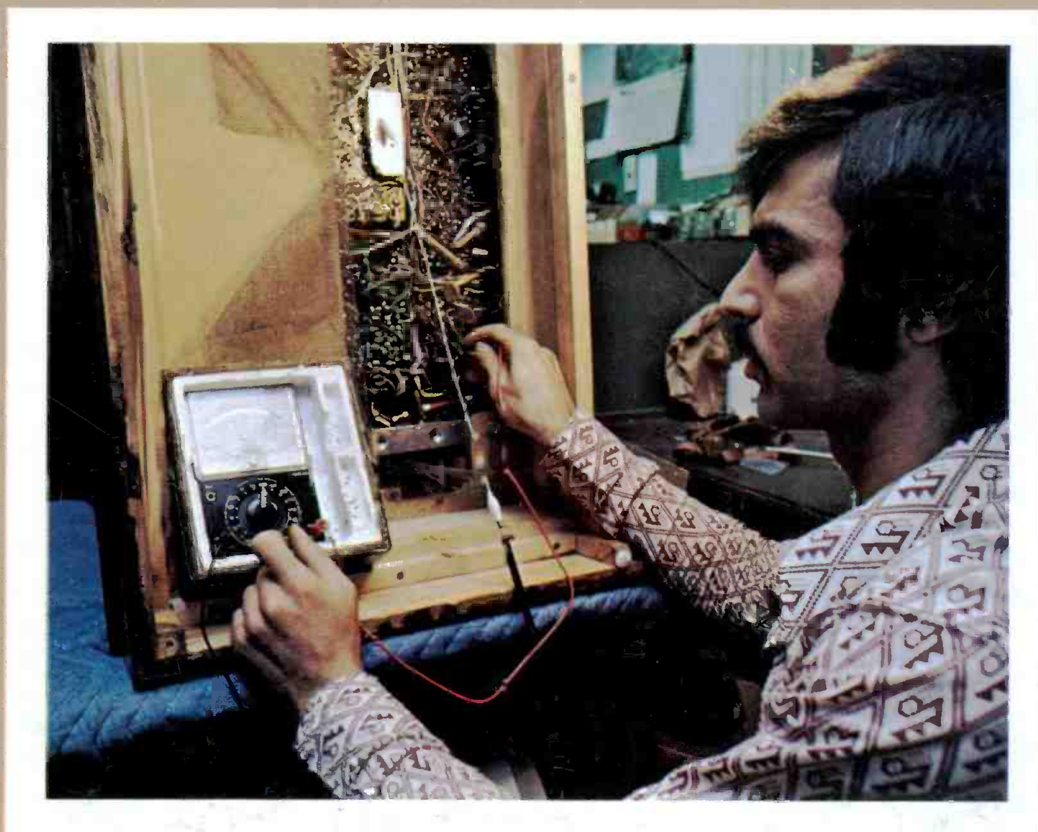
July, 1976 □ 75 cents

Electronic Servicing

A HOWARD W. SAMS PUBLICATION



Servicing CB Synthesizers

VIR Automatic Color

Satellite Update

"How's That, Again?"

July, 1976 □ Volume 26, No. 7

Electronic Servicing

in this issue...

ABOUT THE COVER

David Isaac, one of the technicians at Palo Alto Radio & Television in California, troubleshoots a color receiver after removing the bottom plate. (Photo by Donna Foster Roizen)

DEPARTMENTS

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Riley really rallied to our "rally 'round the tab."

Our 1976 "rally 'round the tab" award program is under way, and a lot of dealers and technicians are already collecting awards ranging from coffeemakers to camping gear.

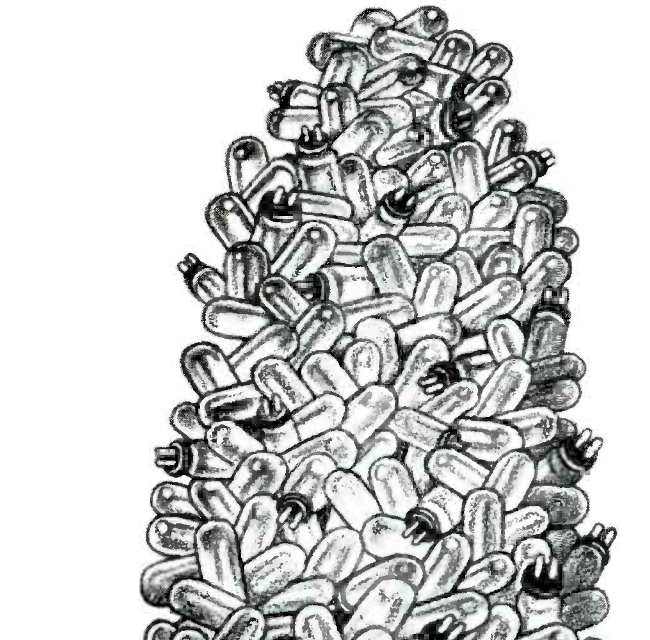
You can start collecting, too. All you have to do is tear off the tab—the end flap of Sylvania receiving tube boxes with the Waltham, Third Ave. or Broadway address on it.

And save color picture-tube serial labels, too. They're worth the equivalent of 20 receiving tube tabs. (You'll find the label on the upper left-hand corner of every carton.)

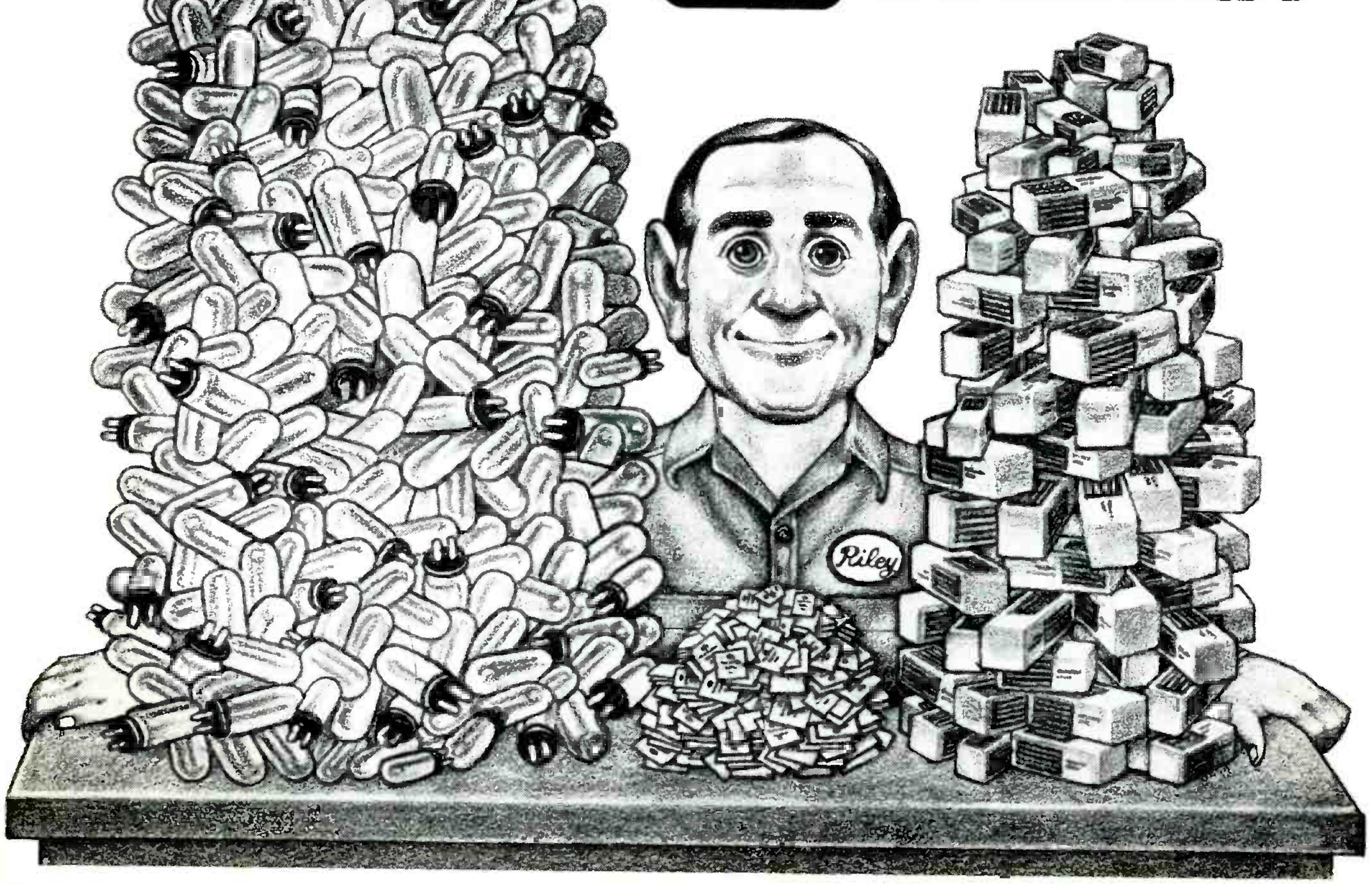
Then just pick the awards you want from over 300 items in the official catalog and drop your order in the mail. Keep in mind, the program ends at midnight November 30th, 1976.

You can get your catalog, order forms and mailing kit from your local Sylvania Distributor or from Sylvania Award Headquarters, P.O. Box 4000, Fenton, Missouri 63026.

Start your tab collection today. It's our way of helping you to live the life of Riley.



GTE SYLVANIA



electronicscanner

news of the industry

Quasar Electronics has started shipments of a new 12-inch diagonal solid-state portable color television receiver. The unit weighs about 28 pounds and consumes less energy than a 75-watt electric light bulb. The receiver has an in-line matrix-striped color picture tube with an additional pre-focus lens to sharpen the focus. A "picture control" allows the customer to regulate or maintain the balance of contrast, brightness and color intensity. Suggested list price is $329.95.

Magnavox has designed a new tuning system for some of its TV receivers. The new system uses five IC chips and a programmable memory. A quartz crystal is used to provide an on-screen time display on demand or when the channel is changed. Channel selection is done with a 12-button telephone-type keyboard. There is a two-digit, one-half-inch-high LED channel display. **Electronic News** states the new system is going into nine 25-inch models and two 19-inch models made by Magnavox, while the older electronic Star tuning system will continue to be used on 12 models.

The Finney Company is to open factory number three in Clinton, Kentucky.

VIZ Manufacturing announced a new product introduction program at the NEWCOM '76 Show in New Orleans. Russel Hurst, president of VIZ, said the program would bring out 12 new products in 12 months. The products will include two new digital multimeters; an FET VOM; signal, pulse, and function generators; an oscilloscope; two wattmeters; a low-price high-quality VOM; and a power supply. VIZ acquired the RCA test instruments business last December.

Both GTE Sylvania and RCA have indicated that they are interested in the Rauland picture tube manufactured for Zenith, but not the glass design. Alfred Viebranz, Senior Vice President of the Electronic Components Group of GTE Sylvania, stated that "The prime new feature of the Rauland tube, of interest to us and our customers, is the tri-potential gun. This premium gun appears to have the potential of providing picture performance equivalent to the current Delta-gun tube while allowing most of the attendant in-line chassis savings to the set producers. We will be competitive in this area."

William W. George, president of Litton Microwave Cooking Products, recently predicted an increase of 40% in industry sales of home microwave ovens to 1.4 million units this year. Litton division's own consumer sales for the first three months are up more than 150% over 1975's first quarter. In 1975, more than 1 million units were sold by the industry.

RCA Distributor and Special Products Division has announced a new program under which dealers and service technicians will receive credit for returning defective, out-of-warranty modules against the purchase of a replacement module. The amount of credit depends on the type of dud returned, with a range from $3 to $10 per module. Credit will not be given for damaged modules. The program is especially important with respect to older chassis designs where some modules are currently being phased out of production.

(Continued on page 6)

TUNER SERVICE CORPORATION

SUBSTITUNER

JUST **$44.95** U.S.A. ONLY

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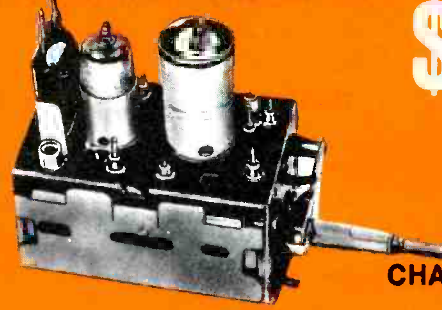
ONE YEAR GUARANTEE



STILL ONLY **$9.95** U.S.A. ONLY

MAJOR PARTS AND SHIPPING CHARGED AT COST

FEATURES

- A UHF Tuner with 70 channels which are detented and indicated just like VHF channels.
- A VHF Hi Gain Solid State Tuner.
- AC Powered
- 90 Day Warranty

Demonstrate the SUBSTITUNER to your customers and show improved reception with their TV sets.

You may place your order through any of the Centers listed below.

NEWS FLASH!

NOW AVAILABLE—TUNER SERVICE PARTS CATALOG OF ALL SARKES TARZIAN VHF AND UHF TUNERS, INCLUDING EXPLODED VIEW DRAWINGS. OVER 200 PAGES. ORDER YOUR COPY TODAY. *SEND $2.50 WITH ORDER TO BLOOMINGTON HEAD OFFICE.*

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

REPAIR

VHF OR UHF ANY TYPE ...... (U.S.A. ONLY) **$ 9.95**
UHF/VHF COMBINATION .... (U.S.A. ONLY) **$15.00**

MAJOR PARTS AND SHIPPING CHARGED AT COST

- Fast, efficient service at our conveniently located Service Centers.
- All tuners are ultrasonically cleaned, repaired, realigned, and air tested.

REPLACE

UNIVERSAL REPLACEMENT TUNER **$12.95** (U.S.A. only)

- This price buys you a complete new tuner built specifically by Sarkes Tarzian Inc. for this purpose.
- All shafts have a maximum length of 10½" which can be cut to 1½".
- Specify heater type parallel and series 450 mA. or 600 mA.

CUSTOMIZE

- Customized tuners are available at a cost of only $15.95. With trade-in $13.95. (U.S.A. only)
- Send in your original tuner for comparison purposes to any of the Centers listed below.

TSC

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HEADQUARTERS	BLOOMINGTON, INDIANA 47401	537 South Walnut Street	Tel. 812-334-0411
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
	MIAMI, FLORIDA 33150	7641 N.W. 7th Ave.	Tel. 305-754-1352
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
	DALTON, ILL. 60419	1507-09 E. 142nd St.	Tel. 312-841-4444
	SKOKIE, ILLINOIS 60076	5110 West Brown Street	Tel. 312-675-0230
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IOWA	DES MOINES, IOWA 50319	5005 Douglas St. #5E	Tel. 515-278-4217
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 2624	Tel. 301-358-1186
MASSACHUSETTS	SPRINGFIELD, MASS. 01108	405 Dickinson St.	Tel. 413-788-8206
MISSOURI	ST. LOUIS, MISSOURI 63132	9577 Page Avenue	Tel. 314-429-0633
NEVADA	LAS VEGAS, NEVADA 89102	1412 Western Avenue No. 1	Tel. 702-384-4235
NEW JERSEY	TRENTON, NEW JERSEY 08638	1139 Pennsylvania Ave.	Tel. 609-393-0999
	JERSEY CITY, NEW JERSEY 07307	547-49 Tonnele Ave., Hwy. 1 & 9	Tel. 201-792-3730
NEW YORK	ROCHESTER, NEW YORK 14615	37 Pullman Ave.	Tel. 716-647-9180
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 Ave., P.O. Box 10141	Tel. 503-222-9059
PENNSYLVANIA	PITTSBURGH, PA. 15209	515 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-1Y3	P.O. Box 5823, Stn. "A"	Tel. 403-243-0971

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

For More Details Circle (6) on Reply Card

(*Continued from page 4*)

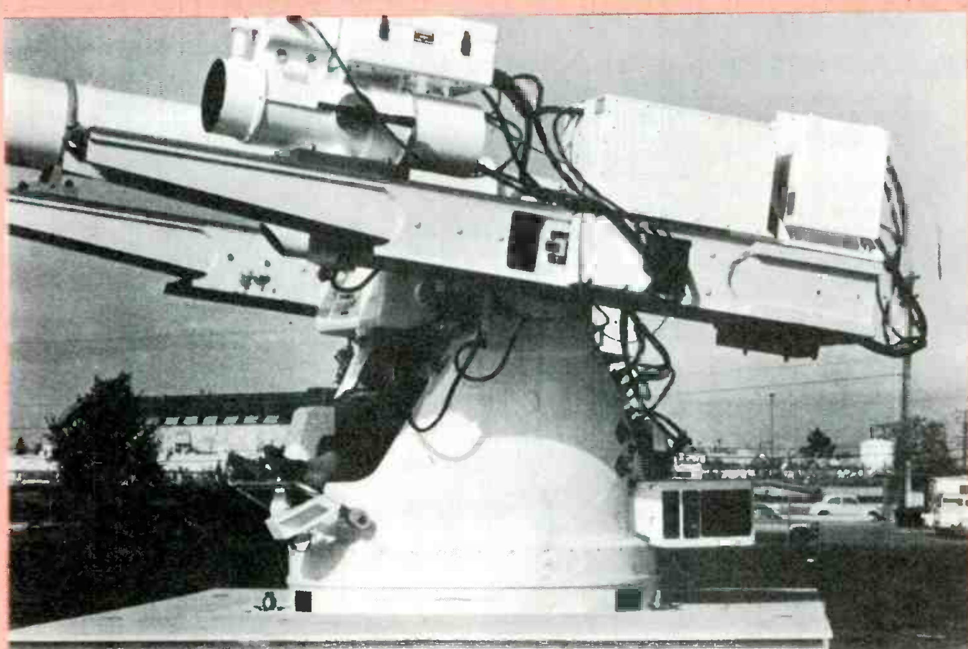
Projection television sales appear to be growing. An improving business climate and a scattering of lower prices seem to be responsible for the upswing. It is estimated that sales may climb to 100,000 annually within the next three years.

A new packaging service is being offered without charge by PTS Electronics. Repaired tuners, rebuilt modules, and tuner test-instrument kits are now packaged in special plastic skin packs to eliminate shipping damage and dirt. The package provides an airtight seal that prevents the contents from moving, as well as providing a cushion during shipment.

Jerrold Electronics has scheduled MATV Schools to be held during the second half of 1976. The schools cover basic and advanced Master Antenna TV systems, including system design, headends, distribution systems, calculating losses, eliminating interference, and installation techniques. Anyone interested in attending these schools should contact the Jerrold Distributor Sales Division, 200 Witmer Road, Horsham, Pa. 19044.

RCA's new 1977 line of color television receivers emphasizes the "Color-Trak" system, and is aimed directly at the second-set market, which now accounts for 60% of the total sales. The "ColorTrak" system has been expanded to include almost three-fourths of the basic new line. A late-summer national promotion, "Trades Fantastic", will be launched by RCA to increase console receiver sales among previous color set owners, who will receive an advertised trade-in allowance of up to $100 on a used color TV set with the purchase of a ColorTrak console.

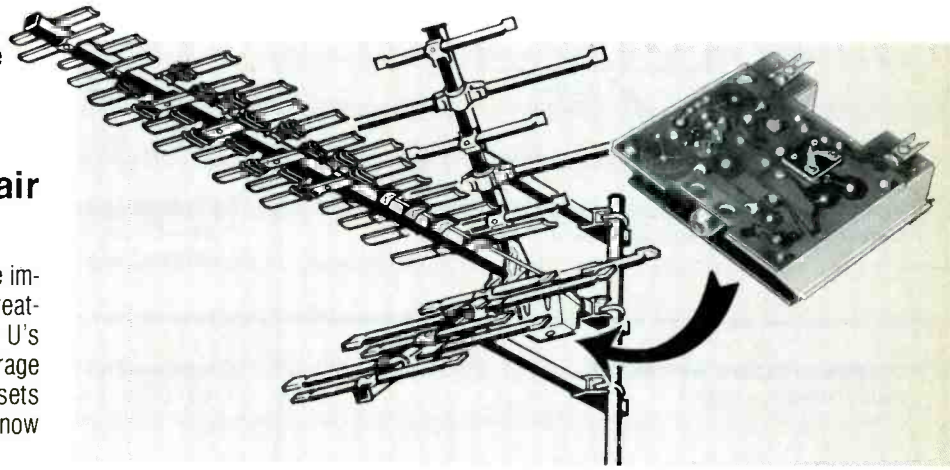
Laser tracking equipment that helps evaluate the performance of new parachutes and ejection systems has been developed by GTE Sylvania. The unit sends a laser pulse to a parachute-mounted reflector which returns it to a receiver. By measuring the transit time and position of the return pulse, the receiver determines the range from the retroreflector. Added to a photographic system, the equipment will provide automatic target tracking.



PHENOMENAL BREAKTHROUGH IN UHF RECEPTION!

Don't say you can't get good UHF reception until you've tried this new combination by Winegard

New Super Lo-Noise Preamp With New Antenna Makes Poor Pictures Good and Fair Pictures Excellent



Winegard AC-4990 Preamplifier Combined With CH-9095 Antenna Delivers Amazing UHF Reception.

Good reception of UHF stations is more important than ever. Programming has greatly improved in recent years on the U's and many offer exclusive sports coverage viewers so eagerly want. If you sell sets or install antennas in UHF areas, you know what we're talking about.

The Problem

You also know what we're talking about when we say that reception of UHF stations in most areas is rarely as good as you get on the VHF stations. This is a major, universal problem.

Why the problem? For one thing, many UHF stations are not on full authorized power. And, transmission line losses at UHF frequencies present difficulties. But the biggest culprit of all is the high noise figure of the TV set tuners at UHF frequencies.

Generally speaking, you have to deliver *3 times* as much clean UHF signal to the set as you do VHF signal—in order to get comparable reception.

The quantity and quality of UHF signal you feed the set is greatly determined by the antenna and preamplifier you use.

SPECIFICATIONS	AC-4990
GAIN	
UHF	17.5db
BANDPASS (MHZ)	
VHF-FM	54 to 216
UHF	470 to 890
MAX. TOTAL OUTPUT (Volts)	
UHF	.882
MAX. TOTAL INPUT (Volts)	
UHF	.126
NOISE FIGURE	
UHF	2.2db

The Solution

A few months ago Winegard Company introduced a new line of Chromstar UHF antennas featuring a new Tri-linear director system. This configuration offers the highest gain we've ever seen on a UHF antenna and the field reports we've been getting from professional installers have been most enthusiastic.

Now Winegard Company is introducing another...and even bigger breakthrough. This is a super lo-noise UHF preamplifier, Model AC-4990.* It has a 6db signal-to-noise improvement over the best UHF preamps previously available.

Combine the AC-4990 with a Winegard CH-9095 Chromstar UHF antenna and you get a 9db improvement or *3 times cleaner signal.*

This means you can give good UHF pictures to customers who can barely get UHF now. It means you can deliver "excellent" reception to those who now receive just "fair" pictures.

*Pat. Pending.

In actual practice, good reception of all UHF stations is now extended up to 30 additional miles...in many cases nearly doubling the effective reception range.

New Sales Potential

Potential sales of CH-9095's and AC-4990's are greatly increased. This combo can be sold in areas where UHF reception hasn't been good enough to bother with *and,* as a replacement for customers who are only getting "fair" reception now.

Incidentally, the AC-4990 preamp has a VHF bypass so it can also be used with any Winegard V-U Chromstar antenna with excellent results.

Antenna dealers in UHF areas are advised to try this new Winegard antenna-preamp combination as soon as possible. Seeing is believing...and the new profit opportunities are tremendous.

NOTE: Due to demand, the AC-4990 preamp will be in short supply for a few months. An order should be placed now with your Winegard distributor.

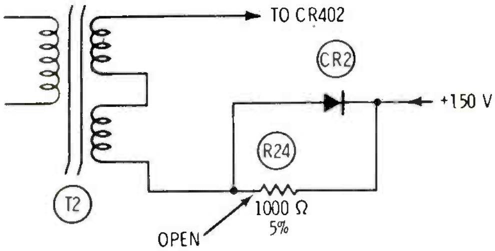
WINEGARD COMPANY
3000 Kirkwood • Burlington, Iowa 52601

For More Details Circle (7) on Reply Card

symcure

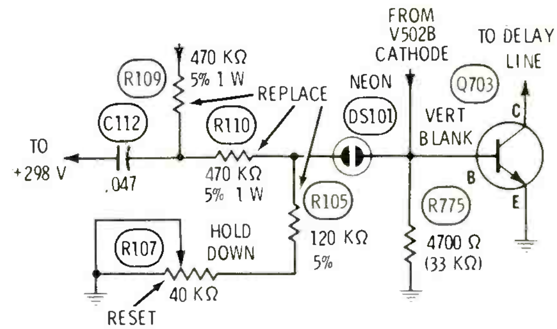
Symptoms and cures compiled from field reports of recurring troubles

Chassis—RCA CTC49X
PHOTOFACT—1187-2



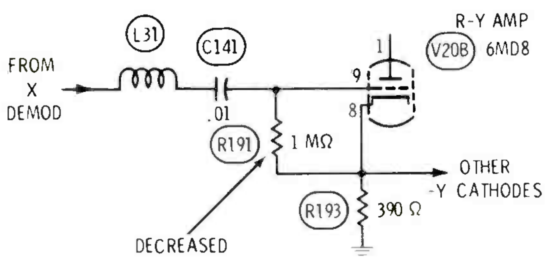
Symptom—Piecrusting that varied with brightness
Cure—Check R24, and replace it if open

Chassis—RCA CTC63
PHOTOFACT—1362-2



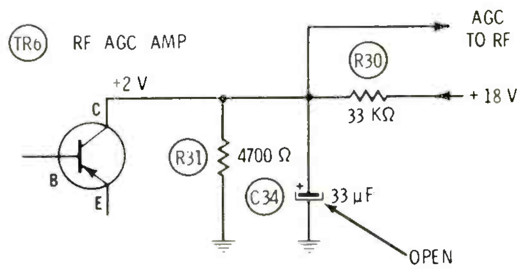
Symptom—Intermittent vertical jitter
Cure—Check R105, R109, and R110. Replace if out of tolerance, and readjust R107

Chassis—Packard Bell 98C17
PHOTOFACT—1023-1



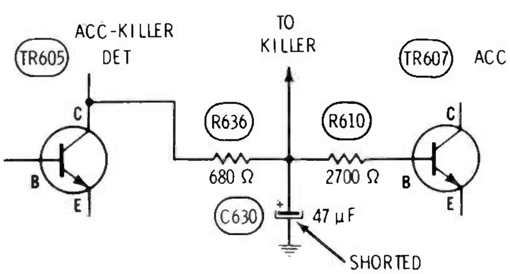
Symptom—Herringbone pattern in red picture
Cure—Check R191, and replace if it is reduced in value

Chassis—Truetone MIC-4212-27
PHOTOFACT—1265-2



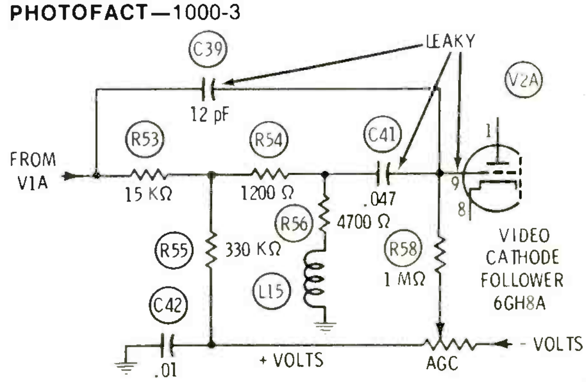
Symptom—No color on left half of screen
Cure—Check C34, and replace it if open

Chassis—Panasonic CT-25P
PHOTOFACT—1211-2



Symptom—Colored snow off channel, but no color on station
Cure—Check C630, and replace it if shorted

Chassis—RCA CTC38
PHOTOFACT—1000-3



Symptom—Video blanks out, requiring adjustment of AGC
Cure—Check C39, C41, and the grid of V2A for leakage

troubleshooting tips

Send in your helpful tips—we pay!

