Q1 DOES NOT have a sawtooth, instead it has negative-going pulses. This paradox requires some careful study.

Why no sawtooth?

When I first discovered there was no sawtooth waveform at the collector of Q1, I was astounded. The major resistances there were R8 plus R608A, R10 and the base resistance of Q2, an emitter follower. As a fast guesstimate, the resistance was unlikely to be less than 33K, so

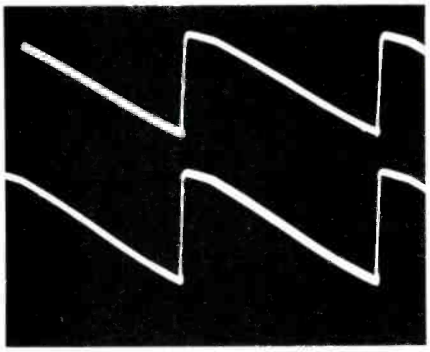


Fig. 12 In a test to determine if the pulse portion of the output waveform came from the driver or from the collapse of the yoke current, a 30-ohm resistor was substituted for the yoke coils. The voltage and current of the test resistor, shown here, were nearly-identical sawteeth, without any pulses. This is proof the pulses come from the yoke.

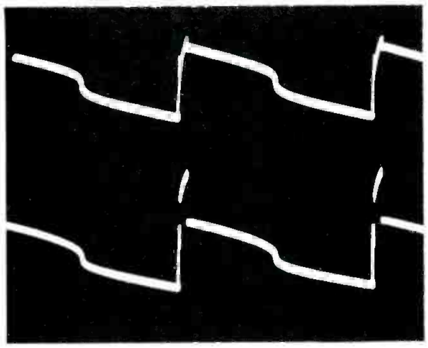


Fig. 13 Waveforms of the drives to bases of the output transistors show the different DC voltages necessary to eliminate crossover distortion. Trace at the top is the waveform from the base of Q101 to the common point of emitter resistors R128 and R129, and the bottom trace is the base signal of Q102 relative to the same point. The sharp descent near the center of each scan period is the voltage difference because of CR102 and CR106. Notice the pulse is missing from the Q101 waveform; evidently the B/E junction of Q101 acts as a diode to clip it.

I breadboarded a low-pass filter with a 33K resistor and a .50 capacitor (simulating C7), and supplied it with negative-going 60-Hz pulses from a Tektronix Model FG-502 generator. As I had surmised, the waveform from the filter was a presentable sawtooth (Figure 10). Switching the generator to positive-going pulses also gave a sawtooth waveshape, but of the opposite polarity. If these two could have been added together, the result would have been virtually **no signal,** because they were identical except for the opposite phase.

Perhaps a similar kind of phase cancellation occurs in C7! At the top end of C7 **should** have appeared a sawtooth of the polarity shown in Figure 10A lower trace. But it was overpowered and mostly cancelled by the reverse-polarity sawtooth at the bottom end of C7 (similar to the lower trace of Figure 9). The net result is that most of the sawtooth from C7 as a waveshaper is phased out, leaving the collector waveform as though C7 was missing. Or is that statement partially wrong?

A tiny sawtooth

A casual glance at the Q1 collector waveshape might convince you that the sawtooth was missing completely. However, a small-amplitude sawtooth is there. It's tiny, but sufficient, because Q3 requires very little signal, probably less than .1 volt peak-to-peak, out of the total with pulse of about .4 volts PP. So, it is easy to overlook the small sawtooth between the pulses. It can be seen (Figure 11) by increasing the scope gain to force the tips off screen.

But what about the pulses? Doesn't the transistor amplify them in proportion? No, most of the pulse waveform is below the .7 volt needed for forward bias (no other bias is provided for Q3). Therefore, Q3 ignores most of the pulse amplitude. The remaining pulse at the collector is mixed with the similar pulse caused by collapse of the yoke current. And both pulses are clipped by the diode action of the B/E junction of Q101.

Incidentally, this is additional proof that the vertical height obtained with **tubes** comes from the small sawteeth between the huge pulses. All those years we were measuring the wrong part of the waveform!

Test with dummy load

To test the theory that very little of the positive pulse in the output waveform (Figure 8, bottom trace) came from the pulses at the base of Q3, I disconnected the yoke and substituted a 30-ohm resistor. This provided current feedback to the bottom of C7 and also allowed the circuit to oscillate. The output voltage and current waveforms of Figure 12 do not show any pulses.

Output-Drive Waveforms

One of the critical areas for good linearity is the base drive for the two output transistors, Q101 and Q102. One is PNP and one is NPN, so if the bases were merely tied together, one or the other would have the wrong bias, resulting in notch distortion. A network of resistors could not give compensation for temperature. Therefore, most circuits have one or more diodes to supply the difference of base voltage. Apparently, this does the job, because with the help of the negative feedback no notch shows in the output voltage or current waveforms, and the crosshatch is linear.

Waveforms of each base relative to the common point of R129 and R128 (emitter resistors) are shown in Figure 13. Because the amplitudes are around 2 volts PP, the

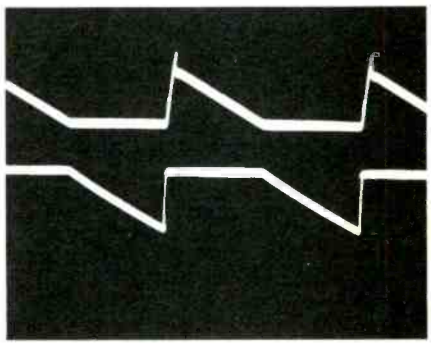


Fig. 14 Voltage drops across the emitter resistors of Q101 (top trace) and Q102 (bottom) show good balance and linearity of the output transistors.

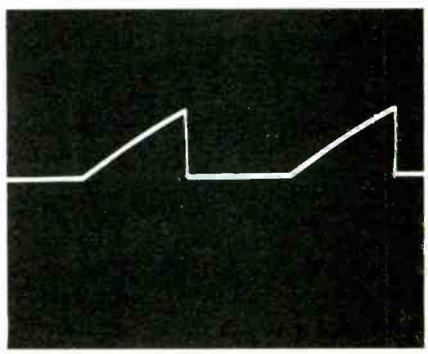


Fig. 15 A sample of Q102's collector current is obtained by R604, which is connected between collector and ground, and used as negative feedback (through the height control) to the collector of Q1. If this 1.8 volt PP signal is missing, locking will be with the hold control at one extreme.

action of the diodes is very evident. Figure 14 shows the emitter current (taken across R128 and R129) of the output transistors. Each has a sawtooth of current for 50% of the trace time. The emitter current of Q101 also shows an extra spike as evidence of the diode action that clips most of the pulse amplitude from the output.

Other Feedbacks

In addition to the (B) negative-feedback path, there are three others that improve the vertical linearity to a small degree. One is path (A) in Figure 3. It is simple, consisting only of one capacitor (C11) between the output signal and the collector circuit of the driver transistor, Q3. If C11 is open, the change of linearity is very small, varying the height perhaps a quarter inch.

The base of Q1, through the hold control, receives some feedback from the collector current of Q102, when it conducts to deflect the bottom half of the raster. The waveform is developed across R604, which is between collector and ground (Figure 15).

If the collector of Q102 is shorted to ground (perhaps from a burned R604 or an accidental short across the mica insulator), the linearity changes somewhat. But the largest symptom is the vertical hold, because it must be rotated nearly to one extreme to permit locking. This a good troubleshooting tip. R604 acts as a fuse, preventing worse damage in case Q102 shorts. **Use an exact replacement.** R604 is mounted just in front of the MAB003 module on the PW600 power-supply board, and it can be replaced without pulling the chassis.

"S" correction

A natural result of wide-angle deflection of the yoke is that the amount of deflection is increased at the edges of the picture. That's most noticeable in causing pincushion distortion, because the corners require the greatest deflection.

