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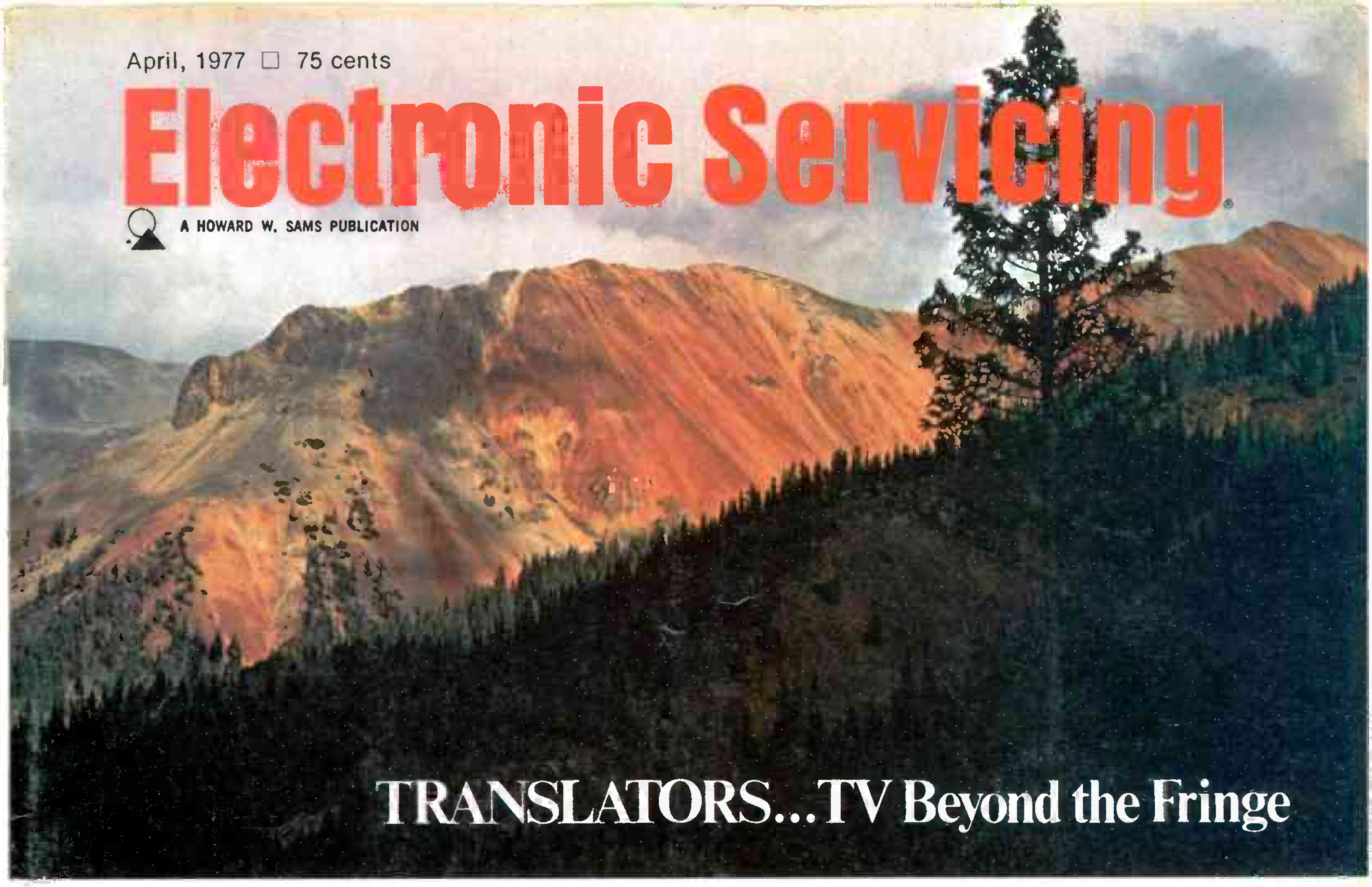
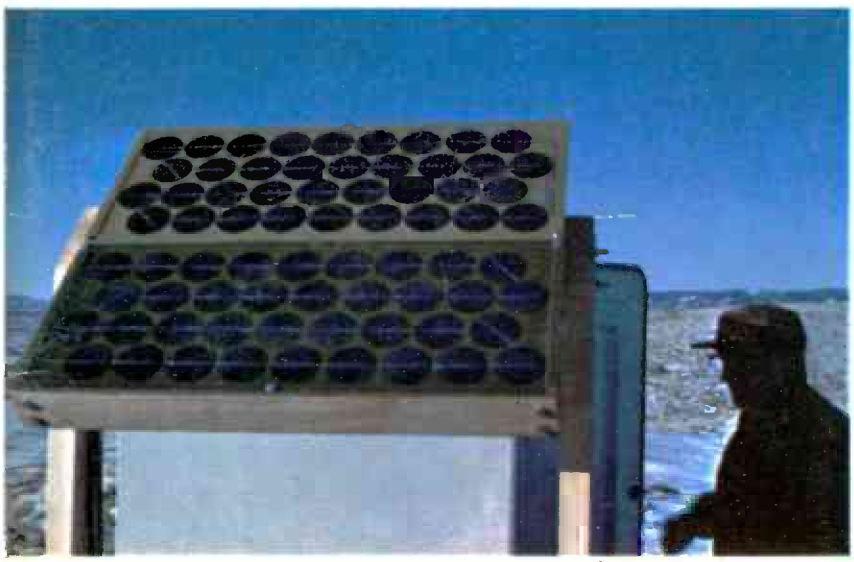


TRANSLATORS...TV Beyond the Fringe



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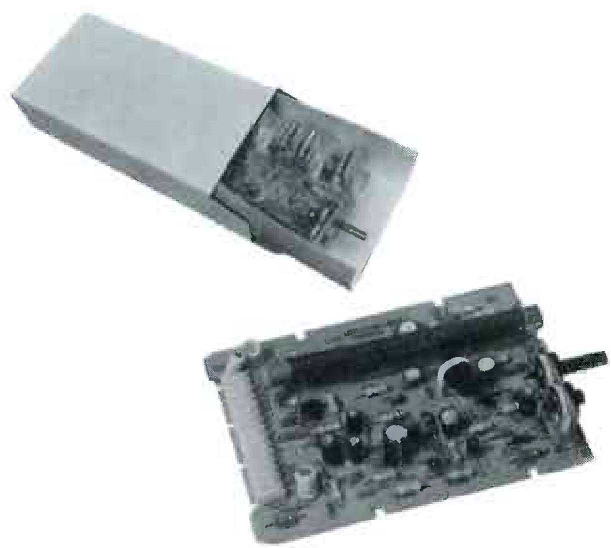

April, 1977 ☐ Volume 27, No. 4

Electronic Servicing®

in this issue...

ABOUT THE COVER

Two pictures show part of the translator system in North Park, Colorado. The photos are by Jim Kluge and Carl Babcoke.

DEPARTMENTS

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Electronic Servicing

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electronic scanner

news of the industry

NEWCOM '77, the electronic industries most-important parts and equipment show, will be held May 3rd, 4th. and 5th in Las Vegas, Nevada. Almost 300 companies are expected to operate 500 exhibit booths, and many conference units, demonstration rooms, and executive suites. A new feature is the "New Technology Center" for the display of a NASA Space Shuttle, an Omega navigation system, and a microprocessor programming center. This show determines, in a large part, the components and equipment your local electronic distributor will offer for sale during the next year.

Any "marking" of the picture tube on an RCA television set, resulting from use of the set with a TV game, is not a defect covered by RCA's warranty to the customers, RCA has announced. Television sets are designed for the display of a continually-moving and changing picture. However, TV games display a fixed pattern at high brightness—a pattern that after extended use might be visible when the television set is off, and is sometimes perceptible during normal television viewing. RCA has suggested that persons using TV games on their sets restrict the use of a television for a game to the time actually played, and turn down brightness and contrast to reduce the probability of marking.

Nearly one million CB radio license applications were received by the Federal Communications Commission in January, 1977, breaking all records for CB-license applications for any one-month period since Citizens Band two-way radio service began in 1958. "January's phenomenal surge in CB license applications bears out the government and industry's feelings that the expansion of service from 23 channels to 40 channels came just in time," said John Sodolski, Vice President of the Electronic Industries Association. "The January application rate is in line with industry's prediction of a ten- to twelve-million-set year for 1977." There are more than 22 million CB sets currently in use in the United States.

The Finney Company now includes in all of its antenna installation instruction sheets a bold "WARNING!!" paragraph that recommends specific safety procedures. This is in cooperation with the request of the Federal Consumer Product Commission that all antenna manufacturers alert the public to the possible dangers of installing antennas.

Total sales of consumer-electronics products to retail dealers for 1976 were greatly improved over those of 1975, according to the Electronics Industries Association. Color TV sales were up 18.7%; monochrome TV sales increased by 4.6%; AM and FM radio sales were higher by 11.5%; and automobile radios increased by 34.7%.

continued on page 6

GTE Sylvania, Electronic Components Group, 100 First Ave., Waltham, MA. 02154.

We've got the longest running feature on TV.

Our Color Bright 85® picture tube warranty is the longest in the industry. We can offer it because we're confident that a Color Bright 85 picture tube will probably last longer than five years.

The warranty is a great selling tool that builds customer confidence in your quality work. Plus, it lets you form a long-term customer relationship with each picture tube you replace.

*Limited warranty, naturally. It does not cover labor for replacing a tube.

The Color Bright 85 picture tube offers economy with the high quality standards you expect from Sylvania. Couple that with the new 5-year warranty* and you'll find the Color Bright 85 is an easy sale.

And it can be better for you in the long run.

GTE SYLVANIA

continued from page 4

The number of consumer electronics firms has increased by 6% over 1976 figures, according to a survey conducted by the National Electronic Service Dealers Association (NESDA). According to NESDA, there are presently 70,526 consumer electronics firms; 4,526 more than last year. The number of electronics service technicians has also increased, according to the survey: up 10,865 from 196,347 to 207,212. The survey also found that nearly 75% of the businesses engage in product sales; nearly 50% of all businesses are owner-operated, one-man shops; a majority of businesses hire part-time servicers; and, many businesses are operated by a servicer who holds a full-time job elsewhere.

Videotape, video discs, video games and TV projection systems show the best potential for growth in the consumer-electronics industry, according to Front and Sullivan, market research specialists. Also, CB radio and semi-conductor manufacturing should continue to expand during the next decade. Videotape systems are expected to peak about 1980, then decline rapidly as video-disc systems reach the market. The most serious video-disc problem is likely to be the lack of standardization. There is a probability that the toy industry will become dominant in the sales of video games within the next two years. The research specialists also suggest that the U.S. TV manufacturers move into a new area, such as security and fire-detection systems; because, if the present trends continue, only two or three U.S.-owned TV manufacturers will survive.

Italian TV owners are to pay an annual fee of $60 for each color TV and $31 for B&W. Retailing Home Furnishings quotes an Italian source as saying that the high fee for color sets penalizes the manufacturers of color TVs and related industries. It is estimated that 12 million of the 14 million Italian families have a B&W TV, while less than 800,000 own color receivers.

PTS Electronics has purchased the Tuner Service Company, located at 5505 Reisterstown Road in Baltimore, Maryland. In addition to TV-tuner rebuilding and module rebuilding/exchange, the Baltimore service center will offer Maryland and surrounding areas a complete inventory of tuners, tuner parts, modules, tuner test instruments and accessories. PTS Electronics now has 43 company-owned branches in the United States and Canada.

Duane Schultz, training director for Sencore, **has held three week-long training sessions for the Sencore technical field representatives,** including a review of the servicing applications of all Sencore instruments. This year, Sencore will hold more than 1,000 technical seminars, called "Tech-a-ramas".

Zenith Radio Corporation sales for the year ending December 31, 1976, totaled $978 million, compared with $901 million for 1975. Sales for the fourth quarter totaled $279 million, up $24 million from 1975.

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Exact Replacement Tuners are available at a cost of $14.95 and up. (U.S.A. Only)

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WATCH US GROW

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

troubleshootingtips

Send in your helpful tips—we pay!

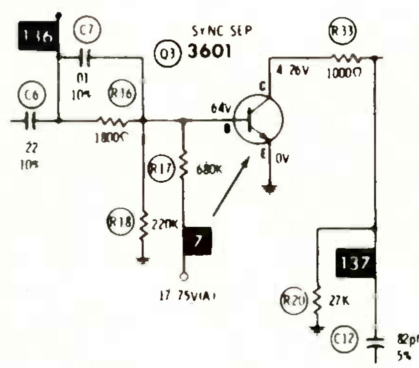
Hum in picture RCA Chassis CTC51E

(Photofact 1332-2)

These two repairs prove that similar symptoms can be caused by completely different defects.

The first set, an Admiral with a 24A2 chassis, had a dark bar floating up through the picture, so I brought the chassis to our shop and connected it to the test jig. First test was scoping all of the filters for excessive hum. There was none. Also, no hum appeared anywhere in the video stages right up to the picture tube.

However, hum was present at the outputs of the color amplifiers. The tubes tested good, without any H-K leakage; but they were replaced to make certain. Also, the hum appeared at **all three** plates. A smaller hum waveform was found at the common cathodes, although the blanking amplifier was free of it. Even more peculiar, the hum was at **both** ends of R187, the 430-ohm common-cathode resistor.



I suspected a bad ground, and noticed that the same copper foil was ground for both the resistor and the cold side of the heater supply for the "Z" demodulator. The foil and ground looked okay, but it must have had some resistance, for when I added a ground wire from the tube socket to the chassis the hum was cured. Heater current flowing through the common "accidental" resistance was causing a hum voltage drop which went to the color amps.

When the CTC51E RCA came in with essentially the same complaint, I thought at first it might be a similar problem. The picture seemed to indicate that 60-Hz hum was intermittently being mixed with the sync, causing picture bending and a single dark horizontal bar.

But, neither the tube tester nor the scope could find any H-K leakage. Sometimes, the symptom would change and resemble bad AGC. Clamping the AGC voltage did not improve the performance.

At the horizontal AFC diode, the sync pulses appeared to have some type of "noise". However, the input and output DC voltages and the signal amplitudes at Q3 sync separator were okay, except for the "hash" at the output.

Acting on a hunch, I replaced Q3 transistor, and **the problem was gone.**

The first case had seemed to be filter hum, but was found to be common-ground hum. The second appeared to be hum in the sync, but actually was some kind of noise in the sync separator that affected the horizontal locking. These are the incidents in a technician's day that make life interesting, even though the symptoms are difficult before they are solved.

Ray Russell
Bear Lake, Michigan

No control of brightness RCA CTC53 and CTC55

(Photofact 1342-2)

We have repaired a number of these receivers for similar complaints, such as, "no control of brightness," "intermittent brightness," or "can't reduce the brightness." The first trouble was hard to find, because it was intermittent. But, finally we found a leaky 6GH8 horizontal-blanking amplifier tube.

Replacing this same tube in the others cured those brightness problems also.

Mac Kellman
Video Master TV
Brooklyn, New York

Got A Troubleshooting Tip?
If you've recently run across an unusual trouble symptom, send a thorough description of it and the solution to:

Troubleshooting Tips
Electronic Servicing
P.O. Box 12901
Overland Park, Kansas 66212

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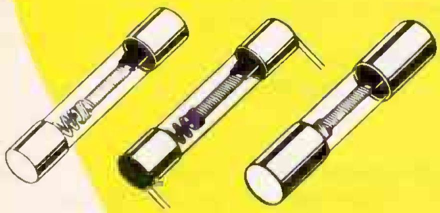

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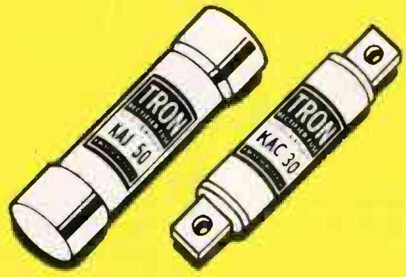

Provide extremely fast opening and high degree of restriction of let-thru current to protect Solid State Devices. Ampere rating ½ to 1000 in voltages up to 1500.

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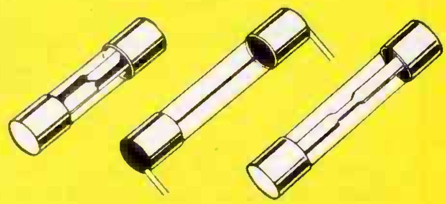

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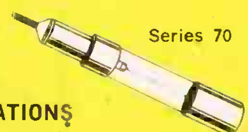
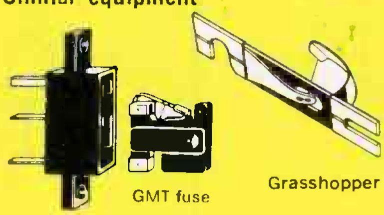


Series 70



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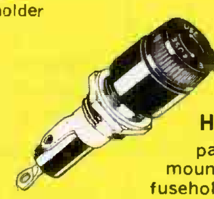
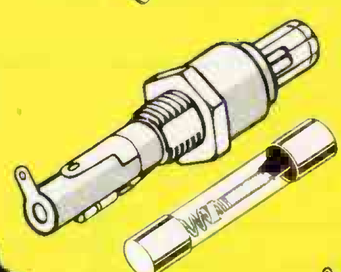
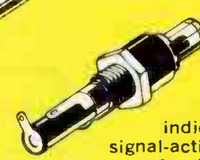


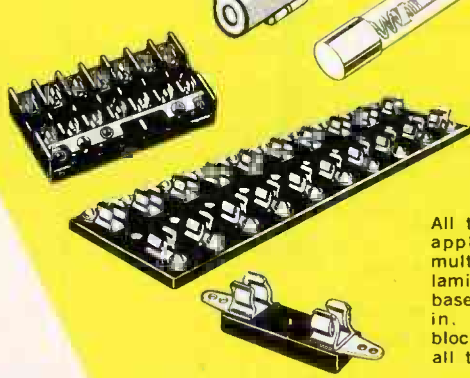
HKP
panel mounted fuseholder for ¼ x 1¼ in. fuses.

BUSS FUSES and FUSEHOLDERS
to meet military specifications.





HKA
lamp indicating, signal-activating fuseholder.



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Chassis—RCA CTC72
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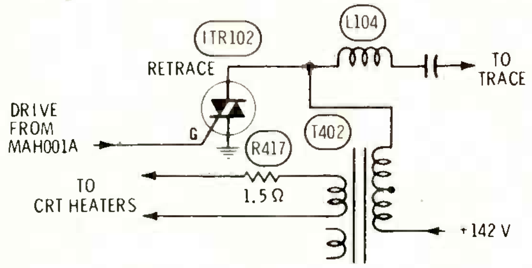
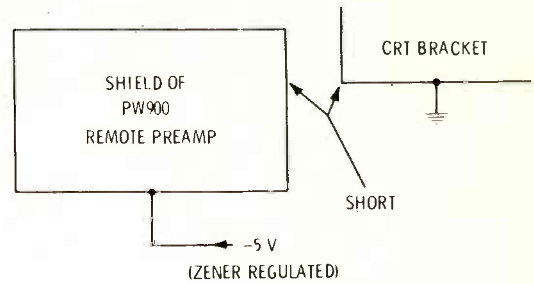


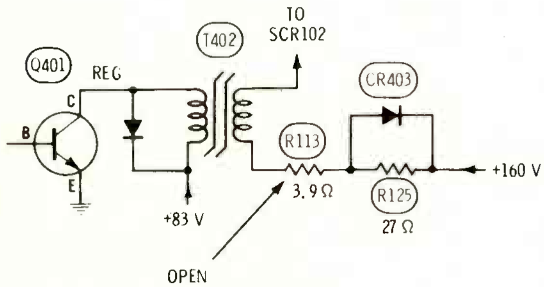
Symptom—No HV, and picture tube heater not lit
Cure—Replace module MAH001A (ITR102 must operate)

Chassis—RCA CTC74
PHOTOFACT—1568-1



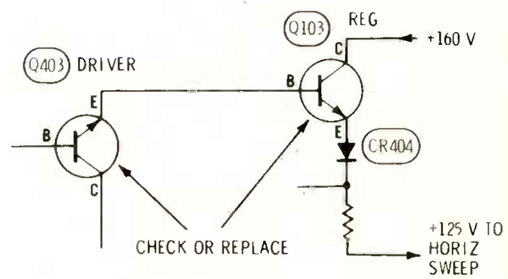
Symptom—Remote cannot change channels
Cure—Check for a short between the PW900 shield and a picture-tube bracket (shield has -5 volts, and bracket is grounded)

Chassis—RCA CTC68
PHOTOFACT—1437-2



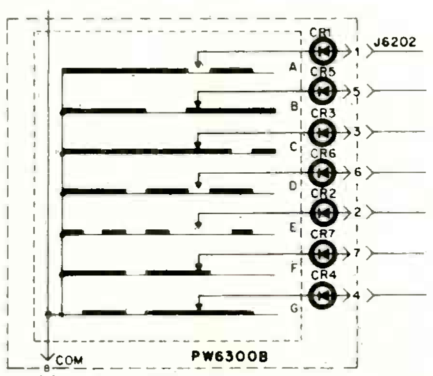
Symptom—No regulation of HV; out of horiz lock
Cure—Check R113, and replace it if open

Chassis—RCA CTC76
PHOTOFACT—1468-2



Symptom—Narrow raster
Cure—Check transistors Q403 and Q103, and replace them if defective

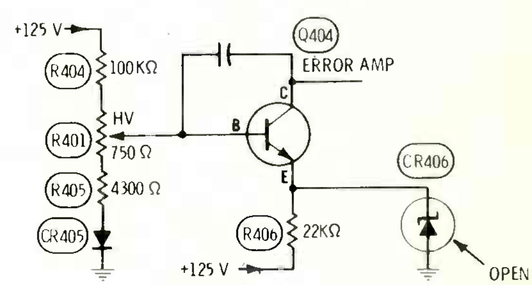
Chassis—RCA CTC68
PHOTOFACT—1437-2



UHF UNITS SWITCH

Symptom—Wrong channel, or erratic digital readout
Cure—Check diodes CR1 through CR7 (on PW6300A & B), and replace any that are leaky or shorted

Chassis—RCA CTC71
PHOTOFACT—1380-2



Symptom—Horizontal can't be locked, or intermittent locking
Cure—Check zener CR406, and replace it if open

readers exchange

There is no charge for listing in *Reader's Exchange*, but we reserve the right to edit all copy. If you can help with a request, write direct to the reader, not to *Electronic Servicing*.