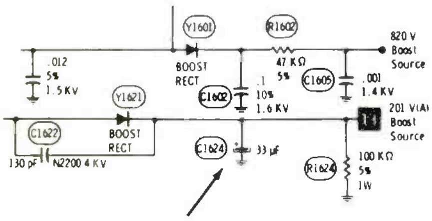
No video, and excessive brightness General Electric 25MB Chassis

(Photofact 1400-3)

The symptoms were a very-bright raster without video, and that the brightness could not be reduced enough by either the brightness or the screen controls. None of the CRT grids should have any kind of AC signal, but each should have the same DC voltage, determined by adjustment of the CRT-Bias control. However, the grid voltages were not suspected because no defect there could remove the video.

Excessive screen-grid voltages would cause too much brightness, but the brightness control should work, and the video should be present.

Neither screen-grid or control-grid troubles could cause the symptoms, so those two areas were cleared of suspicion for the moment.



The brightness control changes a DC voltage in the video amplifiers, thus the cathodes of the picture tube should have video/chroma signals, plus DC voltages that vary with the brightness control. At the cathodes, I measured almost zero volts DC, instead of the normal 120 to 180 volts. This proved the defect was in the video. But where in the video was it?

I removed the video module and measured the DC voltage at pin 13 of the module socket, finding zero again.

Both the boost (screen-grid supply) and the +201-volt boost supply (for video outputs) come from rectification of the sweep waveform at the flyback, and the components are located on terminals above the flyback. Looking there, I quickly spotted a burned resistor, R1602, which feeds voltage to the screens. But that couldn't be the main defect, because the CRT had screen voltage.

Next, an ohmmeter test proved that C1624 was shorted, and the 100-ohm resistor (R1622) in series with the diode checked open. But the two diodes (Y1601 and Y1621) were okay. Replacement of the capacitor, the resistor, and the burned resistor in the boost circuit restored normal operation.

Roger D. Redden
Beaver, West Virginia

Picture bending Zenith 14L36 chassis

(Photofact 707-4)

The customer complained of bending in the picture on the screen of this old portable TV.

The bends were steady, and did not roll as is usual with hum from a tube leakage, or a defective filter capacitor. Pictures from broadcasting stations are not ideal for troubleshooting bends, so I changed to the vertical lines from a color-bar generator. Now, the bends could be changed, by use of the horizontal-hold control, from a distorted "S" curve to a reversed "C" shape.

Concluding that the first circuit to check was the horizontal AFC, I replaced the 6KD8 tube of that circuit; however, there was no change. After measuring +3.1 volts DC of AFC control voltage at the junction of R70 and R71, I clamped this point with the same DC voltage from my bias supply. Although the picture drifted sideways, the bends clearly still were present. From the test, I concluded the defect was not in the dual-diode phase-detector circuit. Next, I checked waveforms and DC voltages at the 6KD8 tube. Nothing abnormal was found.

After some thought and searching the schematic, I noticed a capacitor, C42, which was connected between the horizontal-AFC circuit and the cathode of the vertical-output tube. Could the bends be caused by a defect in the capacitor, or in the vertical-output circuit?

Although I thought those possibilities to be remote, I did replace the vertical-output tube. To my surprise, the trouble of the bends was corrected.

Al Ferrara
Upper Darby, Pennsylvania

reader's exchange

Needed: *Deflection board for Delmonico-Nivico, Model TR-27; quote price.*
C. R. Ashburn
1820 Vista Lane
Timonium, Maryland 21093

Needed: *Power transformer for a Hickok scope, Model #670.*
S. Tagliarini
8816 N. Himes Avenue
Tampa, Florida 33614

Needed: *Schematic and service data for Squires and Sanders Model #SS-310 CCTV camera. Will buy, or copy and return.*
Allen Rees
P.O. Box 1271
Norman, Oklahoma 73069

Needed: *Schematic and other data on Knight oscilloscope, KG-2100 D.C. Will buy, or copy and return.*
Lawson TV Service
8515 S. Throop St.
Chicago, Illinois 60621

Wanted: *Pre-1926 battery radios, crystal sets, tubes, radio magazines and pre-war televisions such as RCA TRK-5, 9 or 12.*
Donald O. Patterson
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15838 Vanowen St.
Van Nuys, California 91406

Needed: *A power transformer for a Jackson Electrical Instruments voltohmmeter, Model #590.*
Royal Furniture Co.
186 Pembroke St., West
Pembroke, Ontario K8A 5M8

Needed: *Operating manuals for Superior Instrument Model #76 bridge, and an RMS bar generator, Model #BAH 1.*
Robert Crocker
936 West End Avenue
New York, New York 10025

Needed: *Unused number 1626 receiving tube.*
Albert Pecaites
4048 West 161st St.
Cleveland, Ohio 44135

Needed: *Schematic and/or power transformer for a Fairbanks-Morse radio, chassis 91. Please write before sending transformer.*
Randy Ives
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Satanta, Kansas 67870

Needed: *Schematic and service data for Monarch stereo amplifier, Model SA-40A. Will buy, or copy and return.*
Precision Radio and TV Service
7512 Marie St.
Columbia, South Carolina 29209

Needed: *Schematic and manual for Series 954 Electronamic tube tester manufactured by Precision Apparatus Company. Will copy and return.*
R. L. Pregitzer
601 Second
Webster City, Indiana 50595

Needed: *Schematic and parts list, or other information, for old Philco table-model radio, Model 60, Chassis T13841.*
Bernard Grupe
3012 Highland Drive
Cary, Illinois 60013

Needed: *Schematic for Superior Instruments TV signal generator, Model TV-30.*

Holiday Electronics
3100 S. E. Lake Weir Avenue
Ocala, Florida 32670

Needed: *Schematic and scope tube (CRT) for RCA scope #158.*

William J. Maida
Rt. 2, Box 471-H
Maitland, Florida 32751

Needed: *Schematic and servicing instructions for McMurdo Silver signal generator Model 906. Will buy, or copy and return.*

Joseph N. Sealey
5336 Klamath Drive
Sacramento, California 95842

Needed: *Flyback for Admiral color TV chassis #4H10NC 57-3, part #79-130-2.*

Welch's Radio and TV Repair
616 Valencia Drive
Belleville, Illinois 62223

For Sale or Trade: *Simpson 260 VOM in A-1 condition. Would consider trade for short-wave receiver or scanner.*

D. K. Schmidt
1031 Terrace
Brainerd, Minn. 56401

Needed: *Schematic for an old Magnovox radio, chassis #CR242AA.*

Arnold G. Schmidt
Route 3
Jamestown, N.D. 58401

For Sale or Trade: *Sencore FS134 field-strength meter, new with warranty for $220. Or take in trade a working B&K portable multimeter.*

Charles Helpsgarden
612 Range End Road
Dillsburg, Penn. 17019

Needed: *Spring type motors in working condition for RCA victrolas. Models VV-100 and VV-XI. State price.*

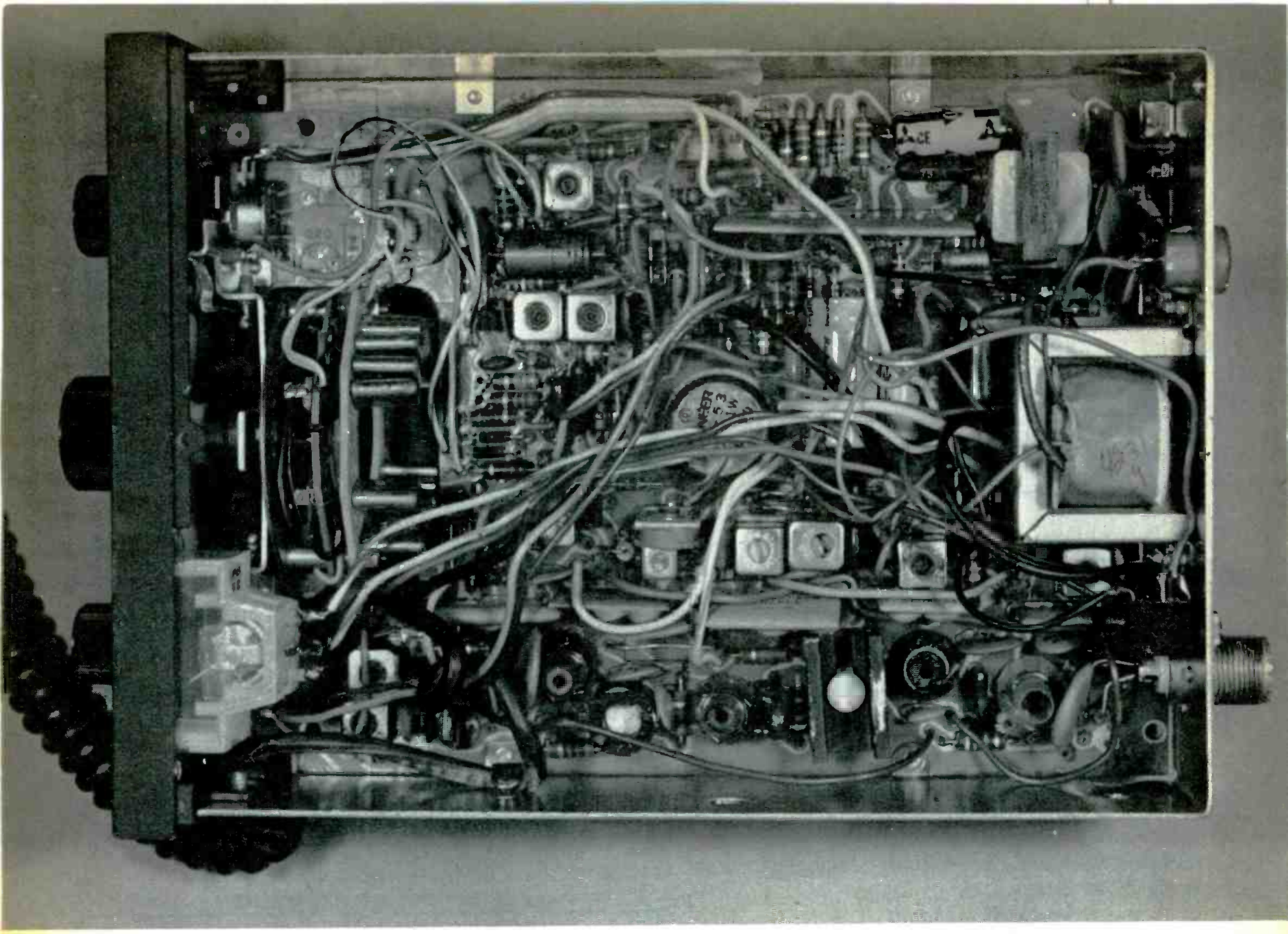
John A. Sheaffer, Jr.
RD #1, Box 79
Tower City, Penn. 17980

Needed: *Manual or schematic for a Monarch Monaco radio, Model #SMX-77A. Also, manual or schematic for an Analab oscilloscope, type 1100. Will buy, or copy and return.*

R. L. Johnson
Rt. 2, Box 2299D
Elk Grove, Calif. 95624

Needed: *Schematic and an up-to-date tube chart for Supreme tube tester, Model #600-61B. Will pay for information.*

Philip Saullo
788 Alter St.
Hazleton, Penn. 18201



Model 123A CB radio from E. F. Johnson (Photofact CB-47) is used as an example of modern synthesizer design.

CB Synthesizers... Theory and Troubleshooting

By Marvin J. Beasley, CET/Land Mobile Regional Manager, E. F. Johnson Company

23-channel synthesizer oscillators probably are the most-complicated and least-understood circuits in CB transceivers. But troubleshooting can become routine, after you know how they operate.

A synthesizer oscillator circuit makes possible full 23-channel CB operation at reasonable cost. In fact, a receiver with standard crystal oscillators for 6 channels would cost about the same as a similar one with a 23-channel synthesizer. Cost saving with the synthesizer is possible because each crystal is used for several channels.

Crystal oscillators

Crystal oscillators are a necessity for transmitting, and a convenience for receiving. That's because the FCC specifies a frequency accuracy of only ±.005% (50 parts-per-million, or PPM). The same crystal cannot be used for both transmitting and receiving, since the receiving oscillator frequency must be higher or lower than the channel frequency by the frequency of the IF. That totals two crystals per channel.

Therefore, a CB receiver without a synthesizer would require 46 crystals to cover all 23 channels by the conventional method.

Typical synthesizers use any number of crystals between 10 and 14, to control both transmitting and receiving frequencies. The economy of 14 versus 46 is obvious.

Best understanding of synthesizers comes from comparing them against the conventional circuits.

Frequency Multipliers

The first Class D Citizens Band transceiver radios (in 1958) used low-frequency crystal oscillators with doubler or tripler frequency multipliers to reach the final channel frequency (see Figure 1).

Many of these old machines still are in use and needing service, so you need to have a general idea of the circuits.

Overtone Oscillators

Shortly afterward, the CB industry changed to **overtone oscillators,** which have outputs at the third harmonic, without any extra stages. Typical circuits are shown in Figure 2.

Servicing overtone oscillators

Here are some suggestions for servicing oscillators having overtone circuits.

Don't make the mistake of viewing a third-overtone oscillator as merely a fundamental oscillator with an output tank that's tuned to the third harmonic. In fact, the output is not quite three times the frequency. A 9-MHz crystal would have an output near (but not precisely) 27 MHz. So, be certain

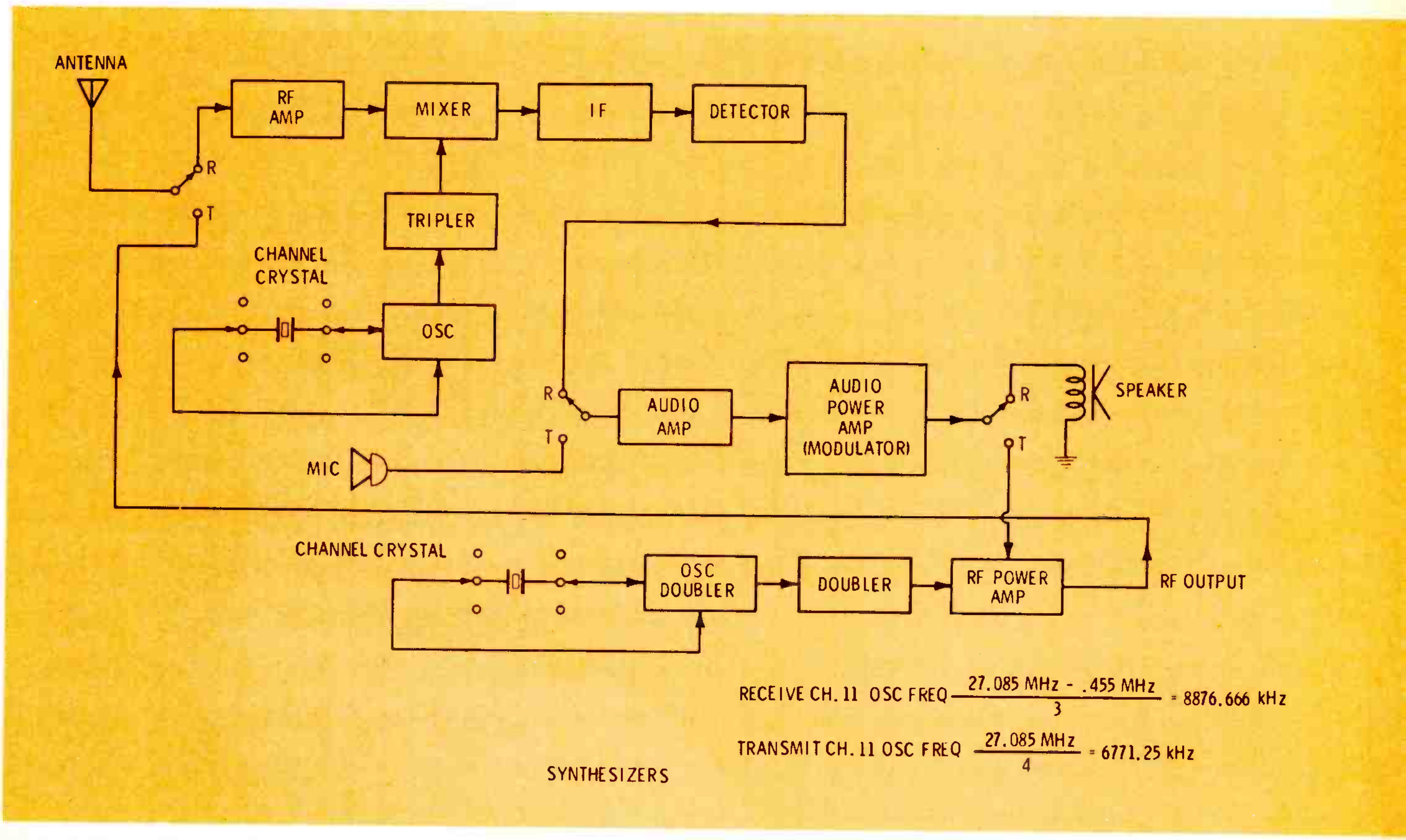


Fig. 1 A block diagram illustrates an older CB transceiver with separate oscillators that operated at low frequencies which were doubled or tripled to reach the CB band.

the crystal is designed for the CB set you're working on. **Do not rely on the frequency marked on the crystal.**

A crystal cut to the specs of one manufacturer probably would oscillate in a radio of another brand, but the frequency might be out of tolerance, or the oscillator could be slow starting or overly-sensitive to temperature changes.

In some overtone circuits, mistuning of the output circuit can cause the frequency to jump out of tolerance. A frequency counter would show a wrong frequency, and you might think that the crystal was defective. However, a correct replacement crystal would give the same wrong frequency before the tank was tuned.

Of course, an incorrect output coil also can produce a wrong frequency. I remember the time I wasted an extra hour by installing a wrong inductor in an oscillator.

Synthesizer Oscillators

By definition, synthesizing is forming a whole by combining parts. In this case, it means obtaining a third frequency by combining

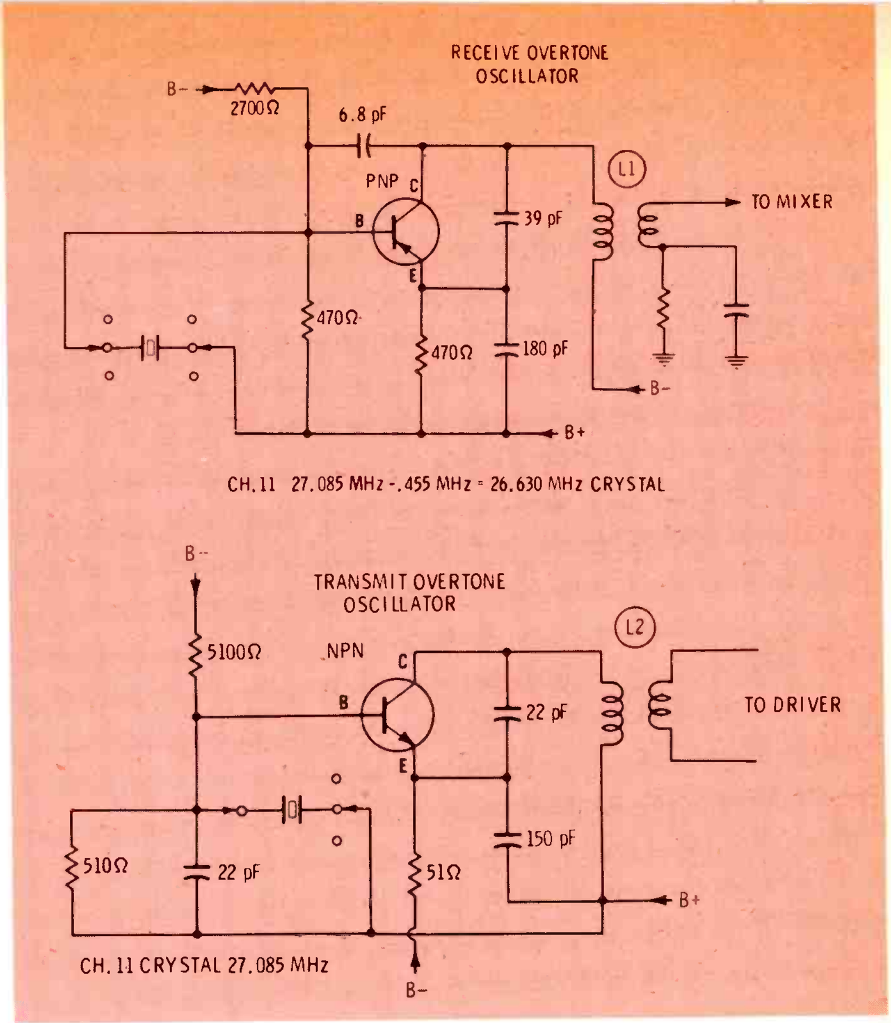


Fig. 2 These are two typical oscillators using a third-overtone circuit.

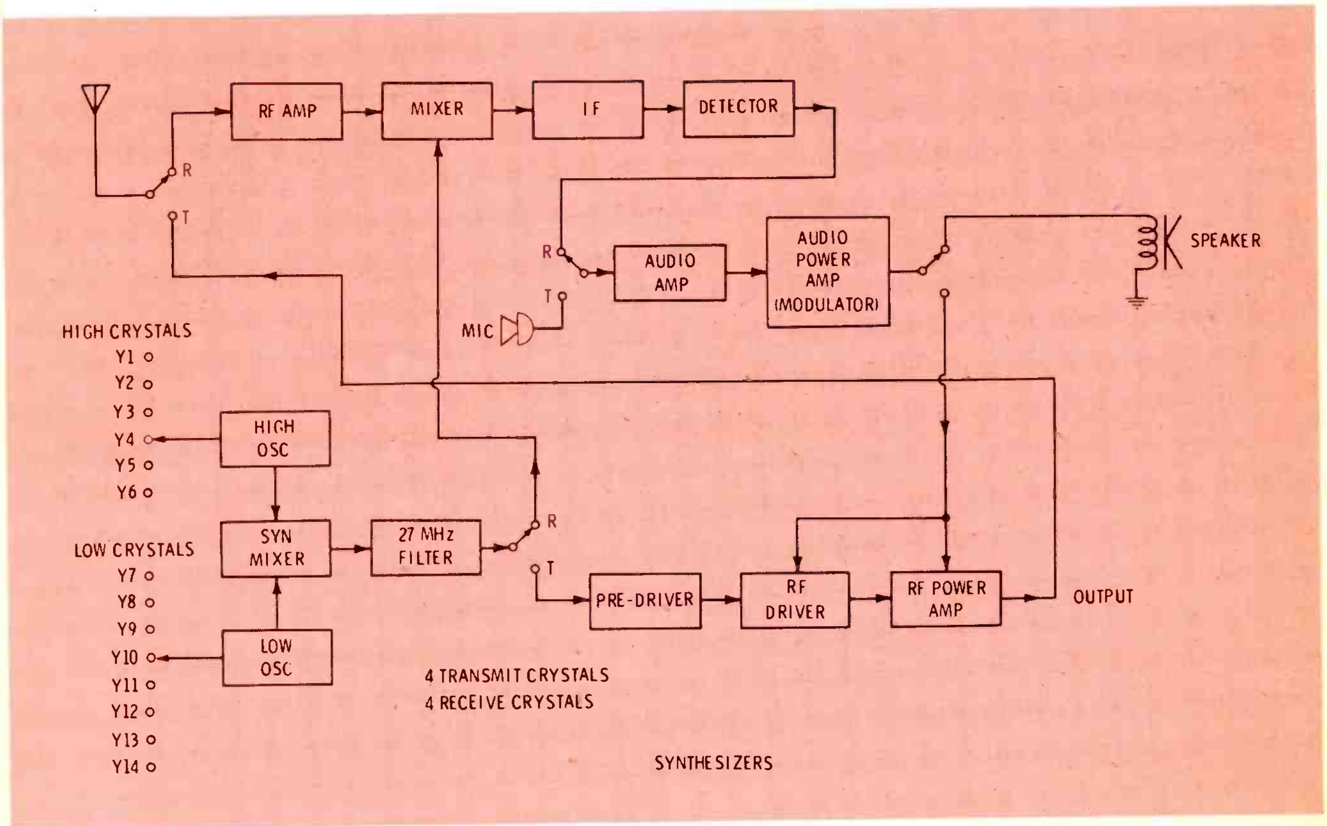


Fig. 3 This is the block diagram of a CB radio that has a synthesizer to furnish the oscillator signal for both receive and transmit functions. In the actual circuit, switching diodes take the place of the switches.

two frequencies. That sounds like a mixer; and it is one type.