This effect requires a slight modification of the perfectly-linear sawtooth of yoke current mentioned before. The engineers call it "S" correction, because if flattens both ends of the sawtooth ramp. In the CTC58 chassis, "S" correction is accomplished by the RC network consisting of R423, R12, C9, R11, C8 and R10. These components filter the output waveform present at MAG001B #5 into a parabolic waveform and apply it to the collector of Q1. Disconnecting the filter, by grounding C8, changed the linearity slightly, perhaps 3/8-inch at top and bottom.

Troubleshooting Tips

Waveforms

Before you attempt to analyze the waveforms of a defective vertical circuit in an XL-100, make certain the frequency is correct. Preferably, it should be locked. Any vertical sweep, even otherwise nondefective ones, will produce some wild waveforms when the frequency is wrong.

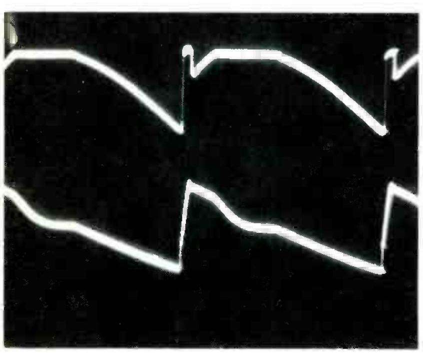
The waveform of yoke current is an important one that we usually ignore because it's too much trouble to obtain it. But, in the CTC58 it's available at pin 1 of the MAG001B module. Remember that the left end of the sawtooth represents the top of the picture, and the right end is the bottom. The slope of the ramp should be almost perfectly straight, with just a slight flattening at each end. Any more flattening represents compression or foldover. Output transistor Q101 supplies the left side of the sawtooth (top of picture), and Q102 provides the right side (bottom of the picture). Sometimes this can provide rapid clues about where the defect is located.

DC voltages

A similar warning should be expressed about the importance of DC voltages. A multivibrator is a closed loop; therefore, any major defect is likely to radically affect all the DC voltages.

For example, the oscillator plate voltage of a tube circuit usually goes down when the circuit fails to oscillate. However, in the CTC58 a loss of positive feedback at pin 5 of MAG001B would be expected to increase the collector voltage of Q1, because the feedback signal is the forward bias. We might imagine the collector voltage would approach the +15-volt supply. But that's not allowing for the direct coupled stages. Actually, the +1 volt at the collector rises only about 10%, because it is direct coupled to the base of Q2, and increased base current limits the rise of voltage.

Incidentally, any defect causing Q2 and Q3 to saturate from excessive bias forces the emitters of



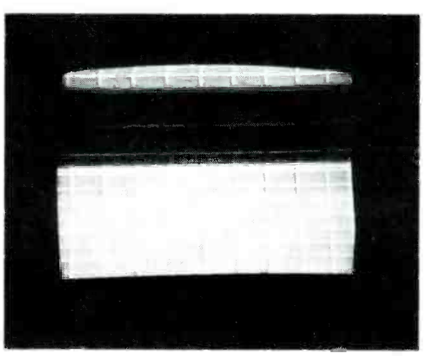


Fig. 16 If the capacitance of C416 is reduced to about 50 microfarads, a portion of the upper picture appears to be blanked out. Actually, that area is greatly expanded, as shown by the yoke voltage (top trace) and current (bottom trace), and also by examination of the crosshatch pattern.

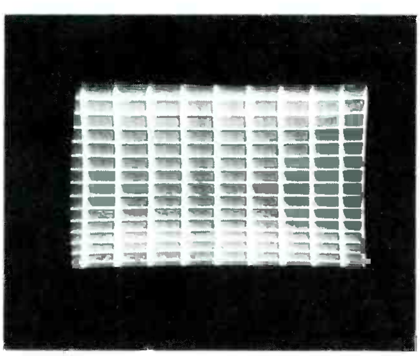


Fig. 17 Leakage of 68K across C7 reduced the height and compressed the linearity at the bottom. That's one of the few defects which can affect the linearity in this way.

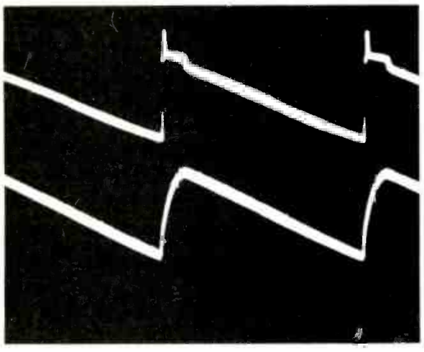


Fig. 18 If either CR2 or CR3 (in series between C7 and R13) shorts, the linearity changes slightly, and the output voltage (top) and yoke-current waveforms (bottom trace) are greatly distorted.

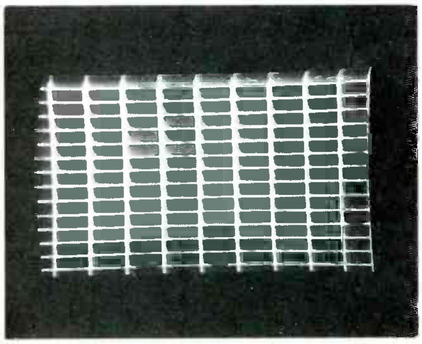


Fig. 19 Many defects, and reducing the height with the control, do not change the linearity, because of the automatic correction.

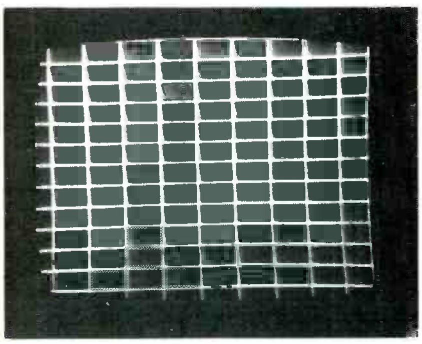


Fig. 20 When all components are normal, the vertical deflection of the RCA CTC58 has more-than-enough height with excellent linearity.

the output transistors to develop zero DC volts.

Failure of one or both output transistors is the most-likely defect in the vertical-sweep circuit. If one shorts, excessive supply voltage is applied to the other, and it probably shorts next. R604 opens from the overload, and that takes the strain from the power supply. However, C416 and C11 would have too much voltage, and either might run hot or short.

Also, it's possible for the zener protective diode (CR4), R17, R16 and Q3 to be damaged during the time the output transistors are shorted.

Therefore, even if you plan to replace module MAG001B, check R604, C416, both output transistors, and the emitter resistors R128 and R129. Do not plug in a new module before you are certain these parts are good.

Here are some miscellaneous troubleshooting tips:

- Either yoke coil open gives a loss of some height and a picture that's trapezoidal;
- An open in some components of the pincushion circuit also can give a trapezoidal raster. Connect a test lead between pins 7 and 8 of the yoke socket. A return to full height (but with pincushioning) proves the trapezoidal raster was caused by the pincushion circuit;
- An open in both yoke coils would eliminate all vertical deflection (very unlikely), but there would be a distorted strong waveform at the emitters of the output transistors;
- An open Q102 gives no sweep at the bottom half, a bright line at the center, and about 4" deflection just above the center;
- If Q101 opens, there will be no height;
- A shorted C10 or reduced value R13 will produce severe foldover at the bottom and stretched linearity at the top of the raster;
- If CR105 shorts, there is little change, for it is there mainly to protect zener CR4 in case of a short in the output transistors;
- A shorted CR102 or CR106 (or both) gives a narrow white horizontal line through the center of the raster;
- If CR105 opens, the linearity is compressed at the bottom, and the raster is pulled up about 2";
- If either CR102 or CR106 opens, there is only about 2" of raster in the center;
- Leakage in C416 is not critical. A leakage of 470 ohms merely moved up the picture about 1". Of course, a dead short is likely to blow both output transistors;
- When C416 was 150 microfarads, there was little change, but at 50 microfarads, a section near the top was spread in linearity so much that it appeared to be blanked out (see Figure 16 for waveforms and raster with crosshatch);
- Leakage in C7 reduces the height and compresses the linearity at the bottom (Figure 17);
- If CR2 or CR3 shorts, the height is reduced slightly and the waveforms change as shown in Figure 18;
- The convergence circuit between convergence-socket pins 5 and 7 is in series with the output transistors and the yoke. An open could eliminate the height. If a test lead is connected between pins 5 and 7, and the height returns, that is proof of an open. (Pin 6 is a connection to make the convergence work; it's not necessary for deflection);
- Good linearity but reduced height (Figure 19) can be caused by: leakage in C6; increased resistance of R8, R608A or R609; a decreased 15-volt supply; or leakage across the service/normal switch; and
- When all components are normal, the linearity is nearly perfect (Figure 20).