Needed: *Service and operation manuals for: B&K television analyst Model 1075; B&K Dyna-Sweep circuit analyzer Model A107; and B&K Model 445 CRT tester. Will buy or copy and return.*

Paul S. Panikowski
5006 Edgewood Road
College Park, Maryland 20740

For Sale: *Fluke RMS voltmeter Model 910A, response to 7 MHz, with manual; RCA WV-97A VTVM changed to FET's, battery powered, with schematic; OS-8C/U Navy 3" scope, AC/DC, with manual; Hickok TV generator Model 610A, with schematic; Jackson dynamic tube tester Model 648SMK, with recent chart; RCA WV-73A audio voltmeter, with manual. All instruments are in working order; reasonable prices.*

Electronic Club
St. Mary Church
R.D. 3
Parker, Pennsylvania 16049

For Sale: *PF Reporter and Electronic Servicing from 1951 to present; most copies. Make offer.*

Bill Oliver
2223 Dana Street
Toledo, Ohio 43609

For Sale: *Heathkit Model IG-57A post-marker/sweep generator, aligned and like new; $160. Telematic Pixmate KP-710, $25.*

K. Camp
Electronic General Service
Harding Hiway, R.D. 3
Elmer, New Jersey 08318

Needed: *Power transformer for Signal Corps TS-418C/U signal generator. Also, need schematic for Zenith "Trans-Oceanic" radio Model G500 (chassis 5G40). Will copy, and return the schematic.*

Stan Modjesky
The Comm Center
9624 Fort Meade Road
Laurel, Maryland 20810

For Sale: *Heathkit post marker/sweep generator (wired) Model IG-57A, with all cables and instructions; four years old, used once, $100.*

Stanley J. Chimahusky
160 Pontotoc Street
Hernando, Mississippi 38632

continued on page 14

Reader's Exchange continued from page 12

Needed: *Heathkit CRT tester IT-5230 (or equivalent); Heath FM generator IG-37; capacitance and resistance boxes IN-27 and IN-17; and impedance bridge IB-28. Please state age, condition, and price.*
Robert Boudreau
290 Prospect Street
Bridgeport, Connecticut 06604

Needed: *Hickok CA-4 or CA-5 universal adapter with setup data for Model 539B tester. Quote price.*
D. J. Lynch, Jr.
138 Washington Street
Manlius, New York 13104

Needed: *Power transformer for a National Model NC-57 radio receiver (Photofact 48-14). Any help will be appreciated.*
McCoy Electronics
P.O. Box 559
Ballinger, Texas 76821

Needed: *Service manual for Kenwood Model TK-88U AM/FM stereo receiver.*
George O. Vincent
3 Summit Drive
Highland Mills, New York 10930

For Sale: *Model D67 Telequipment (Tektronix) scope with dual-trace, DC to 25 MHz, triggered delayed sweep. Asking $825.*
William D. Shevtchuk
One Lois Avenue
Clifton, New Jersey 07014

Needed: *Schematic or manual for a Precision RF generator Model E200C (has 6SJ7 oscillator).*
Electronic Club
St. Mary Church
R.D. 3
Parker, Pennsylvania 16049

Needed: *One second-IF transformer, part number 229-5100-158 (Japanese number TRF731A) for a Philco TV Chassis 19FT20. Also, a 47.25-MHz trap, part 229-5100-261 (TRF732D). Will buy whole panel, if these are not available separately.*
David Halk
Railroad Street, Box 123
Mapleton Depot, Pennsylvania 17052

Needed: *Riders Service Manuals, Volumes 1 through 5. State price and condition.*
Lee Noga
Tri/Tronics
307 East Columbia Drive
Kennewick, Washington 99336

Needed: *Schematic and parts list for a Jordan TW0104 electric guitar solid-state amplifier; made by Jordan Electronics (Phaostron Instrument and Electronics).*

Chester Heitsch
Shawnee Sound
R.R. 6, South Hiway 51
Carbondale, Illinois 62901

Needed: *Horizontal-output transformer, part number 32-8421, for a Philco B&W TV Model 50-T1400. Call collect to 601-434-8839.*

Jim Coleman
Airways TV
1128 Airbase Road
Columbus, Mississippi 39701

For Sale: *Used scopes, meters, CRT testers, and sweep generators for radio and TV servicing. Send self-addressed stamped envelope for prices and description.*

Ben Gaddis, CET
306 North Jackson
Elk City, Oklahoma 73644

Needed: *A schematic for an RME (Radio Manufacturing Engineers, Inc.) Model DB23 Preselector.*

Leonard Duschenchuk
255 Stewart Avenue
Bethpage, New York 11714

For Sale: *Heath IO-102 scope and IO-101 switch (for dual-trace operation). Both in excellent condition for $90, or best offer. Heath IO-1128 vector monitor, $55. Five years of Radio-Electronics magazine (1972-1976), $25, or $7 per year.*

Douglas J. Mace
R.D. 4, Box 84
Bellefonte, Pennsylvania 16823

Needed: *FM antenna coil, #10-312-1 for Sears AM-FM radio Model 528.63781.*

Oscar Perkins
c/o Perkins TV-Electronics
2603 West Front Street
Richlands, Virginia 24641

Needed: *A speaker for an American Bosch Magneto radio, Model 28.*

J. Gregorich
117-2nd Street, North
Virginia, Montana 55792

Needed: *Schematic and instruction manual for a Model A460 field-strength meter by Approved Electronic Instrument Corporation. Will buy schematic or a copy.*

John Szporna
Szporna TV
Route 1, Box 75
Vinegar Bend, Alabama 36584

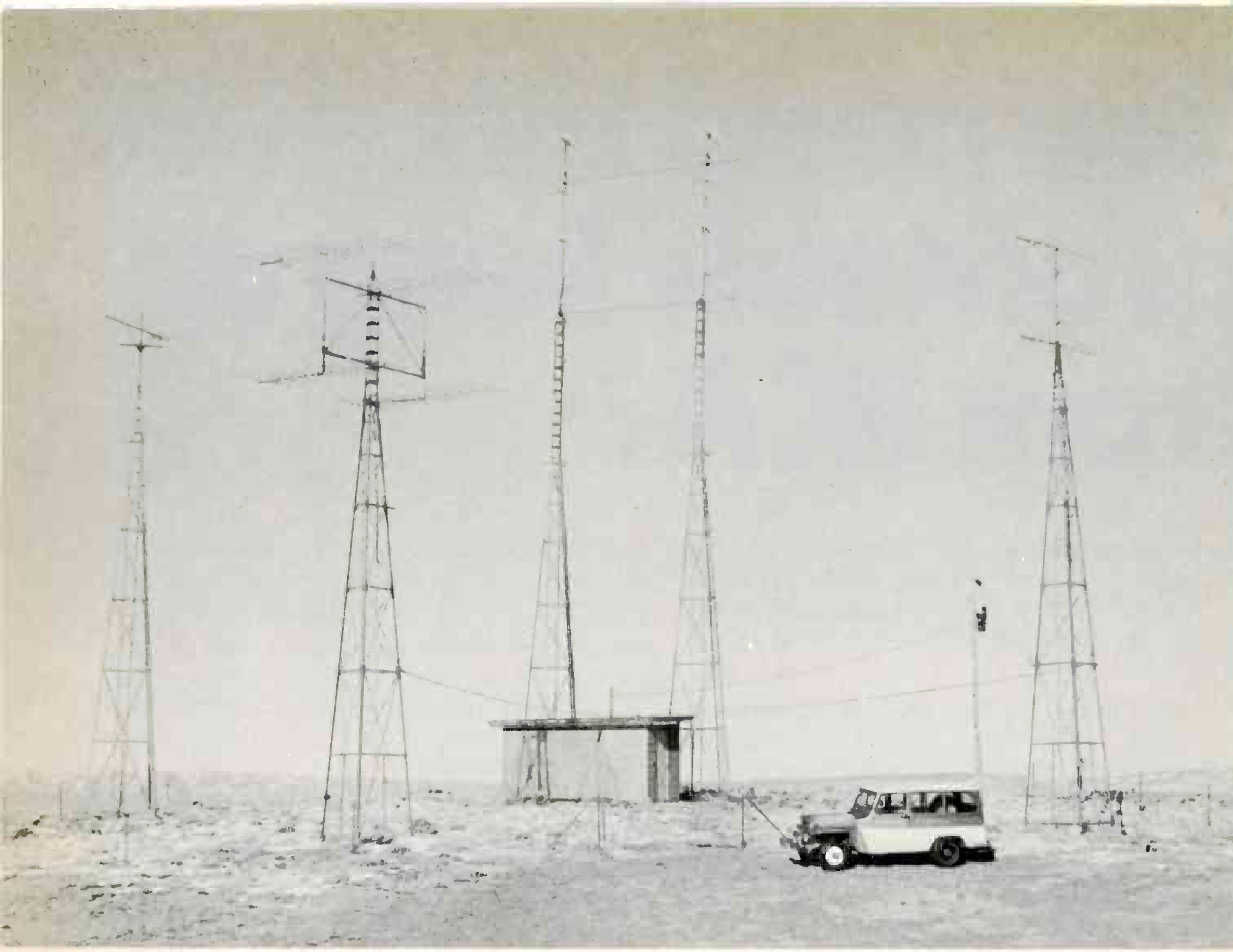


Fig. 1 The translator system on Peterson Ridge in the North Park section of Jackson County, Colorado has five 67-foot antenna towers grouped around the equipment building. The second tower from the left has four yagi antennas for receiving Denver's Channel 4; and two yagis on the tower at the extreme right bring in Channel 5 from Cheyenne, Wyoming. In the center, each of the towers (with taller masts) has four directional antennas for rebroadcasting to the most heavily-populated areas of North Park. One tower transmits Channel 4 on Channel 8; the other transmits Channel 5 on Channel 10. The guy wires are made of glass fibers, to minimize losses. The tower and antennas at the far left are not used at present.

Translators solve impossible fringe TV reception

TV translator systems resemble CATV installations. However, after the CATV signals are received and amplified, they are sent to the customer's homes by coaxial cable. Translator signals are rebroadcast; and conventional antennas at the homes supply the TV receivers. Translators are a better choice where the homes are scattered widely. Hundreds of translator systems have been installed all over the country, although they often go unnoticed by the TV industry.

By James E. Kluge
Technical Editor, Winegard Company

No TV In Jackson County?

About 1,000 families in Jackson County, Colorado would not have TV reception, except for the TV-translator system that has been in operation for the past 12 years.

North Park, which occupies most of the approximately 1,500 square miles of ranch land and recreational area in Jackson County, is surrounded completely by mountains. Although this park is nearly flat and has an average elevation of 8,200 feet, it's bounded by the Continental Divide on the south

What Are Translators?

A translator accepts an input of the picture and sound carriers of one TV station, changes the frequencies, amplifies the power, and transmits the new carriers on another channel.

A typical translator system includes these elements: an elaborate receiving antenna, usually a cut-channel type, located on a tall tower, a high ridge, or a mountain top (where it can receive signals of adequate strength); a translator having sufficient output power; and a transmitting antenna to beam the new signals to the areas where they are needed. Then, at the receiving locations, conventional antennas feed the signals to the TV receivers, in the usual way. This is called direct reception.

Usually translator systems are assembled from individual units, because of the many different power needs, channels, and signal conditions. Each system is custom-assembled. Some are small and privately owned. Others are extensive and elaborate, and these usually are owned by cities, communities, or counties. Sometimes, microwave relays bring the signals for miles to the translator, thus minimizing the snow.

In many ways, translator systems are similar to Community Antenna Television (CATV) systems, except that each TV receiver obtains the retransmitted signals directly from an individual antenna, rather than from coaxial cables, as is done with CATV. Translator equipment *always* converts to another channel, but CATV often retains the original channels.

With proper FCC authorization, a translator can be operated in any VHF TV channel, or any UHF channel between 70 and 83, provided the translator signals do not cause interference with the reception of any direct (non-translator) signal on the same or adjacent channel.

North Park, Colorado is a high mountain valley (8,200-foot elevation) that's ringed on all sides by higher mountains. These mountains form a shield that attenuates the TV signals coming from outside.

and the west, by the Medicine Bow Range on the east, and by Wyoming's Snowy Range on the north.

From the center of North Park, it's about 90 air miles to the five TV transmitters at Denver, Colorado. The distance is not excessive, but those signals **twice** must cross the Continental Divide to get there. Even a good fringe-type antenna mounted high on a home brings in nothing but snow.

Nevertheless, **1,000 families in North Park can watch two TV channels.** Yes, there is some snow, but improvements are planned to eliminate most of the snow, and provide three more channels.

Original System

About 12 years ago, Jackson County supplied $9,000 to equip a translator site on Peterson Ridge, located about 8 miles southwest of Walden, Colorado. Two translators were installed: one for Denver's Channel 4, transmitted on Channel 8; and the other for Channel 5 from Cheyenne, Wyoming, transmitted on Channel 10.

At first, the radiated power was 1-watt per antenna, but this proved to be inadequate for good reception in some areas. So, in 1970, an additional $5,000 was spent to increase the power to 5-watts for each transmitting antenna.

Details Of Peterson Ridge

Peterson Ridge is slightly west of the geographical center of Jackson County, and about 1,000 feet higher than the surrounding high valley of North Park. This is the best location for covering the entire county by retransmitting; and, even after a new receiving-antenna site for the Denver signals is added, it will continue to be the heart of the system.

AC lines have been run to the site, so transmitters having higher outputs can be used without any concern about the amount of power.

Grouped around the concrete-block equipment building are five 67-foot steel towers each with several antennas (see Figure 1).

Receiving antennas and signals

One tower has twin, stacked, cut-

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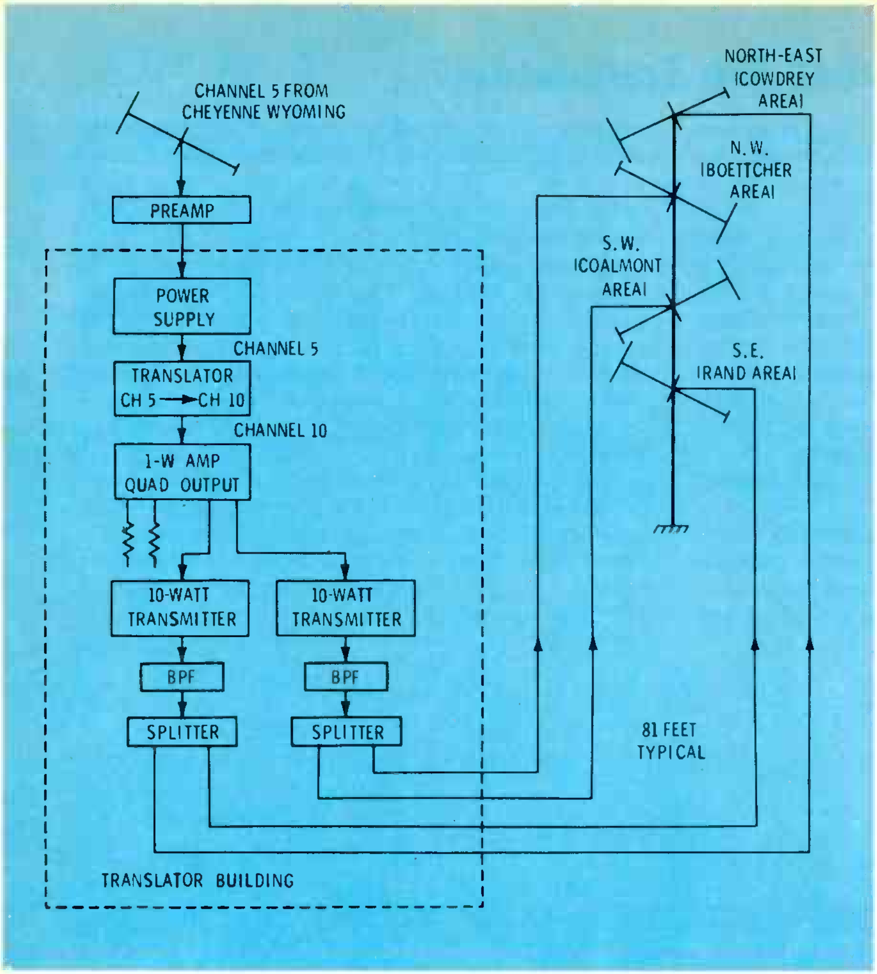
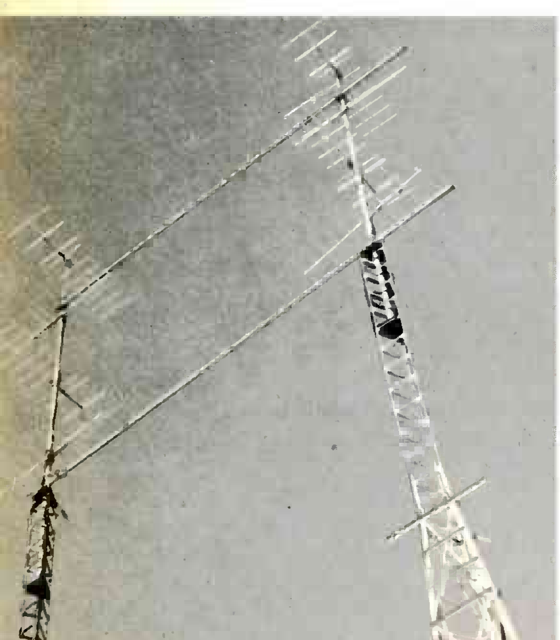


Fig. 2 This block diagram shows the individual items of equipment for the translator that receives Channel 5, and rebroadcasts on Channel 10, using four directional antennas, each supplied by 5 watts of power. The other translator is identical, except for the frequencies. Translator systems are designed according to local conditions, and seldom are two alike.



Here is a closer look at the transmitting antennas on Peterson Ridge.

Translators

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channel antennas to receive Channel 5, the CBS affiliate station in Cheyenne, Wyoming (about 80 air miles to the northeast). After crossing the 10,000-foot Medicine Bow Range, the signal from these antennas is about 450 microvolts. (On the plains of North Park, a picture of marginal quality from Channel 5 can be received with a 30-foot roof-mounted antenna. But the reception is intermittent, varying with the weather conditions.) Another tower is not used at the present time.

A quad-stacked array on the third tower receives Channel 4, the NBC outlet in Denver, Colorado, about 90 miles to the southeast. Signal level varies between 150 microvolts and 250 microvolts at Peterson Ridge, and bad weather sometimes eliminates it altogether. Each receiving tower has a mast-mounted single-channel preamplifier.

Transmitting antennas

Each of the two transmitting towers has extra mast sections with four identical yagi (directional) antennas pointing to the areas that have the most dense population. Each antenna has a separate coaxial cable to the corresponding transmitter output.

All of the antennas of one tower are for Channel 8 (rebroadcasting Channel 4), and those of the other tower rebroadcast Channel 5 on Channel 10.

Translator Details

Figure 2 shows the block diagram of the translator for Channels 5/10, including each separate item of equipment. The use of individual units, rather than having all stages built into one large cabinet, permits an original design that's especially tailored for each translator system. You might compare this to modular Hi-Fi.

The second translator system for Channel 4 to Channel 8 is identical, except for the frequencies.

Both amplified signals and power for the preamp flow through the coaxial cable between the mast-mounted preamp and the power supply that's inside the equipment building. Filters inside the power supply extract the signals, which then go to the input of the translator.