Combining two signals of different frequencies in a non-linear mixer produces an output with **four** frequencies: the original two, plus the sum of the two, and the difference between the two; for example, mixing 20 MHz and 7 MHz gives 20 MHz, 7 MHz, 27 MHz, and 13 MHz. Now if you want 27 MHz, something must eliminate the others. That is done by filters or tuned circuits at the output.

Ten crystals in a 6-by-4 arrangement could synthesize 24 channels, one more than needed. Only 4 more are necessary to crystal-control the receiver.

Analyzing A Synthesized Transceiver

Features of a modern synthesized CB transceiver are shown by the block diagram of Figure 3. Some details are symbolic rather than actual. For example, newer radios don't have a multi-element transmit/receive switch (or a relay used as a switch). Instead, switch contacts in the microphone determine the conduction or non-conduction of **diodes** which function as switches.

Circuits of the E. F. Johnson Model 123A will be used to explain the operation of typical synthesizers.

Here are some general facts. Except for the oscillator crystals, the tunings of both the transmitter and the receiver are not changed for the various channels. The spread of frequencies is narrow enough to permit one adjustment for all channels.

There are 6 "high" crystals, 4 "low" crystals for receiving, and 4 other "low" crystals for transmitting. The channel switch always selects three crystals for each of the 23 channels. The high-oscillator crystal is active all the time (for both transmitting and receiving). One of the low-oscillator crystals is connected during transmission, and the other is used during reception.

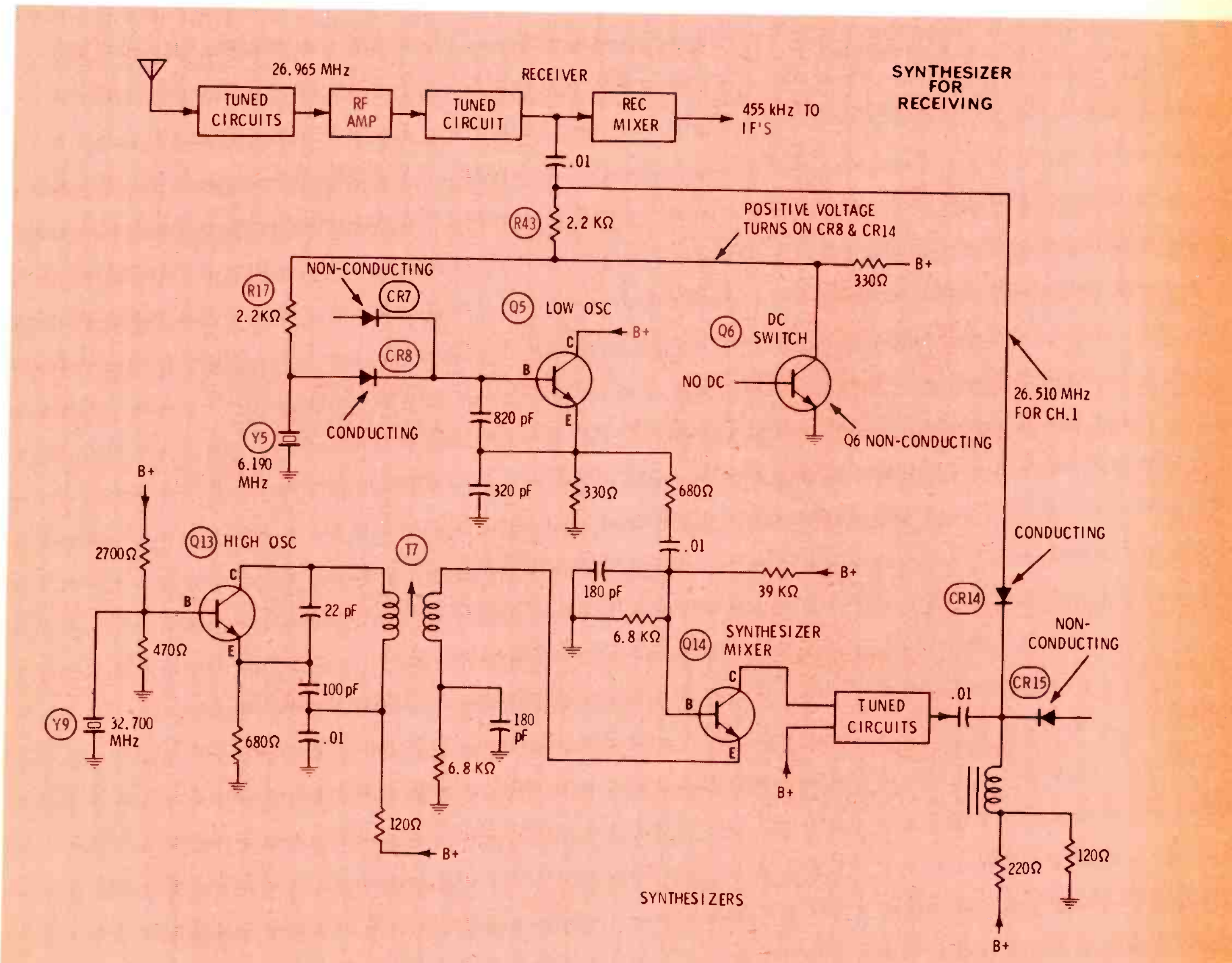


Fig. 4 Diode switching and receive signal flow of the Johnson Model 123A is shown in this block diagram. Notice that the "low" signal is applied to the base of Q14, the mixer, and the "high" signal is injected at the emitter. Q6 is used as a switch to control the conduction of CR8 and CR14. CR8 connects the base of Q5 to the receive crystal that has been selected by the channel switch, and CR14 channels the output of the synthesizer mixer to the mixer of the radio receiver.

Selection between these two is done by diode switching of the transmit/receive function, and not by the channel switch.

Synthesizer during receive

Signal-flow paths during reception are diagrammed in Figure 4. Nothing in the high oscillator is switched except the crystals. Diode conduction determines which low crystal of two is in use, and other diodes route the synthesizer output from the tuned circuits to receiver or transmitter.

In the receive mode, the microphone switches remove the +9.99-volt power, that supplies the base of Q6 through a 22K resistor. Without forward bias, Q6 draws no C/E current, so the collector voltage rises. Some of this collector voltage goes through R17 and forward biases CR8, which then connects crystal Y5 (for Channel 1) to the base of Q5, the low oscillator and also furnishes forward bias for Q5.

At the same time, part of the Q6 collector voltage through R43 forward biases CR14, thus allowing the output from the synthesizer to go to the receiver mixer.

Mixing of the 6.190 MHz low signal with the 32.700 high signal produces 26.510 MHz at the synthesizer output. And this signal beating against the 26.965 Channel 1 input signal in the mixer supplies 455-KHz for the IF amplifiers.

Synthesizer during transmit

Figure 5 gives the signal flow during the transmit mode. The high oscillator circuit (and crystal) is the same as during receive.

Q6 now has sufficient forward bias for saturation; the collector voltage is nearly zero, thus turning off CR8 and CR14.

However, the same microphone keying supplies a positive voltage through R21 to forward bias CR7 so it connects Y1 crystal to the base of Q5, and also furnishes forward bias. Part of the same keyed voltage goes through R59 to force CR15 into conduction, thus channeling the output of the synthesizer to the transmitter RF amplifier.

Mixing the 5.735-MHz low signal with the 32.700-MHz high signal produces the 26.965-MHz carrier that's needed for the transmitter on Channel 1.

Other channels operate the same way, but with different combinations of crystals.

Servicing Synthesizers

Much of the information you need to troubleshoot this kind of synthesizer is found in the next few charts. Always keep in mind the way the signals are mixed, because that knowledge plus the frequency charts often will pinpoint the defect.

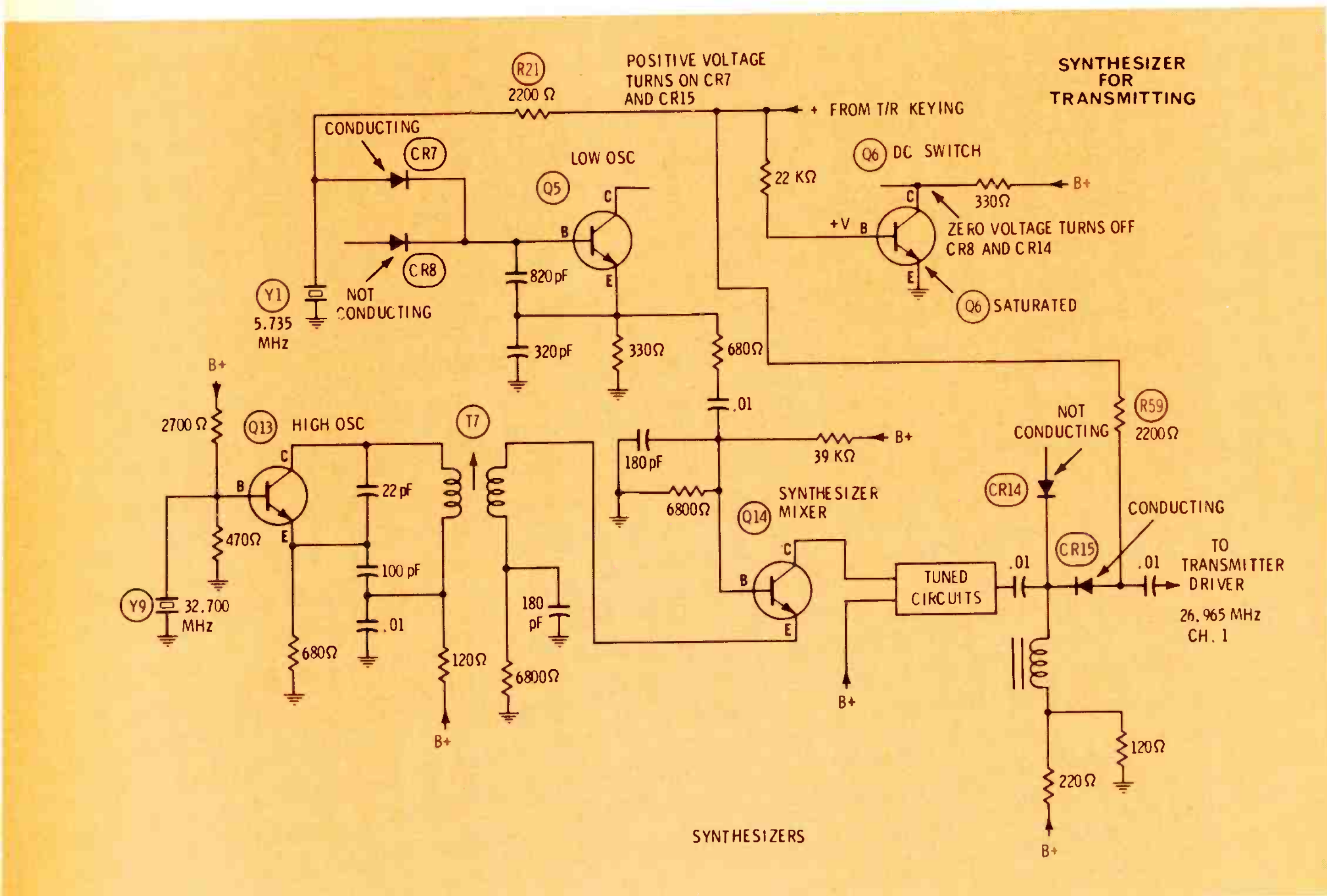


Fig. 5 This schematic shows the same synthesizer with switching and signal flow in the transmit condition. Positive voltage from the mike switch forces CR7 to conduct, connecting the base of Q5 to the low-frequency transmit crystal that has been selected by the channel switch. The same voltage keys-on CR15, which feeds the output of the synthesizer to the transmitter driver stage.

SYNTHESIZER FREQUENCIES

CHANNEL	HF CRYSTAL	RECEIVE LF CRYSTAL	RECEIVE OUTPUT	TRANSMIT LF CRYSTAL	TRANSMIT OUTPUT
1	32.700	6.190	26.510	5.735	26.965
2	32.700	6.180	26.520	5.725	26.975
3	32.700	6.170	26.530	5.715	26.985
4	32.700	6.150	26.550	5.695	27.005
5	32.750	6.190	26.560	5.735	27.015
6	32.750	6.180	26.570	5.725	27.025
7	32.750	6.170	26.580	5.715	27.035
8	32.750	6.150	26.600	5.695	27.055
9	32.800	6.190	26.610	5.735	27.065
10	32.800	6.180	26.620	5.725	27.075
11	32.800	6.170	26.630	5.715	27.085
12	32.800	6.150	26.650	5.695	27.105
13	32.850	6.190	26.660	5.735	27.115
14	32.850	6.180	26.670	5.725	27.125
15	32.850	6.170	26.680	5.715	27.135
16	32.850	6.150	26.700	5.695	27.155
17	32.900	6.190	26.710	5.735	27.165
18	32.900	6.180	26.720	5.725	27.175
19	32.900	6.170	26.730	5.715	27.185
20	32.900	6.150	26.750	5.695	27.205
21	32.950	6.190	26.760	5.735	27.215
22	32.950	6.180	26.770	5.725	27.225
23	32.950	6.150	26.800	5.695	27.255

NOTE: All frequencies in MHz

Chart 1

Chart 1 gives the five frequencies for each of the 23 channels of the Johnson Model 123A. However, much of the service data lists only the Y crystal numbers; so Chart 2 gives Y-numbers versus frequency of the 14 crystals. With both charts you can easily run down the location and frequency of all the crystals.

Servicing by bad channels

If the transmitter is dead on all channels, but the receiver is okay, the problem is likely to be in the transmitter, not the synthesizer. By the same reasoning, if the receiver is dead on all channels, but the transmitter is normal, the defect probably is in the receiver, not the synthesizer. Of course, there are a couple of "howevers". However, the failure of a switching diode in the synthesizer could kill either the transmitting or the receiving function without affecting the other. And a defect in the T/R switching also might eliminate one but not the other.

But if only a few channels are malfunctioning, it's certain to be a problem in the synthesizer; and a crystal (or the switch contacts to the crystal) must be the first suspect.

Continuing with logical reasoning, a dead crystal can cause **no less** than 6 channel functions to be wrong. For example, a defective Y1 transmit crystal kills channels 1, 5, 9, 13, 17, and 21 on transmitting only (a total of 6 functions). However, a dead Y9 high-frequency crystal eliminates channels 1, 2, 3, and 4 on **both** transmit and receive, a total of 8 functions.

Chart 3 has been compiled to take away most of the calculations (or guesswork) in determining which crystal is defective. To use it, first try all 23 channels for both transmitting and receiving, and write down which channels are bad for each. Next, go to Chart 3 to see if your listing of dead channels corresponds to any of the conditions listed.

Other symptoms

Here are some tips for troubleshooting synthesizers:

- Both transmitter and receiver are dead, but the high and low oscillators have correct frequency and amplitude. **Probable cause**—mixer

CRYSTAL FREQUENCIES

Y1	5.735	MHz	LF transmit
Y2	5.725	MHz	LF transmit
Y3	5.715	MHz	LF transmit
Y4	5.695	MHz	LF transmit
Y5	6.190	MHz	LF receive
Y6	6.180	MHz	LF receive
Y7	6.170	MHz	LF receive
Y8	6.150	MHz	LF receive
Y9	32.700	MHz	HF
Y10	32.750	MHz	HF
Y11	32.800	MHz	HF
Y12	32.850	MHz	HF
Y13	32.900	MHz	HF
Y14	32.950	MHz	HF

Chart 2

transistor (Q14) is inoperative.

- Transmitter is okay, but the receiver is dead on all channels. **Probable cause**—switching diode CR8 or CR14 is open.
- Receiver is okay, but the transmitter is dead. **Probable cause**—switching diode CR7 or CR15 is open.
- Improper operation of the low oscillator, although the DC voltages are normal. **Possible cause**—Q6 is open or shorted (Q6 is used as a switch, open on receive and shorted on transmit, so with a bad Q6 one function should be normal, and both transmit and receive crystals would be connected together during the other function. Therefore, check for almost zero volts at collector of Q6 during transmit, and about +9 volts during receive. If the voltage doesn't change, Q6 is defective).
- Baffling symptoms can be produced by a shorted switching diode (CR7, CR8, CR14, or CR15). For example, a shorted CR7 would permit normal transmit but wrong receive. One of my worst service jobs was caused by a shorted CR8 which paralleled both crystals when in the transmit mode. The output was on the wrong frequency, but the synthesizer output seemed

SYNTHESIZER CRYSTAL TROUBLESHOOTING

Channels Inoperative	Receive Inoperative	Transmit Inoperative	Faulty Crystal
1, 2, 3, and 4	X	X	Y9
5, 6, 7, and 8	X	X	Y10
9, 10, 11, and 12	X	X	Y11
13, 14, 15, and 16	X	X	Y12
17, 18, 19, and 20	X	X	Y13
21, 22, and 23	X	X	Y14
1, 5, 9, 13, 17, and 21	X		Y5
2, 6, 10, 14, 18, and 22	X		Y6
3, 7, 11, 15, and 19	X		Y7
4, 8, 12, 16, 20, 23	X		Y8
1, 5, 9, 13, 17, and 21		X	Y1
2, 6, 10, 14, 18, and 22		X	Y2
3, 7, 11, 15, 19		X	Y3
4, 8, 12, 16, 19, and 23		X	Y4

Chart 3

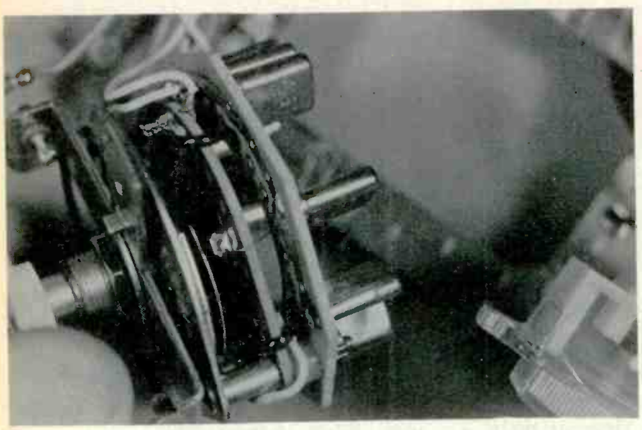


Fig. 6 All the crystals are soldered to the channel switch, and it's impossible to unsolder some of them without removing the switch.

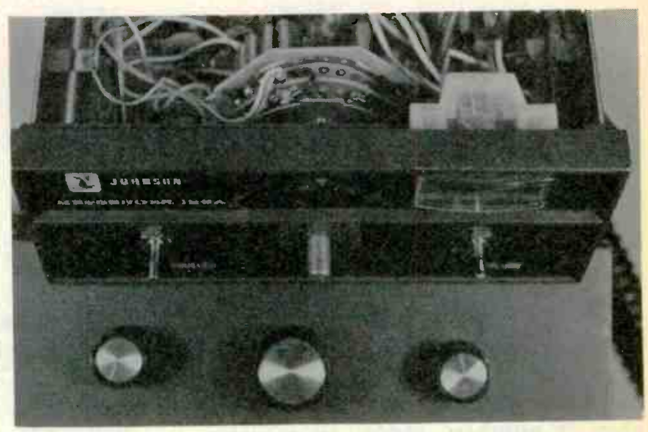


Fig. 7 The knobs slide off the flattened shafts, exposing the nuts on the controls. The large nuts, and two screws at each edge of the panel, must be removed to free the front panel.

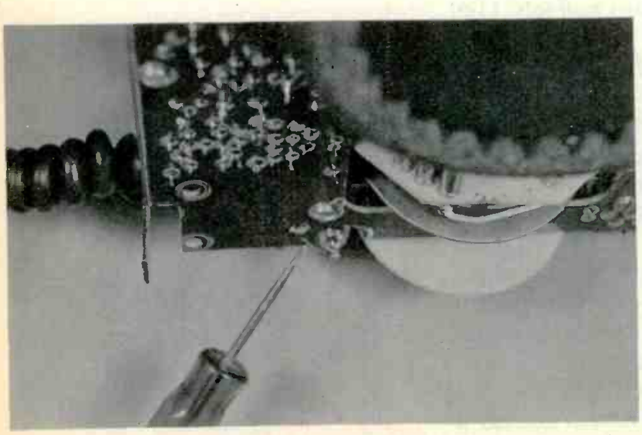


Fig. 8 Only one connection requires unsoldering.

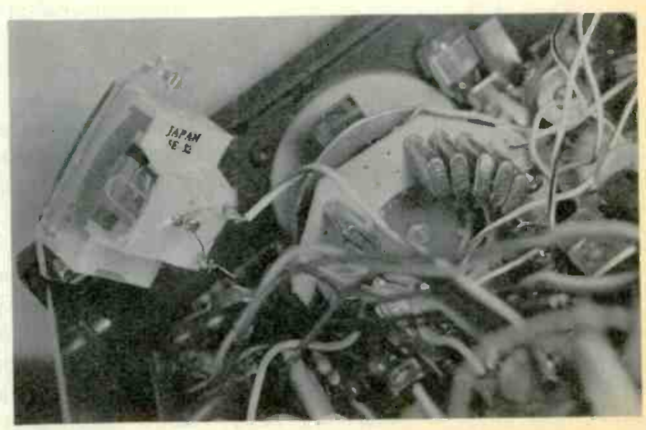


Fig. 9 Two screws hold the meter to the front panel.

to be correct. Evidently both frequencies were there at the same time, and this confused the frequency counter. **Service tip**—check the switching diodes **first**. They are high-speed-switching **silicon** types. Do NOT use germanium.

Access To The Crystals

After your diagnosis has indicated a defective crystal, you must decide how to remove the crystal. They are soldered, and many are not readily accessible. (Figure 6).

With the Johnson Model 123A, the most-workmanlike way (and probably fastest in the long run) is to disassemble the machine, as shown in the following pictures.

Pull off the three front-panel knobs (Figure 7). Remove the nuts holding the two controls, and also remove two screws at each end of the front panel.

In Figure 8, the screwdriver points to the lead of a panel indicator, the only part that requires unsoldering.

Unscrew the screws holding the meter to the panel (Figure 9), then remove the front panel, as shown in Figure 10.

Remove the two screws holding the switch assembly to the circuit board (Figure 11).

Now the switch swings freely against the connecting wires, allowing inspection or repairs to any side of the switch (Figure 12).

One final hint, use caution when you remove an unfamiliar transceiver from its case. The speaker might fall out, as shown in Figure 13, and damage the cone.

Comments

Servicing synthesizers should not be difficult, if you keep these points in mind:

- A synthesizer is used to supply the oscillator signal for both transmitting and receiving; therefore, a bad synthesizer can affect either receiving or transmitting, or both.
- Use a frequency counter to check the individual oscillators, and also the synthesizer output signal at CR14 and CR15 (following the tuned circuits). But, confusing or wrong readings might be obtained in the mixer circuit, or from any source having two or more RF signals together.
- A dead crystal will affect a total of either 6 or 8 transmit/receive functions, in synthesizers similar to the one in the Johnson Model 123A. A defective channel switch could kill just one channel.

If the symptoms do not indicate a bad crystal (or some other definite defect), check the operation of the T/R switch in the microphone, the Q6 keying circuit, and all four of the switching diodes.

- Use the charts to determine which crystal is suspected of being bad. □

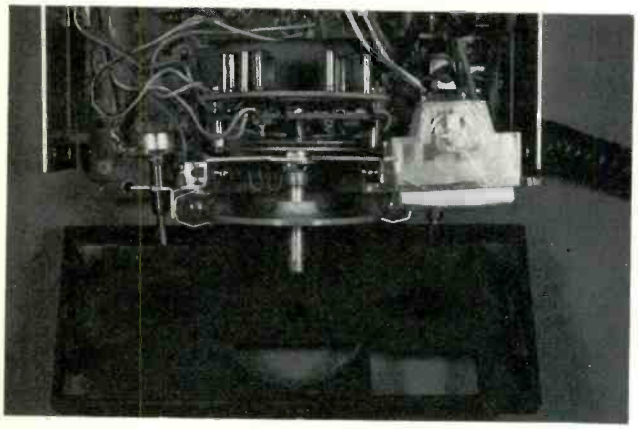


Fig. 10 The front panel now can be placed aside.

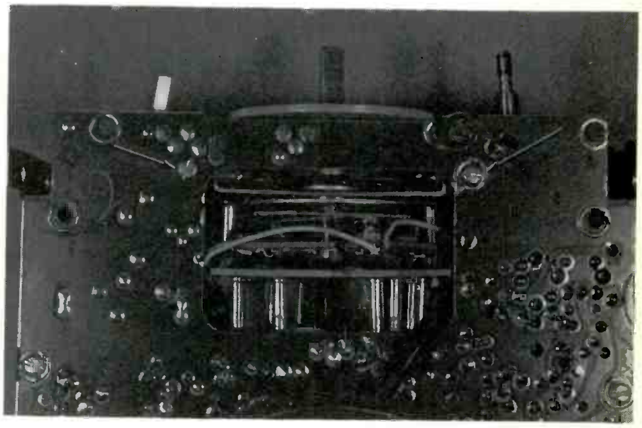


Fig. 11 Removing the two screws marked by arrows frees the switch/crystal assembly so you can move it as necessary to reach the suspected crystal or switch contact.