Next Month

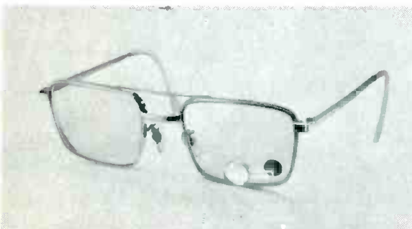
Horizontal sweep with SCR's is the important and interesting subject next month. □

productreport

These features supplied by the manufacturers are listed at no charge to them as a service to our readers. If you want factory bulletins, circle the corresponding number on the Reply Card and mail it to us.

Miniature Magnifier

A tiny Mini-Loupe can be fastened by a suction cup to the lens of eyeglasses or safety glasses, giving 2.4X or 4X magnification.



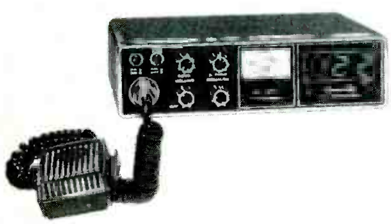
A product of **MecLab**, the loupe consists of a 11-millimeter lens with a swivel ball joint and soft mounting cup. The ball joint permits the lens to be positioned parallel to the glasses, giving best sharpness and least distortion. The loupe can be mounted in a bifocal area where it does not interfere with distant vision.

The MiniLoupes sell for $6.00 for each pair (not sold singly).

For More Details Circle (25) on Reply Card

23-Channel CB

Digi-Tron channel selection with 1/2-inch-high digital readout having bright/dim switching is one feature of the Model 1-610 **Royce** AM CB transceiver.



The dual-conversion receiver has three ceramic IF filters, tuned-RF stage, either positive or negative ground, and a meter that shows power during transmitting or signal strength for receiving.

For More Details Circle (26) on Reply Card

Bonding Liquid

Zipbond, an alpha-cyanoaclate material, bonds most man-made substances together in about 60 seconds. This product of **Tescom** is said to join rubber, metals, plastics, porcelains, glass and woods without heat or pressure.

For More Details Circle (27) on Reply Card

Tool Cases

Xcelite tool case Model TC-100ST contains 41 individual tools, including interchangeable screwdriver/nutdriver blades and handles, pliers, wrenches, knife, snips, wire cutters, Phillips and slotted screwdrivers, and many others.

The case, covered with leather-grained fabric, holds a removable pallet and tray with tool pockets, leaving the partitioned lower section for additional tools. Model TC-200ST with 38 tools also is available.

For More Details Circle (28) on Reply Card

(Continued on page 47)

For More Details Circle (12) on Reply Card

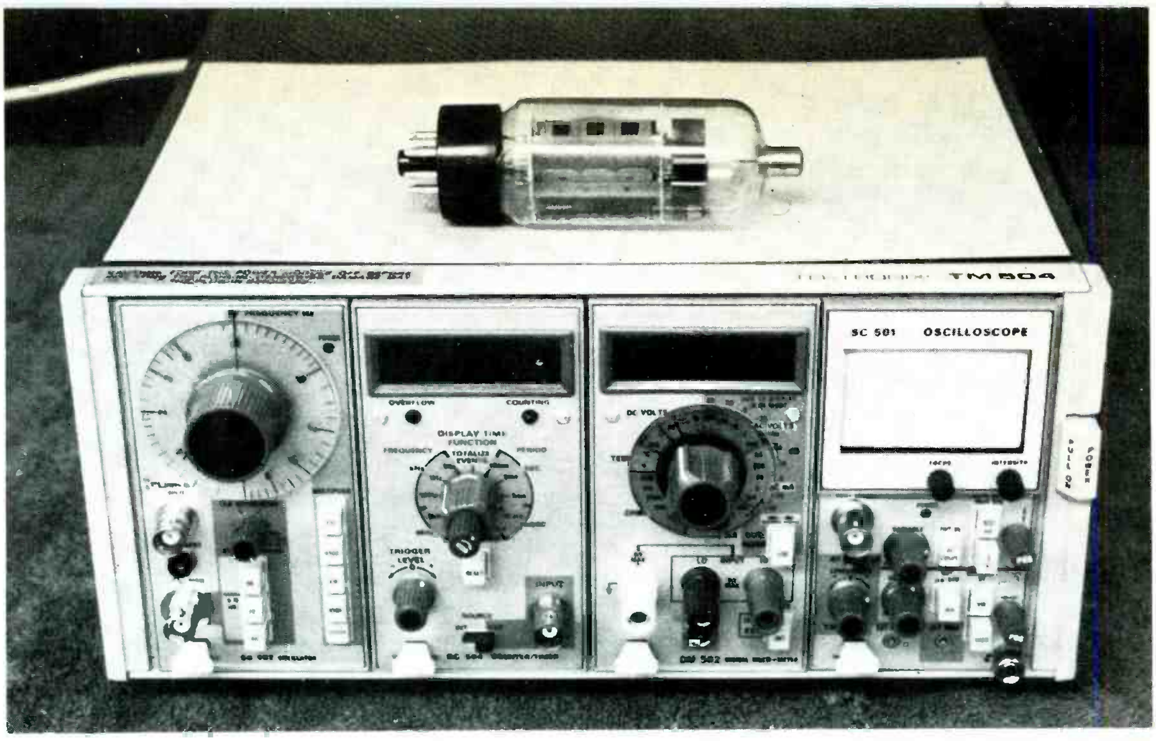


Fig. 1 Small size of the 4-module mainframe is shown by the old horizontal-output tube. These four Tektronix test equipment modules are recommended for audio servicing, although they also function quite well for TV repairs.

Reports from the test lab

By Carl Babcoke

Each report about an item of electronic test equipment or a component is based on examination and operation of the device in the ELECTRONIC SERVICING laboratory. Personal observations about the performance, and details of new and useful features are spotlighted, along with tips about using the equipment for best results.

Modular Test Equipment

Tektronix has developed an extensive TM-500 line of test instruments that plug into a common mainframe. Each mainframe has a power supply for all its units, and versions are available for one, three, four, five, and six single-width modules. A few modules require two compartments.

Extra contacts where the modules plug into the mainframe permit the units to be wired together so they "talk" to each other. When a group of instruments is to be used permanently for one purpose, this can reduce the clutter of external test leads, and minimize wrong connections.

The latest Tektronix catalog shows 11 signal generators, 3 signal processors, 3 scopes, 5 power supplies, 5 frequency counters, 2 digital multimeters, 1 triggering delay, and 5 mainframes; a total of 35 plug-in TM-500 instruments. In addition, blank panels and circuit boards for user-built modules are available. And many accessories are offered.

Small size—large performance

When I first saw these miniature modular units, I thought of toys. But that impression evaporated the minute power was applied to them, for the performance was more than full-sized.

The mainframe with four modules, that was examined in our lab, had a front panel about 11-3/4 inches wide and 5-1/4 inches high (plus the feet on the bottom). The depth was 18-1/2 inches, plus the knobs on front and the cable brackets on the rear. Yet, in a space far smaller than an old-fashioned tube-type scope, this mainframe had a triggered scope, audio-signal generator, frequency counter, and a digital multimeter!