From the translator, the Channel 10 signal drives an amplifier that has four 1-watt outputs (originally this amplifier supplied the four antennas). Two of the outputs are terminated with resistors, and each of the other two drives a 10-watt transmitter. The output of each transmitter goes through a bandpass filter (to remove any spurious byproducts), and then through a two-way splitter to two of the transmitting antennas. Thus, each antenna receives 5 watts of power.

Solar-Powered Translator

In the southeast corner of Jackson County is a valley which is shielded by mountains, so the signals from the translator antennas on Peterson Ridge can't reach the

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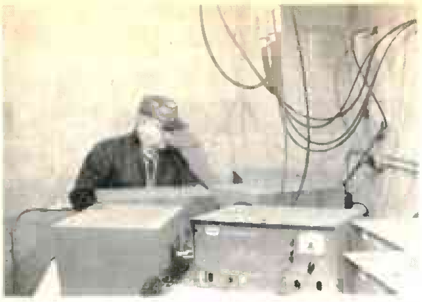

Technician John Gresham of Walden, Colorado periodically maintains and services the translator equipment. Four equipment cabinets are required for each translator channel. These are EMCEE brand.

Radiation polar patterns are marked on a map in the equipment building at Peterson Ridge.

Two masts with antennas, a panel of solar cells, and an old refrigerator cabinet—but no power lines—make up the one-channel translator on Johnny Moore Mountain.

Translators

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45-to-50 homes in Gould, Colorado.

Strangely enough, direct reception of Channel 5 from Cheyenne is good, although you would think that the mountain range in between would block the signal completely. Therefore, only Channel 4/8 reception requires additional processing to permit good results with both channels.

A "satellite" translator system was installed on Johnny Moore Mountain—located east of Peterson Ridge near the eastern edge of North Park—a site permitting the the new signal to travel through the valley towards Gould.

The Channel 8 signal (originally Channel 4 from Denver) from Peterson Ridge is translated on Johnny Moore Mountain to Channel 13, and 1-watt of signal is beamed to Gould up the valley.

Solar power

One unique feature of the site on 9,070-foot Johnny Moore Mountain is that the equipment is solar powered. Sunshine striking a 32-volt, 4-watt solar panel supplies 28 volts at 3 watts for the translator, and charges the bank of telephone-type batteries (which provide standby power for night operation and overcast days). Usually the battery charge remains satisfactory, with no problems.

Another ingenious feature is the use of a discarded home-type refrigerator to house the translator and batteries, protecting them from both the hot summer sun and the cold winds of winter.

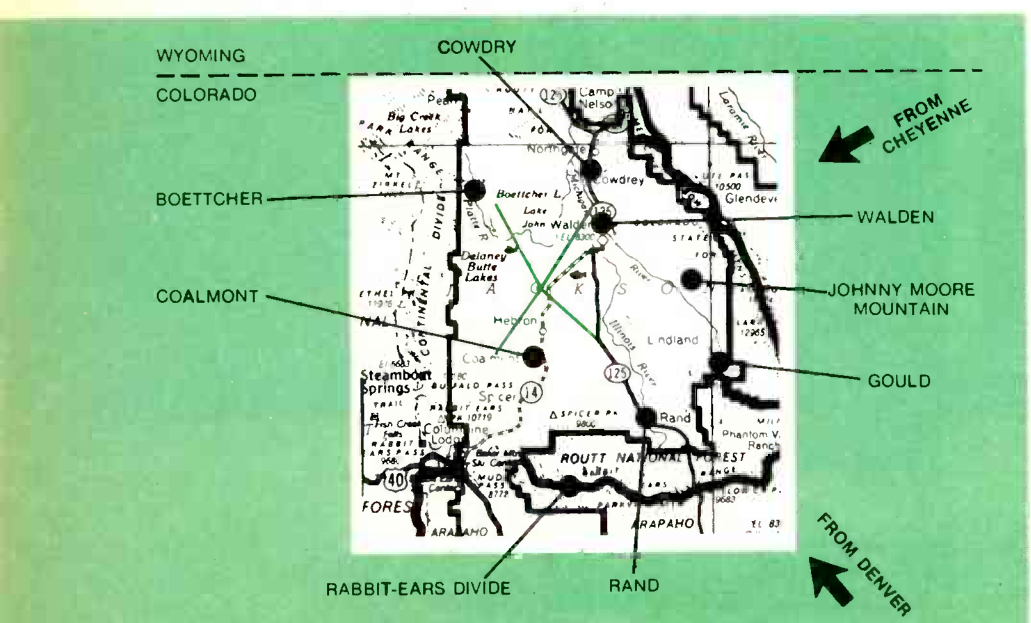
Reception Quality

How satisfied are the TV viewers in North Park, and how good is the quality of the pictures obtained from the translator system?

In most areas of North Park, the picture quality is satisfactory, with some snow at all times, and occasional short periods when one or the other of the signals drop down into the noise.

A few homes are located in the "shadow" of a ridge or mountain that eliminates any reception.

Jackson County has plans to help these isolated viewers by using rugged high-gain antennas located on the highest point within a mile of each home, and a series of Winegard Constant-Level Amplifiers (CLA). These amplifiers are compensated for the attenuation and frequency-tilt for specific lengths of foam-type cable (see Figure 3) so no calculations are required in most installations. Details of CLA systems are given in the October, 1976 issue of ELECTRONIC SERVICING.



The map shows the locations of the principal cities, Johnny Moore Mountain, and Rabbit Ears Divide.

Future Improvements

Although the Jackson County translators serve the North Park area rather well, the Channel 4 signals from Denver do have some snow, and the other four Denver stations are not received at all. It would be preferable to receive a CBS station from Denver because the local news and programming would be more interesting to Colorado people. Also, one Denver station has educational programs, and these could be used to an advantage

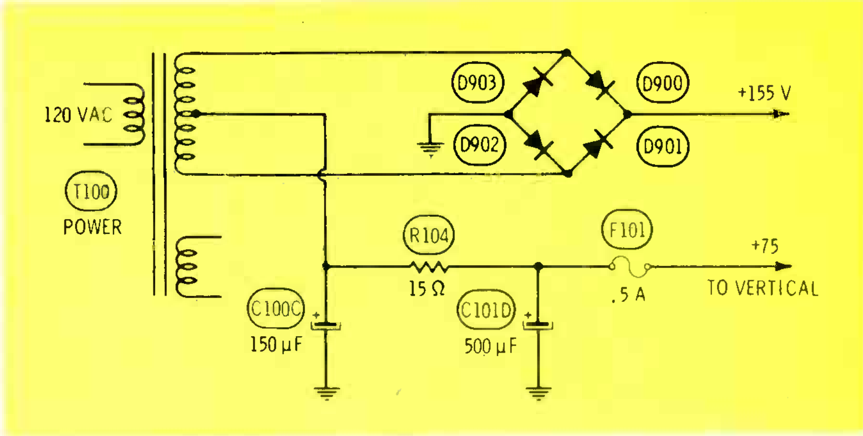


Fig. 2 Four diodes in the main power supply are operated in two different ways. D903 and D902 comprise a full-wave supply, with the B+ taken from the center tap of T100. All four diodes function as a true bridge (the center tap is not used) giving twice the voltage of the other supply. Therefore, overheating of R104 indicates an overload of the +75-volt supply, and not of the +155-volt supply.

linearity, foldover, or a gradually-decreasing size. Of course, an adjustment giving excessive height might cause some foldover, but that's unusual.

Defects in solid-state vertical-sweep circuits usually stop all height, leaving just a horizontal line. Shorted output transistors are typical of the component failures.

Servicing Admiral Vertical In The Home

During home service calls made to correct the loss of all vertical sweep, follow this sequence of tests:

- Reduce the brightness until the white horizontal line is barely visible (that's to prevent burning a line across the screen of the picture tube);
- Remove the back, and check fuse F101 (see Figure 2). If the fuse is open, suspect a leaky or shorted output transistor (replace any bad ones); if the fuse is okay, install a new vertical module (part number A8925-1);
- Check all of the plugs, and make sure the module is seated firmly.

In Figure 2, notice that all four diodes function as a bridge to produce the +155-volt supply, and the winding center tap is not used. For the +75-volt supply, however, diodes D903 and D902 are operated in a variation of the older full-wave rectification circuit, with the B+ coming from the center tap.

C100C, C101D, and R104 filter the hum, and fuse F101 protects against excessive current. Any overheating of R104 probably indicates too much current to the output transistors, and a blown fuse hints of a short, possibly in those same output transistors.

Unplug the AC cable before you replace a module or check the connections. Seat the module firmly, and lock it in place. Then, hold your fingers behind the module as you insert the connectors. Sometimes the center starting pin will jam, keeping the plug too high, and not allowing proper connections. Some force might be required, and bracing the back of the module is good insurance against breaking it.

After the module has been replaced and the fuse checked, apply power to the receiver and check for vertical sweep. Probably the height now is okay.

Replacing output transistors

Sometimes the two original output transistors will be of different types, as shown in Figure 3. "Top-hat" transistors of the TO-66 type mount with two screws, while the smaller TO-220AB kinds mount to the socket with only one screw. This is a complementary stage; Q100 is NPN and Q101 is PNP polarity.

Although I recommend the Admiral exact replacements, these transistors can be used:

Q100

57B205-14	Admiral
57B244-14	Admiral
SK3054	RCA
GE-66	GE
TR-76	IR
HEP703	Motorola

Q101

57B206-14	Admiral
57B245-14	Admiral
SK3083	RCA
GE-69	GE
TR-77	IR
HEP702	Motorola

When replacing these transistors, check for the thin mica insulator that should be between each transistor and the heat sink. Neither collector is grounded, so insulation must be used. Also, be sure only **one** mica insulator is installed. Two or more cause excessive transistor heat.

Always add fresh silicone heat-transferring grease to the mica and to the transistor, even though sufficient grease seems to be there from the original. Air pockets are to be avoided, because they act as barriers to the flow of heat.

TO-66 types of transistors mount without any modifications, but the TO-220AB kinds must have the collector lead cut off (the metal tab also connects to the collector, and the mounting screw makes the connection), and the other two leads must be bent at a 90° angle (use the originals as models). Bend the leads carefully, and do NOT bend near the body.

After the TO-220AB base and emitter leads are inserted into the socket, look at the socket side to make sure the leads protrude correctly through the socket pins, making solid contact (Figure 4).

Tighten the mounting screws, but use only moderate pressure; otherwise, the mica insulator might become cracked and cause a short.

Before you turn on the machine, check from each collector to ground for shorts. Of course, the collector of Q101 returns to ground through R108, a 3-ohm resistor. Therefore, a 3-ohm reading is normal, and any lower reading indicates a punctured insulator.

Check resistors R165, R105,

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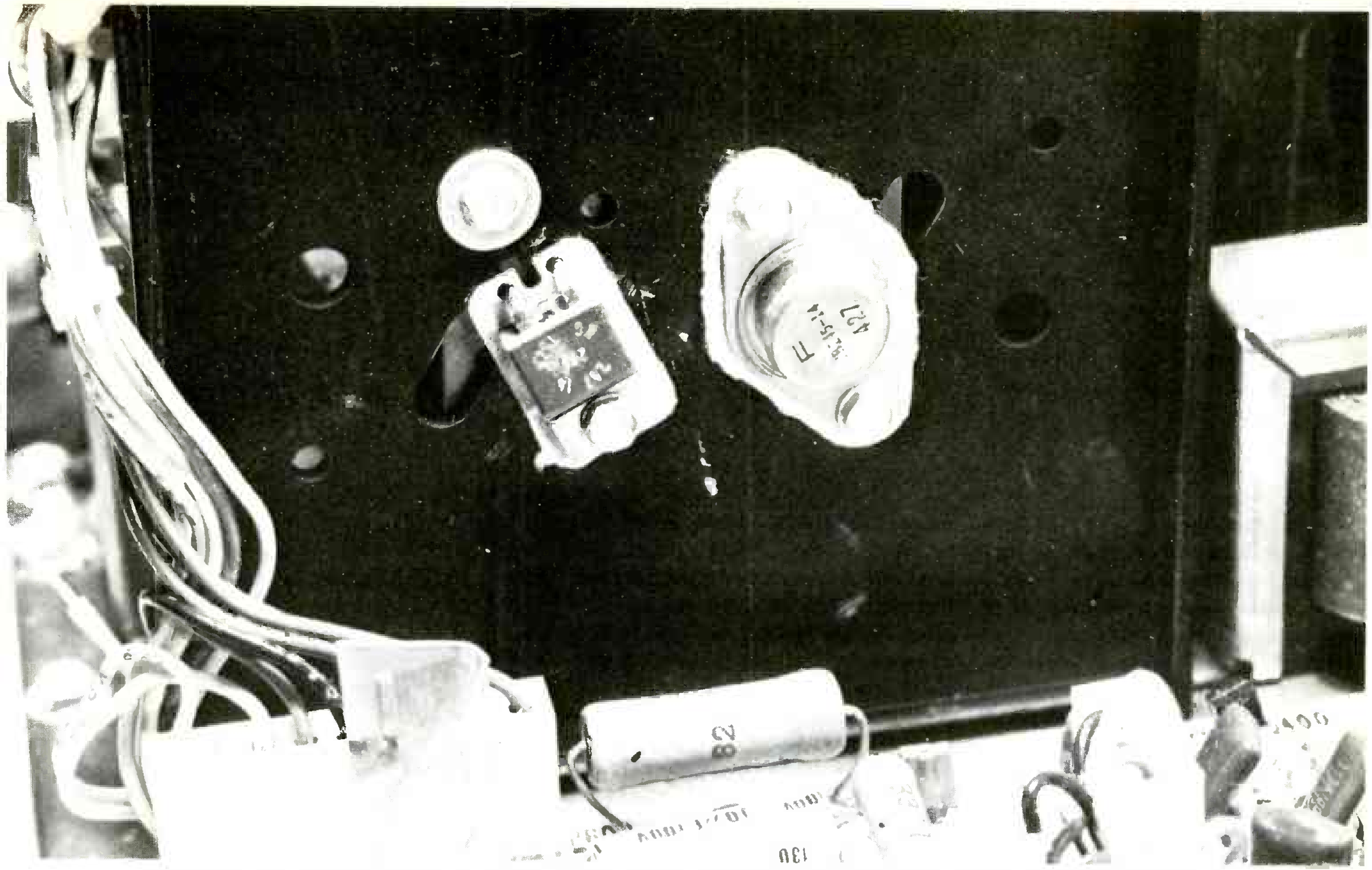

Fig. 3 Often the original Q100 and Q101 output transistors are of different case types. Good substitutes are listed in the text. When you install a "flat" transistor, be sure you don't bend the pins too near the body.

Admiral Vertical

continued from page 41

R106, and R108 for resistance and for any visual signs of having been too hot. Replace any that are questionable.

This amount of servicing can be done efficiently in the home during service calls. However, if a vertical problem still remains, the chassis or TV should be taken to the shop for detailed testing on the bench.

Diagnosis On The Bench

During repairs to the vertical-sweep circuit, some means of viewing the height on a picture tube is nearly imperative. A scope can be substituted for tests of troubles in other sections, but scope waveforms are not precise enough to prove proper height and linearity.

Also, the Admiral circuit (see Figure 5) feeds a sample of the sweep-output voltage to the oscillator "switch" transistor. Without this positive feedback, neither oscillation nor sweep can occur. A yoke of approximately the right impedance is needed.

If you have a suitable test jig, then operate the chassis from it. Otherwise, bring in the entire receiver, place the chassis on top of the padded cabinet, connect extension cables, and troubleshoot without complications. Of course, the extension for the base of the picture tube will blur the sharpness of the picture, but the vertical and horizontal sweeps are not affected.

Circuit analysis

Figure 5 shows the complete wiring of module M600, the complete complementary-output stage, and blocks to represent the convergence, pincushion, and yoke circuits. Remember that this is the solid-state equivalent of an unbalanced multivibrator, such as the two-tube versions used in many pre-solid-state models. In other words, there is a large closed loop, and oscillation cannot occur if the loop is broken at any point. The base of Q601 is the equivalent of the oscillator grid, and the emitter wiring of Q100 and Q101 takes the place of the plate of the power tube that drove the yoke.

In Figure 5, Q602, Q100, and Q101 are emitter followers, which neither produce gain nor invert the phase. Therefore, the circuit can be visualized as Q601 feeding Q603, with a sample of the Q603 collector signal sent back to the base of Q601. This is a closed loop, and both transistors invert the phase, so the signal at the base of Q601 is in-phase positive feedback, which triggers oscillation.

After that overview of the general vertical operation, we need to understand some of the stage-by-stage details.

Sync and sync blanker

The sync/inverter/amplifier stage with Q600 needs little explaining. It produces gain and inverts the phase of the sync, but apparently the

A **4-watt 32-volt** solar-cell panel on Johnny Moore Mountain supplies DC power to operate the translator, and to keep the storage batteries charged.

On the top shelf of the discarded refrigerator (used to give protection against the weather) are the Channels 4/8 translator, and a Channel 8 bandpass filter, while on the bottom shelf is the bank of lead-calcium-alloy storage batteries that furnish DC power at night and during overcast days. John Gresham is shown checking the batteries.

An earlier model of this Television Technology Corporation Model T-99 translator is used on Johnny Moore Mountain. These translators were designed for operation from solar cells, and have 1-watt RF output.

by the schools in North Park. For all these reasons, improvements are planned to the system.

Rabbit-Ears Divide

A **5-element test antenna on Rabbit-Ears Divide produced** signals of 800 microvolts on Channel 4, and 450 microvolts from both Channel 7 (CBS) and Channel 9 (ABC). Rabbit-Ears Divide is 22 miles south of Peterson Ridge and has an elevation of 11,800 feet; therefore, it seems certain that higher-gain antennas on tall towers would give double those signal strengths, eliminating virtually all of the snow.

Because the Rabbit-Ears site is so isolated, each translator there will have to be solar powered. As is done on the Johnny Moore mountain site, power for dark periods will be provided by calcium-alloy batteries, which are kept charged by the solar-cell panels during daylight hours.

New frequencies

Present plans for the Rabbit-Ears Divide call for translating NBC Channel 4 to Channel 11 for transmission to Peterson Ridge, where the existing equipment will translate it to Channel 8. CBS Channel 7 will be translated to Channel 13 for transmission to Peterson Ridge, and then sent out on Channel 10. The CBS signal from Cheyenne will be discontinued.

ABC Channel 9 will be translated to Channel 3 during transmission to Peterson Ridge, and then rebroadcast on Channel 12, using new equipment. Channel 6 (educational) from Denver might require a UHF translator, if it's decided to add it for the benefit of the school district.

Additions to the Johnny Moore Mountain site probably will include only Denver's Channel 9 (ABC), because most homes around Gould can receive CBS Channel 5 from Cheyenne, without a translator.

Completion of the Rabbit-Ears Divide system for the three Denver network stations using new solar-powered solid-state equipment with new tower and antennas is estimated to cost $75,000.

Costs in the past

The initial capital outlay, plus maintenance and service expenses averaging about $1,100 per year, shared by 1,000 users over the 12 years of existence, has cost the county general fund between $2 and $2.50 per year per home. And, that's a small price to pay for television reception beyond the fringe in North Park, Colorado. □

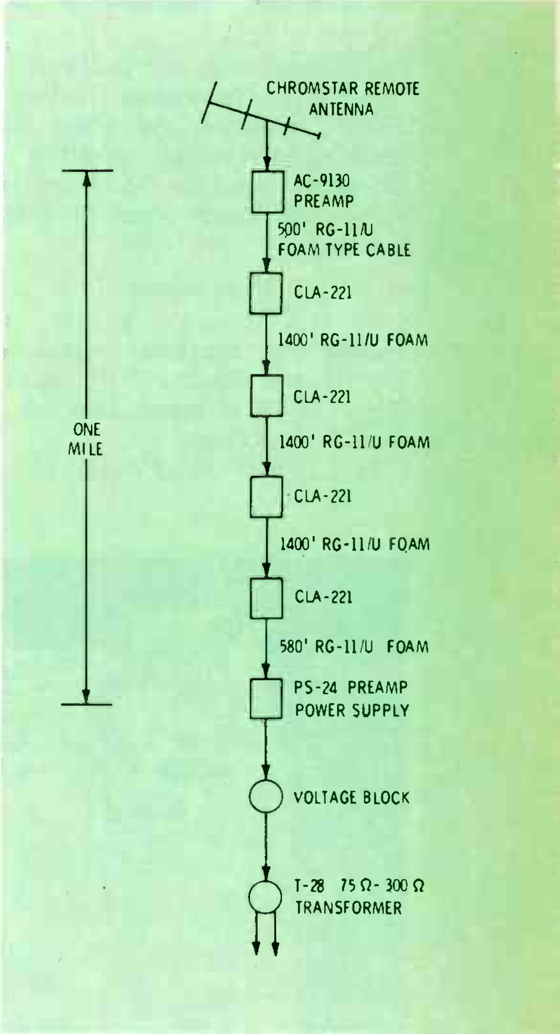

Fig. 3 Those few residents of North Park whose homes are shielded from the Peterson Ridge antennas are to use master-antenna systems with Winegard Constant-Level Amplifiers (CLA) that are designed with the gain and tilted frequency response necessary to give unity gain and flat response overall including the specified length of "foam"-type coaxial cable. No calculations are required for these installations.