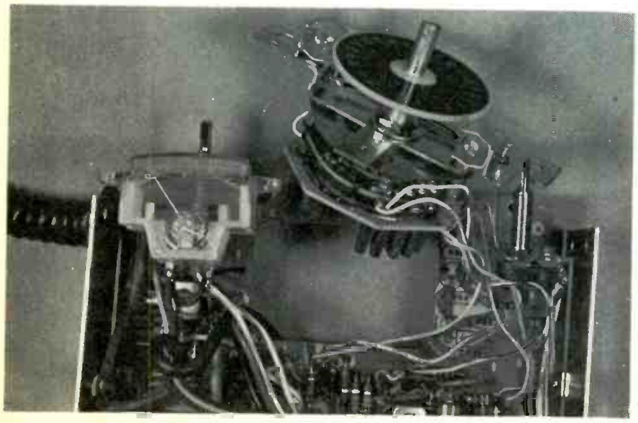


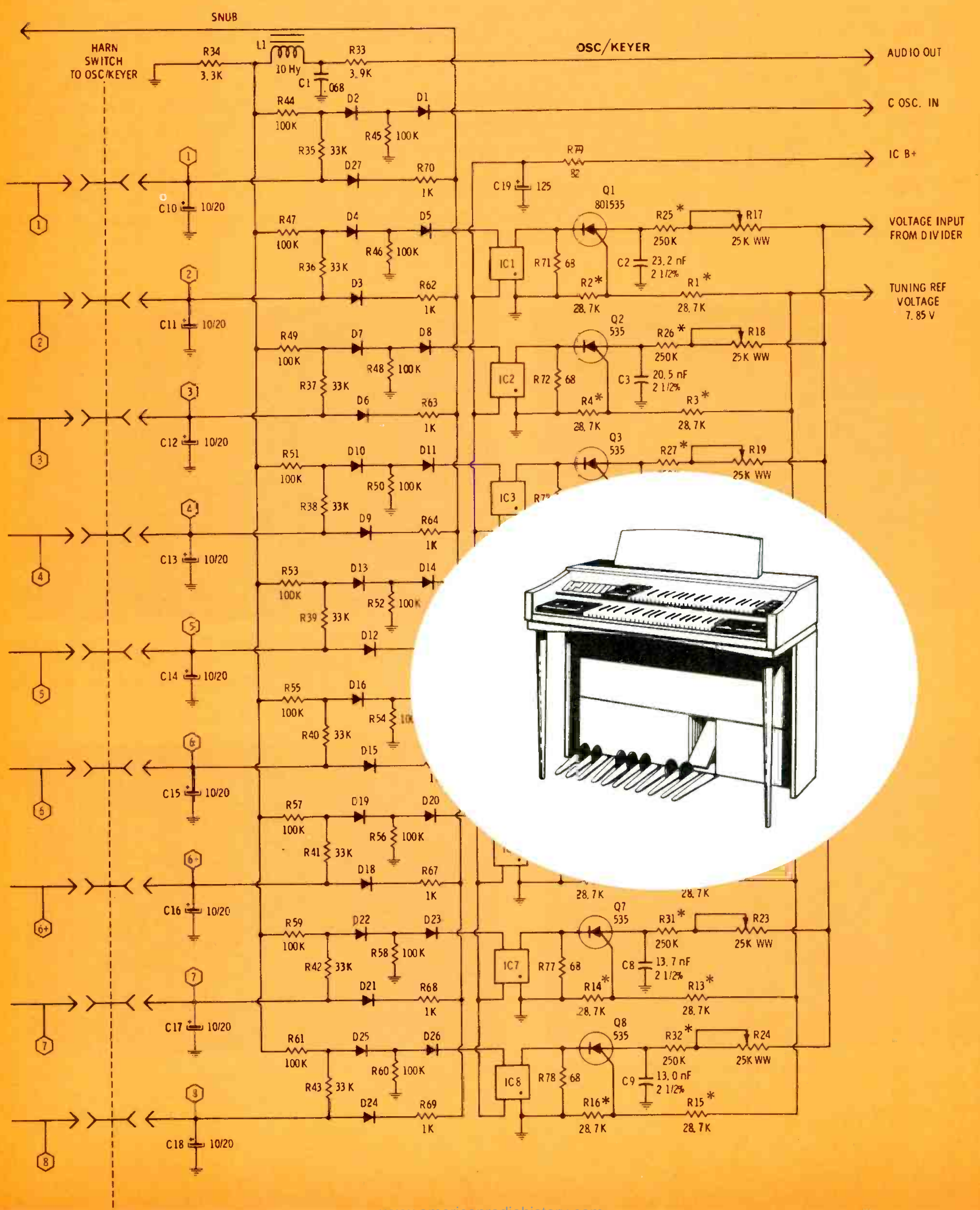
Fig. 12 The wires permit movement of the switch, and yet allow the radio to be operated for tests.

Fig. 13 When you remove the radio from the case, watch for the speaker, which might drop out and injure the cone.

SERVICING ELECTRONIC ORGANS

Part 2/By Norman H. Crowhurst

Certain facts must be known about an organ before you can troubleshoot it logically. Here is the essential information about eleven popular brands of organs. Next month, specific methods of analyzing organ defects will be started.



What Brand? How Old?

Let's assume that the owner of an electronic organ has called you to examine it and repair some malfunction. You don't have a schematic or any data to guide you. No, don't give up and refuse the call. You might be surprised at how many repairs can be made without service data.

Older organs used many tubes, types you might have yet in your old stock. Some popular numbers were 6L6G, 6V6G, 6SN7, 12AX7, 12AU7, and 5U4G. All tube testers list these old tubes, and identifying or replacing them should cause no problems.

The multitude of switch contacts under each keyboard cause typical defects, such as notes that sound continually, or not at all.

Beyond these generalities, it is of vital importance that you know some facts about each organ. Does it use the oscillator/divider system of generating the notes, with each octave depending on the divider above it? Or, is each note supplied by a separate oscillator? A few models use frequency synthesis in which the fundamental and selected harmonics (all sine waves) are combined in the desired ratios.

The next essential is knowing whether the keying switches, couplers, and stops handle the audio of the notes directly, or operate DC voltages to key the notes and functions.

In addition, some organs (including Hammond) have important moving mechanical parts, such as motors, shafts, or belts, that are essential for generating the tones or for adding vibrato. A frozen bearing in a motor does not require a schematic; and many other defects can be found visually.

Details can be learned later. Right now, we will examine general features of the better-known brands, listed in alphabetical order.

Allen Organs

By the late '60s, Allen was using one transistorized oscillator for each note. (We have no data on older models.)

These oscillators were inactive until a note was pressed, supplying voltage to the transistor. Couplers were provided so the same key could control more than one tone

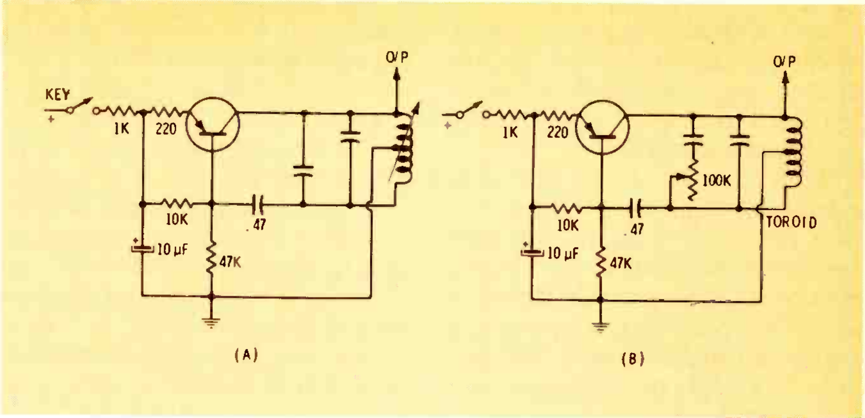


Fig. 1 Allen organs have individual oscillators for each note. They do not operate until the supply voltage is switched on. Two variations are shown.

(octaves, or another manual), and diodes gave decoupling to prevent spurious keying between the various coupled notes. Each oscillator was tuned, and two different methods were used, as shown in Figure 1.

Light-controlled relays were used extensively in the voicing circuits (Figure 2). Voltage from the DC supply could be switched to a light bulb inside a light-tight box, which also contained a cadmium-sulfide or cadmium-selenide cell. When the light was not lit, the resistance of the cell was very high, acting as an open circuit. Light caused the cell resistance to decrease, perhaps to a few thousands or hundreds of ohms, thus functioning as a closed switch.

Switching with light-sensitive cells has another advantage, in addition to the DC control-voltage circuits that are immune to noise and hum. **The change in sound level is not instantaneous.** A resistor in series with the incandescent lamp bulb lengthens the time required to reach maximum brilliance. When light reaches the CdS cell, the resistance decreases moderately fast; however, the resistance increase is much slower after the light is turned off. These time delays virtually eliminate any pops or clicks that often are caused by instantaneous on/off action from conventional switches.

Circuits of Allen organs are quite sophisticated. To trace a fault, you need to prove whether or not the DC control voltages go where they should, as determined by the keys pressed and the stops activated. Secondly, after the voltages reach the oscillators or the stop relays, is the operation normal there or not?

These organs were designed to be highly reliable. So, most service work involves repairing bad switching contacts and replacing shorted diodes.

Newer Allen organs (probably too new to require any service) are even more complex. Every musical note is synthesized at the time of playing, by digital techniques. The digital information is converted to audio waveforms by two digital-to-analog converters in each organ.

Baldwin Organs

Earlier Baldwin organs had 12 generators, each with a tube oscillator for the top octave, followed by 5 dividers using tubes (Figure 3).

The output waveform from each divider was a rounded sawtooth. But square waves were made by adding 50% amplitude of inverted 4' tones to the 8' notes. Voicing was done by low-pass, high-pass, and resonant filters, as shown in Figure 4.

Instead of on/off switches under each note, tiny flat variable resistors were used. This provided a gradual build-up and decay of the notes, since some time is required to move the keys, and it eliminated all keying clicks. Similar construction was used for some expression-pedal circuits and stop switches.

The generators had double-triode tubes. Octal-based 6SN7 tubes were used at first, followed by 9-pin

12AX7 types.

When Baldwin changed to transistorized circuits, the basic philosophy of master-oscillators and dividers was continued. However, the dividers provided square waves, rather than sawteeth.

Square waves have only odd-numbered harmonics, without even ones. When tone colors with even-numbered harmonics are desired, 50% level of the next higher octave is added, plus 25% amplitude of the second higher octave. This provides a useful simulation of sawtooth sounds.

Artificial reverberation and percussion or sustain features were used in many versions.

Latest-model Baldwin organs incorporate Large-Scale-Integration (LSI) components to supply rhythm accompaniment (drums, cymbals, etc.), and percussion voices with automatic strumming or arpeggios (playing the notes of a chord in succession into higher or lower octaves).

The keyboard notes have a single switch under each, supplying a DC voltage for diode keying. Coupling is done with FET's.

Conn Organs

Through many other changes, Conn has maintained a policy of having a separate oscillator for each note of the organ.

Keying of the tube models was achieved by switching the B+, but with decoupling (Figure 5) to eliminate clicks and thumps. Multiple contacts under the keys coupled together the various octaves and manuals. The supply rod for each coupler or octave could be rotated by the stop (Figure 6) so the contacts coming against it when a key was depressed would touch either the insulated side of the rod (stop is off), or the bare metal to make contact (the stop is on).

When Conn changed to transistor oscillators, all oscillators (Figure 7) were kept running constantly, and keying was done in two ways. Pulse output waveforms were keyed as audio (the stop filters removed most of the clicks), and the flute waveforms (more susceptible to keying clicks) were keyed by changing the bias of a transistor.

Keying the bias of flute transistors also made possible a sustain action, so the tones died away slowly, when desired. (Figure 8).

Conn also has rhythm generators using LSI circuitry.

Gulbransen Organs

Gulbransen organs have used solid state longer than most manufacturers. Earlier models had a oscillator for each note, and with keying similar to that of some Conns.

Later, various models have been changed to the master-oscillator/divider type of generator.

Some Gulbransen circuits are unique, so we will defer a more-detailed coverage until another month.

Hammond Organs

As one of the pioneers in the field of electric and electronic organs, Hammond has manufactured some unique designs. First was the model with "tone wheels" to generate sine waves electro-mechanically, and with tubes only for amplification. At the time, Hammond built clocks, so it was natural that the organ have an oversize synchronous clock motor to rotate the generators (Figure 9).

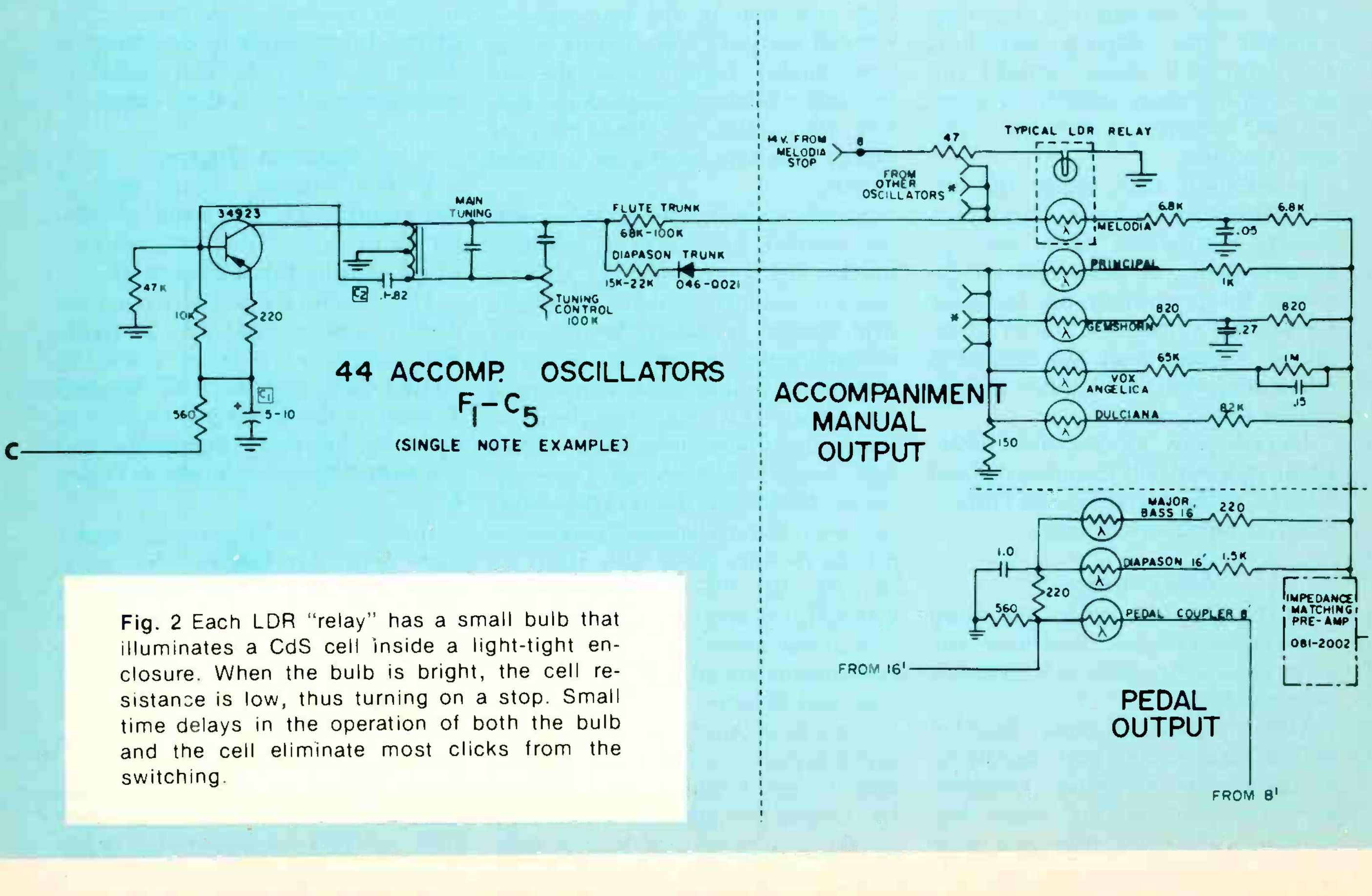


Fig. 2 Each LDR "relay" has a small bulb that illuminates a CdS cell inside a light-tight enclosure. When the bulb is bright, the cell resistance is low, thus turning on a stop. Small time delays in the operation of both the bulb and the cell eliminate most clicks from the switching.

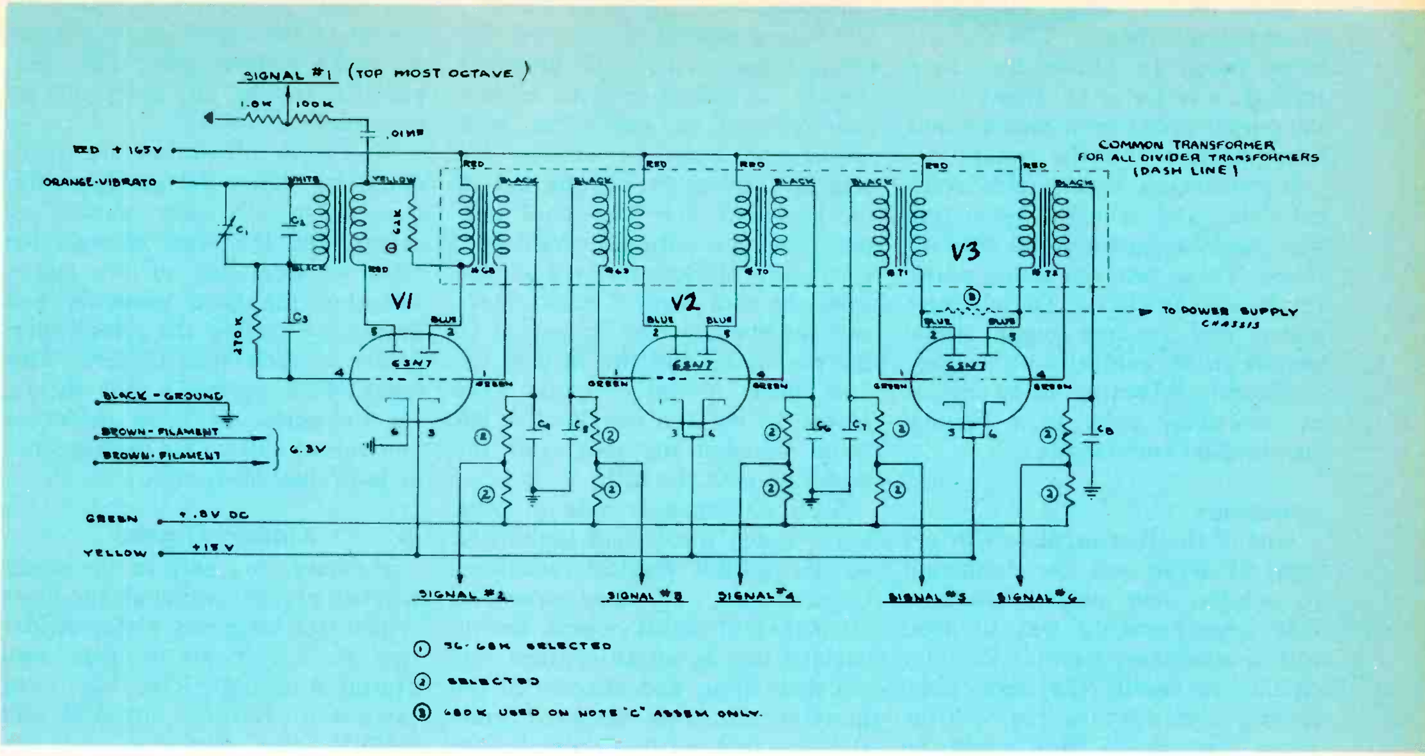


Fig. 3 Six octaves of one note are produced by each of 12 generators, such as this, in older tube-equipped Baldwin organs. These dividers are blocked-grid oscillators, which are synchronized by magnetic coupling between the blocking transformers. Output waveforms are sawteeth, shaped by the capacitors C4, C5, etc. The output signals come from these capacitors, but are decoupled by the resistors labeled (2). If a divider begins to gurgle or thump, use a resistor-sub box across the corresponding capacitor and find the highest value that removes the noise. (The capacitors tend to increase with age, and this restores the original time constant.)

Outwardly, the distinctive feature of these models was the many "drawbars", which provided adjustments for the different tone colors. The musical tones were made by combining fundamental and selected harmonics (all sine waves) in the Harmonic Synthesis method. The drawbars (with plastic ends colored white, brown, and black) determined the amplitude of the corresponding fundamental and harmonics, according to how far out they were pulled. Zero and eight degrees of amplitude were supplied.

In the first models, the drawbars switched each sine wave to one of eight bus bars, which in turn went to a tap on the input transformer. Later versions changed to a tapped resistor instead of a tapped transformer, and added two contacts separated by a low-value resistor. This way it was impossible to reach a dead spot between positions (which was an annoyance with the previous models).

Even today, these drawbar-tone-wheel models are the ones people associate with Hammond, for they sold in large quantities. One of the sales features was that tuning never was necessary (of course, it was impossible, because of the motor drive). Peculiar things can happen during those rare times when the motor doesn't run at synchronous speed. For example, during a church service the lights blinked from a thunder storm. But when the organist next started to play, the music was about five notes flat! Of course, it still was in tune with itself, but the motor had locked to a false sync speed. Restarting it cured the problem.

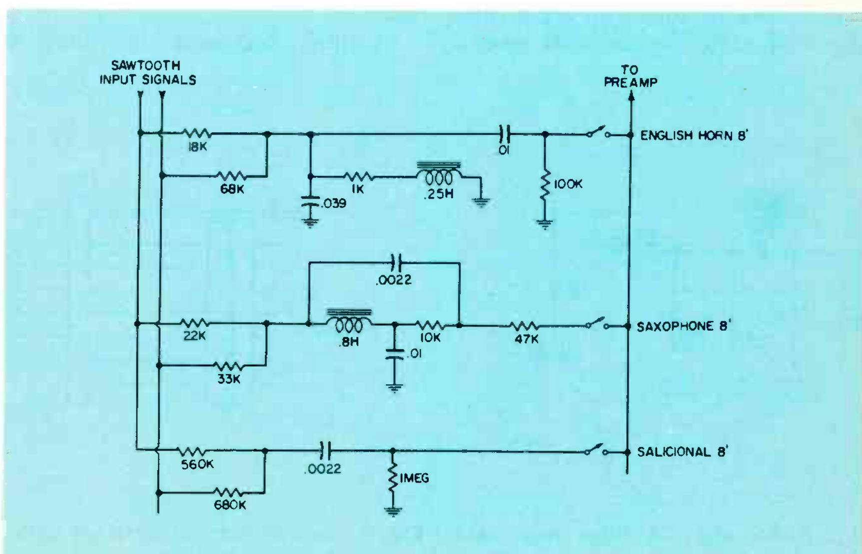


Fig. 4 These are examples of the stop filters used in some models of Baldwin organs.

Later models added electronic/mechanical vibrato. The signals were swept in phase by going through a series of LC filters, with the output taken by a scanner unit (also operated from the motor).

Instantaneous keying adds vertical rising and falling sides to the sine waves at turn-on and turn-off times. These fast rise-times sound to the ear as clicks. To minimize clicks, and because organ music sounds more natural with echoes, artificial reverberation using springs as time-delay units soon became standard on Hammonds.

Novachord

One of the first oscillator/divider types of organ was the Hammond Novachord, now only a memory. One large keyboard was supplied with simple rotary controls for filter circuits to modify the basic tone. Keying tubes were used so both the attack and decay time could be changed. Another unique idea was a separate (mechanical) vibrato for each of the 12 semitones. This gave a chorus effect to minimize the too-perfect electronic sound.

Unfortunately, the model suffered the fate of many ideas born before its time, and few were sold. The organ was large, heavy, complex, and difficult to service. As I recall, about 200 large octal-based tubes were used. Today, many of the space-age organs incorporate some of these features, but with IC's to keep the size and heat within limits.

Chord organ

For those persons who are a little afraid of a full organ with several keyboards and "all those pedals", Hammond offered the Model S-6 Chord Organ. The single keyboard (Figure 10) played only the highest note pressed at any time, with rocker-type stops to change the octaves and timbre. At the left of the keyboard were the chord buttons, complete with an accent bar. Frequency dividers received signals from the root note of each chord, and the musical fifth (in key of C, the root is C, and the fifth is G), and these "pedal" signals were played by the two pedals. The left pedal sounded the root, and the right one gave the fifth.

Such an organ is easy to play, but it posed some rigid limitations on the possible musical variations. Consequently, many new owners of all makes of chord organs shortly decided that being an organist was not their thing, and abandoned the machine. Or, they acquired some skill and realized they wanted more variety, then traded the chord organ for a full model.

Oscillator/divider

Hammond's first solid-state organs had a conventional appearance, tilting stop tabs, and oscillator/divider tone generators. Of course, servicing is similar to others having the same general circuits.

Digital Models

Although the latest Hammond models (Figure 11) resemble the tone-wheel versions (complete with drawbars and reversed-color presets), they also have stop tabs, and the generators are out of the space age.

A single oscillator, operating at just under 4 MHz, determines the tuning of the entire organ. Multi-derivative dividers using LSI components supply all notes of all frequencies.

Two types of vibrato are available. One varies the oscillator frequency, so all notes warble together, and the other changes the apparent frequency of the audio, following the tone synthesis and keying, by varying the phase alternately to each side of zero. This latter system permits a split vibrato; for example, to have different amounts of vibrato for certain stops or individual keyboards.

Kimball Organs

We have data only on the newer Kimball organs. Although the basic system is a master-oscillator/divider type, the circuits are complex, with digital and logic circuitry used extensively. Included are OR and NAND gates, flip-flops and op-amps.

These principles are new to organ technology, so we will describe the details in a later article.

Kinsman Organs

Master-oscillator/divider circuits were used in Kinsman organs that used tubes. The unique difference was that the dividers used **neon bulbs.** Figure 12 shows a 5-octave generator. Probably you can recognize easily the basic neon-bulb oscillator circuit, modified for locked oscillator operation. Two neon bulbs are used rather than just one, to improve the locking, and to isolate the output sawtooth from the higher-octave signal that locks it.

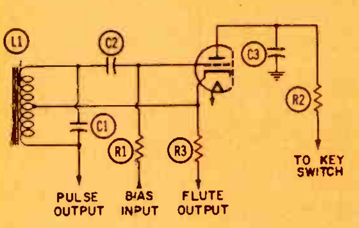


Fig. 5 R2 and C3 filter the plate voltage of Conn oscillators, to eliminate clicks, and to make the attack and decay times more natural.