Accuracy and stability of these TM-500 units exceeds that of the standard instruments in our Test Lab. Therefore, I can't evaluate the

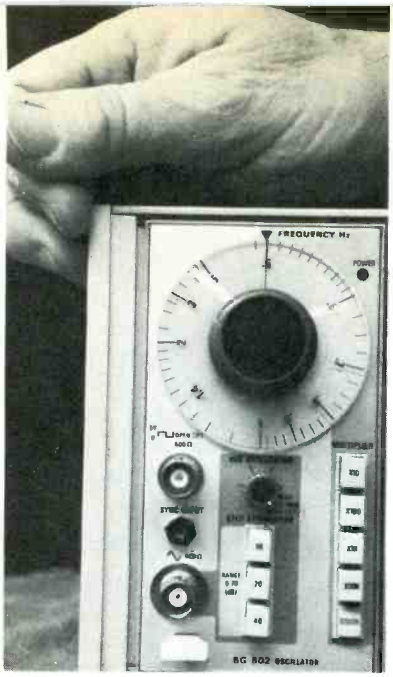


Fig. 2 The Tektronix SG-502 audio generator produces low-distortion sine waves and sharp square waves.

precise performance of these modules. Instead, I will give my impressions as I put the equipment through typical servicing paces.

Audio Equipment

These next four items of test equipment were judged the most practical of the modules for testing audio systems (Figure 1).

Audio generator

Sine and square waves from 5 Hz to 500 KHz in 5 decaded ranges are produced by the Tektronix SG-502 audio generator (Figure 2). Frequency response is rated at .3 dB over the entire range. A quick scope test of the signal amplitudes of all frequencies showed no significant variation. Sine-wave distortion is specified as .035% over the audio band, and it proved to be less than my distortion meter (of uncertain accuracy) could measure.

Shape of the square waves was excellent, with only a slight slowing of the rise and fall lines at 50 KHz. At 500 KHz, the corners of the square waves were rounded. However, a proper termination and a wider bandpass scope probably would have improved the waveshape.

Analysis of the approximate response of amplifiers is a valuable use for square waves, as explained in the "Servicing Stereo" article in this issue.

Three pushbuttons can provide from 10 dB to 70 dB attenuation, and a variable control gives another 40 dB of attenuation. The control and buttons operate only with sine waves.

Frequency counter

Model DC-504 counter/timer (Figure 3) counts frequencies up to 80 MHz, counts events up to 99,999, and measures time periods of waveforms between 1 microsecond and 999.99 seconds.

Perhaps you have not considered a frequency counter as being essential for audio servicing. And it's true that uses in servicing TV's and two-way radios are better known. But if you have a counter available, it's a cinch you'll find many jobs for it.

If you need to know a frequency exactly (perhaps to set a SCA trap or determine the 38-KHz stereo carrier), a counter is the answer. Audio generators seldom are calibrated for better than 5% dial accuracy, but the DC-504 is accurate to 1 part in 10 to the 5th power, plus or minus 1 count.

Other uses include determining the speed of a tape machine or a record turntable. This is done by a test record or tape that has a sine wave tone of known frequency recorded on it. If the test frequency is 1000 Hz, but the counter during playback shows it is 1050 Hz, then the speed is 5% fast, etc.

Measurements of very-low-frequency audio tones can be made more accurately by taking the reciprocal of the time for one cycle than by actual counting. In other words, the time of one cycle (expressed in seconds) divided into 1 gives the frequency.

Five red LED digits show the frequency readout. Accuracy of the reading can be increased beyond the five digits by allowing the counter to overflow.

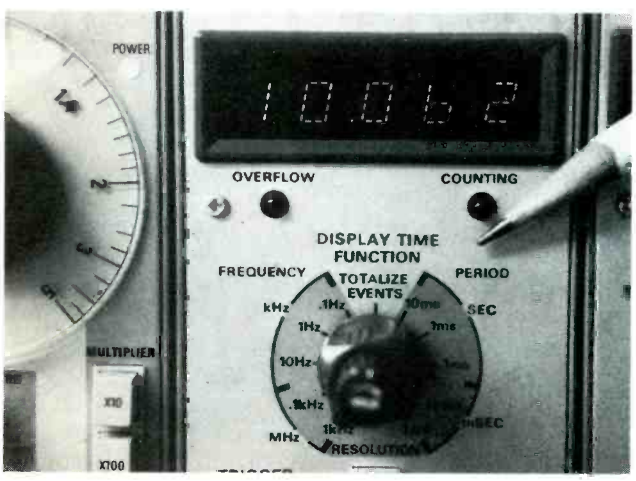


Fig. 3 Counting of frequencies up to 80 MHz, measuring the time period of recurring signals, and totalling events are the three functions of the DC-504 counter/timer.

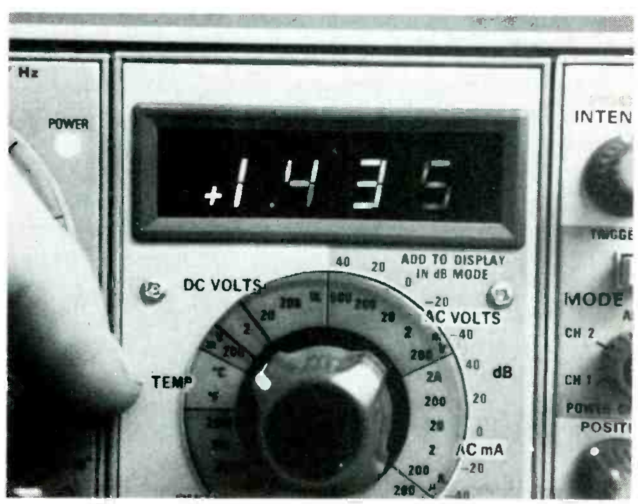


Fig. 4 A high-accuracy digital multimeter (that measures DC and AC volts, resistances, AC and DC current, and decibels) is the DM-502.

Digital multimeter

I chose the DM-502 digital multimeter (Figure 4) because it is the only one on the market, to my knowledge, that has dB measurements. Of course, dB readings are essential for audio work.

The DM-502 has a 3-1/2 digit readout with red LED's. Five DC ranges measure from .2 volt to 1000 volts full-scale at 10 megohms input resistance, and with automatic polarity indication. AC ranges are similar, except the maximum is 500 volts RMS. To obtain dB readings, you must depress the dB pushbutton, select an AC range, then add or subtract the number of dB's marked for that range.

Five each DC and AC current ranges are provided, covering from 200 microamperes to 2 amperes full-scale. Six resistance ranges measure between 200 ohms and 20 megohms full-scale.

Readings are taken at about three per second. All digits blink to indicate an over-range condition.

With the addition of an accessory probe, temperature readings either in Fahrenheit or Centigrade can be obtained.

Scope

Perhaps smaller scopes have been built. But I doubt if any have had the many features of this one. Here are some of the specifications and features of the SC-501 scope (Figure 5):

- 10 millivolt sensitivity of the vertical amplifiers at 5 MHz bandwidth, plus AC or DC coupling. Two pushbuttons give 10 MV, 100 MV, or 1 volt per division, and a control provides variable gain between X1 and X10;
- the sweep is triggered either from internal or external signals;
- three pushbuttons provide six sweep times between 1 microsecond-per-division and 100 microseconds-per-division, and an uncalibrated variable control adjusts between X1 and X10. An X5 sweep magnifier also is provided;
- the vertical and horizontal amplifiers can give X/Y vector patterns, and
- the scope screen is 1-1/4" X 2", with internal black graticule lines for zero parallax error.

Performance and stability of the SC-501 were excellent. Locking was solid and non-critical using one knob. The pushbuttons used instead of rotary switches required some practice to break my old habits.

Scope for TV?

The 5-MHz vertical bandwidth suggested the scope might operate effectively for TV waveforms, and I investigated this possibility.

And, except for a couple of minor limitations, the scope performed very well. Video waveforms probably are the most difficult of any to lock on a scope, especially at the vertical rate. Scopes that do not have an internal sync-separator circuit (such as the SC-501) can be locked solidly by applying a sample of vertical or horizontal sweep signal to the external-sync jack.

Figure 6 shows the video waveform obtained by positioning a lead from the external-sync jack near the horizontal-sweep system of the TV.

The other limitation is the maximum possible PP voltage that can be viewed on the screen. Pushbuttons take the sensitivity down to 1-volt-per-division, and the variable control gives a factor of 10, making it 10-volts-per-division. Addition of an X10 low-capacitance probe provides a final figure of 100-volts-per-division for 6 divisions, or a total of 600-volts PP for the complete height. Of course, there are few waveforms of higher amplitude that require analysis. Those two limitations certainly are not serious.