Servicing GE Modular Color TV
Part 8/By Gill Grieshaber, CET

Analyzing The VIR Module

Continuing with our analysis of the circuit operation on the VIR "Broadcast-Controlled Color" module of the General Electric 19YC-2 chassis, we show by words and waveforms how the sensor determines whether or not the VIR signal is being broadcast on Line 19 of the video. Also, suggestions and scope adjustments are given to help you obtain similar waveforms for yourself.

Last Month

In last month's article, we learned that **the first function of the General Electric VIR module** (Figure 1) **is to locate Line 19** of each field of video.

Sync from the TV chassis is integrated into a single pulse (the same as when sync is used to lock the vertical sweep of a TV) which triggers the first monostable multivibrator. In turn, the multivibrator "enables" the counter to start counting at the end of Line 4. It counts 15 times, producing at Line 19 a pulse of 63 microseconds duration—the same width as one line of video. From this pulse, two monostable multivibrators (called pulse slicers) produce other pulses of shorter duration.

These are the four pulses:

- a 63-microsecond positive-going 5-V PP pulse (at TP20) which occurs at the same time as Line 19 of each video field (this pulse identifies Line 19);
- a 15-microsecond positive-going 30-V PP pulse (TP24) that occurs during the first quarter of Line 19;
- a 35-microsecond positive-going 30-V PP pulse (TP22) occurring during the last two-thirds of Line 19; and
- another 15-microsecond pulse of only 5-V PP. There is no test point for this pulse, but it can be found at IC40 pin 13 and IC10 pin 2.

This latter pulse is the one required by the circuit that senses the presence of the VIR signal in the composite video. All of these pulses occur only once for each field of video (59.94 times per second), so they are difficult to see on a scope (Figure 2).

VIR Sensor

After Line 19 is identified, the next step is to examine the video of Line 19 to determine whether or not it has a VIR signal. The DC voltage resulting from the examination operates DC electronic switches to select either conventional manual tint and color controls, or the VIR electronic control. That selection is the purpose of the VIR sensor stages (see the block diagram in Figure 3).

If I had been the designer, it's likely I would have proposed a circuit to detect the 3.58-MHz chrominance-reference part of the VIR signal. But that's analog thinking, and such a circuit would not be compatible with the remainder of the digital stages.

No, the GE method is foolproof and more simple. When the composite video signal is positive-going, and the VIR 3.58-MHz components have been removed by low-pass filters, the line that formerly was the center of the chrominance reference becomes a "low" lasting for 24 microseconds. Without the VIR signal, a "high" line connects the blanking pulses. The circuit

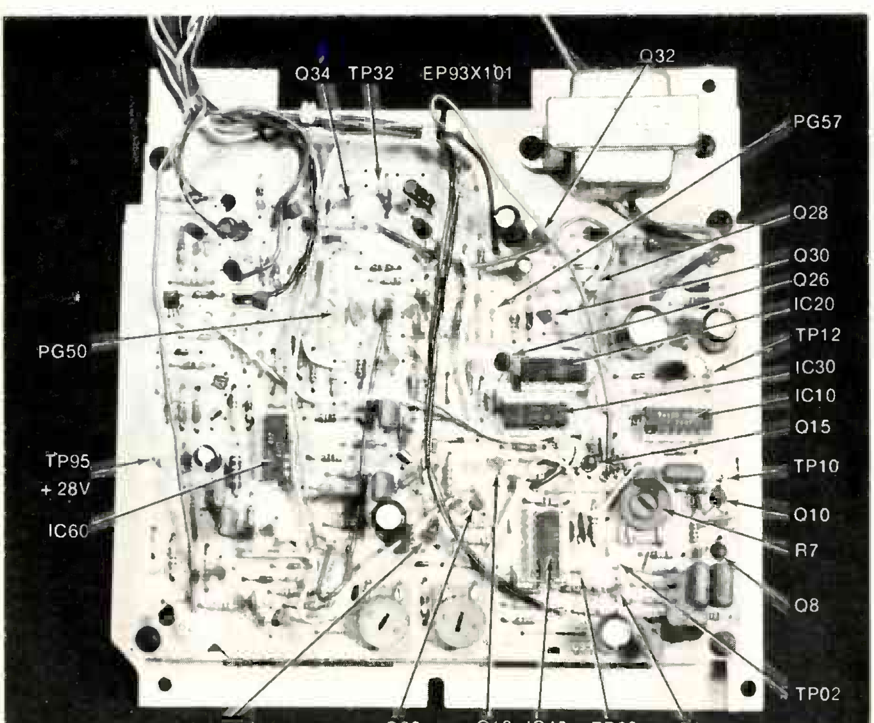

Fig. 1 Arrows point to the test points, transistors, and ICs mentioned in our coverage of the VIR module for the General Electric "Broadcast-Controlled Color."

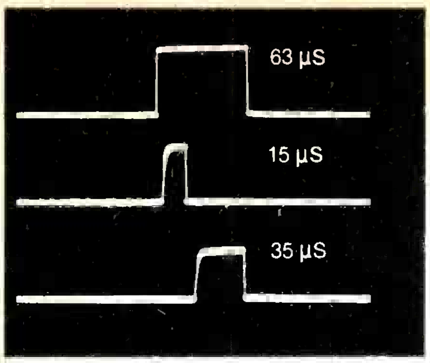

Fig. 2 These are the three pulses necessary for the VIR circuits, shown in the correct phase. The 63-microsecond pulse identifies Line 19. The 15-microsecond and 35-microsecond pulses are used later in the color and tint controllers. Another 15-microsecond pulse, having a lower amplitude, is one of the two input signals to the VIR sensor.

checks for a "high" or for the falling side of a "low" during the first 15 microseconds of Line 19. Each condition causes a different DC output voltage. The waveforms shown later should make these operations clear.

Sensor inputs

Two input signals are necessary for the VIR sensor. One is the positive-going 15-microsecond pulse from the "Q" output of slicer #1; the other is composite video after it is filtered and clipped by the circuits of Figure 4. Part of the action is difficult to understand.

Video waveforms

I was surprised to find the extensive filtering of high frequencies from the video waveform before it reaches the VIR sensor. First, the video is taken from a video stage of the receiver **following** the 3.58-MHz trap. So, the video supplied to the module input (see Figure 5) has little burst amplitude.

That's not all. R25 and C25 round the corners completely by the time the video reaches the base of Q26. **It would seem impossible to find a "high" or "low" in all of those smooth curves.** The GE information says only that the video is "processed" before it's applied to the VIR sensor. But there's more to the processing.

VIR, "highs" and "lows"

Before we go on, a short detour is needed to explain the reason for my surprise when I discovered the intentional removal of the high frequencies from the video sample.

Carefully examine the waveform of Figure 6. It shows one video line of VITS at the left, one line with positive-going VIR waveform (all of the other VIR waveforms have been negative-going), and one line with **no** video signal. **This particular waveform can't be found anywhere on the VIR module.** It isn't a fake exactly, but I had to simulate it by using the scope to invert the negative-going video-detector signal of the receiver. It is the waveform that **would be** fed to the VIR sensor **if** the signal were allowed to retain the full frequency response. In that case, the signal would be positive-going, as shown here.

Imagine that the 3.58-MHz signals (burst and chrominance reference) are filtered out. Where the center of the chrominance reference had been, now there is a horizontal line. As the horizontal-blanking pulse drops to this line, it supplies the rapid "falling transition" that's necessary to trigger the VIR sensor. No doubt the waveform **could** trigger the sensor. There's just one problem. The waveform of Figure 6 is **NOT** the one fed to the input of the sensor. Good high-frequency response is required to reproduce such a fast fall time. (Or, at least it is for analog circuits.) But the actual signal at the sensor has suffered from high-frequency attenuation.

Now, for the big question: after all of the fast rise and fall edges of the video have been filtered into gentle curves, where can we obtain a rapidly-falling edge of the blanking pulse to trigger the sensor? Well, we have proof that it happens, but only a partial explanation of why it occurs.

Peculiar diode clipping

When the VIR switch is turned on, the only components at the base of Q28 are the coupling capacitor and the diode, Y27. There are no bias resistors.

(When switch SW27 is closed, the signal is eliminated, and the circuit switches automatically to manual operation.)

GE says diode Y27 "clamps the composite video" and "effectively shifts the DC level of the composite video to a constant reference near chassis ground". And, of course, we all know that the positive peaks of an AC signal at the base of a NPN transistor will act as Class "B" bias. But, without Y27, a DC meter would measure a negative voltage at the base. When Y27 is there, the base measures +0.6 VDC. It seems that Y27 rectifies the signal, thus generating a positive voltage that serves as bias for Q28.

This all sounds very logical, and indeed it is a part of the truth. But there are more facts to consider. The base/emitter junction of Q28 is the equivalent of a diode with its anode at the base and the cathode at the emitter. Therefore, Y27 and Q28 together act as two diodes of opposite polarity in parallel. If all things were equal, the two operations would cancel, leaving both signal peaks clipped and zero DC voltage.

The diode and the transistor both are silicon devices; however, the diode measures about 30% lower in forward resistance. Perhaps this explains why the diode effect is dominant; it obscures and overpowers the operation of the base/emitter diode. DC waveforms show

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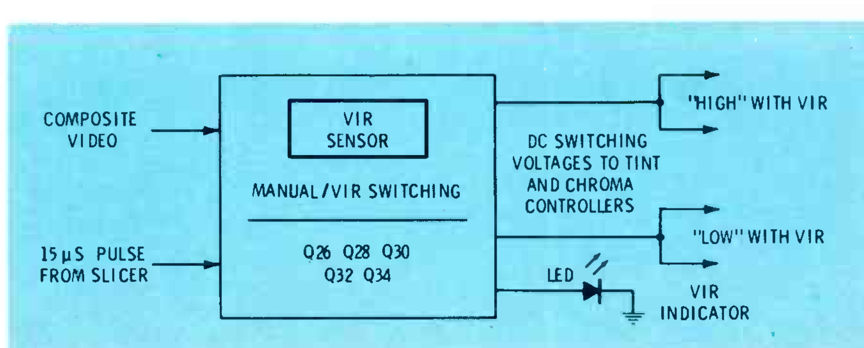

Fig. 3 This block diagram shows the sensor input signals, functions of the stages, the transistors used, and the output switching voltages.

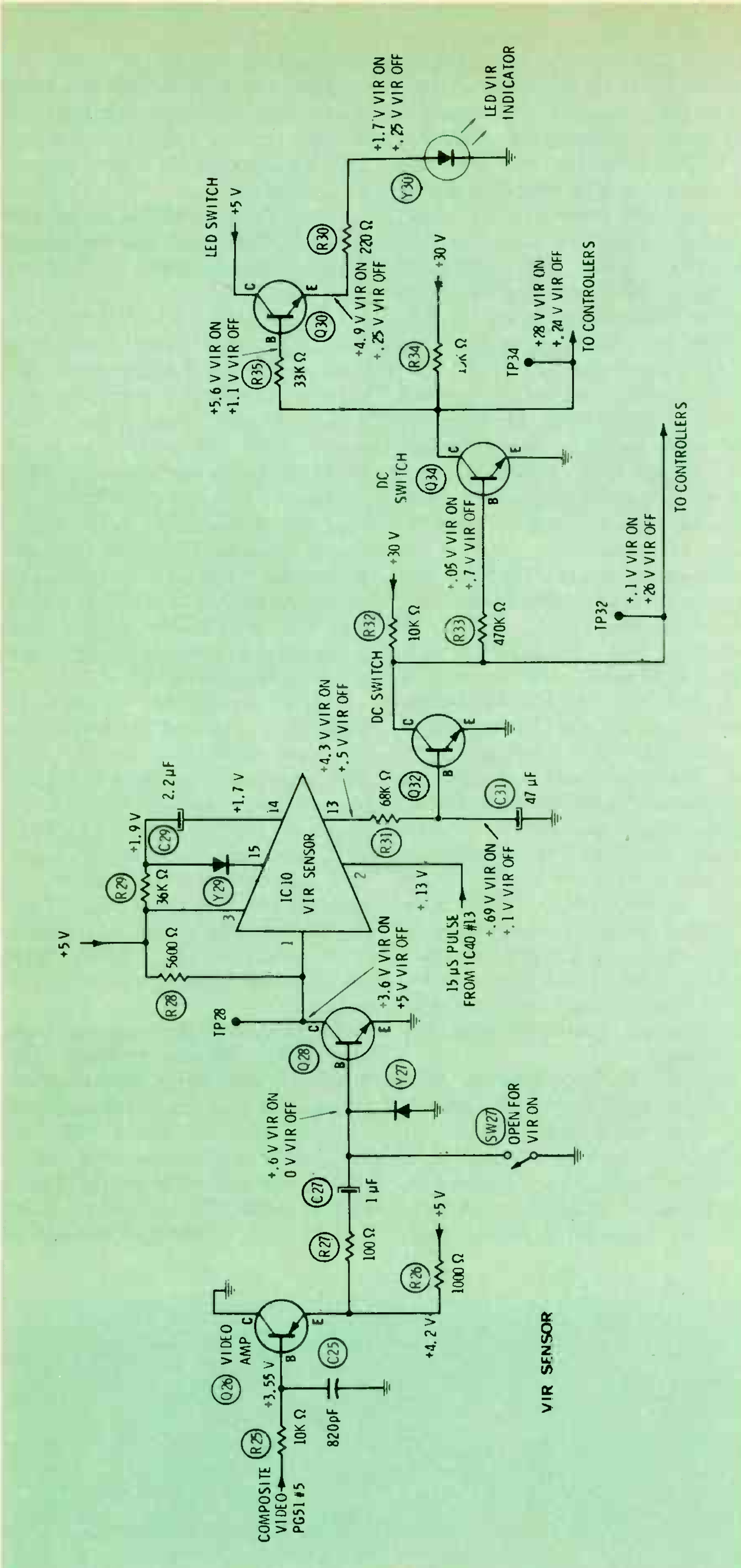

Fig. 4 These are the VIR stages we're discussing this month: video-processing stage, the VIR sensor; and the DC-switching transistors. The VIR sensor is a two-input monostable multivibrator.

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that the negative peaks of the Q28 base signal are at zero voltage, thus proving that clamping has taken place. The GE information is not wrong, but just incomplete.

Obtaining fast-rise pulses

Figure 5 traces the changes of waveform as the video is filtered, and finally is clamped at the base of Q28. The results of the filtering are predictable; the effects of the clamping are very unusual. At the base, Y27 conduction places the tips of the negative-going sync at zero DC voltage, making the remainder of the waveform positive.

Therefore, the collector waveform of Q28 should be exactly opposite: positive-going, and perhaps with clipping at the top. Now look at the waveform of Figure 5E, the collector of Q28. The top clipping is there, okay, and the clipping line is nearly +5 volts—the supply voltage—indicating the transistor is cutoff much of the time. But the waveform is wild! It **seems** to be negative-going, and the waveform is missing in the area where the blanking pulses and sync should be. This waveform tells only part of the story, because it shows only the response at the horizontal-scanning rate, and Line 19 must be viewed at the vertical rate.

More information is added by the waveforms of Figure 7. The top trace is the composite negative-going video that's included for a reference; and the trace at the bottom is the Q28 collector waveform, which **appears** to be negative-going (but it isn't, as we shall discover).

The scope was locked to the sync (at TP2), with the trace starting at about Line 4 (near the center of the vertical sync), and was adjusted to show about 35 lines. The VIR signal of Line 19 is just to the left of picture center in the top trace, and the VITS are on Line 17 and Line 18.

Now, on the bottom trace (Q28 collector signal), notice the absence of pulses below Line 17, and on Lines 20 and 21. The pulses on Lines 17, 18, and 19 (from VITS and VIRS) are present all of the time. They are the only stable part of the lower waveform.

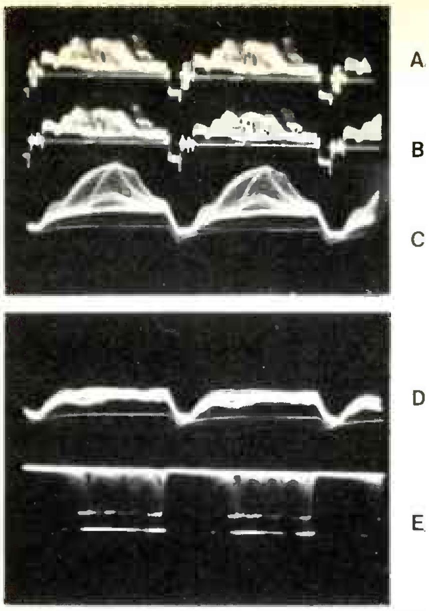

Fig. 5 Changes of the video waveform (because of the low-pass filters and the diode clamper) are shown by these five horizontal-rate scope traces. (A) This is normal video before any filtering. (B) Video at the input of R25 is taken after the 3.58-MHz trap, so the burst is attenuated. (C) At the base of Q26, following the filtering by R25/C25, the video is barely recognizable. (D) D27, at the base of Q28, has clamped the smeared video, with the negative peaks at zero volts. (E) The signal at the collector of Q28 (input pin 1 of the VIR sensor) has no blanking or sync pulses. The clamping line at the top is equal to the supply voltage.

It was fascinating to watch the waveform, because the pulses on Line 21 and above varied greatly, according to the picture video. No pulses showed during some scenes, a few steady pulses could be seen during others, occasionally a hint of video appeared mixed with the pulses, and sometimes the pulses varied in height, as shown in the lower trace. **But there is more!**

The waveforms of Figure 8 prove several things. In the center are the pulses present at the collector of Q28 (also, pin 1 of the VIR sensor), and the bottom trace shows the video waveform that would be there if the video had not been filtered and clipped. Notice that the VIR signal, the VITS, and the sync/blanking pulses have been mysteriously transformed into a digital waveform! In other words, **a signal that should have been a smeared analog signal has been changed into a sharp fast-rise digital signal!** Also, the digital "highs" and "lows" correspond to those areas of the video waveform; thus, proving that the signal **is** positive-going, as predicted by theory.

Inputs to the VIR sensor

The top trace of Figure 8 shows the 15-microsecond pulse that is one of the two necessary input signals to the VIR sensor (IC10). The center trace is the processed-video waveform that's applied to the other input at pin 1.

Now, this section of IC10 is a monostable multivibrator which will have a "high" output at pin 13 **when**—and only when—pin 2 is "high" and pin 1 has the falling edge of a waveform. The dotted lines between the two traces prove that those conditions are satisfied when Line 19 has the VIR signal.

But, when Line 19 does not have a VIR signal, that side of the blanking pulse has no edge; therefore, there can be no falling edge. Without the falling edge, the monostable multivibrator can't fire. (Refer to Line 20 in Figure 6 and Figure 8—that's the way Line 19 looks without the VIR signal.)

Sensor output

We learned last month that the length of time any monostable multivibrator remains active after it is triggered depends on the time constant, which in this case consists of R29 and C29 that are connected between IC10 pin 14 and +5 volts.

The time constant is longer than the time of one video field; therefore, the VIR waveform of each new field triggers the monostable multivibrator again before it deactivates from the previous one. Thus, a steady "high" is maintained at pin 13, so long as the station broadcasts the VIR signal.

Switching voltages

The "high" at pin 13 of the VIR sensor drives switching transistors which in turn determine whether the TV receiver operates from manual controls or from the VIR control circuit. Another switching transistor lights an LED to show when the VIR waveform is being received.

Referring again to Figure 4, the +5 volts at pin 13 of IC10 is filtered by R31 and C31 before it's applied to the base of Q32. R31 reduces the DC voltage, so when the VIR signal is being broadcast, the base of Q32 has nearly +0.7 volt, which is enough to saturate Q32. The collector of Q32 connects to TP32; therefore, the DC switch-

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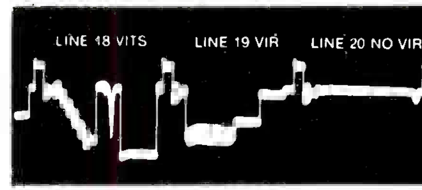

Fig. 6 This is the waveform that *would* appear at pin 1 of the VIR sensor *if* there were no filtering or clamping in the stages before. Notice the falling edge of the blanking pulse at the left of the VIR signal, and the lack of a blanking pulse at the next one between Lines 19 and 20. The falling edge is the trigger for the VIR sensor. When the VIR signal is missing, Line 19 has only a straight horizontal line, as in Line 20. The vertical lines have been reinforced to make the waveform more clear.