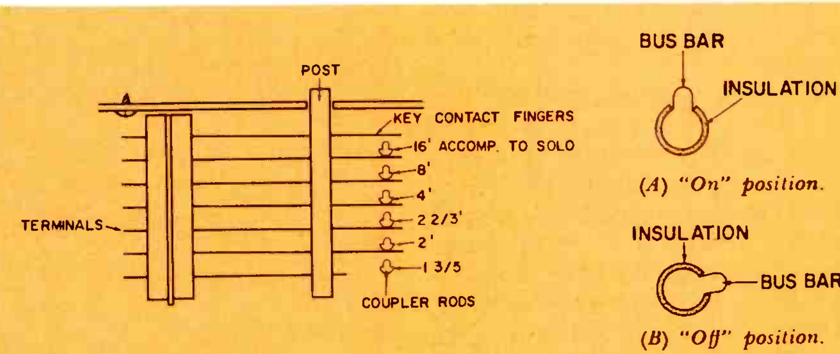


Fig. 6 Many switch contacts are under each Conn keyboard. Depressing a note makes contact when the coupler rod is turned with the metal side toward the key-switch finger. The note cannot play when the coupler rod is turned with the insulation toward the switch wire.

Neon bulbs have a long lifespan and seldom fail. But if you should need to replace one in a Kinsman, the best bet probably would be one of the small ones used as indicator lights on panels (see Figure 13). These have an internal current-limiting resistor, which must be removed or shorted out. Also, new bulbs should be artificially aged to improve the stability. Through a 470 ohm resistor, apply 120 volts of line power to the bulb for two or three seconds. Repeat the procedure after a few minutes, to allow the bulb to cool. This should prevent any extreme changes later.

Lowrey Organs

Tube-equipped Lowrey organs were of the master-oscillator/divider type, with Eccles-Jordan dividers. One unusual feature was the DC voltage at the key switches which ionized neon bulbs. Of course, neon bulbs are essentially open circuits when not ionized, and partial short circuits when ionized. So, the DC voltage ionized each neon bulb, passing the audio signal to the stop-filter circuits. (Figure 14).

When Lowrey began using transistors, the neons were replaced by diodes. The lower operating voltages made the design of sustain and percussion actions much easier.

The newer Lowreys have extensive LSI circuitry, with a master oscillator operating in the megahertz range, multiderivative count-down, followed by dividers for the lower octaves. The Automatic Orchestra Computer (AOC), Auto-Wow, Symphonic Golden Harp, and Brass Symphonizer are extra features of Lowrey.

Rodgers Organs

Rodger's organs have an oscillator (sometimes more) for each note of every voice to provide realistic pipe-organ tone.

These organs are superbly engineered, and are custom built to order. Anyone who can afford a Rodgers probably should contact the factory if service is required.

Thomas Organs

The earliest Thomas organs were small models using tubes, and each oscillator provided 2, 3, or 4 adjacent notes. This reduced the number of tubes and components, but

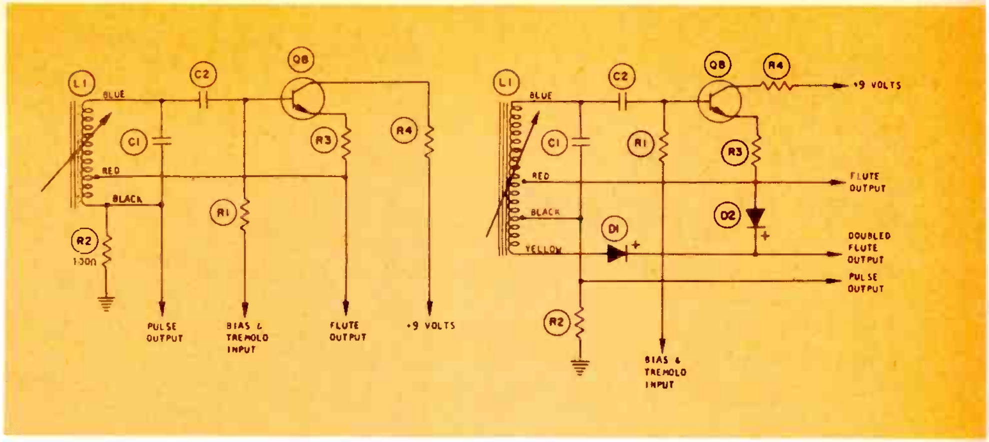


Fig. 7 These two examples of Conn oscillators show how two waveforms are obtained from one type, and three waveforms come from the top-octave type that has diodes acting as a doubler. These oscillators operate continuously. The pulse outputs are keyed directly as audio, while the flute outputs are keyed by transistors, with one transistor per note.

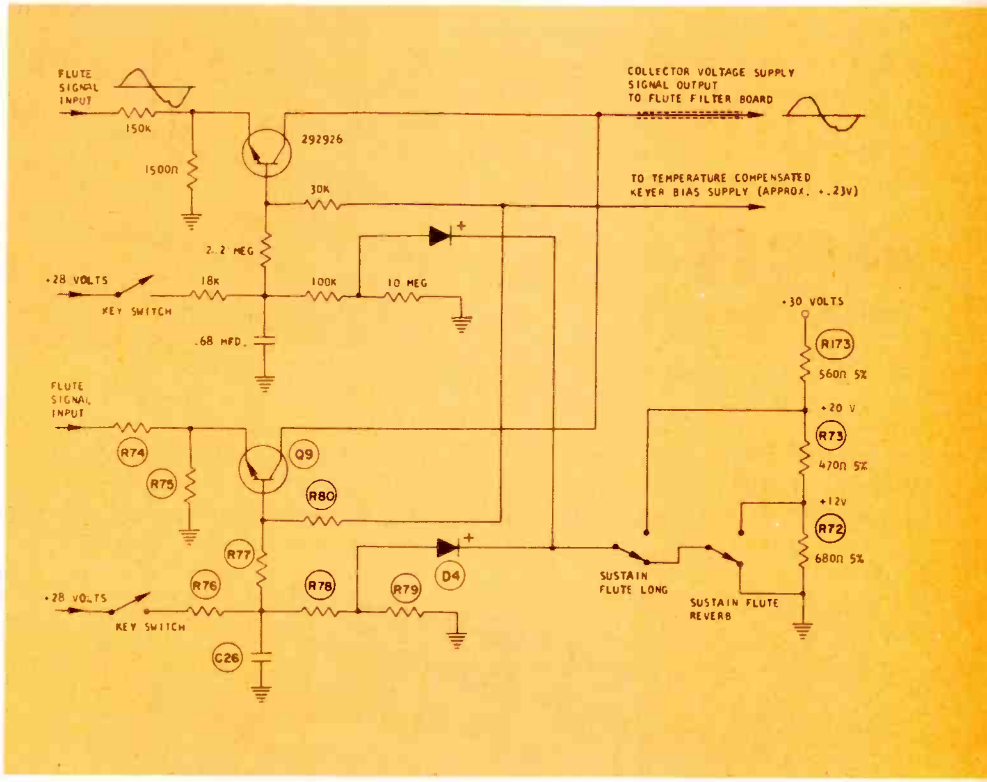


Fig. 8 The flute output from each Conn oscillator is keyed by changing the bias of a transistor, as shown. C26 delays the change of bias voltage to eliminate any clicks, and a fixed voltage through D4 determines the sustain time before the note dies away.

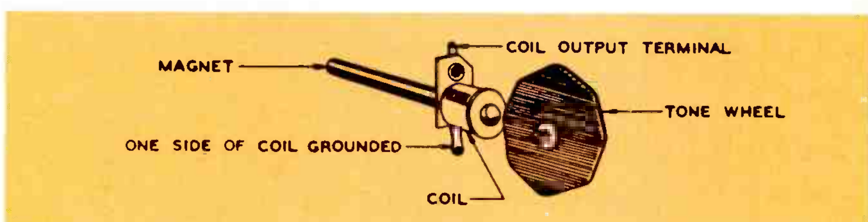


Fig. 9 Older model Hammond organs made complex musical notes by combining sine waves coming from small generators using "tone wheels", which were turned at the proper speed by a synchronous motor. Tuning was neither necessary or possible.

placed some limitation on the chords that could be played. Seventh chords, for example, have two notes just two semi-tones away. With these older model organs, the two adjacent notes would require fingering them in different octaves, else only one of the two would sound.

Later organs were transistorized, with master oscillators followed by dividers. From the dividers came square waves, so octaves were combined to make a stair-step simulation of sawteeth, when even harmonics were desired.

Thomas has carried "unitizing" of construction farther than have most other manufacturers. Therefore, much of the servicing consists of replacing blocks, or packages, which contain various components.

Wurlitzer Organs

"The Mighty Wurlitzer" was a byword in the days of silent pictures accompanied by pipe-organ music. Perhaps it was natural, then,

Fig. 10 This is the Hammond Model S-6 chord organ. Such chord organs were very popular for a time. Operation was somewhat like that of an accordion, but with the advantages of bass pedals, vibrato, and many stops.

Fig. 11 The new Hammond Concorde organ is similar in appearance to the older models with tone wheels, but the circuits are all-solid-state with IC's and transistors. DC through the keyboard switches controls the sine waves.

for some of the early Wurlitzer home and church organs to have reeds which were electronically amplified. There is a limit to the number of electrostatic pickups that can be placed on each reed, so such organs suffered from not having many tone colors. However, the timbres were very "musical", especially when aided by electronic vibrato produced by variable phase-shifting.

When Wurlitzer changed to solid-state, the circuits were of the oscillator/divider type, with flip-flop dividers. In the larger models, Wurlitzer has tried to improve the "body" of electronic music, using multiple types of vibrato (for example, the Spectra-tone rotating speaker plus tremulant of lower frequencies), percussion (drums, shh-

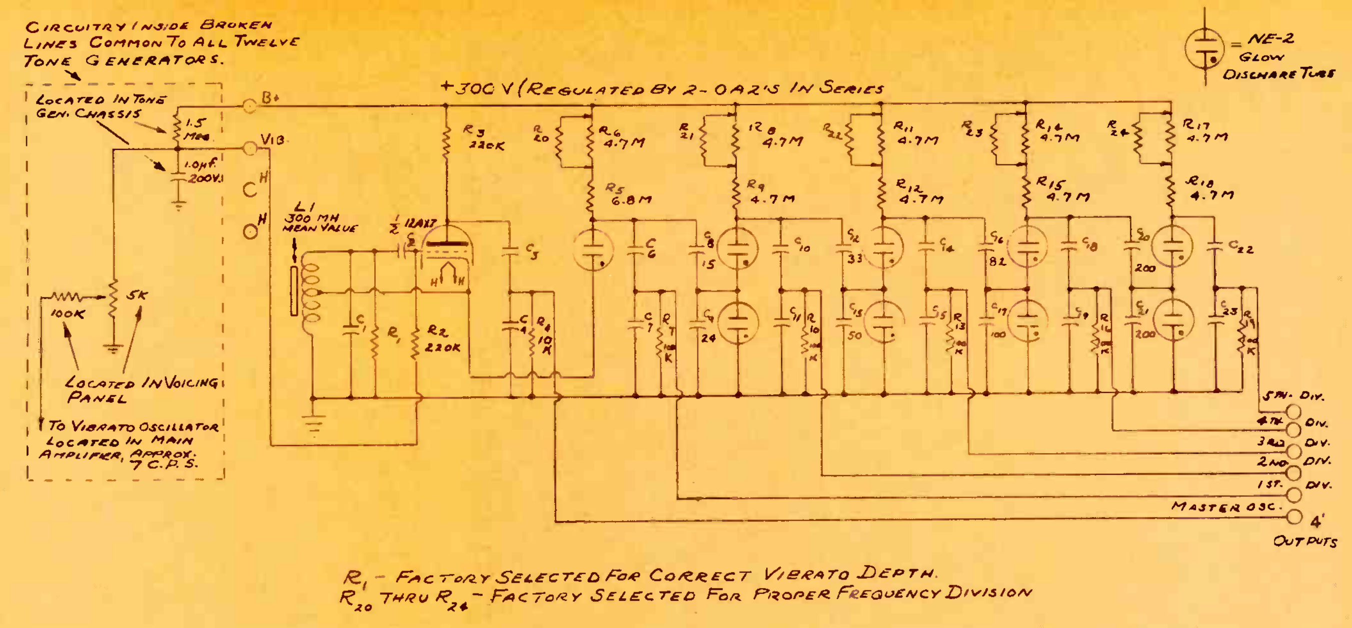


Fig. 12 Kinsman organs are unique for using neon bulbs in the dividers. One generator of six octaves is shown in the diagram.

boom, etc.), reverberation, and external speakers.

Newest models use the count-down method from a 666-KHz oscillator to obtain the 12 notes of the highest octave. And these then drive dividers for the lower octaves. LSI is used extensively.

Comments

One reason for this article is to familiarize you with the terminology of organ repairing. Also, the facts about the specific brands should make troubleshooting them much easier, because an important part of servicing organs is in knowing and understanding the types of circuits.

For those of you who would like more detailed circuit information, we refer you to a series of Howard W. Sams books:

- Electronic Organs, Volume 1 (book 20188): first published in 1960 and updated in subsequent printings; it's now out of print, but some copies probably can be found. Most of the coverage is on tube-type organs, with a few transistorized models.
- Electronic Organs, Volume 2 (book 20754): covers second-generation models up to 1969 (the ones needing the most service); it has one chapter about how organs work, and another about tuning methods.
- Electronic Organs, Volume 3 (book 21176): published in 1975; describes circuits and features of new models that have ICs and LSIs.

Next Month

Servicing methods are the subject for coverage next month, with both general and specific tips. □

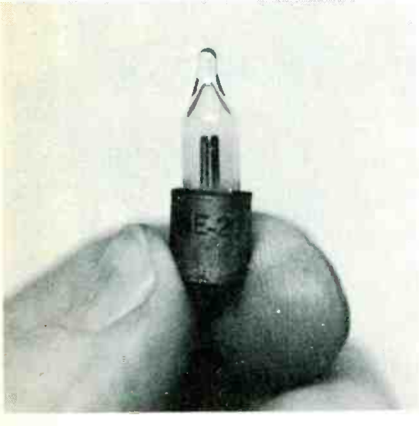


Fig. 13 If you need to replace a neon bulb in a Kinsman, remove the base from a small panel bulb, such as this NE-20, and short across the series resistor that's inside the base.

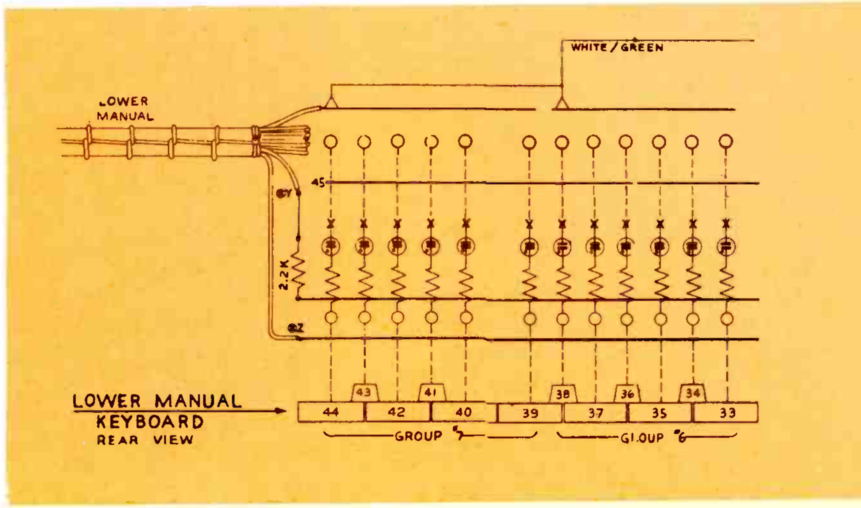


Fig. 14 Some Lowrey organs key the audio tones by applying DC voltage to neon bulbs, which act as low-value resistors when they are ionized.

The lighter side of servicing

By Max Goodstein

Several times in my life, I found I had talents above my electronic abilities. For example, once I was busy in a customer's living room repairing the TV, when I heard a frantic call from the lady of the house. Quickly, I ran into the kitchen to find a youngster with a blank expression sitting at the table. The lady demanded, "Yell at him, he doesn't want to drink his milk!" Obligingly, I snarled and shouted, "Drink".

My compensation for this above the-call-of-duty help was that she paid my service-call-plus-tubes without any comments about the price.

From that time, I was the neighborhood "bogeyman", used by the mothers to threaten their balky children. They would say, "Eat your cereal, or he will put you in his box (red and black tube caddy) and take you away."

Not long afterwards, I decided to stop these extra services, but I proudly can claim some credit for the healthy teen-agers around Flushing.

Many years ago, while I was working on a b-w TV, a little boy snuggled up to me. "Mister," he asked, "what do you want to be when you grow up?" At first, I thought the question was cute and funny. Later, the serious side occurred to me. Probably there **are** men in their late thirties who don't have any goals in life.

Chicken soup has been recommended as a cureall for the ills of mankind. However, it doesn't seem to be very beneficial to electronic equipment. I received a call from a young man whose grandmother accidentally spilled chicken soup into the rear of a color TV. Evidently, the engineers hadn't given any thought to making the set soup-proof, for I found an area of the circuit board had been burned. The grandson couldn't imagine how the soup got from the kitchen to the bedroom where the TV was located. Needless to say, this was an expensive repair, and the woman still asks me, "How could just a little soup do so much damage?"

Sometimes the logic of laymen is beyond comprehension. One customer called, saying "Mr. Goodstein, I have the latest model all-solid-state color set, and it just quit working. It's probably only a small tube that burned out."

Incidents, such as these, continue to surprise and amuse me. □

VIR PREVIEW

At Last! Automatic Color

By Carl Babcoke

In the article "Goodbye, Color Controls", starting on page 15 of ***ELECTRONIC SERVICING*** *for March of 1975, the prediction was made that future color-TV receivers would have NO color controls, or would have them hidden because they would be needed so seldom. The VIR signal, allowing the TV stations to make continuous adjustments to the color signal, was to make this breakthrough possible. Now the General Electric company has made that prediction come true, even before the TV stations have taken full advantage of VIR. Not only does the GE VIR system correct for color errors originating* ***before*** *the signal leaves the transmitting antenna, but it also corrects any* ***receiver*** *deficiencies. In a later issue, we will present a more-detailed analysis of the circuit operation.*

Background

Another "hidden" signal has joined the others that are included in the composite video of color-TV programs. Three horizontal lines, during the vertical-retrace time, now are reserved for VIT and VIR signals.

VIT Signals

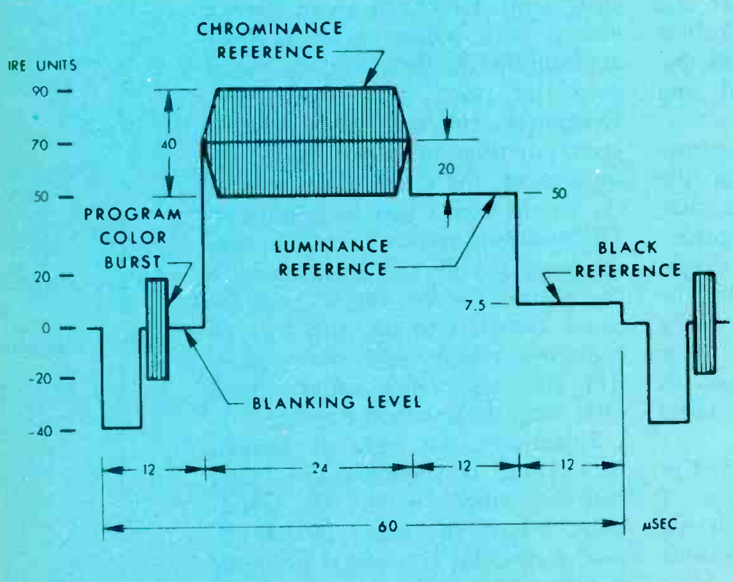
Vertical-Interval-Test (VIT) signals have been used for years on lines 17 and 18, or 18 and 19 of each video field. These can have several different waveshapes (page 16, March, 1975 Electronic Servicing) as needed to evaluate frequency response, overshoot, amplitude linearity, and other characteristics of: network lines; studio-to-transmitter-links; video-tape recorders; or complete transmitters.

VITS are not associated with any certain program; they can be keyed out and new ones inserted as often as required, and seldom are they used to adjust an individual program.

VIR Signals

Vertical-Interval-Reference (VIR) signal (there's only one kind) supplements VITS, but does not replace them. The VIRS waveform (Figure 1) is simple, because it is designed to test only the black reference, luminance reference, chrominance reference, and the blanking level.

VIRS is added to the video of



NOTE: THE CHROMINANCE REFERENCE AND THE PROGRAM COLOR BURST HAVE THE SAME PHASE.

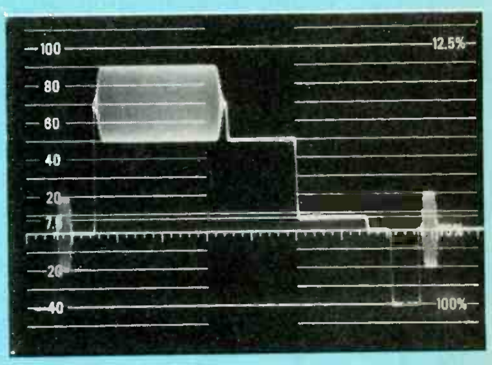


Fig. 1 The new VIR signal waveform is shown here both as a drawing and the way it appears on a scope screen, direct from a VIR generator. TV stations can use it to correct many video and chroma distortions. Some General Electric TV receivers now automatically adjust both tint and color saturation, when the VIR signal is broadcast.

each color program of the ABC, CBS, NBC, and PBS networks, and it must remain with that program until it is broadcast.

This permits the engineers to make either continuous or occasional adjustments to that **individual** program, thus maintaining the original color quality until the program is broadcast.

It is expected that each station eventually will install equipment which will make these corrections automatically and continuously, and do it so rapidly that the viewers will not be aware of any manipulation.

In October of 1975, the FCC reserved line 19 of both fields for the VIR signal. However, the VIR signal is not mandatory, but optional. VITS now appears on lines 17 and 18 of each interlaced video field.

Color Quality Today?

At this time, I see no evidence of any uniformity of color quality that could be attributed to the use of VIRS, by either networks or stations.

In addition, TV receiving antennas and distribution systems often provide stronger color on one channel than on others. This certainly would cause color variations, even if all station signals were identical in quality.

General Electric has jumped ahead of the broadcasting stations by providing a system of correcting color saturation and tint errors that originate in network, transmitter, receiving antenna, and the color receiver.

VIR "Broadcast-Controlled" Color

GE calls this new feature "Broadcast-Controlled" color, and it is available in five top-of-the-line 1977 models (some YM and YC-2 chassis).

All of the VIR circuitry is contained on one seven-inch-square module (see Figure 2). A helpful service feature is that the receiver can be operated on manual adjustments, without the VIR module, merely by unplugging the module and connecting together the two plugs from the main chassis.

Mathematical formulas prove these two conditions to be true:

- When the chrominance reference amplitude and the black reference amplitude are equal at the output of the **R-Y signal** in the receiver, the chroma phase (tint) is identical to that of the transmitted reference signal; and
- When the chrominance reference amplitude equals the black reference amplitude at the **blue-drive output,** the chroma level (color) is matched to the color saturation of the original program.

Therefore, the GE VIR system samples these two signals to determine the correct tint and color saturation, and adjust it if it's wrong.

The circuit is not simple; 5 plug-in ICs and 30 transistors are used on the VIR module.

Figure 3 is a block diagram of the VIR module. You will notice inputs (in addition to power-supply voltages) from receiver sync, horizontal-sweep pulses, negative-going video, R-Y, B-Y, and positive-going Y (video).

VIR Circuits

Although a defeat switch is provided for times when the signal is snowy, or in case you prefer to try your own color adjustments, the circuit can switch automatically from manual (no VIR) to automatic (VIR present), also lighting an LED to show that the set is controlled by the VIR.

Line recognizer and VIR sensor

Because the VIR signal appears only on line 19 (with VITS and video on the others), the circuit must accept the waveform of line 19 and reject all the others. Line 19 first must be identified, and this is done from the receiver sync pulses by using digital counter techniques.

Next, each line 19 must be examined for the presence or absence of the VIR waveform. When line 19 has no VIRS, the horizontal blanking is widened to reach from sync pulse to sync pulse. By contrast, the VIRS waveform does have normal horizontal blanking pulses. One edge of the blanking pulse is used to prove the VIRS is there.

After line 19 is identified, the circuit generates a 63-microsecond (the time of one horizontal line) pulse that coincides with it. From this pulse, a 15-microsecond slice is fed to one input of the VIR sensor. If, during this time the falling edge of the VIR-waveform blanking pulse also is present, the VIR sensor is turned on for a time longer than one field. Each repetition of the VIR waveform again triggers the circuit before the previous one releases control. That way the VIR sensor remains "on" continuously, even when the VIRS is received only once each field.

Three outputs come from the VIR sensor. One works the LED indicator to show the set is controlled by the VIR. The other two produce either zero or +28 volts, as required to switch the tint and color controllers.

Tint controller

Automatic tint is determined by the relative amplitudes of the VIR chroma reference and the black reference in the R-Y signal.

From the 63-microsecond pulse, generated by the line recognizer, two other narrower pulses are made. The 15-microsecond pulse

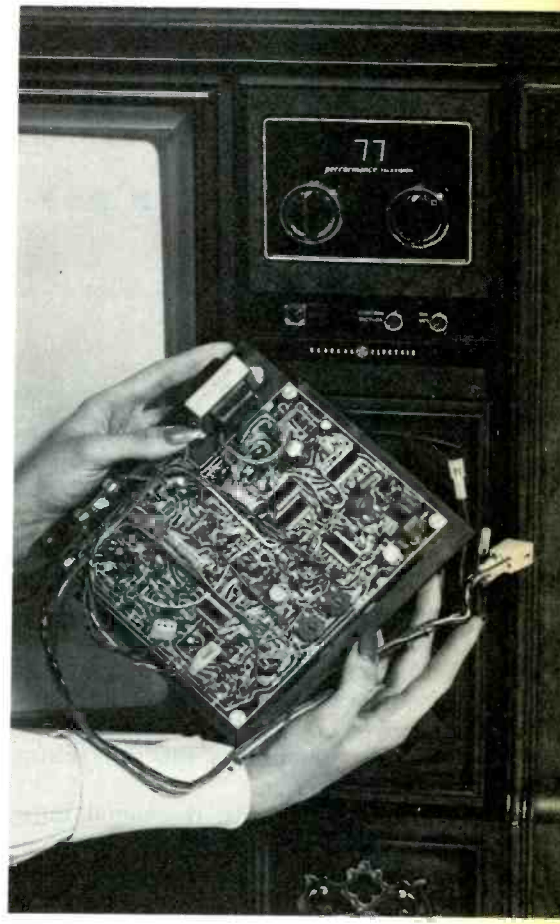


Fig. 2 Size of the module containing the GE VIR "Broadcast-Controlled" color circuitry is contrasted with one of the new receivers using it. Digital readout of switching-type tuners is another feature.