Summary for audio

The four instruments just described perfectly performed all the functions for which they were designed. Their functions cover everything required of equipment for audio-system repairs, except for distortion measurements and sweep alignment.

Additional advantages are the small size that requires little bench space, and the convenience of portable operation.

Another possibility is to use these units for in-home TV analysis to solve those rare problems that can't be found in the shop. I would have been delighted to have taken it with me when, years ago, I traveled a large territory for a distributor, repairing dogs and settling complaints.

Changing Modules

Exchanging modular test instruments requires only a few seconds time with the TM-500 mainframe (Figure 7). Just pull out on the release tab at the lower-left corner, and the module slides out easily. Then slide the other in until it latches. That's all. Of course, it's advisable to turn off the master power switch. But that's to prevent any arcing from pitting the contacts; it's unlikely any damage would occur to the circuitry in the module.

Equipment For TV

For servicing TV receivers regularly, you might prefer other modular test instruments. For example, some function generators provide many extra waveforms besides sine and square waves.

Function generator

The FG-502 Tektronix function generator (Figure 8) has sine, square, triangular, two polarities of ramps (sawteeth), and two polarities of pulses. Few generators have such a variety.

Repetition rate for sine, triangle, and square waves is continuous in 8 decade ranges from .1 Hz (cycle-per-second) to 11 MHz! Amplitude variations are practically zero up to 1 MHz. The 1 to 11 MHz range (according to a 15-MHz scope) varies 1 or 2 dB. Who can tell which instrument is not flat in this range? Square waves were as good as the scope could reproduce.

Ramps and pulses have repetition rates just 1/10th of the others, so they are available from .01 Hz to 1.1 MHz. Their waveshapes remained quite good up to the limits imposed by the scope, when the generator output was loaded with the proper 50-ohm load.

This is off the subject, but interesting. In trying to see if the generator actually had an .01-Hz positive-going pulse output, I set the scope to DC coupling and used a sweep fast enough to show a horizontal line. Of course, at such slow speed it was impossible to show an actual waveshape or have locking. But with the trace at the bottom of the screen, after about 95 seconds the trace moved rapidly to the top of the screen, remained there for about 4 seconds, and fell to the bottom again. Such a test was difficult because of my im-

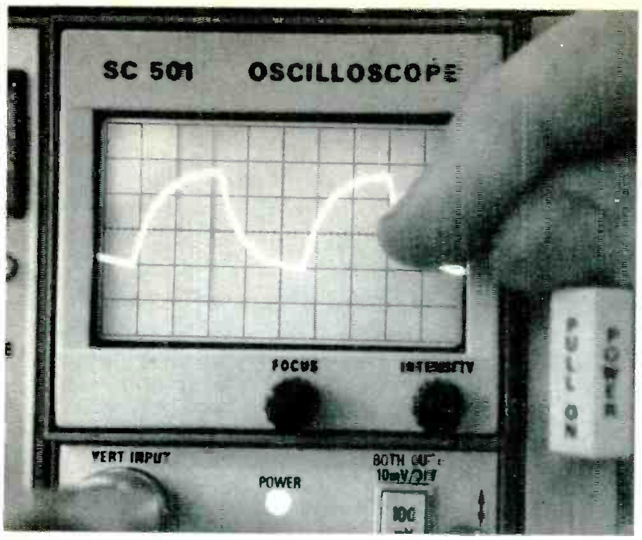


Fig. 5 A miniature triggered scope, with most features of larger ones, is a short description of the SC-501.

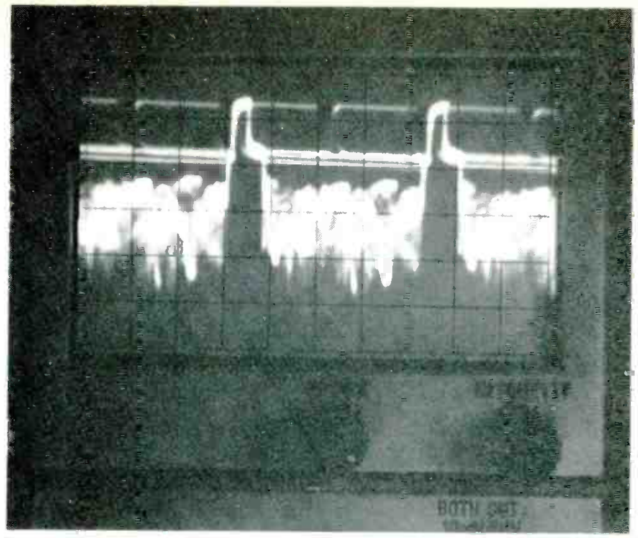


Fig. 6 This video waveform, on the SC-501 screen, compares favorably with those on full-sized scopes.

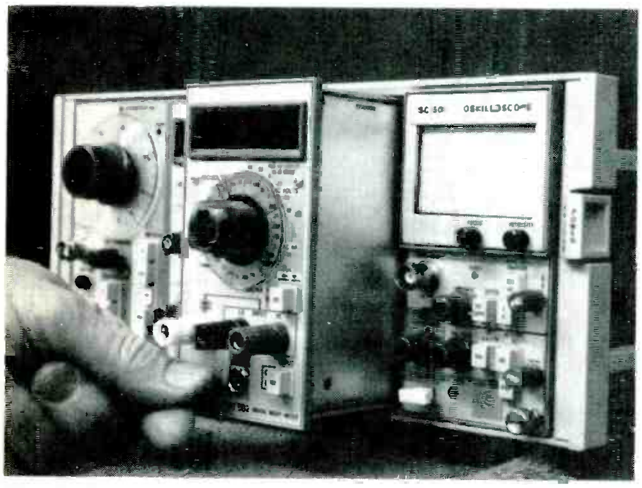


Fig. 7 Modules can be removed or reinstalled in seconds and without tools.

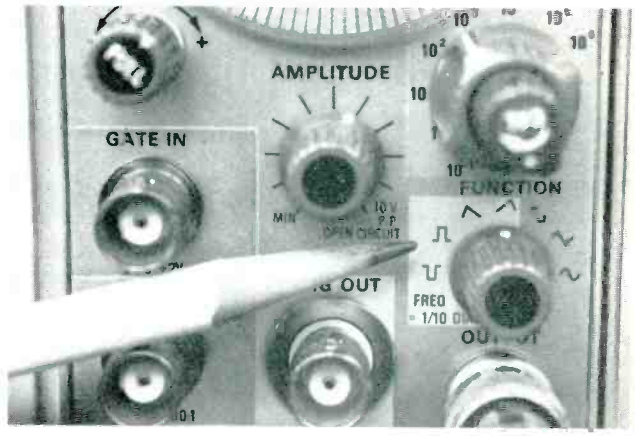


Fig. 8 Sine, triangle, and square waves from .1 Hz to 11 MHz, or ramp and pulses of either polarity from .01 Hz to 1.1 MHz are produced by the FG-502 function generator by Tektronix.

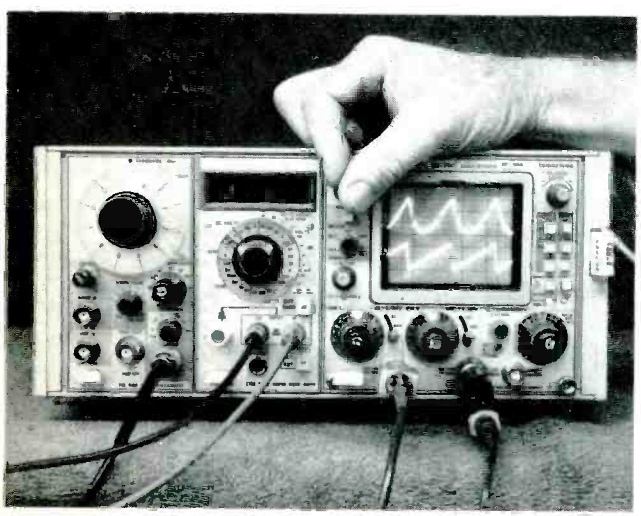


Fig. 9 The new super-bright SC-502 dual-trace 15-MHz scope is on the right, DM-502 digital meter in the center, and the FG-502 function generator is in the left compartment. This combination works well for almost any kind of service, including TV.