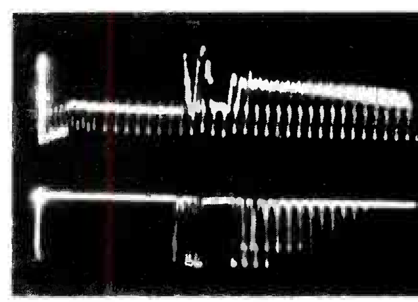

Fig. 7 The top trace shows composite video from about Line 4 to Line 36. Just to the left of center are the VITS and VIRS of Lines 17, 18, and 19. Line 20 and half of Line 21 have no video. Clipped video at pin 1 of the VIR sensor is shown by the bottom trace. The VITS and VIRS have been changed to digital pulses. They seem to be negative-going, but instead they are positive-going pulses that are clamped at the top (supply voltage). Only the pulses made from the VITS and VIRS are there constantly. The signals to the right vary with the picture on the screen. Scope locking came from the receiver sync, so the scope trace started at the end of Line 4. Scope sweep time was about 0.15 milliseconds, and dual-trace alternate-sweep mode was used. Therefore, the sync tips of the two traces are offset by one-half of a TV horizontal line (because of interlaced scanning).

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ing voltage there measures about +0.1 volt with the VIR signal, and about +28 volts when it's not broadcast.

Q34 operates in the same way. A sample of Q32's collector voltage is fed to the base of Q34, and it's sufficient to saturate Q34. Therefore, TP34 (and the collector of Q34) measures about +28 volts with the VIR signal, and about +0.2 when no VIR is broadcast (just the reverse of TP32).

The collector of Q34 feeds the base of Q30 through R35. However, Q30 does not invert, as the other two did, instead a current-limiting resistor (R30) and a red LED are series-connected from emitter to ground. When Q30 conducts, the LED (on the TV front panel) lights to indicate that the VIR signal is being received.

Switching voltages from TP32 and TP34 go to the color-controller and tint-controller circuits where they electronically switch-in the controllers during those times the VIR waveform is received by the sensor.

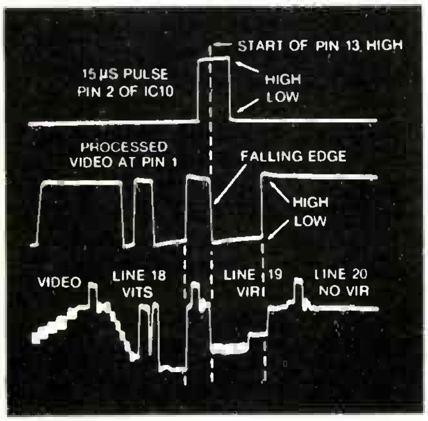

Fig. 8 Triggering of the VIR sensor (monostable multivibrator) requires two specific simultaneous input signals. *Pin 2 must be "high," and pin 1 must have a rapidly-falling edge at the same time.* The 15-microsecond pulse of the top trace is timed to be "high" during the time that the falling edge of the blanking pulse occurs, as shown by the trace in the center. Triggering *cannot* occur if either signal is missing, or if they are not there at the same time. The dotted line between the top and center traces shows where the conditions are fulfilled, and IC10 develops a "high" at pin 13. This "high" operates the transistorized switching-voltage stages to light the LED and change the receiver to automatic VIR color and tint. The composite video of the bottom trace shows the source of the signal that is processed into the *digital* pulses of the center trace. Since there is only one 15-microsecond pulse per video field, the other rising and falling edges at pin 1 are not important. When the VIR waveform is not broadcast, the blanking pulse will have no edge, as shown by Line 20. Vertical lines have been drawn on actual waveforms.

Comments

Next month, we will analyze the color and tint controllers. Before we do, I thought it might be helpful (to those of you who have triggered scopes) to describe how a scope must be adjusted to obtain waveforms in the VIR circuit.

Scoping VIR Waveforms

Two serious problems (and several minor ones) must be overcome before you can show the actual VIR-circuit waveforms on your scope screen.

Interlaced video fields

First, some of the waveforms are composite video, or sync obtained from video. And the first problem arises because it's necessary to lock your scope to the vertical sync pulse. However, interlaced scanning requires the vertical sync pulses of the two vertical fields to begin a half horizontal line apart. So, adjusting the scope by certain ways to obtain the waveform you want often gives **two** waveforms that overlap by that half horizontal line. We'll show examples later.

Low brightness

The other problem concerns the brightness of the scope trace. Now, your scope can have much more brightness than you need for the usual waveforms, yet some VIR waveforms will be so dim that the screen must be seen in near darkness. It's not a scope defect, nor is it an effect that's unique with VIR waveforms. No, the problem is that the waveforms are on the screen only a very short time.

Usually, when we look at a video waveform, the scope is adjusted to show a couple of horizontal lines. The brightness is high because the waveform is traced many times, with only a short retrace and waiting time in between each horizontal sweep of the scope beam. If you look carefully, you'll see ghost images from the vertical-sync pulses and equalizing pulses, which are dim because there are only nine total per field. By ignoring those few peculiar lines of the vertical-retrace period, we find that **those two lines of video are traced 7867 times per second.** The brightness builds up by the repetition of the same waveform.

But, when just one or two **individual** horizontal lines are observed, the brightness becomes very dim. That's because the scope traces the lines we want, retraces, and waits at the left side of the screen for the time those few lines appear again. The trace is resting for most of the time.

Narrow pulses

Think about the 63-microsecond pulse, which has the same width as one horizontal line. Imagine that

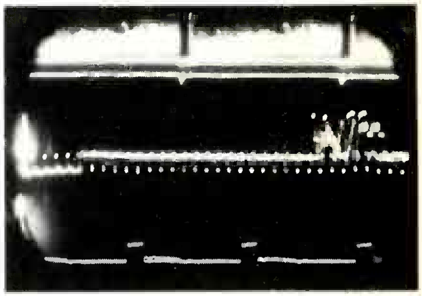

Fig. 9 These three scope waveforms are multiple camera exposures taken to show the *normal* change of scope brightness from different kinds of scope sweeps. Top trace shows the usual way of looking at video by using the vertical rate. Sweep time was about 3.5 milliseconds, showing about 590 horizontal lines. The scope beam rested for only a short time between each sweep, so the brightness is high, causing a slight overexposure. The center trace has about 34 horizontal lines (17 per field), and the exposure is about right. Only three horizontal lines are shown at the bottom. The sweep time was only 10 microseconds, and the trace is dim because these three lines were swept, then the scope waited during about 259 lines before tracing the same three lines again. The same camera exposure was used for all three waveforms, and the scope was locked to the vertical-sync pulse of the TV receiver.

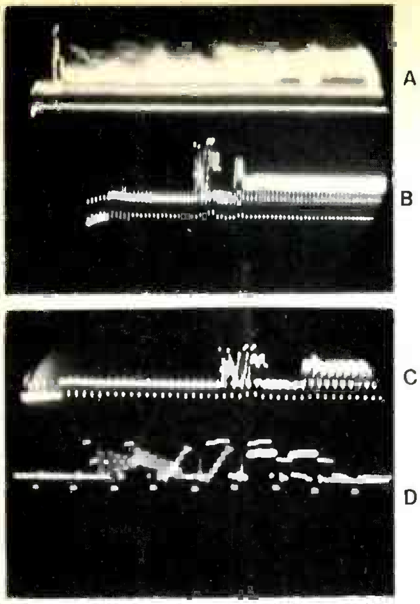

Fig. 10 When only *one* vertical-retrace-time area is present on the screen (trace "A", 1.5 milliseconds sweep), both fields will be in the waveform. Trace "B" is the same as "A", except the X5 expansion switch was used as the centering was changed. The original picture clearly shows the overlapping VITS and VIRS of both fields. When the sweep was changed to 0.15 milliseconds, the VITS area expanded, even with X1 (trace "C"). Finally, trace "D" is the same as "C" except the X5 expansion is used to show only about 4 lines of video. There can be no doubt that both fields of video appear when this scope method is used. The VITS, VIRS, and negative-going sync tips of the two fields are offset because of interlaced scanning of the video signal.

you wanted to show one complete field of 262.5 lines, and you adjusted the scope so the pulse was one inch wide. The total scope trace would be 262.5 inches wide! Of course, we don't have 21-foot scope screens, so the triggered scope is adjusted to display that one-line-wide pulse, then it rests for 261.5 lines before the trace starts again to show the pulse a second time. Obviously, such a waveform **must** be extremely dim; and it is.

Waveform movements

A secondary problem is the instability of the waveforms. Video traces normally move vertically, as the DC level changes with the picture content. Add to those movements some small horizontal motions (from tiny variations of scope locking that are magnified by the delayed sweep and expanded width), and you begin to appreciate the difficulties of photographing dim traces for several seconds. Many pictures are spoiled by such movements.

Photographing dim waveforms

The traces of Figure 9 were photographed in sequence, using the same exposure for all three. (At other times, the exposure is changed to provide approximately the same apparent brightness.) The top trace is overexposed, the center waveform has correct exposure, and the bottom trace is too dim. In fact, the bottom trace could not be seen properly until the room lights were turned out.

Separating the fields

The procedure for looking at the VITS and VIRS of a video signal seems to be both simple and foolproof. Just lock the triggered scope to the vertical sync (either from the integrator of the receiver, or by means of the built-in sync separator, if your scope has one) and expand the trace by decreasing the scope's sweep time until those waveforms appear.

Notice the sequence of traces in Figure 10. A sweep time of about 1.5 milliseconds displays slightly less than one video field (each field is 1.668 milliseconds). Therefore, merely expanding it with the X5 switch and recentering should show the VITS and VIRS of one field. Right? Wrong! Trace (B) is a bit squeezed, but it does show **two** sets of those test signals. Trace (C) expands the VITS area again, showing overlapping VITS and VIRS. Also, the equalizing pulses and the horizontal-sync pulses have the same spacing; that's certain proof both fields are there simultaneously. Trace (D) leaves no room for doubt; the test signals of both fields are there, and the horizontal-sync pulses of the two fields are alternated.

Alternate trace separates them

One way to observe the video and VIRS of just **one** field of video at a time is to use dual-trace operation, selecting "alternate" trace, rather than "chop". Figure 11 shows the VIR 63-microsecond pulse displayed by the previous method. Trace (A) has the pulses of both fields, separated by a half horizontal line. Obviously, such a waveform is not very valuable. A single pulse (B) results from dual-trace operation, when one beam is moved off of the screen by misuse of the centering control.

Unfortunately, the alternate-trace method has a serious drawback. Because each trace starts from a vertical sync pulse, and those sync pulses are offset by one-half of a horizontal line (for interlaced scanning) the two waveforms do not—and cannot—have the same phase. Notice in Figure 12 that the VIR signals and the sync pulse tips of the two fields are offset by half a horizontal line. (Chop mode is worse yet. It shows both fields together, and the chop waveform also is visible.

Two fields

There is another way of viewing individual VIRS, although it too has a shortcoming. The requirement is that more than one vertical-retrace area must be visible at normal (X1) trace width (see Figure 13A).

Video fields are designed to repeat, so when there are two, as in

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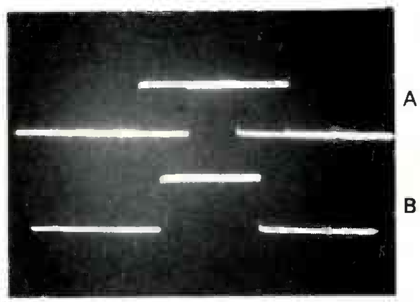

Fig. 11 If the "one-field" method of Figure 10 is used to look at the 63-microsecond pulse in a VIR module, the overlapping pulses of *both* fields will be seen (top trace "A"). This waveform can be obtained from a single-trace scope. It does show a pulse is there, but it's rather confusing. Trace "B" was obtained the same way (0.15 milliseconds and X5), but dual-trace alternate-trace was used, and the second trace was moved off the screen by rotation of the vertical-centering control. Although the brightness of the waveform is low, it can be seen if the room lights are dimmed, and such a pulse waveform can be very useful in diagnosing VIR problems.

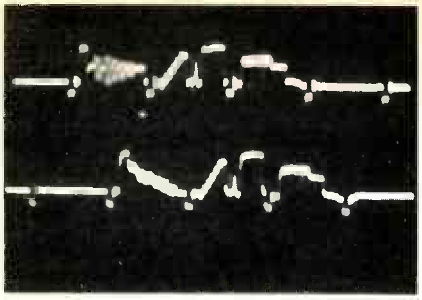

Fig. 12 One limitation of dual-trace operation when viewing video, or video-derived waveforms, is the difference of phase between the two waveforms. In order to lock and view specific individual lines of video (rather than having *all* lines lumped together and averaged), it is necessary to lock to the vertical-sync pulse of the composite video. If your scope has an internal sync separator, use it for easy locking. If it doesn't have one, connect the external sync input of the scope to the integrated sync just before it goes to the vertical oscillator of the receiver. Therefore, the scope locks to the *phase* of the vertical-sync pulse of *each* video field. And, because of the requirements for interlaced scanning, one of these vertical-sync pulses starts *between* two horizontal sync pulses. So, dual-trace alternate-trace waveforms have the horizontal-sync tips of the two fields alternated, as shown, rather than correctly one above the other. Sometimes, when correct phase is vitally important, I cut the picture and slide the halves to the right position.

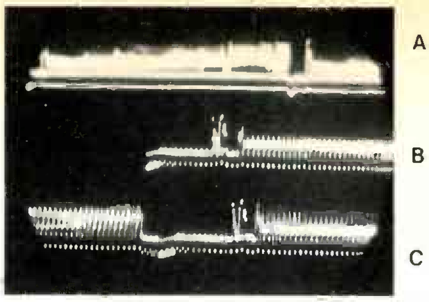

Fig. 13 By using the "two-field" method, you can view either of the two vertical fields. The vital requirement is that the scope show parts of two vertical-retrace sections, when adjusted for normal (X1) time and locked to vertical sync, as shown by trace "A". Scope sweep time was about 2 milliseconds (one video field requires 1.668 milliseconds), without the X5. Trace "B" is the same, except the X5 expansion is switched in, and the waveform was moved to the right by recentering to show the *first* vertical interval (the one locked by the scope). Trace "C" also is the same as "A", except X5 was used, and the waveform moved to the left to show the *second* vertical interval. The original pictures were so sharp that differences of the VITS and the equalizing pulses of the two video fields could be seen clearly, proving the two vertical intervals were indeed part of two separate fields. The limitation of this "two-fields" method is that the expansion shown here is about the maximum possible.

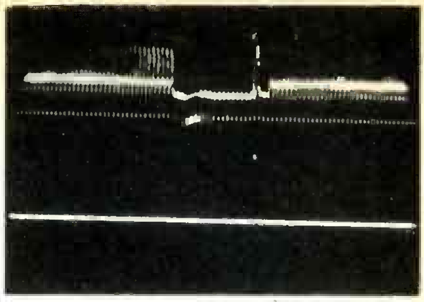

Fig. 14 The "two-fields" way of expanding the vertical interval is completely inadequate for viewing the narrow pulses of the VIR circuits. This dual-trace waveform shows the video signal at the top and the 63-microsecond Line 19 pulse below. The top of the pulse looks like a white blot made by a mistake of printing! It could prove that some kind of pulse was there, but nothing more. Contrast the waveform expansion of this picture to the pulses of Figure 8, which were photographed by the "one-field" dual-trace method. Of course, the "two-field" technique is the only one that can show *all* of a vertical interval, including the pre-equalizing pulses and the complete segmented vertical-sync pulse. You must select the method which is best for the waveform you need at the moment.

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Figure 13A, one **must** be Field #1 and the other Field #2. Traces (B) and (C) were derived from (A) by widening with the X5 switch and then rotating the horizontal-centering control; and they **do** show different fields. (If you reduce the horizontal-sweep time with the variable control, this moves the vertical-retrace section at the right end farther to the edge. And when it disappears, the one at the extreme left suddenly has both fields in it. Try it sometime, it's interesting to watch.)

The limitation of the two-fields method is that a scope with an X5 switch can't stretch the vertical-retrace area much more than the width shown in Figure 13. Of course, if your scope has an X10 control or switch, the retrace area can be made twice as wide as shown.

Compare the width of the 63-microsecond pulse in Figure 11 with the same pulse displayed by the two-fields method in Figure 14. That's why we say: the alternate-trace method permits **much** greater magnification than does the two-fields method, just described.

Comments

Some of the waveforms shown here approach the limits of a good scope, in brightness, stability, solid locking, and sharpness of trace. If you can duplicate these waveforms, we congratulate you; they are not easy to obtain.

Or, if you don't understand how to obtain similar waveforms, we suggest that you carefully read the scope settings we used, and then practice until you too can achieve them. The VIR waveforms can be observed in the video of any TV receiver; it does not have to be a type with a VIR module. You'll be surprised at the many things—both about scopes and about circuits—that you can learn.

Digital circuits are the designs of the future. And a scope is one of the few instruments to use for troubleshooting them.

Our thanks go to B&K Dynascan for the long-time loan of a B&K-Precision scope Model 1470. All of the waveforms in this article were photographed from it.

Next month, details of the color-controller and tint-controller VIR circuits will be discussed and illustrated. □

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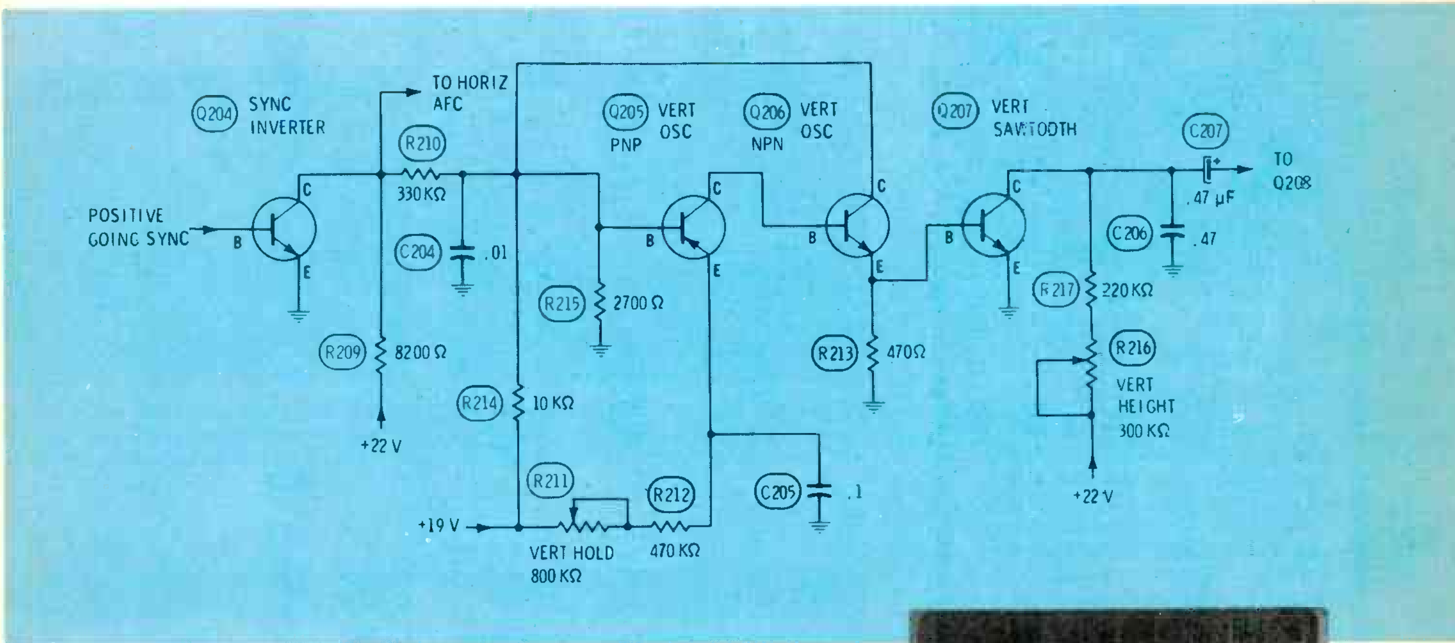
For More Details Circle (10) on Reply Card

VERTICAL CIRCUIT PICTURE SYMPTOMS

By Robert L. Goodman, CET

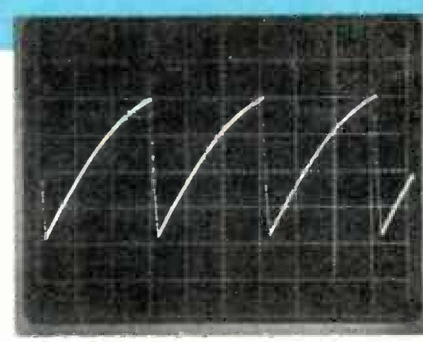
Pictures taken from the screen of a TV receiver tell far more about height and linearity symptoms than words can. These symptoms apply totally only to General Electric B&W chassis XA and XB (Photofact 1491-2), but there are large similarities to the JA, QA, and QB chassis, and a family resemblance to the YC series.