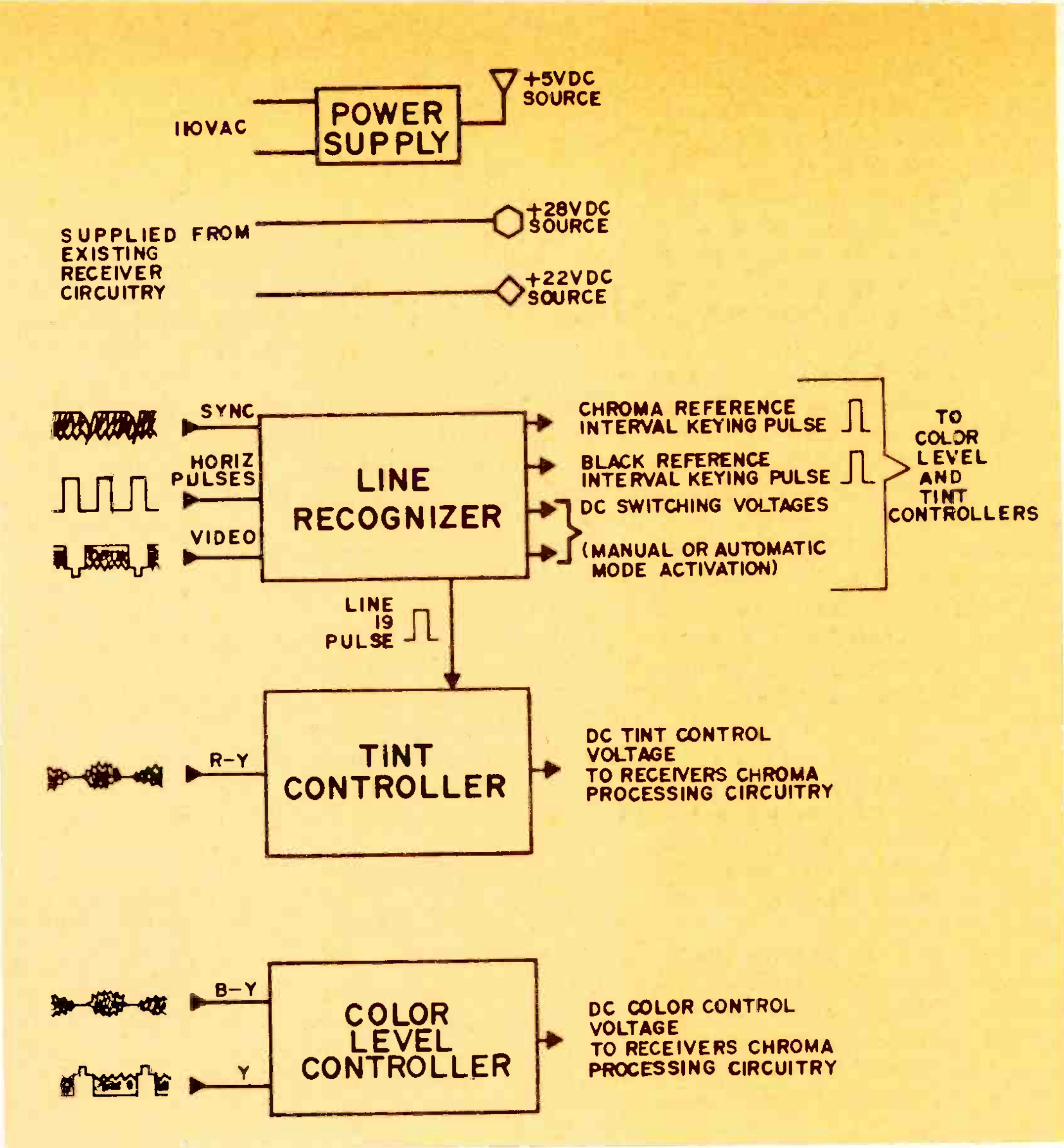


Fig. 3 Circuitry of the "Broadcast-Controlled" color feature can be classified into three areas: line recognizer and sensor of the VIR waveform, plus switching voltages for manual or automatic modes; tint controller; and color level controller.

occurs first during the time of the chroma reference, and the 35-microsecond pulse happens later during the time the black reference is there.

These pulses key on two channels of the comparator circuit, which judges the relative amplitudes of the chroma reference versus the black reference. Output of the comparator is a DC voltage of approximately +7.4 volts. This voltage determines the tint setting of the receiver.

In other words, the signal input to the "tint controller" is the same one whose phase is being adjusted by a DC output voltage from the controller. It is a closed loop that continuously restores the optimum tint.

Color controller

Operation of the "color controller" is similar, except the input signal comes from a combination of B-Y and positive-going video (together these simulate blue video drive).

Again, the 15-microsecond and 35-microsecond pulses sequentially extract samples of the chroma reference and the black reference, but this time from the blue-drive signal. Output of the comparator is a DC voltage of approximately +7.4 volts, which varies until the circuit balances the two signal amplitudes, producing the correct color saturation.

The color controller also is a closed loop, that controls the circuit which supplies the AC input signal.

Other General Electric Features

All of the picture tubes used in the new General Electric 1977 line of modular solid-state color receivers have horizontal in-line guns, dots of phosphor rather than stripes, and black-matrix construction. These are said to be the first 25-inch in-line picture tubes available in the United States. The convergence adjustments have been reduced to 4, compared to the usual 12.

Many YM and YC-2 GE chassis feature a digital-readout channel indicator system, combining electronics and mechanics. The digits are of the glow-discharge type with a standard 7-segment display. On the shaft of the VHF tuner is a 15-pole double-throw switch that switches the display segments for numbers from 2 through 13. Similarly, the UHF shaft operates a 14-pole switch. Except for mechanical alignment, these assemblies are non-repairable. □

"HOW'S THAT AGAIN?"

When you set your clock ahead in the spring for daylight-saving time, do you lose an hour of sleep that first night, or do you gain an hour? After many years, people continue to argue that puzzle. The same kind of uncertainty sometimes is aroused by hum symptoms or wrong vertical and horizontal frequencies. You can troubleshoot TV receivers faster and more accurately after you understand the principles illustrated here.

By Gill Grieshaber, CET

A Rolling Picture

On a TV screen, the picture is rolling slowly downward (Figure 1); a condition we all have seen many times. Obviously, the frequency of the vertical sweep is wrong. Is it running fast or slow? Of course, you could measure the frequency, but can you prove it by logic?

One wrong answer

All electronic technicians know that vertical sweep is scanned from top to bottom. It seems logical, then, for the picture to be moving faster than the sweep, thus arriving at the bottom of the screen before the sweep does. According to this faulty reasoning, the sweep frequency is too low. **That answer is wrong!** Why? Because the wrong reference point was used.

The picture from the station **always** must be the standard for judging either vertical or horizontal sweep frequencies.

Sweep is too fast

Actually, the vertical sweep is running fast when the picture drifts downward. Let's prove that statement.

When the vertical frequency is fast (above 60 Hz for b-w or 59.94 Hz for color), the scanning beam travels farther **down** the screen before it's time for the corresponding part of the picture to arrive. That moves the picture **lower** on the screen. What's more, each succeeding field also moves the picture lower than it was before. So, the picture continues to roll downward.

Freerunning frequency

Each sweep of the vertical system is locked by a separate vertical sync pulse. For best locking, this sync pulse should arrive slightly before the retrace would start if there were no sync. In other words, the sync pulses force the vertical oscillator to fire ahead of the natural time.

Therefore, if the vertical has been locked correctly, and then the sync is eliminated, the frequency should be slightly low (when it runs slower, the picture rapidly spins upward, as shown in Figure 2).

A picture that occasionally spins up is said to have a "vertical flip."

Fig. 1 When the picture and blanking bar move slowly **down** the TV screen, is the vertical sweep too slow so the video moves ahead of it on the way to the bottom of the screen? Or is the sweep too fast and moves part way to the bottom before the blanking bar arrives?

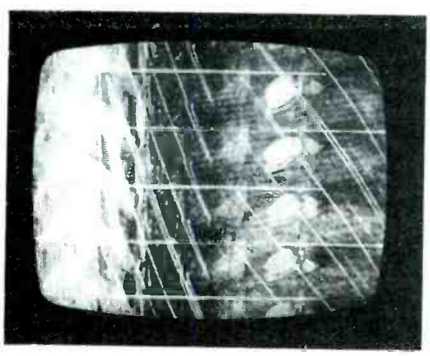


Fig. 2 If the vertical is locked correctly and then the sync is eliminated, does the vertical sweep run faster or slower? Truth is, the sync should force the oscillator to fire ahead of time; therefore, a loss of sync makes the sweep run slow (flips upward rapidly).

Intermittent vertical flip

Have you ever watched a picture that had good, solid vertical locking, except periodically would flip upward several frames, then lock fine again until the next flip?

Now, this can be caused by variable ghosts. However, the ghosts will be seen, and that's not the problem I'm talking about. The defect I have in mind causes a

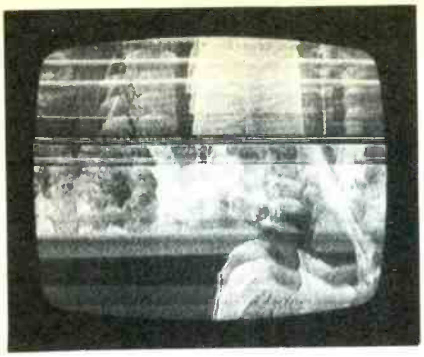


Fig. 3 A vertical roll that happens regularly every 16 seconds is caused by a certain kind of hum.

short period of vertical flip about every 16 seconds, and does so very regularly. Figure 3 has a picture of such a flip. What kind of condition repeats every 16 seconds?

Vertical versus 60 Hz

During b-w TV broadcasts, the vertical scanning frequency is 60 Hz. In other words, there are 60 fields per second, making 30 frames per second, because of the interlaced scanning requirement.

However, the vertical scanning rate for color is reduced to 59.9402 Hz, which subtracted from 60 Hz gives 0.0598 Hz. That's how much the vertical sweep frequency is reduced for color TV. Of course, the difference between the two frequencies is only about 0.1%, and it is of no importance to the vertical sweep circuit, which will deflect and lock just as well for either one.

No, the importance of this slight difference of frequency comes about because the TV receivers are powered from the 60-Hz line. Therefore, both 59.9402 Hz from the vertical sweep and 60 Hz or 120 Hz from the ripple of the DC power supply are present in each TV receiver.

When the TV is normal, the two waveforms of nearly the same frequency co-exist peacefully. But when either has excessive amplitude (usually it's the 60-Hz or 120-Hz ripple of the power supply), they can affect one another and cause trouble.

Let's take a short detour before stating what kind of symptoms the trouble between the ripple and sweep signals can cause.

Time versus frequency

The reciprocal of the frequency equals the time of one cycle (reciprocal means to divide it into 1), or the reciprocal of the time equals the frequency. That's theory we probably don't use often enough.

Using a calculator for the reciprocal of 0.0598 Hz (Hz means cycles-per-second) gives 16.7224 seconds. In other words, the 60-Hz and 59.9402-Hz signals will drift slowly in phase, becoming in-phase every 16.7224 seconds. (Or, out-of-phase once every 16.7224 seconds.)

By this time, you should understand the origin of a vertical flip (not roll) that occurs approximately every 16 or 17 seconds. At one certain phase, the 60-Hz hum eliminates the 59.9402-Hz vertical sync, and without sync the vertical runs slower (flips upward). Usually, the cancellation of the vertical sync occurs in the sync separator stage, regardless of where the hum originates. In rare cases, it might happen in the horizontal AFC or oscillator stage.

Visible symptoms?

Sometimes the hum that eliminates the vertical sync every 16 seconds shows in the picture on the screen. It might be a large horizontal bar with rounded edges. Or it might appear as a smaller gray or black line across the picture. One bar shows it is 60 Hz, two prove it's 120 Hz.

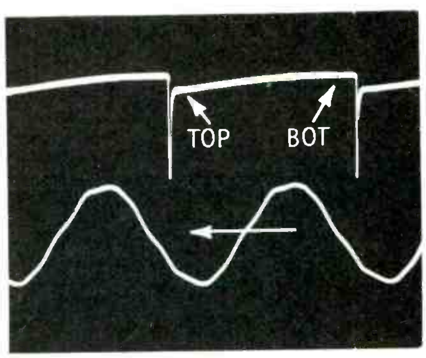


Fig. 4 A dual-trace scope waveform clearly shows the slight difference between vertical and power-line frequencies. When the scope is locked to the vertical (top trace) the heater waveform (60 Hz) moves slowly to the left (going upstream of the scope trace, so it's faster). Also, the hum moves from the part of the vertical waveform representing the bottom of the picture on to the top of the picture; that's exactly the way visible hum moves—from bottom to top of the TV picture.

There's one more important symptom: the hum bar **always** moves. And it moves steadily and slowly. Any bars of other descriptions might be caused by AGC or horizontal-locking problems. Don't be deceived; they are not hum bars.

Which way do the hum bars move?

Again, we'll try logic. Before, when the vertical sweep ran faster than the picture, the picture rolled downward. 60 Hz is faster than 59.9402 Hz; therefore, the hum bar should drift downward. Right? **Wrong!**

True hum bars definitely drift upward through the picture, when the picture is locked vertically. This time the vertical frequency (and, of course, the vertical sync, since the vertical is locked) is the standard, and the hum is the signal that is changing phase, relative to the sweep.

Proof

You can prove by two methods the statement about hum bars moving slowly **up** the picture. First, you could add hum to the video by connecting a resistor-substitution box between a 60-Hz source (perhaps the heaters of a tube set) and the video, and varying the resistance to obtain a visible hum bar.

Or, the elegant way is to use a dual-trace scope, with the top trace

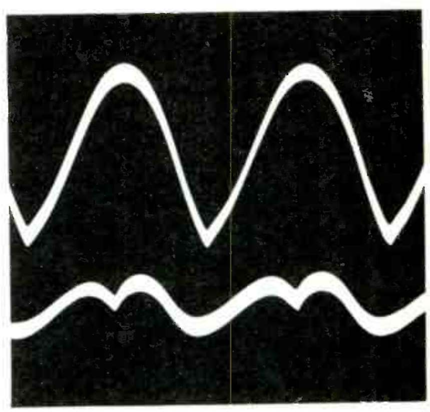


Fig. 5 Power-supply hum and a sample of the vertical sweep can be found together at some point in every TV receiver. The waveform always changes in waveshape and amplitude as the vertical parabola moves slowly to the right (slower than the 60-Hz hum). The scope controls were not changed between these two pictures, but the pictures were taken when the waveform had maximum and minimum amplitudes.

Fig. 6 These shaded areas have been called "silicon-diode radiation", but that's wrong. Instead, they are *modulation bars* caused by a change of signal strength from conduction of the power-supply diodes. They can't be seen unless there is a carrier which can be modulated.

showing a sample of vertical sweep, and the lower trace with a 60-Hz sine wave from the power line (Figure 4). When the top trace (with the vertical-sweep waveform) is locked, the lower waveform slowly moves to the left.

There are two ways to visualize the meaning. One is that the sine wave is going "upstream" so it must be moving faster. Also, a peak of the sine wave passes the portion of the sweep waveform corresponding to the **bottom** of the picture (just to the left of each pulse) and moves slowly to the part representing the **top** of the picture on the TV. This proves that hum **must** move from bottom to top of an otherwise normal TV picture.

B+ waveforms

Surprisingly, one of the power-supply waveforms proves the frequency relationship between hum and vertical sweep. Figure 5 shows a double exposure, taken a few seconds apart, of the waveform found at the output of the filter choke in a normal tube-powered color set. The scope controls were not changed for the two exposures; only the waveform changed.

The waveform at that point is a composite of a near-sinewave of 60-Hz ripple from the power supply rectification (this supply doubled voltage but not the frequency) plus a parabola (with the points at the bottom) produced by integration of the vertical-sweep current (59.9402 Hz).

As you watch the waveform, it changes. The notch from the parabola moves slowly to the right (slower than 60 Hz), with maximum amplitude (top picture) occurring just 90 degrees from minimum amplitude (bottom trace). This is a kind of poor man's dual trace!

Receivers that have 120-Hz ripple show a different waveform. Every alternate cycle is large, because of the vertical component added.

These waveforms are normal, but they pose a question. Where during this change of waveform do you measure the ripple? What is the peak-to-peak ripple?

Other lines

Another kind of horizontal bar is pictured in Figure 6. Actually, there are two bars, one at the extreme top and another near the bottom. Imagine them drifting slowly toward the top of the picture. They make a complete revolution every 16 seconds, but are they hum bars?

The answer is both yes and no. Yes, because their source is the 60-Hz power line. But no, because they are not true hum bars; instead they are **modulation** bars.

Notice the sharp top and bottom edges, unlike the gradual shading of hum bars. At the top of each bar is a lighter area, and a darker fringe is at the bottom of each.

These edges show AGC action. The signal is stronger during the time of each bar, so at the bottom of the bar, a period of several scanning lines is required to reduce the AGC voltage. Until the AGC stabilizes to the new signal condition, the excessive AGC gives reduced contrast. In the same way, the beginning of the bar (top) has excessive contrast until the AGC increases to reduce it.

Bars of this kind are **not** new. They have been called "silicon-diode radiation" or "diode radiation". Tube diodes can cause the bars, too, but solid-state diodes make the edges of the bars sharper.

However, these bars are NOT produced by any mysterious kind of radiation; instead, they are created by a change of signal strength. The signal strength is modulated during those times. How can a power supply change signal strength?

Antennas and grounds

Most antennas and lead-ins are balanced, and then the path between chassis and an earth ground has little to do with signal strength. But monopole antennas (or dipoles with the rods unbalanced) require a ground to complete the signal path. Of course, it's usually done by bypassing the AC line to the chassis, and perhaps we forget how this acts as a ground.

Diode conduction during rectification temporarily connects B+ to the hot side of the AC line (or to the winding of a power transformer), thus changing the resistance of the signal ground. That's why half-wave rectification causes **one** shaded bar, and full-wave circuits produce **two** shaded bars. **The signal has been amplitude modulated by the changes of ground resistance.**

Curing modulation bars

Two general methods are used to minimize modulation bars. The best one is to use a balanced antenna system, twisting the 300-ohm flat lead-in wire where it runs near the TV, or dressing the lead-in away from the area of the power supply and power wiring.

Another method, that's employed by most manufacturers already, is to connect capacitors across the power supply diodes. This provides a constant AC path, so the diode conduction doesn't make such a drastic change. In extreme cases, capacitors might be needed across the secondary winding of the power transformer, or from one side of the AC line to chassis (if that isn't already provided). Of course, any such capacitors should be of the "fail safe" type.

Fluorescent-light bars

Figure 7 shows one example of the lines produced by fluorescent lights. There are two main horizontal narrow bars, having sharp edges (probably the tube conducts on both positive and negative peaks). In between these large bars are many narrow ones. They are rather faint and difficult to photograph.

Because they are produced by current from 60-Hz, the lines drift upward slowly, taking the usual 16 seconds to return.

Random lines and dots

Random narrow horizontal lines and dots (Figure 8) are caused by noise that is not synchronized to the 60-Hz line. These were produced by a brush-type motor. Similar lines and dots can originate from arcs of the HV system in a TV receiver.

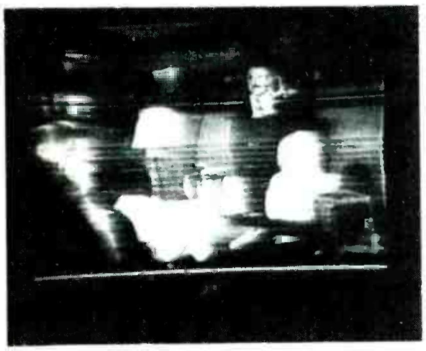
Lines and dots resembling these, except bunched in approximate horizontal bars that drift slowly up screen, are power-line noise, coming from arcs and coronas in the power distribution system.

Hum bars

Figure 9 illustrates two kinds of hum bars, or rather two parts of one cycle of hum; dark or light bars. The shape depends on the waveshape producing it. A lightly-loaded peak-reading power supply (such as a bias supply) might show a narrow bar in the shape of a sawtooth (sharper on top than bottom, or vice versa). And it might be accompanied by a horizontal bend of any vertical parts of the picture (Figure 10).

On the other hand, hum from a 60-Hz sine wave would have a wide and rounded bar, either dark or light.

Of course, all such hum bars drift up the picture very slowly.



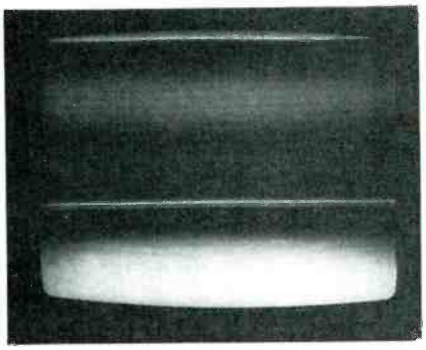


Fig. 7 Fluorescent lights also can cause modulation bars. They're seldom seen, but easy to recognize by the two strong horizontal bars with many weaker, narrower lines in between.

Fig. 8 Noise that isn't synchronous with either the vertical or the power line appears at random, without any pattern. This noise was made by a brush-type motor.

Fig. 9 Here are two examples of 60-Hz hum. Although the appearance can show in many different forms, two white or dark bars are produced by 120-Hz hum, and one white or dark bar is caused by 60-Hz hum.

Vertical Lines And Horizontal Frequency

All **vertical** lines generated by a malfunction in a TV receiver must come from the horizontal-sweep circuit. There can be one or more, and they vary in width and position on the screen. Also, each kind usually comes from a different defect.

Several years ago, noise in the form of vertical bars (Figure 11) gave a lot of trouble. Usually they were caused by an obscure defect in the high-voltage rectifier tube, and the cure was easy after you knew this: a new tube stopped the bars.

Today's sets are susceptible to "jail bars" (Figure 12), a series of four or five vertical bars, when a horizontal-blanking diode fails. Barkhausen and snivets were two other kinds of single vertical lines that originated in horizontal output tubes. Modern sets do not have them.

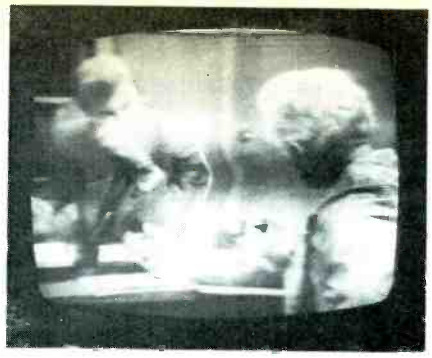


Fig. 10 A hum bar can be white or black; and it can cause an intermittent vertical roll every 16 seconds, a hook in the vertical lines of the picture, or both together.

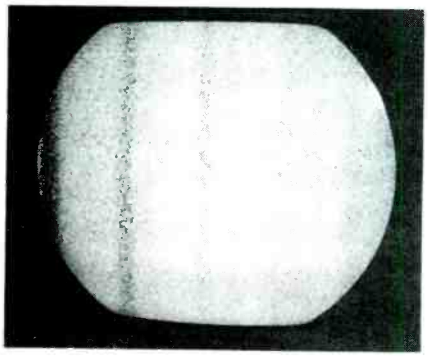


Fig. 11 Certain kinds of corona in the high-voltage circuits can emit noise pulses that form vertical bars.

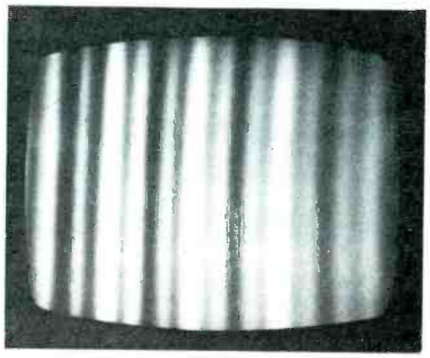


Fig. 12 Defects in the horizontal-blanking circuits (usually bad diodes) can allow the ringing between pulses of the high voltage to come through the video amplifiers, causing vertical bars.

Out-of-lock bars

All TV technicians and most TV set owners know that a picture broken up into diagonal bars proves the horizontal is not locked. But, let's be more scientific, and develop some facts and rules to help in our troubleshooting.

Look at the picture of a cross-hatch pattern in Figure 13, and assume that the horizontal-blanking bar shown near the center is moving slowly to your right. Is the horizontal-sweep frequency higher or lower than it should be for locking?

By using the same logic we did with the vertical sweep, we find the frequency must be too high (running too fast). The beam goes from left to right, and a fast speed brings the beam past the center before the video of the blanking bar arrives.

Before this point, the information had little value, because you seldom see the condition as described. But, when we increase the frequency, the picture changes to the familiar out-of-lock stripes (Figure 14).

Now, it's a definite help during troubleshooting to know whether the horizontal frequency is too high or too low. We'll develop a couple of rules to make it easy to judge whether it's high or low by the direction the stripes go.

The scanning beam traces from left to right, and in Figure 14 the stripes go downhill from left to right. All vehicles coast faster downhill, so we can say: **Diagonal bars going downhill to the right prove the horizontal frequency is too high.** This applies whether there is just one bar (from the horizontal-blanking bar in the video) or a dozen.

Of course, bars sloping the other way show the opposite. **Diagonal bars going uphill to the right indicate the horizontal frequency is too low,** as shown in Figure 15.

Remarks

Now that we have solved all the disagreements about the visual effects of hum versus vertical, and locked versus out-of-lock sweep, do we gain or lose an hour when Daylight Savings Time begins? □

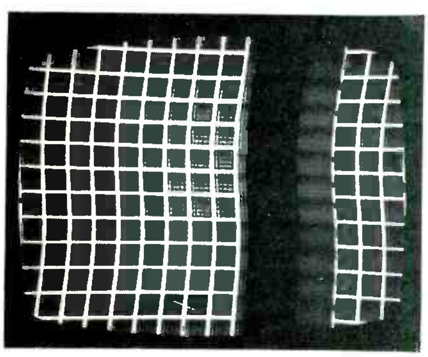


Fig. 13 When the horizontal sweep runs slightly fast, the picture is moved to the right on the screen. Diagonal bars are formed when the frequency is 60 Hz, or more, out of lock.