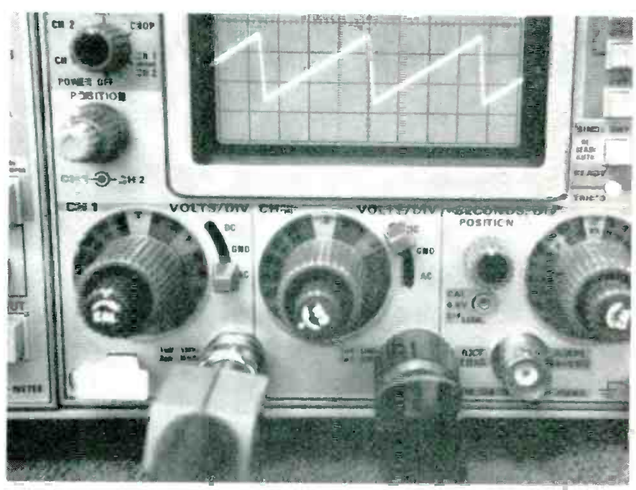


Fig. 10 Each of the three large knobs shown here has two areas behind the dial calibrations to allow the black numbers to show against the light background on the SC-502 scope. Thus, you can see at a glance the vertical sensitivity with X1 or X10 probe, and with or without the X10 horizontal magnification.

patience, but it did prove the correct signal of .01 cycles-per-second were there.

In addition to indicating the relative frequency response of audio amplifiers, the ramps and square waves can provide drive for vertical and horizontal circuits when testing for dead oscillators. Square wave analysis could indicate frequency response of the video amplifiers, or a graph using sine waves could produce an accurate response curve.

VCF and gated operation

Two other functions of the FG-502 were not fully explored. VCF stands for Voltage-Controlled Frequency, and one application is to apply a linear ramp to the VCF connector, turn the dial to the .1 mark and select an appropriate range of sine waves. With care in adjusting everything, the sine-wave output can be swept across the audio band. By using this as an input signal for an amplifier, and looking at the amplifier output with a scope, you can see the approximate frequency response. That's how the swept response curves shown on page 19 of the September issue of ELECTRONIC SERVICING were obtained.

Gated operation produces bursts of generator frequency according to a control signal which is applied to the GATE IN connector. The impulse burst of Figure 7B of the "Servicing Stereo, Part 4" in this issue was obtained. It's possible also to generate amplitude modulation that looks exactly like the textbook illustrations for radio modulation.

Dual-trace scope

Figure 9 shows a mainframe with function generator, digital multimeter, and the newest addition to the TM-500 line, a SC-502 dual-trace scope, that occupies two compartments.

The first thing I noticed about the SC-502 was the extreme brightness of trace. Even looking at only 3 cycles of an 11-MHz sine signal (with X10 trace expansion), the trace could be made almost uncomfortably bright. There was no blooming at any setting of brightness.

The specs gave one figure that explained the brightness: a total of 12 KV is used on the CRT with a screen measuring 2" X 2-5/8". The picture in Figure 9 was taken with bright fluorescent lighting in the office, yet both traces appeared to be very bright.

One pushbutton switches onto the screen the waveform that's being used to sync the sweep. A test lamp (probably an LED) lights to indicate when the sweep is locked to the signal in the vertical amps.

Another feature is shown in Figure 10. Two light areas behind the vertical sensitivity knobs show the gain with an X1 probe and with an X10 probe. Also, the Seconds/Div knob has the two lighter areas to indicate the horizontal sweep time with and without the X10 sweep magnification.

Vertical sensitivity is from 1 millivolt-per-division to 20 volts-per-division in 14 steps with an X1 probe. And from 10 millivolts to 200 volts-per-division with an X10 probe.

Horizontal sweep times also have a wide range, from .2 microsecond-per-division to .5 second-per division in 20 steps. The X10 magnification changes the specs to .02 microsecond/D and 50 milliseconds/D.

Comments

Testing the TM-500 series of Tektronix equipment gave me an opportunity to do some things that were impossible before. For example, the FG-502 function generator produced excellent, calibrated pulses, plus swept audio and burst frequencies. Many counters give false readings on the large-amplitude ragged-waveform low-frequency signals from the deflection circuits of TV receivers (although they might count a 100-MHz sine signal in a shielded environment). For one reading, the DC-504 counter/timer gave 15,734.3 as the horizontal sweep frequency during a colorcast. And it proved my theory that the diagonal stripes (when a picture is out of horizontal lock) each represent a frequency error of 60 Hz. Yes, I successfully counted many frequencies, and can imagine many more uses for counters.

My overall impression of the Tektronix TM-500 line is that it does everything it is supposed to do, and without problems. Operating equipment of this versatility and quality was a pleasure. □

(Continued from page 41)

Theater Organ Kit

The **Schober** "Theater" electronic organ kit requires about 200 hours to complete. Sounds of the old silent-movie pipe organs are recreated by special voicing of the two 61-note manuals and the full pedal board.

Average price of a "Theater" organ kit is about $2,500, with optional accessories, and this is said to be about half the usual cost of a comparable factory-built instrument. Schober also offers spinet and liturgical models.

For More Details Circle (29) on Reply Card

Wired CRT Brightener

Perma Power offers a universal wired-in type of picture-tube brightener for all tubes using 60-Hz power. Three connections are required, using the tab connectors supplied. There is no socket and no extension of grid and cathode wires to cause loss of picture sharpness. The transformer is an autoformer type, so it is not to be used where cathode-to-heater shorts indicate an isolation type.

The Tech-Brite Model C-611 retails for $5.85.

For More Details Circle (30) on Reply Card

Precision Crystals

Quartz crystals from **United States Crystal** are said to improve reception by giving greater stability and better adjacent channel rejection. All Monitor "Center Frequency" crystals are tested in-circuit before being blister-packed.

For More Details Circle (31) on Reply Card

Adapter For Testing Trinitron

An adapter consisting of two sockets and wiring makes possible the testing of a Trinitron color picture tube as though it were a 21AXP22.

This Sony-Trinitron test adapter from **Coletronics Service** sells to dealers for $6.95 each.

For More Details Circle (32) on Reply Card

Scanner/Monitor Radio

Model CS6794 from **Channel Master** provides automatic or manual scanning of 10 crystal-controlled channels. These channels can be intermixed between VHF Low Band, VHF High Band, or UHF Band 1 (also UHF Band 2 with realignment). LED lights and channel-bypass switches are included for each channel.

The scanner radio comes with both a 120-volt line cable and a 12-volt power cable for mobile use. The system incorporates two telescoping antennas, and a car-mounting bracket and hardware are included.

Suggested retail price of the Channel Master CS6794 is $169.95.

For More Details Circle (33) on Reply Card

Emergency Signal

A "call police signal" using universal symbols is designed to help the stranded motorist. Manufactured by **Nova Products**, a set of two reflective signs in bright fluorescent orange with adhesive and magnetic mounting is $3.95.

For More Details Circle (34) on Reply Card

Communication Accessories

The Mark II communications-accessories center by Ultratec, a new line of **Workman Electronic Products**, features 56 different items such as microphones, meters, cables, connectors, and adapters.

For More Details Circle (35) on Reply Card

Alarm Siren With Control

Both an amplified electronic siren and relayless electronic control circuits are built into the **Mountain West** Model S-8 alarm.

Operating from one 12-volt battery, the alarm provides 6 to 12 month battery life with closed-loop wiring, and shelf life with open loop. A separate control box is not required. The warbling siren has 110 dB level, and an internal timer provides on-and-off operation until the alarm is cleared.

The S-8 siren alarm case is weatherproof, measures 6" long, and weighs 1.5 pounds. The price is $89.00.