Schematic #1 These are the sync inverter, time-constant oscillator, and sawtooth-forming stages of the General Electric black-and-white XA chassis. Q204 amplifies and inverts the 1-VPP sync signal, supplying about 20-VPP of negative-going sync to the horizontal AFC, and following the integrator network (R210 and C204), feeding vertical sync to the base of the vertical oscillator, Q205.

Actually, there are two oscillator transistors, one PNP and the other NPN. Both transistors draw current at the same time, in extremely narrow pulses. Although the oscillator appears to be some sort of multivibrator, it is not. When B+ power is applied, the base of Q205 immediately becomes positive. But it is a PNP type, so that is reverse bias, and no conduction occurs. The time constant of R211, R212 and C205 delays the arrival of the B+ at the emitter. Finally, the emitter becomes more positive than the base, and conduction begins. Q206 has been without any forward bias, and so it also has been cut off. The Q205 conduction brings positive voltage to the base of Q206, and it conducts. However, the conduction comes from the voltage at the base of Q205, thus increasing the forward bias of Q205 and increasing the conduction. The rapid conduction bleeds C205 of its voltage, and the emitter becomes less positive than the base of Q205, causing a loss of conduction. This loss of conduction removes the forward bias from Q206, and it too stops conducting. That is the end of one cycle, which then repeats. Negative-going sync at the base of Q205 initiates the sequence of actions just before the natural time constant would allow conduction, thus locking the vertical sweep. About 1-VPP of very-narrow positive-going pulses are applied to the base of Q207, which has no forward bias until the pulses arrive each time. C206, in the collector circuit of Q207, slows down the arrival of the positive voltage to the collector, forming a ramp. Before the ramp becomes non-linear, Q207 conducts and instantly brings the voltage to zero, forming sawteeth as shown by the waveform. These sawteeth are the drive signal for Q208. (In some variations, Q207 is replaced by diode Y207.)

Defects in the sync-separator or sync-inverter stages can cause the type of locking failure that permits the vertical-hold control to roll the picture either up or down without locking. The oscillator stage can produce pulse waveforms without help from any others; therefore, use a scope to check the oscillator and the sawtooth-forming stages. Of course, complete failure of the oscillator or the sawtooth stage stops all height.



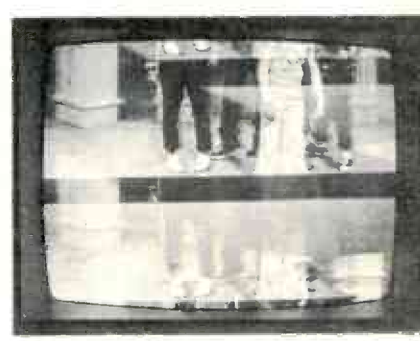


Photo #1 If the hold-control rotation can cause the picture to roll up and roll down slowly, but without locking between those points, the defect is a loss of sync. If the hold control can't lock the picture or even slow down the roll to show one complete picture only, the oscillator probably has a bad part.

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Vertical circuit picture symptoms

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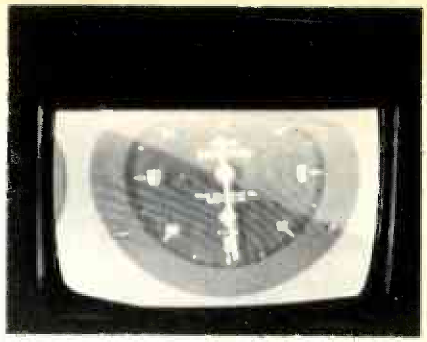


Photo #2 Compression at the top of the picture can be caused by leakage or a short in C207. Sometimes, retrace foldover occurs, also.

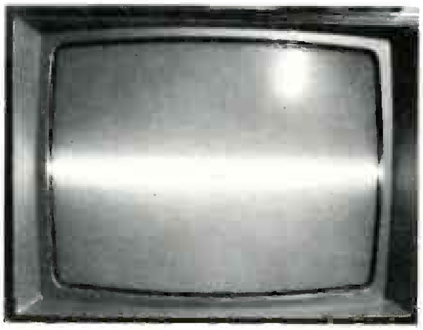


Photo #3 An open R218 stops the vertical sweep, except for about 1" just below the center of the raster.

Photo #4 A stretched, non-linear picture with retrace lines can be the symptoms of a reduced value of R221, R226, or R228.

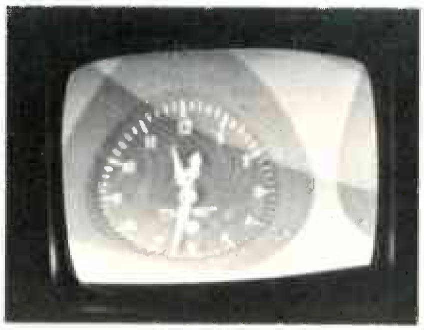


Photo #5 If R219 is open, the picture will be stretched at the top and have compression at the bottom.

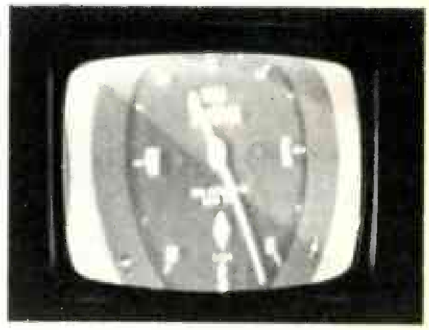
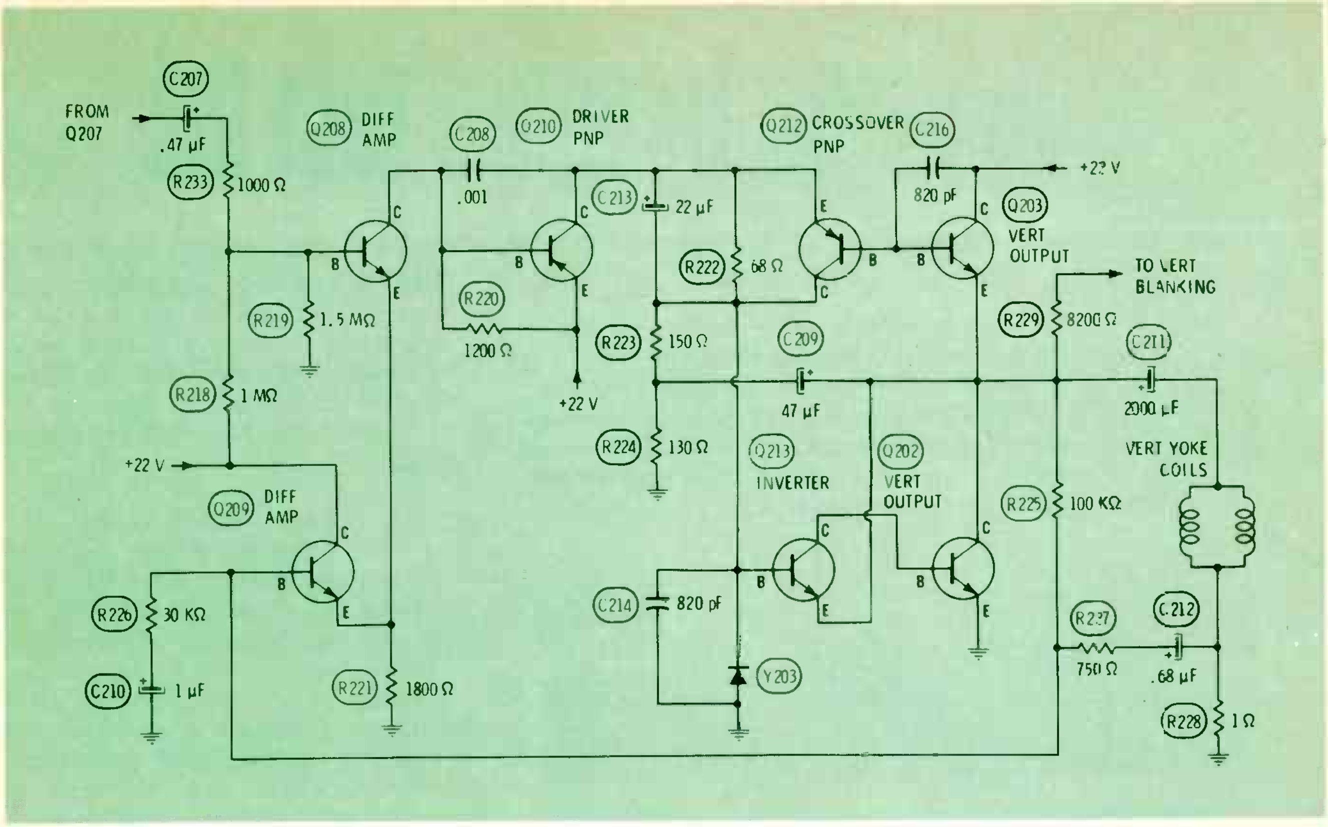


Photo #6 An open feedback capacitor, C212, or open resistor, R227, produces excessive height, along with poor linearity.

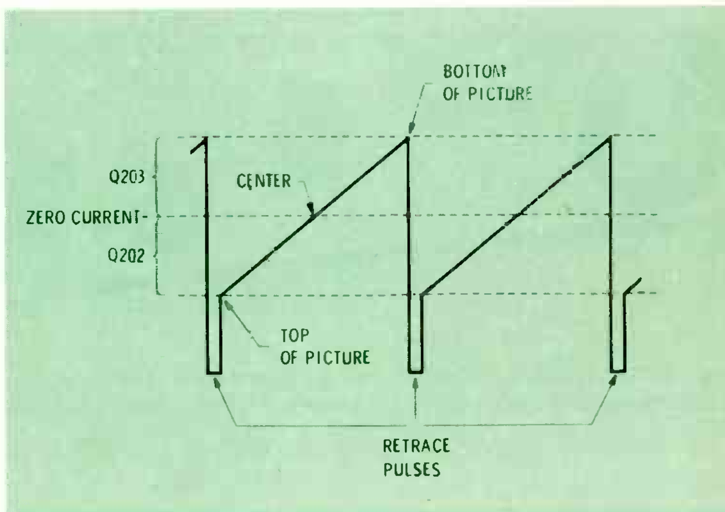
Photo #7 When C210 or R226 opens, the picture is stretched at the top and compressed at the bottom.

Photo #8 A horizontal white line across the center of the picture (sometimes with retrace lines) indicates a defective component (such as Q212, Q213, or R222) in the inverter or the cross-distortion network.



Schematic #2 Transistor Q208 amplifies and inverts the signal from Q207. However, the waveform and amplitude of the signal is modified by the feedback signal developed across R228 (in series with the vertical defection coils) and sent through C212, R227, and Q209, where it joins the main vertical signal by sharing a common emitter resistor (R221) with Q208. These differential stages with feedback eliminate any need for a linearity control.

The driver transistor, Q210, amplifies and inverts the phase of the processed signal from Q208, before it's used to drive the output transistors. However, both output transistors are NPN types, so the phase inverter, Q213, is required before Q202. To minimize crossover distortion, Q212 is added, instead of the usual diode. The output signal from Q203 and Q202, through C211, drives the vertical-yoke coils to supply the picture height. Q202 supplies the top, and Q203 the bottom of the raster, so the condition of the picture can indicate which is defective.



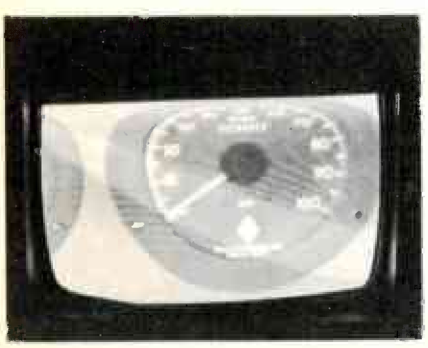


Photo #9 Loss of the top half of the picture, or compression there, can be caused be a defective Q202 output transistor.

Photo #10 An open power-supply filter (C269— not shown on the schematic) reduces the height at both top and bottom.

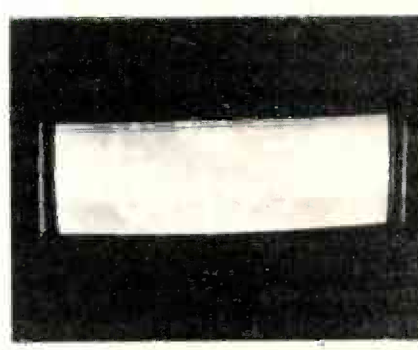


Photo #11 Insufficient height can be caused by a defective Q203 transistor, or an open R225 or R214. Also, check the soldering around these components.

Reports from the test lab

By Carl Babcoke

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.

Fig. 1 The TeleMatic "Ferret" not only provides VHF and UHF tuners for substitution tests, but also has a generator of crosshatch and dot patterns.

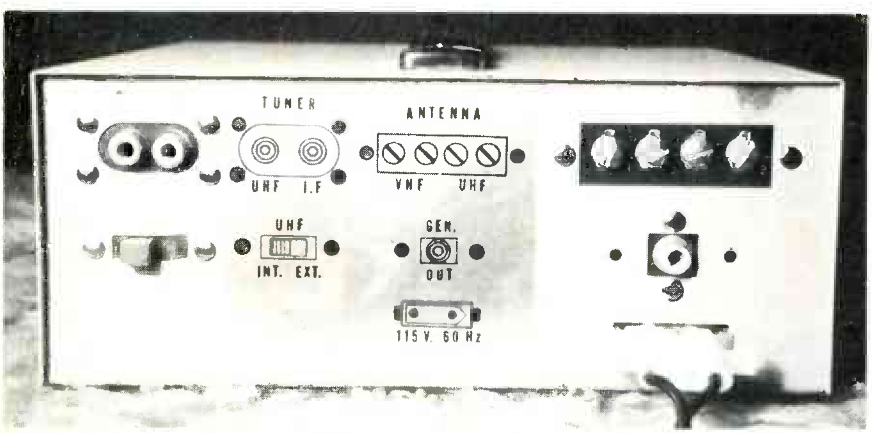


Fig. 2 A chart on the back of the instrument shows the location and functions of the various terminals, jacks, and switches.

A tuner-substitute with crosshatch and dots patterns for convergence appeals to me as a practical instrument to carry along during service calls. And TeleMatic offers such a helpful device in the "Ferret" TV Mini-Nalyzer (Figure 1).

Tuner And IF Tests

The TeleMatic Ferret has both VHF and UHF tuners. The VHF tuner has a one-set fine tuning for individual channel adjustments, and a vernier continuous-tuning system is provided for the UHF tuner. Calibration numbers are printed around the RF gain-control knob. These can be used to estimate the IF gain of the receivers under test.

Operation is by AC power only, and an on/off switch and LED indicator complete the list of front-panel controls, except for the generator switches. Although the idea of battery operation seems good for a portable instrument, the extra current drain of the generator section and the impossibility of a battery failure at a crucial time are more important reasons for the AC-only power.

Located on the back of the instrument (Figure 2) are separate output jacks for signals from the VHF and UHF tuners, a switch to allow substituting the internal UHF

Fig. 3 This is a photograph of a good-quality color picture obtained when the Ferret VHF tuner was connected to the input of the IF stages of the receiver.

tuner or feeding an external UHF tuner into the machine, four terminals for UHF and VHF antennas, and a jack for the IF/RF signal from the pattern generator. Incidentally, the AC cable is removable.

In tests with a late-model solid-state color receiver, the Ferret was substituted for the VHF tuner, producing a snow-free picture of good quality with strong color (Figure 3). Only a few small overshoot lines showed the slight deviation from perfect overall alignment that is normal for any tuner substitutions. This is excellent performance.

Convergence Patterns

Two patterns for convergence adjustments are supplied by the Ferret. The crosshatch pattern (Figure 4) has the proper number of vertical versus horizontal bars to produce squares on the screen, when the TV receiver height, width, and linearity are all perfect.

The dots pattern has small, sharp dots, which can be very useful for center convergence, or other critical adjustments.

These patterns start with a crystal-controlled oscillator, and then has flip-flop dividers to provide the proper frequencies for vertical and horizontal bars, plus the vertical and horizontal sync for locking of the receiver. Therefore, the patterns are completely stable.

One technical detail misled me for a time. The video of the crosshatch and dots patterns modulates an oscillator so the output can be fed to the IF's or to the set's tuner terminals. This oscillator carrier has a frequency of 42 MHz, which passes through the IF's very readily. Also, the instructions say a harmonic is in the "Channel 3 tuning range." I turned to Channel 3 with the AFT on and received a scrambled picture. Finally, I turned off the AFT and tried adjusting the fine tuning. That was the answer; for the sharp, stable crosshatch pattern appeared then. Therefore, if you want to connect the patterns to the antenna terminals, vary the fine tuning of Channel 3 for the best picture quality. The carrier frequency is not the same as that of the original factory adjustment, but it is within the adjustment range of the fine tuning.

In addition to the usual use during convergence adjustments, the crosshatch pattern is very good for signal tracing in the IF's.

Comments

The TeleMatic "Ferret" performed both the tuner-substitution and convergence-pattern functions very well, and I can recommend it, without any reservations. □

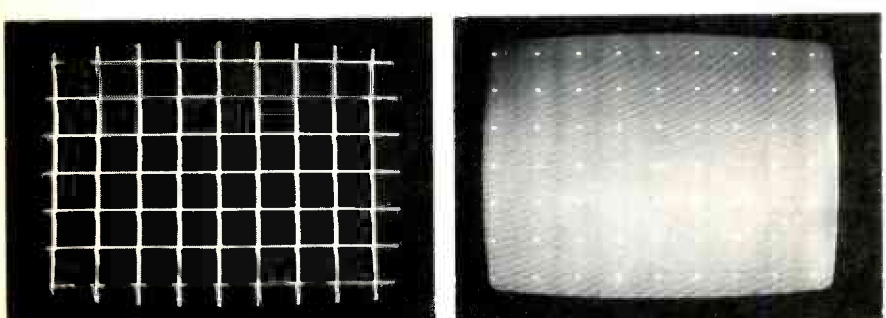
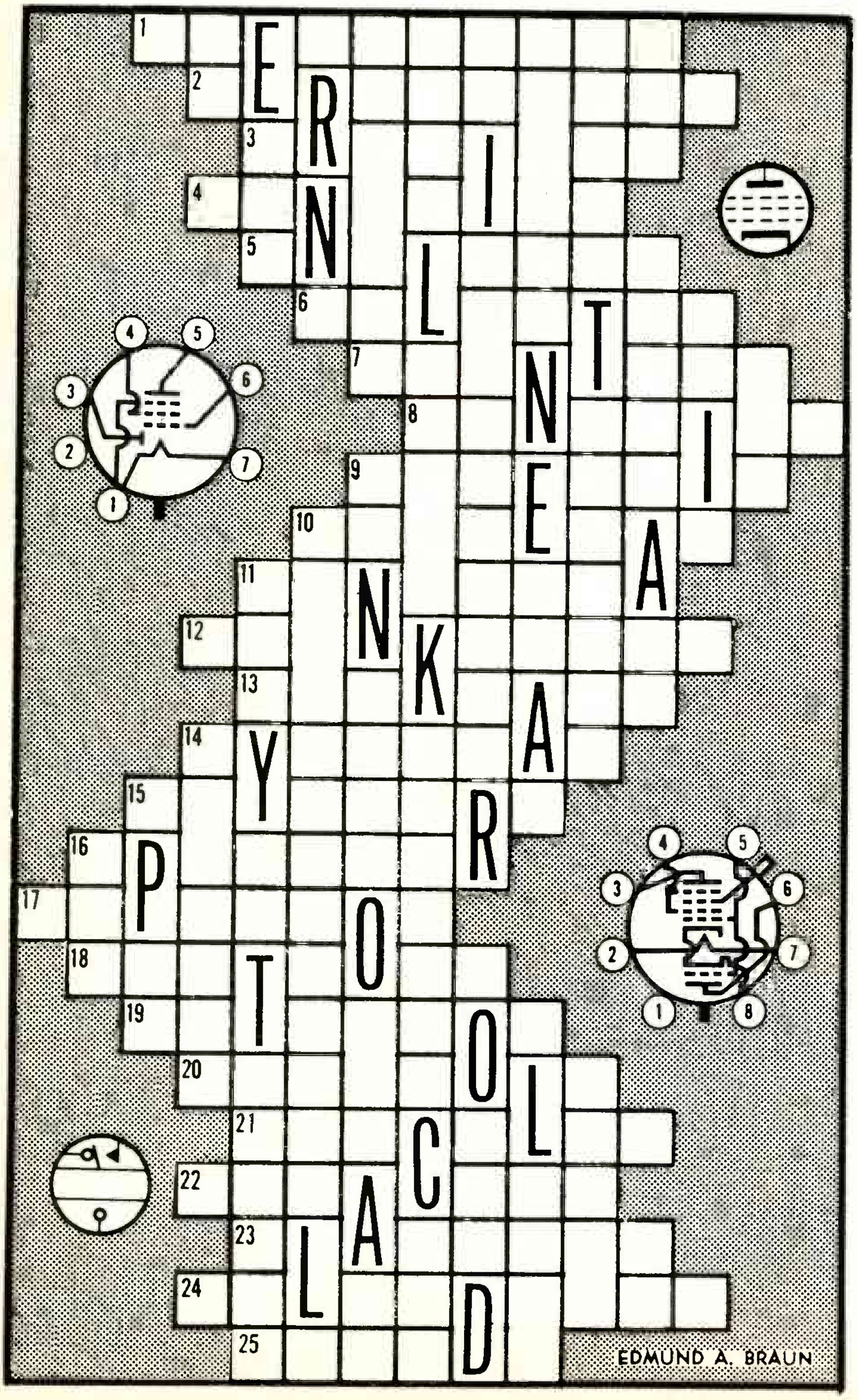


Fig. 4 When the pattern-generator output was connected to the antenna terminals and the fine tuning adjusted on Channel 3, these stable patterns were observed on the picture tube.