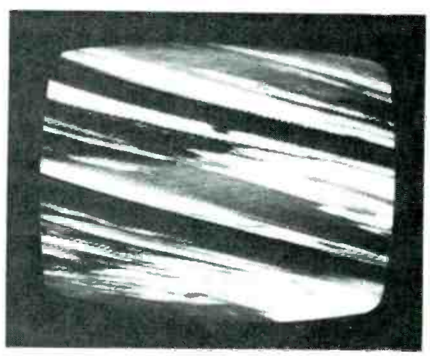


Fig. 14 When the horizontal-sweep frequency is too high, the black bars of the horizontal-blanking bars in the video slant downhill to the right. Remember it as a signal going *faster downhill*. Each black bar represents a frequency error of 60 Hz; therefore, the frequency here is 15,914 Hz.

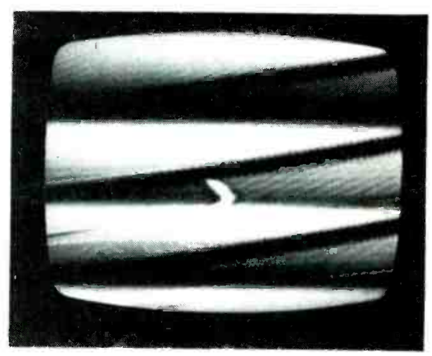


Fig. 15 Black blanking bars sloping down to the left prove the sweep frequency is low. Remember it by a signal *going slower uphill* to the right. One bar is lost in the vertical retrace, so the frequency is low by 4 bars, measuring 15,494 Hz.

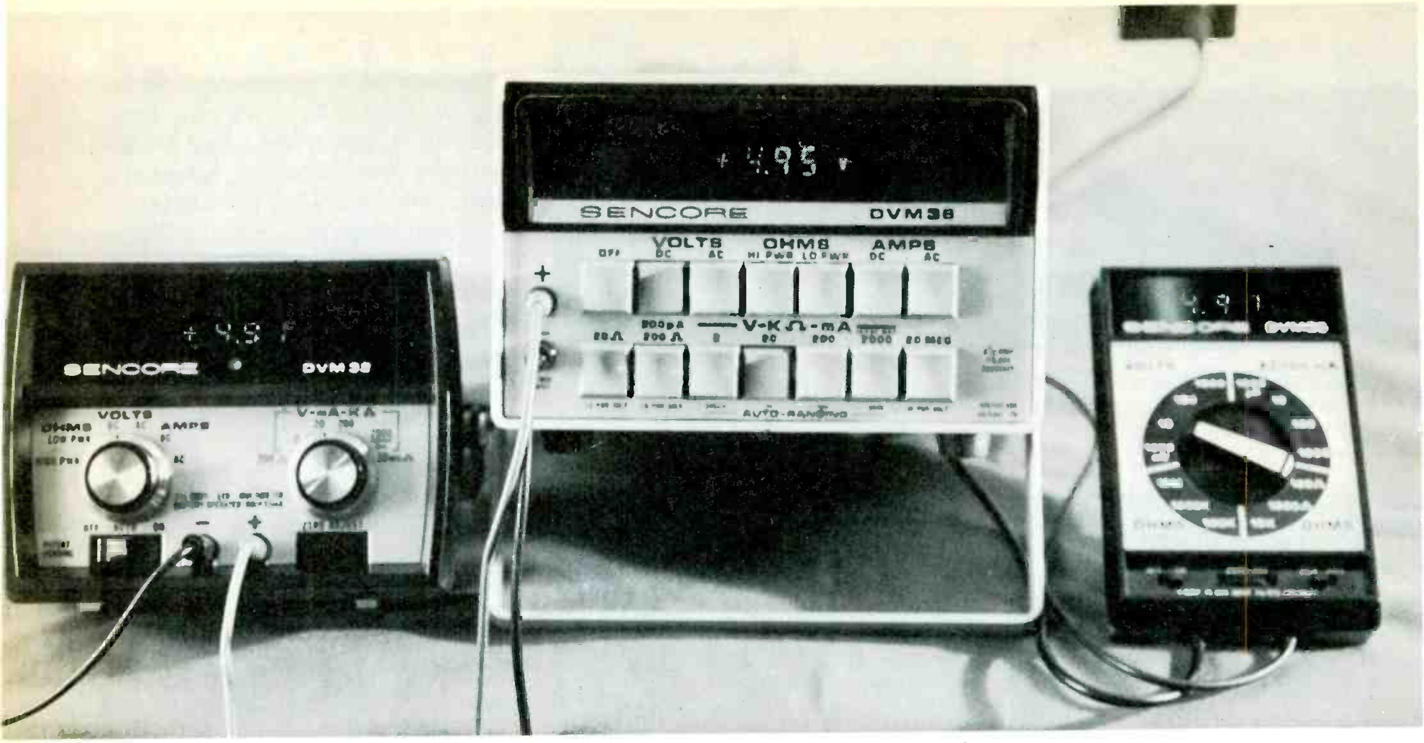


Fig. 1 Starting from the left, these are the Sencore DVM32, DVM38, and DVM35 digital multimeters on our test bench. The DVM36 was not available at that time.

Reports from the test lab

Each report about an item of electronic test equipment 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.

By Carl Babcoke

Sencore Family Of Digital Multimeters

There are now four models of digital multimeters in the Sencore line. It is fair to ask why four are needed. The pictures in Figure 1 provide part of the answer, although only three of the four are shown.

Large, heavy, high-accuracy multimeters (such as the DVM38) are more appropriate for stationary operation in the laboratory or on a workbench. While a light, small DMM (DVM35, or the higher-accuracy DVM36) lends itself for movable operation at a moments notice anywhere, powered either by internal batteries or an external transformer.

A good compromise between these extremes would be a medium-sized battery-portable DMM (with AC option), having most of the ranges and accuracy of the large lab model. That niche is filled by the DVM32.

Of course, these four models have some family characteristics, such as automatic polarity on DC, and more resistance ranges (than most digitals) with both high-power and low-power operation.

But unique features also can be found (special DVM35 probe with "push-on" and DCV-times-2 readings, or the one-step autoranging with the DVM38).

Sencore Model DVM35

Smallest of the Sencore digital meters is the portable DVM35 (Figure 2). A single rotary switch selects four voltage ranges, four current ranges, and six resistance ranges. At the bottom are an on/off switch, DC/AC switch, and a "zero adj" control. Readout is by three LED digits .3-inch high, and decimal points which are positioned by

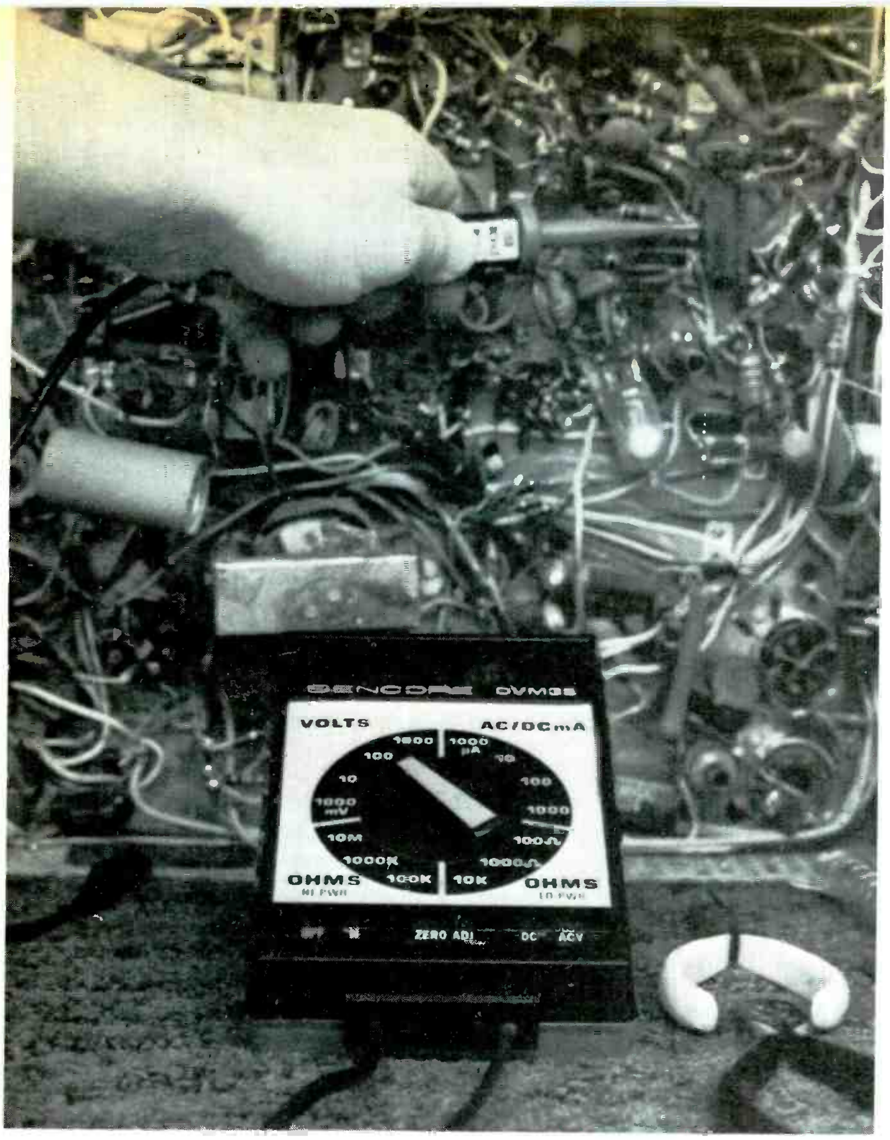


Fig. 2 Smallest of the Sencore digitals is the DVM35, shown in use here.

the range switch.

Digital meters usually overrange when the input is equal to the range. That's the case here. For example, with the 10-volt DC range, if you gradually increase the voltage it reads 7.78, 8.24, and so on up to 9.99 volts. Any slightest increase above that causes the meter to overrange (in this case, the reading is all 8's, which flash on and off). Therefore, the maximum readings of the AC and DC voltage ranges are 999 millivolts, 9.99 volts, 99.9 volts and 999 volts. (If you prefer to have the low range in volts, just imagine a decimal point in front of the three numbers. Example: 740 millivolts is .740 volts.)

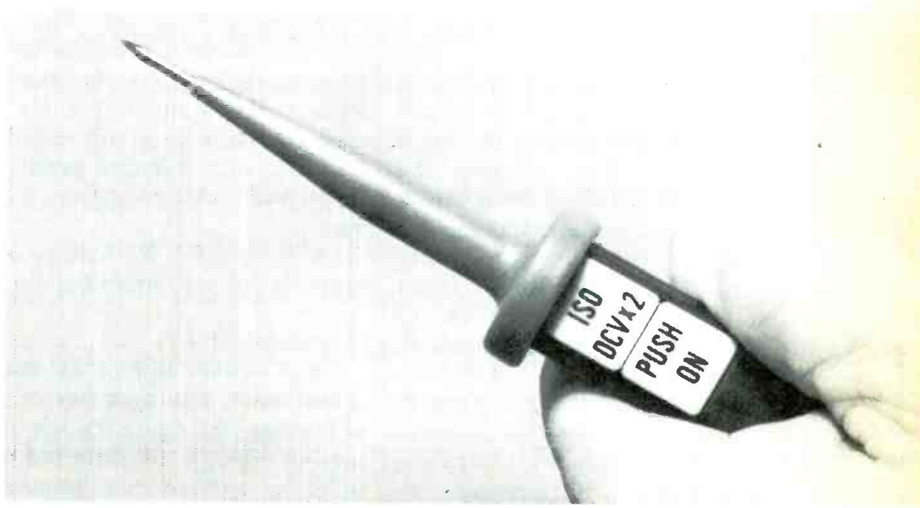


Fig. 3 The "push-on" button of this DVM35 probe extends battery life by allowing momentary operation, even when the main switch is off.

DC volts

When checked against the 0.1% DVM38, this individual DVM35 was low in reading by only 0.66% at

Fig. 4 Although the DVM36 appears to be nearly identical to the DVM35, it has 3-½ digits, permitting overranging up to 1999 instead of stopping at 999, and has a basic accuracy of 0.5% for DC voltages.

Fig. 5 Functions and accuracy of the DVM32 are similar to those of the DVM36, but there are separate knobs for function and range selection.

9-volts DC; which is better than the specs of ±1% of reading ±1 digit.

Also, it passed the difficult test of reading accurately with DC voltages having high ripple or pulses. Some digital meters, unfortunately, give readings that change rapidly from too high down to too low, when measuring half-wave unfiltered DC voltages. One worst example varied almost 20%. **None** of the Sencore digitals had this problem.

Test probe

Two test leads are attached permanently to the DVM35, with a special probe (Figure 3) that has two buttons. One is labelled "PUSH ON", and it applies power to the digital meter when the main switch is off. This extends the battery life by reducing the drain to zero, except during a reading.

The other button has two markings: "ISO" and "DCVX2". Input resistance of the meter is 15 megohms on all voltage ranges, so the probe adds a 15-megohm resistor in series when it is pressed. This gives **isolation** to prevent detuning circuits that are sensitive to capacitance, and increases the input resistance to 30 megohms. At the same time, all DC voltage scales are **doubled** (DCVX2), thus permitting readings up to 1999 DC volts. Caution: don't remove your thumb from this button when the input voltage at the probe tip is above 1000 volts; the meter is protected internally only to 1000 volts (total of DC plus peak AC).

Inside the tip (which screws into place) is a 2-ampere fast-blow 3AG fuse.

AC volts

The same four ranges are used also for AC voltages, and the input impedance is the same (15 megohms and 60 pF). Detection of AC waveforms is average-responding, and the calibration is RMS.

At 60 Hz, the accuracy is specified at ±1.5% of reading ±1 digit, and from 40 Hz to 1 KHz it is ±5% of reading ±1 digit. This digital multimeter tested better than those specs. Response was fairly flat from 20 Hz to about 1000 Hz, then rose gradually to about +4 dB at 16 KHz, with a broad peak at 21 KHz and falling response above that.

Of course, the X2 feature of the probe is not recommended for AC.

DC and AC current

Total average sum of AC and DC is measured, with accuracy of ±2% of reading ±1 digit. It's not necessary to change to different input jacks for current measurements; a handy feature.

Resistance measurements

DC voltage at the probes for the three low-power ohms ranges is about 1 volt, with infinite resistance across the leads. The "hot" lead is positive, for the times when polarity is important. High-power ohms have just under 3 volts across the leads, when they are not connected to anything.

Lower resistances reduce the voltage across the leads. For example, a 36-ohm resistor on the 100-ohm range measured +.67 volts, while 56 ohms increased it to +.110 volts. Using the 100K range, a 5.5K resistor had +.054 across it, 20K had +.207, and 63K produced +.635 volts.

Power

The DVM35 can be operated on the six internal AA-size alkaline cells, or from the power line by using a PA202 AC-Power adapter. However, the batteries must be left in place to act as filters. Or, NiCad batteries can be substituted, and the PA202 used as a battery charger.

Model DVM36

In appearance, the DVM36 digital multimeter is nearly identical to the DVM35 (Figure 4), except for the switch markings. This model has 3½ digits, so the 10-volt range goes up to 19.99 before it overranges; that's why it's called 20 volts here.

Basic accuracy is rated at .5% on DC volts.

Sencore Model DVM32

Specifications of the DVM32 are almost the same as those of the DVM36; however, the function and

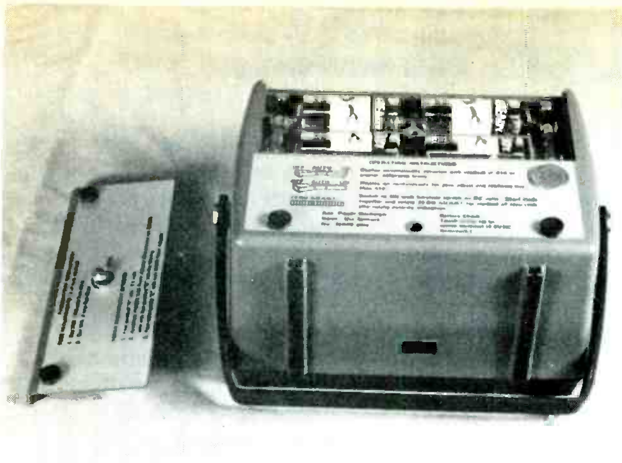


Fig. 6 Larger size of the DVM32 permits operation from four "C" cells, thus allowing longer operation before battery replacement. An adapter is used when line power operation is desired.

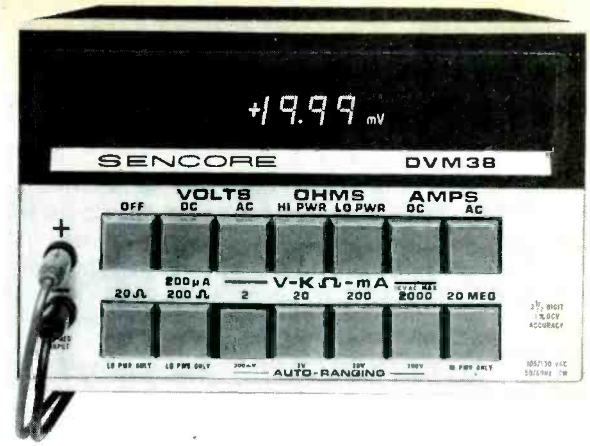


Fig. 7 Largest Sencore digital multimeter is the DVM38; it has more ranges (which are pushbutton selected), large red LED readouts, and single-step auto ranging, a convenient feature.

range selections are made with separate knobs (see Figure 5). Also, the resistance ranges have separate high-power and low-power for each of the six scales. Maximum voltage with high power is about 4 volts, compared to approximately .4 volt for low power.

The larger size permits battery operation from four "C" cells (Figure 6), with a 39A90 Power Adapter allowing operation from line power.

Incidentally, don't use the power adapter without any internal batteries to act as filters. Before I bought a set of batteries, I tried the DMM and found the DC readings to be about 20% low. Of course, the operation became normal when the batteries were installed.

Auto-off

A third position of the on/off switch provides a unique feature. Between measurements, the LED display digits are blanked out, saving about 80% of the battery power. In the sample meter, a reading of 1% or less caused the display to darken.

AC volts

Input impedance for AC measurements is 1.8 megohm shunted by 18 pF. Specifications list the response as 40 Hz to 3 KHz within ±1 dB, but this one was better. The response was essentially flat from 20 Hz to about 4 KHz, then rising slightly to about +3 dB at 15 KHz, and rolling off above that point.

Probe

A switch in the "hot" probe adds a 200K resistor at the tip for isolation.

Sencore DVM38

Perhaps the first things you notice about the DVM38 are the pushbutton selection of ranges and functions, and the larger .4-inch red LED display digits (Figure 7).

Seven ranges are supplied for resistance measurements, covering 20 ohms to 20 megohms full scale. A certain resistor checked .03K (30 ohms) on the 20K range, .017 (17 ohms) on the 2K range, 16.8 on the 200 ohm range and 16.76 on the 200 ohm, lowest range. That is excellent performance.

In addition, high-power and low-power ohms voltages are available for all resistance ranges.

DC voltages up to 1999 can be measured without extra probes.

When DC volts are being measured, extra LED's at the right of the 3½ digits light up "mV" for millivolts or "V" for volts.

Autoranging

The most unique feature of the DVM38 is the single-step autoranging. If you punch in the 200 volt DC buttons, but the voltage is less than 17 volts, the machine ranges down to the next scale to provide better accuracy of reading. For example, a voltage around +19 might read +19.4, but one around 17 volts would read 17.63.

Accuracy

DC voltage ranges always provide the best accuracy for any meter, and the DVM38 is rated at ±.1% of reading ±3 digits, with other functions having slightly lower accuracies. That is very good performance. Response of AC voltages was down to -1 dB at about 8 KHz, and -3 dB at 20 KHz, with no peaks.

Comments

All four of the digital multimeters feature automatic polarity for DC voltages and currents. The DVM35 and DVM36 showed "-" for minus voltages and no symbol for positive, while DVM32 and DVM38 showed either "-" or "+".

DVM38 also has automatic zero function. The other three had "zero adjust" controls on their front panels, but none required adjustment during the time of the evaluation.

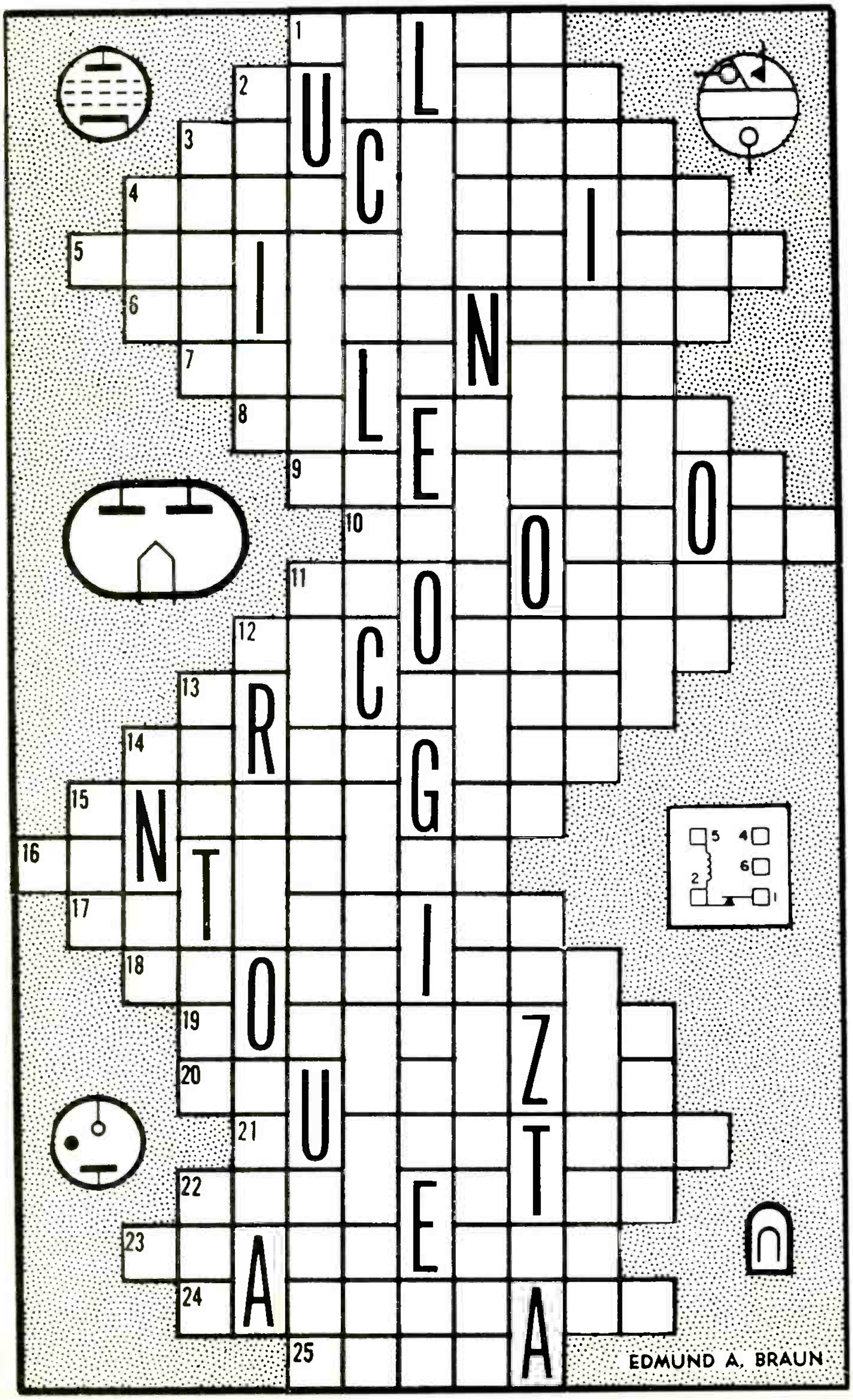
All digital multimeters provided a final reading very rapidly after the probes were applied for a measurement. None had excessive "bobble" of the last digit, and the DVM38 was outstanding in this respect.

All models performed very well. In fact, the only problem you should have is in deciding which model is best for you. □

BE A SHERLOCK OHMS!

by Edmund A. Braun.

Have a few minutes to spare? Then have fun solving this Just-across-word puzzle based on Electronics. Each word is connected to the word above and below by one or more letters although only one is usually shown as a clue. Each correct answer is worth 4 points; a perfect score is 100. It shouldn't be difficult to get a high rating except perhaps for someone who is sure "scrambler" is for preparing eggs, or that "achromatic" refers to a tumbler who performs gymnastics! Ready? Then start deducing!



1 Intimately fused mixture of two or more metals.
2 In an oscillator, the undesired change from a desired frequency.
3 Vary irregularly; to rise and fall.
4 Antenna characteristic determining orientation.
5 Immeasurably small; approaching zero.
6 The servicing, repair, overhaul, and upkeep of equipment.
7 Having an output that doesn't vary in direct proportion to the input.
8 The suitability of a subject or model for televising.
9 Quality of being sharply or exactly defined. Accuracy.
10 Centimeter-gram-second electromagnetic unit of electrical quantity.
11 Vacuum tube whose electrical properties are modified by action of light.
12 A transformer's output winding.
13 The initial transient response to a unidirectional change in output.
14 A coating that forms like rust on brass, copper, or bronze.
15 Not having electrical energy stored in a capacitor or battery.
16 Five-electrode tube that provides push-pull amplification with a single tube.
17 An alkaline metal having photosensitive characteristics especially in blue light.
18 Two triodes in same tube envelope.
19 Pertaining to a plug that may be inserted in receptacle in only a predetermined position.
20 A combination of components which, when inserted in a circuit, change the frequency response of the device.
21 Pertaining to a current which varies periodically but doesn't reverse itself.
22 An electrode of a transistor.
23 A cgs electrostatic unit of charge.
24 Cathode-ray tube with screen composed of halide of sodium or potassium.
25 Type of coil named for an Austrian-born American electrician and inventor.