For More Details Circle (36) on Reply Card

Scanning Monitors

RCA has introduced a line of Scan-Aire VHF and UHF scanning monitors. Two models are home/mobile types, and two are portable Pockette units.

These solid-state radios have programmable channels, lockout switches, squelch control, LED channel indicator lights, and built-in speakers. They automatically tune to which of the pre-selected police, fire, weather, and other channels happen to be transmitting.

Suggested retail prices range between $129.50 to $184.95.

For More Details Circle (37) on Reply Card

Phone Message Announcer

The Informer Announcer automatically answers your phone and gives a personally-recorded message to inform family, friends and business people where you can be reached.

Complete with endless-loop repeating cassette, the IAM-700 can be used with any standard cassette recorder. No AC or battery power is required. From **Telco Products,** the compact unit costs $39.95.

For More Details Circle (38) on Reply Card

Most-Needed GE Parts Kit

Four parts kits from **General Electric** contain the solid-state components that are needed most frequently in GE TV receivers produced from 1961 to the present.

The parts are packed individually, and are marked with the GE catalog number. Also, each kit has a cross-reference chart and location diagram.

Basing diagrams of the transistors are listed. A "Module Repair Digest" identifies those components on the modules that are most-likely to fail. If you decide to repair the defective

module, this information is a valuable help.

For More Details Circle (39) on Reply Card

Magnetic Nutdrivers

Xcelite offers 4 styles of magnetic fixed-handle nutdrivers, each in 2 sizes. A permanent alnico magnet in the insulated socket holds fasteners firmly for easy, one-hand driving or retrieving after removal.

Styles range from a 3-1/2-inch midget pocket clip to a 20-3/4-inch driver, all in 1/4-inch and 5/16-inch hex openings.

The line includes two sizes of interchangeable shanks, which fit the Xcelite Series 99 handles, both regular and ratchet types.

For More Details Circle (40) on Reply Card

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test equipment report

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Dual-Trace Triggered Scope

Model 1471 10-MHz, triggered-sweep, dual-trace scope is the latest from **B&K-Precision.** There are 18 calibrated horizontal-sweep ranges from .5 second-per-centimeter to 1 microsecond-per-centimeter. The 5X magnification provides a maximum of .2 microsecond-per-centimeter. Manual or automatic triggering is optional, and the dual-trace mode shifts automatically between CHOP and ALTERNATE according to the sweep time.

Vertical-deflection sensitivity has 11 ranges between .01 volt-per-centimeter and 20 volts-per centimeter.

Z-asix intensity modulation enables the Model 1471 to be used with time and frequency markers, or with TTL character display systems.

A 60-Hz 1-volt PP square wave calibration voltage is available from a front panel jack.

Model 1471 B&K-Precision scope sells for $495.00, less the two PR-20B probes.

For More Details Circle (45) on Reply Card

Autoranging Digital Multimeter

Intended for operation on a workbench is Model DVM34 from **Sencore.** This digital multimeter has a 3-1/2-digit readout using .4" LED's, a basic accuracy of .1%, and an input resistance of 15-megohms for all voltage functions.

Four voltage and current ranges permit DC readings between 100 microvolts and 2000 volts, AC from 100 microvolts to 1000 volts, plus AC and DC current from 100 nanoamperes to 2 amperes. Seven resistance ranges provide readings from 10 milliohms to 20 megohms, with either higher voltage for reading diode and transistor junctions, or with a lower voltage for measuring resistance in solid-state circuits.

A single-step autoranging circuit operates, when the voltage reading is 180 or less, to step down to the next range. For DC readings, positive or negative polarity is indicated automatically.

Fuses protect against accidental overloads. Although Model DVM34 is compact, the display and pushbuttons are large, it's said that the instrument will not slide when the buttons are pressed.

The Sencore Model DVM34 digital multimeter sells for $295.00, and the optional HP200 50-KV probe is $25.00.

For More Details Circle (46) on Reply Card

Portable Tube Tester

An exclusive test for open elements, plus basic tests of shorts, H-K

(Continued on page 51)

antenna systems report

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Computerized MATV Surveys

A computerized signal survey for customers planning MATV systems has been announced by **Jerrold Electronics.** By sending the geographical coordinates (longitude and latitude) of the proposed site, or the name of the nearest town to a Jerrold regional office, any MATV contractor or consulting engineer can receive a free computerized read-out, giving details on the channels receivable at the site; types of antennas, towers, and preamps required; and possible sources of interference.

Variations in local terrain have been excluded from the program; therefore, Jerrold recommends an on-site signal survey to supplement the computer survey.

For More Details Circle (51) on Reply Card

Antenna Amplifiers

Channel Master has introduced two Spartan antenna-mounted TV amplifiers designed to provide improved reception of the UHF translator band, channels 70 through 83.

The transistor-powered amplifiers are Model 0070B, a $56.95 unit with up to two 300-ohm inputs and Model 0071B, a 75-ohm unit which lists for $66.25.

An average gain increase of 7dB, and a reduced noise figure distinguish these units from previous Spartan models. The high input capacity of these amplifiers reportedly allows clear reception of strong, local UHF signals without overload, and clear reception of amplified weak signals.

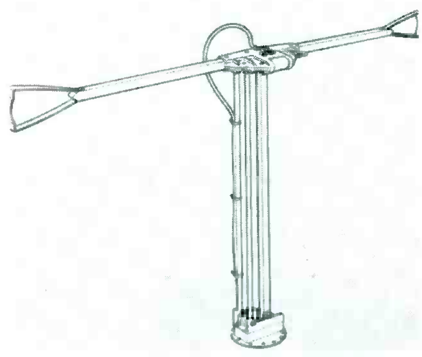
Each unit comes with the indoor power supply and splitter network.

For More Details Circle (52) on Reply Card

Solid-State Modular TV Antenna

Target 360 TV antenna from **S&A Electronics** mounts easily on any vehicle and receives UHF/VHF TV channels 2 through 83, and AM/FM radio.

The antenna can be raised, lowered, or rotated 360° from inside the vehicle. Streamlined for minimum wind resistance, the unit folds down for travel.



Model TRV-75 is of solid-state modular construction and comes complete with 300-ohm shielded transmission line and installation hardware. Model TRV-76A includes a signal amplifier.

For More Details Circle (53) on Reply Card

Directional Wattmeter

The Thruline® RF directional wattmeter for the measurement of forward or reflected CW power features an RF-sampling output for frequency analysis on a scope, spectrum analyzer, or frequency counter.

Model 4527 is designed for ±5% power measurement from 100 milliwatts to 1000 watts from 2 to 200 MHz and up to 500 watts from 200 to 512 MHz, using the same standard plug-in elements in discrete bands and power levels as Model 43. No plug-in elements are needed for RF analysis. The sample signal is available from a BNC output port at about 53dB below the main signal level.

A major feature is a low insertion VSWR of 1.05 maximum made possible by the use of the patented QC quick-change connectors, which permit mating with male or female N, BNC, TNC, UHF, C, SC, HN, GR type 874 and 7/8-inch EIA lines without the need for performance-degrading adapters.

Model 4527 is priced at $245.00. Plug-in elements range from $32.00 to $75.00. The wattmeter is manufactured by **Bird Electronic Corporation.**

For More Details Circle (54) on Reply Card

Bonded-Foil Drop Cables

A 75-ohm coaxial cable which uses a foil shield bonded to the primary insulation is available from **Cerro Communication Products.** The bonded-foil construction reportedly eliminates foil "push-back" and simplifies connector installation. The product features high tensile-strength center conductor and extra-duty messenger strand.

The cable is available in several combinations of foil and braid (or drain wire) shield, dual and messengered versions in both RG/59 and RG/6 types. RG/58 and RG/8 sizes in 50-ohm types also are available.

For More Details Circle (55) on Reply Card

Cable-Preparation Tools

A series of stripping tools for coaxial cable is available from **Blonder-Tongue Laboratories.** To use the strippers, insert the cable in one end of the tool and rotate to either expose the center conductor or strip the outer jacket, depending on the specific tool used. Then the cable is inserted into the other end of the tool and rotated to either remove the outer jacket or remove the dielectric cable. The process is said to take less than 15 seconds. The cutter blade reportedly will not nick the center conductor of the coax or leave loose strands of wire that can cause shorts.