LOOK WATTS UP!

Watt about it? You'll 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 should prove simple to get a high score except perhaps for someone who is sure "align" is what some men give a girl; or that "tweeter" results from adding more sugar! So sharpen your pencil, make yourself comfortable, and GO!

by Edmund A. Braun



1. This is used for temporary mounting of components for experimental work.
2. Instrument for making permeability and hysteresis tests of iron or steel.
3. Rate at which a variable quantity increases or decreases.
4. Numbering systems using base number, or radix, of 2.
5. Test instrument used to check electronic equipment, parts, etc.
6. Device for making connection on a choice of circuits.
7. Unit of radioactive exposure.
8. Grouping pairs together for identification or testing.
9. Tubular coil for production of a magnetic field.
10. Pertaining to a vacuum-tube socket having 12 pins.
11. An unbroken or widely-extended view.
12. The overriding of a signal by a more powerful one or by interference.
13. Plate in a pot core which connects center post to the sleeve.
14. A germanium PNPN semiconductor switching device.
15. Rows of control levers operated by the fingers.
16. Any person who works, adjusts, and maintains equipment.
17. The highly ionized layer in the ionosphere which often reflects radio waves back to earth.
18. A cgs electrostatic unit.
19. Relay part converting electrical energy into mechanical motion.
20. Locus of points equidistant from a fixed point and a straight line.
21. A branch of high mathematics.
22. Current-output capability of a cell or battery over a period of time.
23. Process of rendering a channel or device inoperative for a desired interval.
24. Metallic element sometimes used for grid or plate electrodes.
25. One of the secondary emitting electrodes in an electron multiplier tube.

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bookreview

Servicing Biomedical Equipment
Author: Elliot S. Kanter
Publisher: Howard W. Sams, 4300 West 62nd Street, Indianapolis, Indiana 46206
Size: 160 pages
Price: $5.50 ($6.60 in Canada)

An explanation of the types of electronic and electromechanical devices found in modern-day hospitals acquaints the reader with the biomedical servicing field. The author presents observations on why medical devices fail, how they can be fixed and suggestions on how future failures can be avoided. Several chapters describe the advantages of practical and formal education in the field; employment opportunities for the biomedical equipment technician; equipment types, service and maintenance techniques, electrical shock hazards, and how to successfully interface the technician with the hospital community. Numerous photographs and illustrations support servicing explanations for centrifuges, electrocardiographs, defibrillators, monitoring devices, oxygen and vacuum devices, and other equipment.

TRANSISTOR TECHNIQUES FOR TIMID TECHS

By Wayne Lemons

Almost thirty years ago, the first crude transistor was made in a laboratory. After such a long time and many improvements of transistors, it's reasonable to expect that **all** technicians would work on solid-state equipment, and service it without having anxiety or misgivings. Not so!

Of course, not all techs are as timid as one old-timer I know who longs for the return of the 5-tube radios that had series-heaters. I do talk and write, however, to many men who turn down all repairs of transistorized TV receivers. Why do they feel this way?

Do they believe that a perfect knowledge of atomic theory and the internal construction of transistors is necessary for successful servicing? Or, maybe they think any device that's so tiny must be equally fragile. Perhaps the crowded wiring and small components discourage them. Whatever the reason, many men avoid transistors as much as they can.

Are you one of those? If so, **this article was written for you.** We are NOT going to discuss complex theories or circuits. Instead, we will explain the most-simple (and most-accurate) concept of all: in-circuit transistors can be tested much as you do resistors, because they have DC voltage drops across them. In other words, they conform to Ohm's Law. After all, the name "transistor" comes from the words **transfer resistor.** There are a few simple ground rules, of course, and a few practical precautions, such as preventing failures by not overlooking the transistors. But those things can be taken in stride later on, after you become familiar with ordinary conditions.

To begin, we'll discuss only small transistors that are operated in Class "A" mode.

Transistor facts

Remember these simple things about transistors:

- A transistor can operate in just one of three DC conditions: no conduction (open, or wrong voltages); full conduction (shorted, or saturated); or some value in between those extremes. Most leakages are included here.
- A non-defective transistor **must** operate as it is commanded by the circuit (or as you manipulate it during tests). And,
- You can force the transistor to indicate whether it's bad, or if it is refusing to work properly because of the wrong "commands."

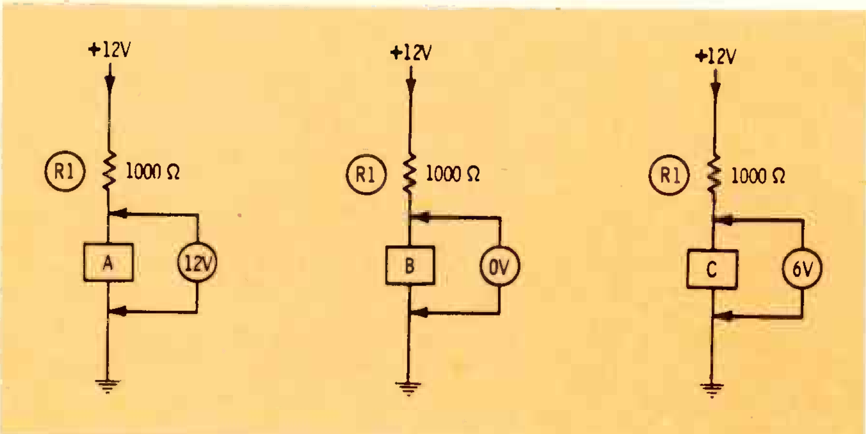

Fig. 1 From the voltages given, can you determine what is inside each box? Box A has an open circuit, as proved by the full supply voltage across it. Box B must have a near short, because the resistor has all of the voltage, and the box has none. Whatever is in Box C has a DC resistance of 1,000 ohms, because the box voltage and the resistor voltage are equal.

Now, we didn't say a thing about crystal structures, current carriers, atomic theory, or any other scientific principles. Instead, we stated that **DC meters don't discriminate. They read the same for "fast" electrons as they do for "slow" holes.** As I wrote in my Howard Sams book, "Transistor Servicing Made Easy," "It really doesn't make any difference to my voltmeter if the current carriers are electrons, holes, or billiard balls!" Forget about transistors being an untouchable miracle, and concentrate on what your test equipment tells you about them.

Here are some examples of that advice.

Testing "black boxes"

Don't be concerned about what is inside a transistor; think of it as a "black box" with unknown contents.

In the circuit of Figure 1A, all of the voltage drop is across the box, and none across the series resistor. Those conditions prove the current is zero. So, the box has nothing inside; it is an open circuit.

The box of Figure 1B, according to the same logic, probably has a short piece of wire between the terminals. While in Figure 1C, the equivalent of a 1,000-ohm resistor must be in the box, because the voltage drop across the external 1,000-ohm resistor equals the voltage across the box.

Probably by now, you are thinking, "Okay, so what?" Well, the point is that the boxes could just as well have had the C/E path of a transistor inside. Box "A" might have contained an open transistor, or a transistor having no forward bias. In Box "B," the transistor could be shorted, or be one with excessive forward bias that saturates it.

Box "C" might have a normally-operating transistor. In Class-"A" operation, every transistor C/E path acts (according to my VOM) as a plain garden-variety resistor.

You can find most transistor troubles in the same way that you find an open resistor, shorted capacitor, or a changed-value resistor: measure and analyze the voltage drops; or make resistance readings.

continued on page 44

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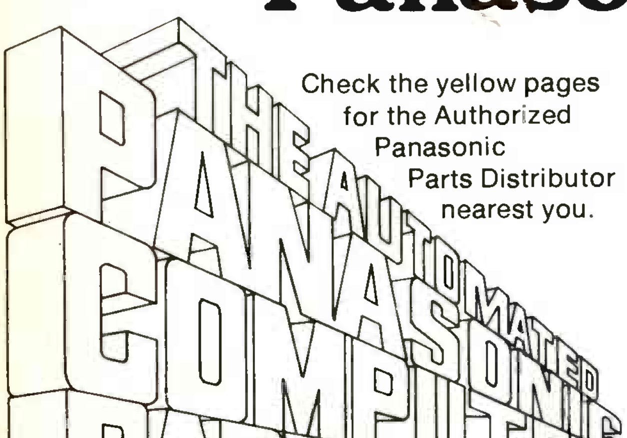

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Transistor Techniques

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One circuit condition makes possible effective tests based on the transistor voltage drops—series resistors always are present at the emitter or collector of all small Class-"A" transistors, such as those for RF, IF, video, and audio stages. **The voltage drops across such resistors can be compared to the voltage drops across the transistor.**

Resistor Voltage Drops

If someone asked you to diagnose the circuit of Figure 2A, you could tell at a glance that R2 was open. This is the same shortcut we used years ago with series-heater tubes. When none of them were lit, we checked for voltage across each heater. The tube with 120 VAC across the heater was the open one. The method never failed.

Imagine R2 as the collector-to-emitter path of a transistor; then, the old shortcut works just as well as for these new circuits.

In Figure 2B, resistor R2 must be shorted. The calculation of Figure 2C is not much more complicated. You could solve it Kirchhoff's Law, or figure it in your head by saying, "If two 1,000-ohm resistors have 4 volts, then the unknown with 8 volts must have twice the resistance, or 4,000 ohms."

Transistor Voltage Drops

It's an easy step from resistor voltage drops to transistor voltage drops (Figure 3). If you think a transistor is not working, measure the voltage from collector to emitter. A reading equal to the supply voltage proves the transistor is not conducting.

A non-conducting transistor can be "open" because (A) it is defective, or (B) it does not have enough base/emitter forward bias voltage to "turn it on." How do we command the transistor to tell us which it is? **Just measure the bias voltage from base to emitter.**

For silicon-type transistors (which are nearly the only type we find in modern equipment), the forward bias must be higher than 0.5 volt to make it conduct enough to imitate a resistor.

This is one time that tube experience can trick us into making mistakes of diagnosis. With tubes, a grid bias of half or double would give improper operation, but still allow **some** current and amplification. That's not true of any transistor. Forward bias of transistors perhaps is a hundred times more critical than for tubes. What's more, the best transistor bias voltage depends on the temperature of the transistor. Even so, we can have some trustworthy guidelines.

Let's say you measure the bias accurately from base to emitter, finding it is less than 0.3 volt. That's a bias problem. But don't fall into the trap of thinking 0.3 volt of bias will give half the collector current and half of the amplification possible with 0.6 volt. Silicon transistors ignore any forward bias voltage that's less than 0.5 volt. The effect is the same as zero bias.

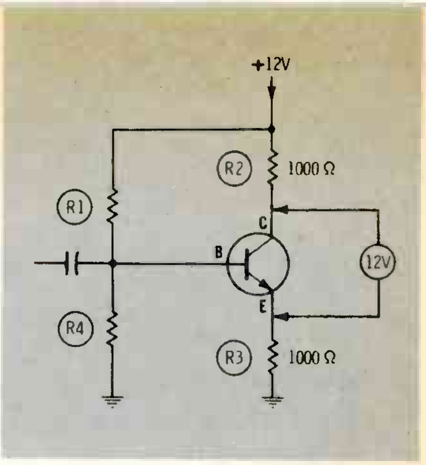


Fig. 3 By considering only the voltage drops across them, transistors can be thought of as resistors. This C/E path is open, as proved by the full supply voltage across it.

What are the defects most likely to reduce the forward bias? R4 might decrease in resistance (Figure 3), but that's not a good bet. Most small resistors do not go down in resistance unless they have been overloaded and show it by being discolored or having a swelled surface. R3 might increase in resistance; however, low values are not so likely as the ones with higher values to change because of age and normal operation.

The best guess is that R1 has increased in resistance. Of course, the input coupling capacitor could have leakage, or the transistor might have base/emitter leakage. Even so, R1 is the best suspect.

Remember, we are discussing Class-"A" operation only. Oscillators, clippers, sync separators, or horizontal-output transistors draw base current from the input AC signal, so different voltages must be expected. For example, many of these transistors will measure a reversed bias, when the voltage is checked with a meter.

High Bias—No Conduction

In Figure 4, notice the DC voltages. Then, take a long second look at the bias of the transistor. The meter indicates a forward bias of more than 1.5 volts. According to the bias, the transistor should have a collector current of several thousand amperes! Yet, the voltage drops prove the transistor is simu-

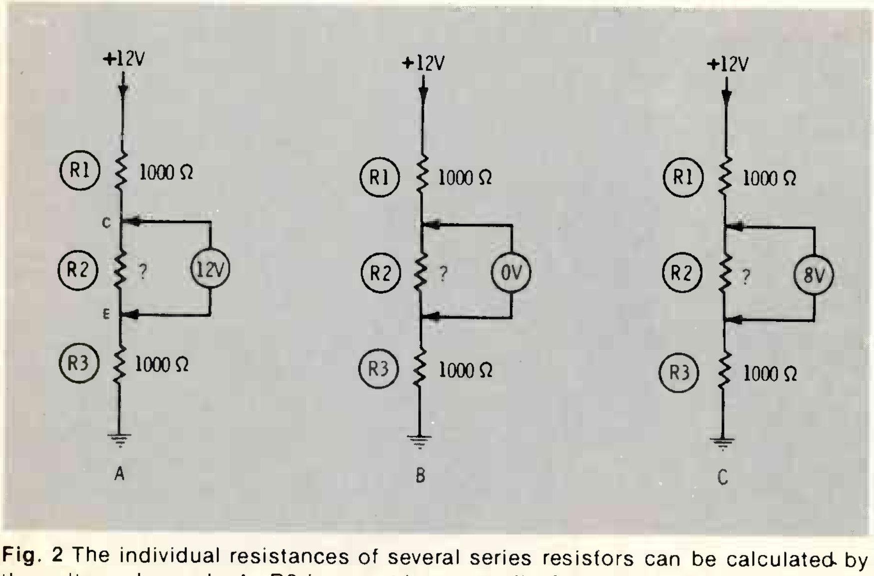


Fig. 2 The individual resistances of several series resistors can be calculated by the voltage drops. In A, R2 is open, because all of the voltage is across it. R2 in B must have nearly zero ohms to account for the zero voltage. In C, each 1,000 ohms has 2 volts, so R2 must be 4,000 ohms.

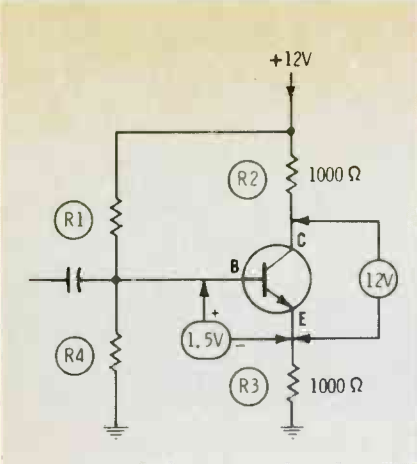


Fig. 4 B/E forward biases above about 0.9 volt prove the junction of the transistor is open. Diode action limits the bias of most transistors to a maximum of about 0.7 volt.

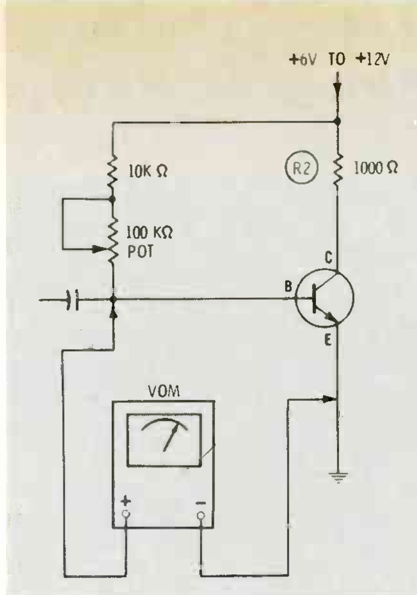


Fig. 5 Try this experiment, noticing how slowly the bias increases, and you always will remember the statement in Figure 4.

lating an open resistor; there is **no** conduction.

We learned, over the years, that defects can cause huge variations of tube grid voltage. Transistor base voltages can't vary as much.

Because of the diode effect, the B/E forward-bias voltage of a non-defective silicon transistor cannot be forced above about 0.9 volt, without ruining the transistor.

If you find a non-conducting transistor with a forward bias of more than 0.9 volt, there are five possibilities:

- The transistor has an open B/E junction;
- Your meter is not reading correctly (perhaps you're using the wrong scale of an analog meter);
- You are **not** measuring between the base and emitter terminals (be very certain of your testpoints);
- Someone (surely not you!) has mistakenly installed a PNP type for a NPN, or a NPN for a PNP. Reverse bias gives an open circuit;
- Someone has installed a new transistor with the leads soldered into the wrong holes of the circuit board.

Let's discuss the first possibility a bit more. It's not true that merely decreasing the value of the bias resistor can raise the B/E voltage to **any** amount. All diodes, including the diode junctions of transistors, have a nonlinear ratio between the voltage across the diode and the current. Doubling the voltage might produce a hundred times more current, depending on the starting voltage. In fact, ordinary diodes can be used for low-voltage regulators, when precise regulation is not needed.

Test these facts for yourself by trying the circuit of Figure 5. Use the 1-volt or 2.5-volt range of VOM or VTVM, and watch the reading as you turn the pot to decrease the resistance. One transistor I checked this way showed a maximum bias of 0.66 volt (at 6 milliamperes of base current, or a calculated 110 ohms of resistance), while the current was only 0.3 milliampere (calculated 1800 ohms) when the bias was reduced to 0.55 volt.

By the way, there seems to be a relationship—in some cases—between the maximum bias obtainable and the frequency response. For example, if you can't force the bias much above 0.6 volt, the transistor probably is an audio or low-frequency RF type. Some IF and RF types require about 0.7 volts. But, some UHF silicon transistors have been measured up to about 0.85 volt.

Anyway, we can say this for certain: If you measure a B/E forward bias that's more than 0.9 volt, the transistor is open; or one of the four errors previously listed is responsible.

No C/E Voltage

The opposite condition with nearly zero voltage across the C/E junction of the transistor (Figure 6) indicates a transistor that's either shorted or saturated. If it's shorted,

continued on page 46

Transistor Techniques

continued from page 45

it must be replaced. Incidentally, many transistors have been found to have C/E shorts, but the B/E and B/C junctions were normal. This is hard to understand, since the base physically is between the emitter and collector. Probably the overload burns a hole in the thin base layer, thus accounting for the strange condition.

Can we force the transistor to show us whether or not it is shorted? Yes, we can. Just short between the base and emitter, and notice the change of voltages. The short removes all of the forward bias; therefore, the transistor—if it is not defective—becomes an open circuit, and should show the full supply voltage between collector and emitter.

Some caution should be used in direct-coupled circuits. No damage should occur to the transistor with the short between base and emitter, but another one, perhaps two or three stages downstream, might be overloaded. Have your meter connected by insulated clips to collector and emitter. Maintain the B/E short only long enough to read the meter, then turn off the power before the other transistors have a chance to build up excessive internal heat.

If the C/E voltage does not increase when the base is shorted to the emitter, the transistor is defective. If it does increase, it's likely the base-biasing network has a bad component, or the transistor has internal C/B leakage.

What About Tuned Stages?

When the transistor is in a tuned circuit (see Figure 7), should this same method be used? Yes, definitely. Of course, the test probes **will** detune the circuit, but it's dead anyway. And the detuning does not change the DC voltages. Or, if the emitter resistor is bypassed, measure the DC voltage across it. Under most conditions, this gives a reliable indication of transistor conduction.

Low-gain IFs

For example, not long ago a color TV had symptoms of low contrast, intermittent color, and no snow on channels that did not have a signal. The AGC adjustment

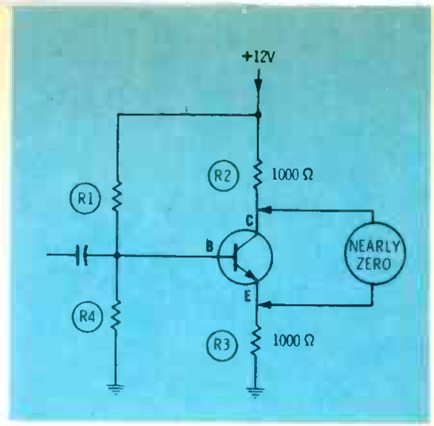


Fig. 6 When the C/E voltage is very low, the transistor either might have a C/E short, or the biasing resistors (R1 and R4) might be supplying excessive forward bias.

would make it worse, but not better. These symptoms suggested weak IF gain, although of course AGC defects can simulate that.