We know you wouldn't sneak a peek so we'll tell you frankly the solution is on page 54.

the solution is on page 54.

SERVICE ASSOCIATION CONVENTIONS

NESDA

During August 13th through the 17th, the annual conventions of the National Electronic Service Dealers Association (NESDA), International Society of Certified Electronic Technicians (ISCET), and Texas Electronic Association (TEA) will be held simultaneously in San Antonio, Texas. A partial listing of convention events is as follows:

Friday,
August 13
Open Golf Tournament
TEA Meeting
Welcome To Texas

Saturday,
August 14
Keynote Breakfast
(Sponsored by GTE Sylvania)
Speaker is Toby Mack, EIA
ISCET Meeting And Election
Mercado Electronica '76 (Trade Show)
Refreshments by Raytheon
RCA Luncheon
Howard W. Sams Cocktail Party
Zenith Banquet

Sunday,
August 15
ISCET Breakfast
Manufacturer Panel Discussions
Technical And Business Seminars
Sony Luncheon
Sony video-disc demonstration
NESDA Officer Nominations

Monday,
August 16
Panasonic Breakfast
NESDA Annual Meeting and
election of officers
Magnavox Luncheon
Hall Of Fame Banquet
Don Martin, Master of Ceremonies

Tuesday,
August 17
Executive Council Planning Meeting
Profitable Service Management School
Ladies Business Seminar

Convention registration fee is $40 per person, exclusive of fees for optional events, such as Business Management Schools, Texas barbeque, Air Museum tour, and the golf tournament. San Antonio is a historic city with many opportunities for sightseeing.

For more details, contact:

NESDA
1715 Expo Lane
Indianapolis, Ind. 46224
Phone: 317/241-8160

NATESA

National Alliance of Television & Electronic Service Associations (NATESA) has chosen August 19th through 22nd at the Pheasant Run Lodge in St. Charles, Illinois (a suburb of Chicago) for its 1976 convention.

Convention activities include: official business meetings; meals; banquets; floor show; and many other features, including messages from leaders of the electronics industry. A full-participation ticket for the convention is $25.

For more details, contact:

NATESA
5908 South Troy Street
Chicago, Illinois 60629

photofact™ bulletin

ADMIRAL
Chassis 4M10D35-1 1591-1

BROADMOOR
3513 1591-2

HITACHI
P-04, P-05 1577-1

J C PENNEY
2877B, 685-2877B (855-1996) 1585-1

K MART
SK9B617/M,
SK12B618/M 1583-1

RCA
Chassis CTC81B 1589-1
Chassis CRK22A/DAP-1 .... 1589-A

SANYO
91T51 1590-1

SEARS
562.40092500 1590-2

SHARP
3M-46 1588-2

SONY
Chassis SCC-64B-D/-64B-E 1592-1
Remote Control RM-301 .... 1592-1-A

SYLVANIA
Chassis E21-3/-6 1587-1

TOSHIBA
Chassis TAC-550 1592-2

TRUETONE
GEC3713A-77/15A-77 1589-2

product report

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.

CB Converter

"Signal 23" from **Finney Company** is a CB converter for auto installation. It converts all 23 CB channels to the standard AM broadcast frequencies.

The converter uses the auto radio's antenna, eliminating the need for a special antenna.

"Signal 23" has a gain control, a crystal-controlled oscillator, and incorporates an RF stage. It uses a FET to provide sensitivity of less than 1 microvolt at 10 dB SN ratio. A dual-gate MOSFET mixer minimizes cross modulation.

The converter takes only a few minutes to install and comes complete with all hardware, instructions, and a limited consumer warranty. It has a list price of $38.00.

For More Details Circle (24) on Reply Card

CB Installation Kits

Two CB auto-stereo installation kits now are available from **Littelfuse.**

The kits contain everything necessary to install a CB radio or auto stereo: fuses, wire connectors, tab terminals, quick-connect terminals, and in-line fuseholders. Each kit also contains quick-release set disconnectors, which allow the unit to be removed from the vehicle.

The kits are available in a "single-pack" version, containing everything needed for one installation, and in a "six-pack" for six complete installations. Each kit has easy-to-follow instructions.

For More Details Circle (25) on Reply Card

Savbit Solder

Multicore Solders has developed a solder specifically to prevent the dissolving of fine gauge copper wires and thin copper foils during soldering.

The new solder, called Savbit, is a copper-loaded, tin/lead alloy wire solder with 5 separate cores of rosin-base flux. Test results show it reduces the solution of copper by as much as 100 times.

Savbit is recommended for applications where copper soldering tips are used, because it prevents rapid pitting and wear.

For More Details Circle (26) on Reply Card

CB Repair Kits

Two kits for repairing CB and scanner radios are available from **General Electric.** The solid-state kits supplement GE's basic K-935 kit introduced last fall for repair of CB and other Far-East-built consumer electronics.

Kit K-936 provides 16 types with a quantity of 37 items. Kit K-937 has 16 types with a total of 36 devices. Parts for each kit are filed in a 24-drawer storage cabinet with pull-out drawers. All drawers are interchangeable.

The kits are complete with a special 12-page cross reference parts guide (ETRO-7622) keyed to the brand of equipment to be repaired.

For More Details Circle (28) on Reply Card

Antenna Alarm

A new accessory from **The Magitran Company,** called the Antenna Anti-Theft Alarm Activator, activates a car horn or auto alarm system when a protected antenna is lifted from its base. The CB 10-57 will work with any auto-alarm system, car horn, or for extended range, an external trumpet or siren. It is compact and

CB Transceiver

The **Sparkomatic Corporation** now is marketing a 23-channel CB transceiver.

Model CB-1123 has an easy-to-read illuminated channel selector, transmit modulation light, volume control/on-off power switch, illuminated signal-strength and radio-frequency output meter, variable squelch control, automatic noise limiter switch, and comes with chrome mounting bracket and hardware.

The CB-1123 also includes a public address switch, jacks for P.A. speaker and external speaker and a screw-down type detachable microphone.

For More Details Circle (27) on Reply Card

easily concealed; it can be used with all grounded antennas having a base loading coil, and is powered by the vehicle's regular battery.

For added protection, the CB 10-57 comes with an antenna retention strap that keeps the antenna attached to the vehicle even after it has been unscrewed.

For More Details Circle (29) on Reply Card

Microwave Oven Control

Litton's variable power control is now offered on its two new Micromatic Model 900 double-oven microwave ranges.

The Vari-Cook oven control allows the homemaker to change microwave cooking speeds for different foods. By varying the power from 65 to 650 watts, she can get the slow-cooked flavors of a stew or gourmet sauce, but at microwave speeds. The self-cleaning lower ovens on both units are also the first to feature a new see-through door without a heat shield.

For More Details Circle (30) on Reply Card

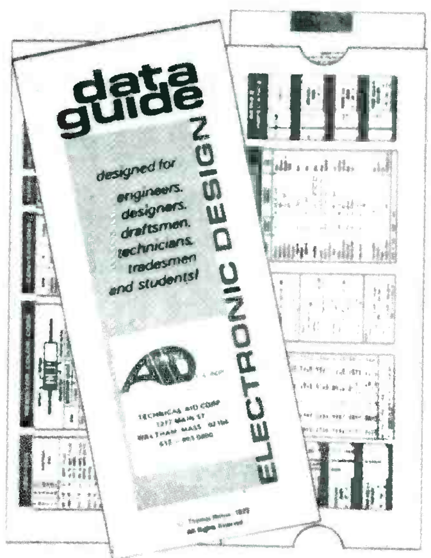
ECG Semiconductors

A new **GTE Sylvania** kit provides replacements for semiconductors most often subject to failure in CB radios. The kit includes 23 transistors and three integrated circuits for replacing drivers, modulators, RF outputs and other semiconductors. The devices are available in rack or carton pack.

For More Details Circle (31) on Reply Card

Pocket-Size Data Guide

This 3-1/2" X 8-1/2" slide-rule Data Guide contains up-to-date material from recognized standards that is useful in everyday technical applications. It contains data such as impedance formulas for series and parallel circuits, copper-wire tables, conductor and insulator properties, DB tables, current, power formulas, AC and DC circuits, resistor color codes, metric conversions, common conversions, etc.



Price of the Data Guide is $2.95 pp, and it is available from **Technical Aid Corporation.**

For More Details Circle (32) on Reply Card

For More Details Circle (11) on Reply Card

For More Details Circle (12) on Reply Card

For More Details Circle (13) on Reply Card

test equipment report

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.

Portable DMM

Model 6000 is a portable digital multimeter from **Weston Instruments.** Automatic ranging is provided for the five standard measurement functions: AC volts, DC volts, AC amps, DC amps and resistance. Twenty-six different ranges cover voltage measurements from 200 mV to 1 kV, current measurements from 2 mA to 10 amps, and resistance from 200 ohms to 20 megohms. A "Hold" input jack provides memory-retention for remote measurements. Automatic zero and automatic polarity are built-in.

Basic accuracy of Model 6000 is 0.35%; resolution of the voltage ranges is 100 microvolts, and 0.1 ohm for resistance.

It has a 0.5" high Liquid-Crystal Display (LCD), with large black digits that can be seen easily. Alternate blinking of the display indicates over-range.

The Model 6000 is powered by two 9-volt transistor batteries. Typical battery life under normal instrument operation is approximately 200 hours. Model 6000 sells for $195.

For More Details Circle (15) on Reply Card

CB Test/Power Meters

Eico has a complete assortment of test equipment for CB's. The 715 "Transmatch" measures: RF power to 50 watts; standing wave ratio; both forward and reflected power; and modulation percentage. It features a built-in 50-ohm dummy load. The 715 sells for $69.95.

The 725 SWR/Power meter connects between the transceiver and the feedline to the antenna, thus causing minimal insertion loss. The dual-range wattmeter selects either 0-10 or 0-100 watts, and has a broadband frequency response of 3 MHz to 144 MHz. The 725 is priced at $39.95.

Eico 735 is a 1000 watt, inline power-output meter for 50-ohm lines. It absorbs negligible power when in use, and will continuously monitor powers up to 1000 watts. Three ranges expand the meter from 0-10 watts, 0-100 watts and 0-1000 watts. The frequency range is 3 MHz to 150 MHz. It is priced at $29.95.

The 745 SWR/Field-Strength Meter connects into the circuit and continuously monitors standing wave ratio, relative forward-and-reflected power, and field strength. It is capable of measuring standing wave ratios of 3:1 or higher, and sells for $19.95.

The 755 Mini Mobile Field-Strength Meter monitors both antenna and transceiver operation and performance. It does not need tuning or attachment to any part of the transceiver; frequency range is 2 to 200 MHz. The 755 is priced at $9.95.

For More Details Circle (17) on Reply Card

3½-Digit Multimeter

The Model 283, a new 3½-digit multimeter priced at $170, has been announced by **B&K-Precision.**

Model 283 has high-intensity LED displays, 0.41" high, that can be read easily in brightly-lit rooms at a distance of at least six feet, according to the manufacturer. It measures DC volts, AC volts, DC current, AC current and resistance, with 100% overrange. Out-of-range is indicated by a flashing digit and three zeros. All readings have an automatically-positioned decimal point.

Model 283 has 4 DC voltage ranges, with ±0.5% accuracy on the 1.000, 10.00 and 100.0 ranges and ±1.0% on the 1000V range. Polarity indication is automatic. Four AC voltage ranges have ±1.0% accuracy on 1.000, 10.00 and 100.0 ranges and 1.5% accuracy on the 1000V range. There are four AC current and four DC current ranges, with the similar accuracies. The six resistance ranges, 100 ohms, 1k, 10k, 100k, 1000k and 10 megohms, have ±1% accuracy, except for the top range which is ±2%. Input impedance is 10 megohms on all voltage ranges.

For More Details Circle (16) on Reply Card

RF Signal Generator

VIZ Test Instruments Group offers a new solid-state radio signal generator called the VIZ WR-50C.

It covers fundamental frequencies from 85 KHz to 40 MHz in six ranges, and harmonic frequencies on higher bands. The selection switch has two positions for special 455 KHz and 107 MHz sweep outputs for broadcast and FM IF sweep alignment. The RF output is 75 millivolts or more for all ranges; dial calibration accuracy is ±2%. The generator has built-in modulation plus a crystal-controlled oscillator circuit. Included is a two-step ten-to-one switch plus vernier for VFO sweep-output attenuation and a two-position seven-to-one switch for crystal oscillator attenuation. Suggested price is $117.

The signal generator is one of several new products announced since VIZ acquired the RCA test-instruments business.

For More Details Circle (18) on Reply Card

RF Wattmeter

Coaxial Dynamics has a 4-range termination-type wattmeter that covers 20 to 512 MHz and services everything from hand-held portable transmitters to base-station installations. The most-sensitive power range measures three watts full scale. Model 85 is designed for use in 50-ohm coaxial systems as an accurate direct-reading RF wattmeter, and a 150-watt non-radiating dry termination load.

For More Details Circle (19) on Reply Card

Solution to:
BE A SHERLOCK OHMS

1 alloy
2 pulling
3 fluctuate
4 directivity
5 infinitesimal
6 maintenance
7 nonlinear
8 telegenic
9 precision
10 abcoulomb
11 photocell
12 secondary
13 precursor
14 verdigris
15 uncharged
16 pentatron
17 potassium
18 duotriode
19 polarized
20 equalizer
21 pulsating
22 collector
23 stathenry
24 draktrace
25 Tesla*

(*Nikola Tesla (1856-1943) designed power system at Niagara.)

Start with 100 points and deduct 4 points for any part you may not have answered correctly.

Your rating:
60 - 64 Fair.
68 - 72 Pretty good.
76 - 84 Very good.
88 - 96 Excellent.
100 PERFECT/
Congratulations, Sherlock Ohms!

audio systems report

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.

Motorcycle Speakers

Neosonic Corporation has available Sonosphere SPR-12 speakers for use on motorcycles.

The SPR-12 speakers mount directly onto the sides of the ignition-switch console, and can be swiveled up or down and side-to-side to provide the most effective position for sound direction. The entire installation protrudes approximately 5" from the surface. Speakers are sealed in 4¾" diameter steel spheres that are rear-damped with fiberglass to eliminate the back wave.

The 4-ohm speakers have a response from 100 Hz to 16,000 Hz, and are rated at 10 watts RMS. They are compatible with any radio used for moving vehicles. Suggested resale price is $24.95 for black or cream finish, and $29.95 for chrome.

For More Details Circle (20) on Reply Card

Tape-Player/Radio

A universal 8-track player and AM-FM stereo receiver has been introduced by **Audiovox Corporation.**

Model ID-400 is a compact, solid-state sound center with the following features: AM-FM slide-bar selector, FM local-distant reception switch, tape program indicator lights, and flip-away dial scale/tape-cartridge door. Power output is 7 watts per channel; for 12-volts negative ground.

No additional kits are needed for installation; all necessary parts are included in the package, with photographic instruction guide. Suggested retail price is $145.50.

For More Details Circle (21) on Reply Card

70-Volt Transformer

Model A102A is a weatherproof, low-loss, 70-volt line-matching autotransformer from **Shure Brothers.**

Four power taps (50, 25, 12 and 6 watts) are provided for connection to the 70-volt speaker line from the power amplifier. Power rating is 50 watts; frequency response is 50 Hz to 15 KHz.

Model A102A has barrier strips with captivated screws for direct connection to speaker wires. Suggested net price is $31.50.

For More Details Circle (22) on Reply Card

Extension Speaker

Components Specialties offers an extension speaker designed specifically for the CB audio response of 700 to 2,000 Hz.

SPECO Model CBS-4 comes with a miniature plug on the end of its 10-foot cable for connection to most CB base stations. Also included is a PL-55 adapter plug in the event the base station has a standard-type jack. The 4" speaker has a heavy ceramic magnet and provides 5 watts of nominal power. Impedance is 8 ohms or lower.

Made of ABS, Model CBS-4 is heat-resistant and weatherproof. It has an adjustable, metal mounting-bracket that locks into any position. Suggested resale price is $14.95.

For More Details Circle (23) on Reply Card

Help!

Anytime you have a question about your subscription to Electronic Servicing, please include a mailing label to insure prompt service on your inquiry.

Change of Address

If you're about to move, please let us know approximately four weeks before the move comes about. Simply affix your present label here, and carefully print the updated information below.

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The MARKETPLACE

This classified section is available to electronic technicians and owners or managers of service shops who have for sale surplus supplies and equipment or who are seeking employment or recruiting employees.

Advertising rates in the Classified Section are 35 cents per word, each insertion, and must be accompanied by cash to insure publication.

Each initial or abbreviation counts a full word.

Minimum classified charge $3.00.

For ads on which replies are sent to us for forwarding (blind ads), there is an additional charge of $3.00 per insertion to cover department number, processing of replies, and mailing costs.

Classified columns are not open to advertising of any products regularly produced by manufacturers unless used and no longer owned by the manufacturer or a distributor.

FOR SALE

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

CONVERT any transistorized T.V. tuner to a tuner substituter. Plans $2.00. New accelerated Radio & T.V. course. RADIO TELEVISION TRAINING, Box 279, ES-66, Syracuse, N.Y. 13206. 8-75-tf

STOP...don't junk that television set. ASE manufacturers the world's most complete line of television picture tubes. No other company offers: Over 1700 types of television picture tubes. Most types immediate delivery. Transportation in the Midwest—paid, ½ transportation paid in other states. Tubes for Old or New Models. Complete line of both black & white and color. Full 2 year factory warranty. Lowest prices anywhere. Finest quality. Write today for more information. Allied Sales & Engineering, Inc., Dept. 27, Pimento, Ind. 47866, Telephone - 812-495-6555. 6-76-2t

TV SALES/SERVICE BUSINESS. Southern British Columbia, Canada. Store built 1967 has two levels, 960 square feet each level on ½ acrealand on main road. Three major brands. Close to resort area, hunting, fishing. Gross 1975 $78,000 and growing. $100,000 plus stock. Dept. 509, 1014 Wyandotte, K.C., Mo. 64105. 6-76-3t

TV SERVICE BUSINESS in small mountain community. Operating for 10 yrs. Retiring. Gross $15,000 only part time. Only service in 30 mile radius. Expansion potential unlimited. $15,000 includes 74 van. R. Murray; Box 816; Hayfork, Calif. 96041. 6-76-2t

REJUVENATE TELEVISION PICTURE TUBES without equipment. Use power from TV. Send Tube Number and $5.00 to: W. R. Collins, Jr., HHC, 4TC, BDEPPD, APO N.Y., 09451. 7-76-1t

JERROLD MODEL 890 sweep frequency generator. Range 25 mHz to 1000 mHz. $450. Videon TV 1-717-564-4566. 7-76-1t

FOR SALE (CONT.)

TRANSISTOR TESTER. Convert transistor radio into in-circuit transistor tester. Tone indicates good transistor. Plans $2.00. SZA Electronic Systems Inc., 39 Bayberry La., Levittown, NY 11756. 7-76-3t

PICTURE TUBE MACHINE—We buy and sell NEW and USED CRT rebuilding machinery. COMPLETE TRAINING. Buy with CONFICENCE from the ORIGINAL MFGR. For complete details, sen name, address and zip code to: LAKESIDE INDUSTRIES, 3520 W. Fullerton Ave., Chicago, Ill. 60647, Phone: 312-342-3399. 7-76-1t

EASY-DOES-IT—One-Man TV Cart! Will tote a color TV stereo 6' long. The answer to the one-man shop or the high cost of sending two men to do it! Box 296, Mt. Pleasant, Utah, 84647 for information. 7-76-1t

132 ASSORTED TV-Tubes. Price $100.00. Call 215-WA7-2938. 7-76-1t

GET LATE MODEL Color TV's (rebuildable) for $10-$20-$30. All you can use. Practical plan makes to $100 day plus for skilled TV Techs. Detailed instructions, method, $10 ppd. Economy TV Rentals, Box 2890, Denver, CO 80201. 7-76-2t

SAMS TV PHOTOFACTS—57 thru 1334 of most popular models, about 400 folders. Best offer. Calais Repair Service, 2819 E. Smicoe St., Lafayette, La., 70501. 7-76-1t

SELLING SUPREME PUBLICATIONS' manuals to 50% discount. Beitman, 1760 Balsam, Highland Park, IL. 60035. 7-76-1t

SONY REPLACEMENT PARTS, For Color Televisions. Tuners, filament transformers, audio transformers, antennas, handles, etc. All items new, and priced far below Sony replacement cost. Volume discounts. Inquire: 22525 Kingston Lane, Auburn, CA, 95603. Phone (916) 272-1971. 7-76-1t

ARIES—50 mHz frequency counter $110. H. Geller, 12622 NE 3rd, Bellevue, Washington, 98005. 7-76-1t

UNUSUAL SURPLUS AND PARTS Catalog. $1. ETCO Electronics, Dept. E.S., Box 741, Montreal "A" H3C 2V2. 7-76-10t

WANTED

PICTURE TUBE REBUILD PLANT complete. Cost between $1500.00 & $2500.00. Vern Fisher, 388 E. 300 N. #18, Springville, Utah, 84663. 6-76-2t

WANTED—One used Telequipment Oscilloscope TL-D61. B & A Radio-TV, 30 Oak, Hogansville, Georgia, 30230. 7-76-1t

EDUCATION-INSTRUCTION

REPAIR TV TUNERS—High Earnings; Complete Course Details, 12 Repair Tricks, Many Plans, Two Lessons, all for $2. Refundable. Frank Bocek, Box 3236 Enterprise, Redding, Calif. 96001. 4-76-4t

TV PROBLEMS??? Send symptoms with a copy of schematic and self-addressed stamped envelope and $2.00, to Troubleshooter, Box 4553, Downey, Ca. 90241. Results Guaranteed. 9-75-tf

BUSINESS OPPORTUNITY

CONVERT black/white TV to color: experience not necessary. $3.00 (refundable). Tayo Paul, 980 Greene Ave., Brooklyn, N.Y. 11221. 5-76-3t

TV SHOPS—Increase your income. Repair and update MATV systems with patented method. $200.00 day possible. Training available. P.O. Box 809, Boynton Beach, Fla. 33435. 7-76-6t

ESTABLISHED TV SERVICE shop in beautiful Piedmont Section of North Carolina. Excellent opportunity at reasonable price. Write E. M. Brown, 313 Linville Springs Rd., Kernersville, NC 27284. 7-76-1t

FOR SALE—Established 21 year old TV repair business, large store with attached 6 room house, 50' basement, 50' attic, separate paneled 20' x 20' garage with heat & electric. Entire property approximately 60' x 135'. All Zoned business. Located in lovely residential area. Well equipped shop, all electronic instruments. House, furnished or unfurnished. Retiring & moving South. Asking $48,000. Bellmore, Long Island, New York. 516-785-9127. 7-76-1t

TV SALES & SERVICE in same location 15 years. Nets over $25,000. Retiring. Including truck, equipment & inventory $25,000. A. Bolin, 6361 Balsam Lake, San Diego, Ca. 92119. 6-76-tf

advertisers' index

NEW 3½ Digit Multimeter from B&K-PRECISION

B+K PRECISION MODEL 283—$170

...you'll want it for its features ...but it's the price that will sell you!

- High intensity LED display is easily read from at least 6 feet in the brightest room
- 0.5% DC accuracy
- 100% overrange (1000 scale reads to 1999)
- Automatic polarity
- Automatic decimal point
- Flashing overrange indication on display
- Four ranges each for voltage and current
- Six resistance ranges to 10 meg.
- Reliable In-circuit resistance measurements
- Overload protection on all ranges

Complete new circuitry makes the Model 283 the most dependable and versatile 3½ digit multimeter you can buy. The extra-bright display allows you to use it where other units would cause reading problems. The selectable "low ohms" function permits accurate measurement of semiconductor shunted resistors.

An optional, internal battery pack (BP-83, $50.00) provides 8 hours of continuous use on one overnight charging and charges when the Model 283 is in use on 115/230VAC.

Thoughtful, convenience features like a side carrying handle, tilt stand and detachable line cord add to its usefulness.

Your B&K-PRECISION distributor has them in stock and will be glad to demonstrate its features to you. Call him, or write for additional information.

B+K PRECISION
PRODUCTS OF DYNASCAN
6460 West Cortland Avenue
Chicago, Illinois 60635 • 312/889-9087
In Canada: Atlas Electronics, Toronto

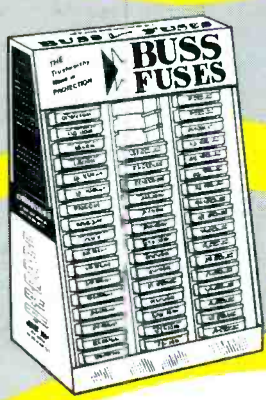
For More Details Circle (2) on Reply Card

Buss® Fuses Specialize Too!

in the protection of

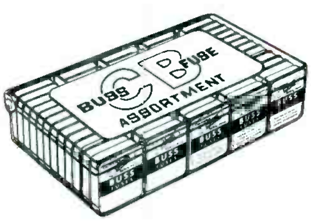
CB

EQUIPMENT

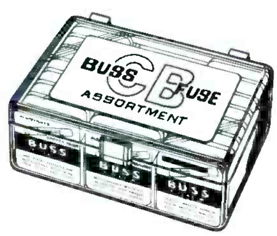


No. 240CB-3
Metal Display Stand

No. 80CB-1
Metal Display Stand



No. 240CB-4
Plastic Display Box



No. 80CB-2
Plastic Display Box

Now . . . four new BUSS fuse assortments exclusively designed with replacement fuses to service most Citizen Band Radios — offering a whole new area of opportunities for increased profits.

Two assortments contain 48 — 5 in metal boxes (240 fuses). BUSS No. 240CB-3 fuse assortment comes in a handy metal display stand. BUSS No. 240CB-4 fuse assortment is packed in a compact plastic display box.

In addition, there are two fuse assortments containing 16 — 5 in metal boxes (80 fuses). BUSS No. 80CB-1 fuse assortment packed in a metal display stand and BUSS No. 80CB-2 fuse assortment in a plastic display box.

Both BUSS fuse assortments contain a careful selection of the most popular fuses used in CB radios.

CB dealers can now have the fuses they need in a neat complete package to service all their customers fuse needs.

For full fuse assortment details, write for BUSS Bulletin CBA.

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