The tools are available for cable sizes from RG-59 to 0.75-inch aluminum cable. □

For More Details Circle (56) on Reply Card

Test Equipment

(*Continued from page 49*)

and grid leakage, and emission are features of the **Hickok** Model 230 tube tester. The heater-to-cathode leakage test is read on the meter, with a sensitivity of 2 microamperes.

Included is a Hickok Data Book, which lists all the old and new tubes. Update sheets will be available from Hickok, when new types are released.

For More Details Circle (47) on Reply Card

3" Scope With Quick Tests

The **RCA** WO-33B 3-inch scope has all the usual recurrent-sweep functions, plus a built-in Quicktracer transistor-and-diode junction tester, facilities for "ringing" tests of yokes and flybacks, and a terminal for vector patterns.

Frequency response of the vertical channel varies according to the sensitivity. High-gain ranges of .05 to .5 volts cover 20 Hz to 150 KHz at -3 dB, while the high-gain ranges from 1.5 to 150 volts have a bandwidth from 6 Hz to 5 MHz at -3 dB. Sensitivity of the high-gain ranges is about 10 millivolts-per-inch.

Model WO-33B scope sells for $229, complete with direct/low-capacitance probe and cable and a special probe for the Quicktracer tests. Probes for signal tracing or RF-demodulation are optional.

For More Details Circle (48) on Reply Card

Low-Profile Digital Multimeter

LSI circuitry allows the 28-range **Simpson** Model 464 DMM to be housed in a small case. Five DC and AC voltage ranges cover to 1000 volts, with automatic polarity on DC, six AC and DC current ranges measure to 10 amperes, and six resistance ranges read to 20 megohms.

Other features include: pushbutton selection; 3-1/2-digit display with .43" LED's; adjustable handle for tilting; automatic zero; and .2% accuracy on DC volts.

Two models are available. Model 464A, priced at $210, is for line-voltage operation only. Model 464D operates either on 120 volts AC or from

internal batteries with built-in charger; it is priced at $235. HV probe, RF probe, and a custom carrying case are optional.

For More Details Circle (49) on Reply Card

"Extra-Chance" VOM

Triplett Corporation has introduced a VOM that has built-in protection against accidental electrical overload, is shock resistant to drops up to a 5-foot height, and has modular construction for quick and easy service in the field.

The $90.00 "Extra-Chance" Model 60 VOM is battery-operated, has no exposed metal parts, and features a 3-fuse protection system.

An "Accu-Test" feature is built-in for a calibration check after misuse. The unit comes complete with batteries, spare 1/8 amp and 1 amp fuses, and instruction manual. □

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For news of our industry, read Electronic Scanner, page 4

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SAMS PHOTOFACTS 1 thru 1325 complete with four 4-drawer metal cabinets, good condition, make offer. Mrs. Robert Perdelwitz, Princeville, Illinois 61559, 309-385-4405. 12-75 1t.

HEATHKIT TV Post-Marker/Sweep Generator model IG-57A complete with all test leads and manual-ready to use. $140.00. Bailey's TV, 430 S. Jefferson, Lebanon Missouri. 12-75 1t

NEW Canadian Magazine "Electronics Workshop". $5.00 yearly. Sample $1.00. Ethko, Box 741, Montreal "A" Canada. 10-75-12t

FOR SALE (CONT.)

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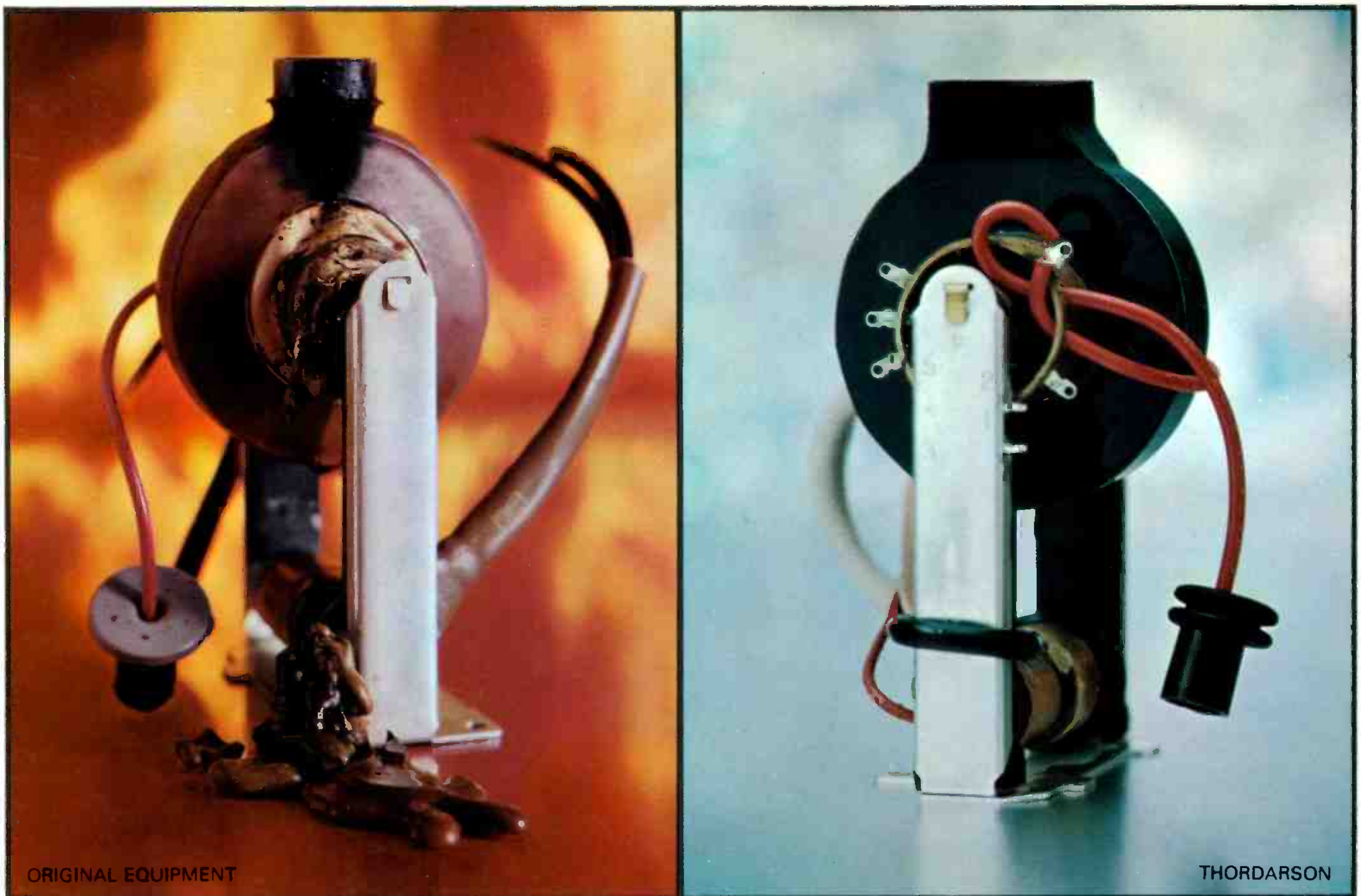

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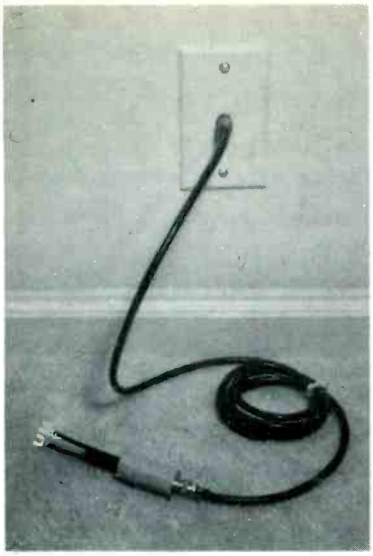

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