I used a VOM to check from emitter to ground of each of the IF transistors. The first and second transistors had emitter voltage, but the third did not. Base-to-ground tested about four volts. The symptoms pointed to an open transistor, and a new one restored normal operation.

If the emitter voltage had been high, a shorted transistor or wrong bias would have been indicated.

Direct-coupled stages

Here are a few more tips about testing circuits that have several direct-coupled stages. First, removing the bias by shorting together the base and emitter is certain to stop the conduction of a non-defective transistor. But, the conduction of the next transistor might minimize the increase of the C/E voltage, making the test result less definite.

Also, to minimize any change of overloading subsequent transistors downstream from the one you're testing, connect a 330-ohm resistor from base to emitter, rather than using a dead short.

If the original defect has zapped the output transistors, make as many tests as possible before you install new ones. Then, if you must install replacement outputs, but still are not sure that the circuit is okay, break the power-supply line to the output transistors and temporarily connect a 100-ohm 10-watt resistor. This will limit the maximum current of shorts or over-

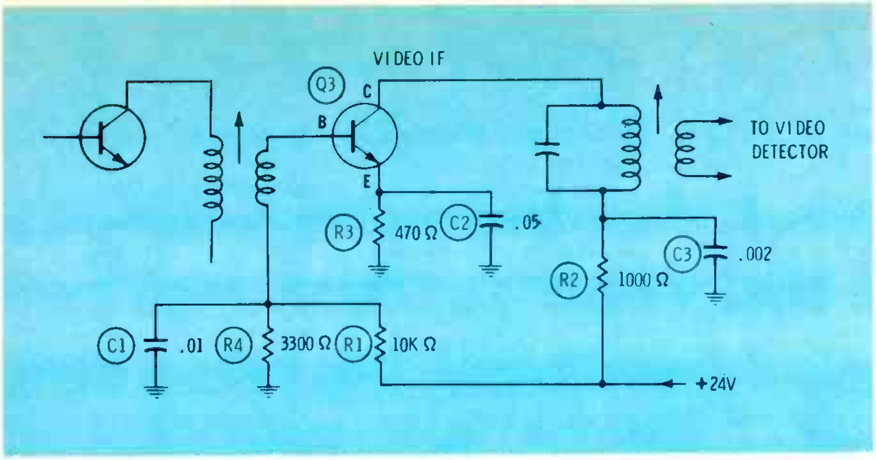


Fig. 7 Yes, the capacitance of the meter and test leads will detune stages such as this one. But, the DC voltages are not affected.

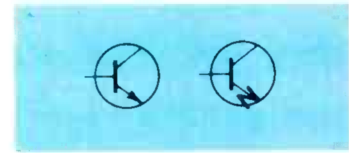


Fig. 8 Remember which transistor terminal is negative by imagining that the arrow point of the symbol is changed to an "N."

loads, and give you time to make tests. For example, most push-pull or complementary-symmetry outputs should have nearly the same DC voltage from collector to emitter, else one will heat and fail early.

PNP Or NPN?

The arrowhead of the transistor symbol on schematics points from the positive element to the negative one. Unfortunately, that's exactly opposite the theory of electron current flow. After some frustration and friendly arguments with other techs, I have concluded we should forget about the significance of the arrow, and merely try to remember transistor polarity by some shortcut. There are several, so pick the one that appeals to you. Figure 8 shows my suggestion. In your mind, change the arrow to an "N" for negative. (With an NPN, as shown, the emitter is negative compared to both the base and collector, when the transistor is operated in Class-"A".)

Comments

The techniques described here can be extremely helpful, and we urge you to practice them until they become a habit.

However, these and other go/no-go tests are best used when the transistor condition either is normal, or completely defective. No quick test can be infallible in borderline cases. In later articles, we will describe more-sophisticated tests, to be used when the others are not accurate enough. □

Reports from the test lab

By Carl Babcoke

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.

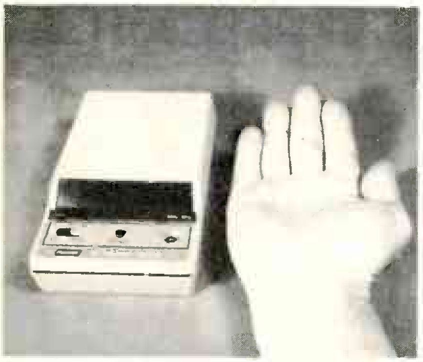
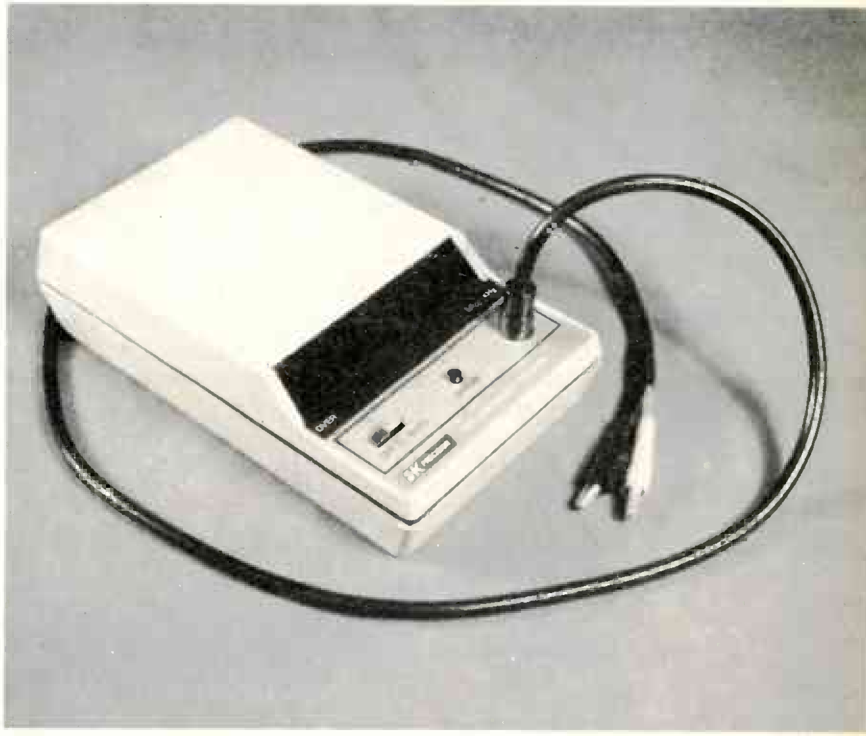


Fig. 1 Size of the Model 1827 is illustrated by this comparison with a man's hand. The weight is about one pound.



The only external controls of the B&K-Precision frequency counter Model 1827 are the combination on/off 1-second/auto-gating selector and the push control to turn on the display. The counter can fit in a large pocket.

Fig. 2 Brightness of the LED digits is shown here by the light of a single 40-watt fluorescent bulb about four feet away.

Fig. 3 Only three controls are on the uncluttered control panel. The three LEDs for the "over" "MHz" and "KHz" indications are under the dark anti-glare window, along with the six digits.

When I lifted the B&K-Precision Model 1827 frequency counter from the shipping carton, I thought, "They've made a mistake and sent me the cabinet mockup that's used for photographs!" It was so light, I couldn't believe the cabinet had any circuits inside. Later, I found out that the shipping weight without batteries is only one pound, with packing and carton.

And the small size matches the light weight. Officially, the dimensions are 6-5/8" x 3-3/4" x 1-3/4", but this coat-pocket size is best illustrated by comparing it with a man's hand (Figure 1).

With solid-state test equipment, we must stop equating small size and weight with toys, for the Model 1827 performs as one much larger.

Here are some of the features:

- 6 digits (Figure 2) of the 7-segment LED type, about 1/4-inch high (although the overflow feature can be used to give the effect of 7 or 8 digits);
- autoranging over three gating times, with automatic positioning of the decimal, LED's to indicate MHz or KHz ranges, an overflow LED, and a 1-second count to give maximum resolution for the KHz range (Figure 3);
- range is guaranteed from 100 Hz

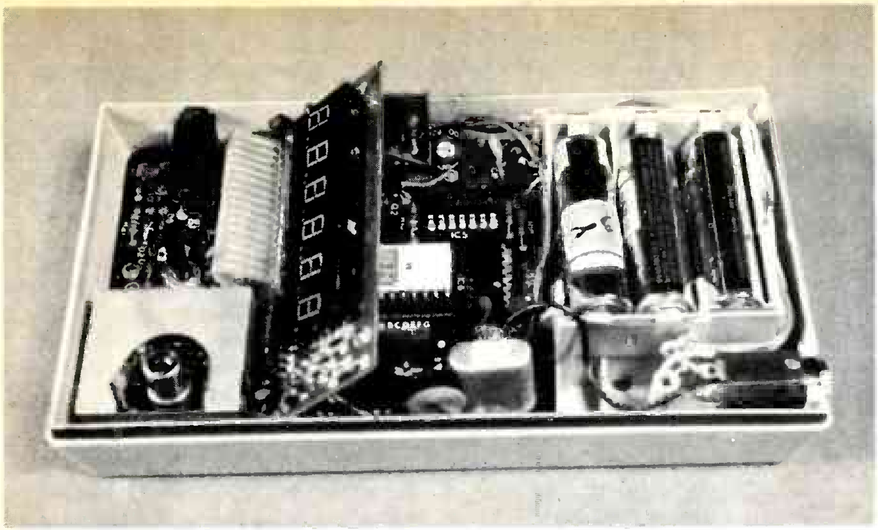


Fig. 4 The battery compartment and the external power plug take up more than a third of the total room inside the Model 1827 case. And yet the electronic components are not stacked or crowded.

to 30 MHz, but a maximum of 50 MHz is typical;

- the accuracy can be set to within 1 Hz, and the temperature stability is better than ± 10 parts-per-million;
- above 200 KHz, readings can be obtained from sine waves of 100 millivolts, or more; and
- a "battery saver" circuit turns off the display, except while the "display" button is pressed, and for 10 seconds after the button is released. Six penlight cells operate the counter for about 8 hours (Figure 4).

Testing The B&K-Precision Model 1827

Not all digital frequency counters have the ability to count signals other than those of RF frequency without amplitude variations or mixtures with other frequencies. Some counters give wild readings of 200% to 500% too high in frequency when around TV receivers. A few refuse to count sine waves from an audio oscillator.

Therefore, I always check a new counter with signals from several sources. First, the Model 1827 counted the sine wave output of an audio generator, and did so very well.

Next, I tried it in various circuits of a color TV receiver. The color oscillator measured 3.57955 on automatic, and overflowed to read 3.579547 on the 1-second position. I connected a 100K resistor in series with the input cable, and the horizontal oscillator frequency read 15,735.3 Hz. How many times I've wished for something that would indicate the precise horizontal frequency!

The only signal I was unable to measure was the vertical sweep. Perhaps a low-pass filter to remove the horizontal pulses might have made it work. None of the other counters I've tested would count vertical-sweep signals, either.

Comments

Many frequency counters have some kind of control that must be adjusted very carefully to obtain a count. The Model 1827 does not need or have such a control. This is an important and helpful feature.

Nine accessories are available for the 1827, including an AC adapter and charger, a battery pack of 6 NiCad rechargeable cells, a power cable for 12 volts in autos, a DC power supply cord, a signal tap for CB radios, a mounting bracket, a 12" antenna for direct pickup of RF signals, a carrying case, and an input cable (supplied with the counter).

The B&K-Precision Model 1827 frequency counter operated perfectly for all the tests. The price is said to be $120. □

test equipment report

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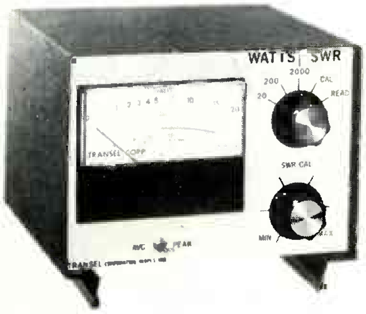
VSWR/Wattmeter

Transel now has the Mark II wattmeter for amateur and CB radios. The Mark II features three power ranges



(20, 200, and 2000 watts) on a single meter scale. Frequency range is from 3.5 MHz to 30 MHz, with ±5% full scale accuracy.

Along with the direct-reading SWR scale in red, there is a complementing percentage-of-reflected-power scale. The SWR function can be used as an aid in the adjustment of carrier suppression for SSB operation. A peak/average switch allows measurement of either the positive-peak power or average power.

The back of the unit is open to allow removal of the RF connector box for remote reading of the wattmeter. Suggested retail price is $79.95.

For More Details Circle (38) on Reply Card

Snap-Around Volt-Ohm-Ammeter

For appliance repairs, **Sperry Instruments** offers Model EXP-300 which measures up to 300 amperes of AC current in five ranges using a clamp probe that doesn't require breaking the circuit, has a single

ohms scale with 25 ohms at midscale, and three expanded AC voltage ranges. These AC voltage ranges measure only between 100 volts to 150 volts, 200 and 300 volts, and 400 to 600 volts with ±2% accuracy at 60 Hz.

Rotating voltage and current scales change with the range selected, to show only one at a time.

EXP-300 Snap-Around Volt-Ohm-Ammeter comes with probes for resistance measurements, a carrying case, battery, fuse, and operating instructions.

For More Details Circle (39) on Reply Card

Techlite VOM Multitester

For use where measurements must not appreciably disturb the circuit being tested, the **Mura** Model 90-M VOM features 50,000-ohms-per-volt, DC and 12,500-ohms-per-volt AC sensitivities on all ranges. The meter is protected from extreme overloads. There are 7 DC voltage ranges, 6 AC and dB ranges, 5 current ranges, and 4 resistance ranges. A mirror arc has been provided to help eliminate parallax reading errors.

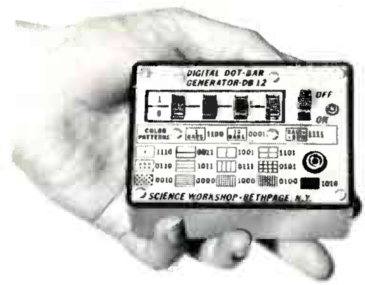
The unit is equipped with test leads, battery, instruction manual and optional carrying case.

For More Details Circle (40) on Reply Card

test equipment report

Color Alignment Generator

Science Workshop's color alignment generator derives the sync, blanking, and video signals from the master clock through digital counters in an IC chip, thus eliminating drift and jitters. Model DB-12 uses digital-switching techniques with four slide-switches to select 1 of 16 patterns (13 patterns on Model DB-11), which are coded on the front panel. The oscillator/modulator stage provides RF and video from the same output jack for signal injection and signal tracing. Model DB-11 is available with 13 patterns in kit form at $39.95, or is available in wired form at $49.95. DB-12, which has 16 patterns and 3 colors, costs $49.95 in kit form and $64.95 wired. Both have 2-year warranties.



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Antenna Impedance Matcher

For those cases where a favorable VSWR can't otherwise be obtained, **Mura** has the CBT-8 Antenna Impedance Matcher. The unit has a range of 25 to 140 ohms for matching, and is used with a VSWR meter to provide the lowest VSWR reading. Model CBT-8 can be left permanently connected without significant power loss.

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antenna systems report

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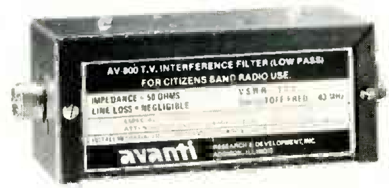
TV Interference Filter

One possible cause of TV interference is the radiation of harmonics from CB transceivers. The **Avanti** AV-800 low-pass filter is useful for minimizing harmonics on TV channels 2 and 5 when installed in the coaxial line between the CB transceiver and



the antenna. It has a impedance of 50 ohms, VSWR of 1.1:1, negligible line loss, and 3-dB cutoff frequency of 43 MHz. Attenuation on channel 2 (54 MHz) is 80 decibels. The unit has a power rating of 1000 watts.

For More Details Circle (43) on Reply Card

Base Station Antenna

The MegaBeam directional-beam base-station antenna from **Shakespeare** features fiberglass construction for improved weather resistance. The fiberglass elements are said to exceed metal in reducing precipitation static.

The MegaBeam antenna provides a low VSWR over the entire bandwidth.

For More Details Circle (44) on Reply Card

CB Antenna

Gladding's U.S. Fiberglass Division has introduced a tunable high-performance 40-channel Citizens-Band antenna made especially for small boats.

The "Bassin' Man" marine fiberglass antenna is 3 feet long, with a fully adjustable lift-and-lay rachet mount. The antenna can be installed on virtually any surface at any angle since it requires no ground plane.

The special mount allows the antenna to be placed out of the way when the boat is being docked, stored, trailered, or whenever the antenna might interfere with operations.

The Bassin' Man can be tuned without tools to achieve the lowest possible standing wave ratio (SWR). All tuning parts are sealed against weather and moisture.

The antenna is sold complete with mount, 7 feet of white coax cable, PL-259 connector, and all necessary stainless steel hardware. Suggested retail is $39.95.

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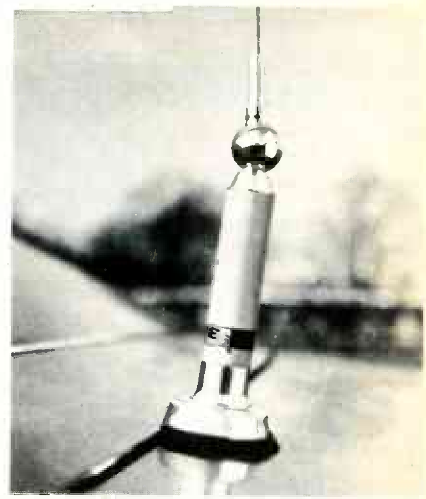
CB Antenna

A new swivel-adjustable CB antenna, Model M-275, has been introduced by **The Antenna Specialists.**



The swivel-whip adapter (M-279/12) provides for adjustment of the whip to compensate for sloping trunk mounts, and incorporates a trunk mount that makes permanent installation possible without holes.

Suggested list price for the M-275 is $25.95. The M-279/12 swivel-whip adapter lists for $4.25.

For More Details Circle (46) on Reply Card

CB Base Station Antenna

AVA Electronics has introduced an indoor base-station antenna adjustable to 36 inches. Model 1776 is for use where outside antennas are not available, such as high rise apartments and college dormitories. It features a two-piece construction of fiberglass and stainless-steel whip with a right angle connector. The antenna gives maximum performance with a 52-ohm match, which can be adjusted by shortening the center rod by ¼ inch at a time. It also has a low standing-wave ratio.

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For More Details Circle (25) on Reply Card

Antenna Coupler

Winegard has introduced a new antenna coupler, Model CA-2830, designed to combine signals from separate 300-ohm VHF and UHF antennas into a single 75-ohm output. Input connections are 300-ohm no-strip screw type, and the output has a standard 75-ohm F-type connector.

The CA-2830 features low insertion loss, averaging -.6 dB for VHF and -1.5 dB with UHF. It has a VSWR of 2:1 at VHF and 1.3:1 at UHF, and isolation of 30 dB or better on both bands.

The CA-2830 lists at $13.75.

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"Target" CB Antennas

S & A Electronics has announced a new line of "Target" CB and radio-communications antennas.

The antennas come complete with coaxial cable, PL-259 connector and mounting hardware. They are available with six different mountings: trunk lip, snap-in, rain gutter, trunk groove, mirror, and a new side mount for trucks and recreational vehicles. All mountings can be installed easily, and four require no drilling. All of the antennas are 43 inches high, with the exception of the rain-gutter-mount model which is 18 inches.

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UHF Series Connector

A new "In-Line" SO-239 type connector has been introduced by **Gold Line**. The No. 72 series connector eliminates the need for double-female splice connectors (PL-258) when additional cable lengths are required. A crimping of the center conductor is featured, with manual or production ferrules available.

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productreport

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Dust Remover

A dust-removing device for records, the "Electroduster", is available from **Audiotex**. The "Electroduster" mounts on the turntable base and snaps onto the spindle. A small velour pad moves across the album lifting dust and dirt from the grooves as the record plays. Accumulated particles then are picked up by a statically-charged plastic belt driven by the turntable. The belt deposits the particles onto a separate felt pad.

For More Details Circle (51) on Reply Card

Pulsating Aerosol

"Vibra-Jet," a new device developed by **Chemtronics**, works on the principle of the "Venturi Effect" which creates a pressure differential in an aerosol spray, producing a pulsating solvent jet.

When connected to an aerosol cleaner or degreaser, the pulsating action provides the mechanical force necessary to dislodge hard-to-remove contaminants, remove dirt from horizontal surfaces, and increase solvent penetration of surface pores.

Vibra-Jet comes complete with a 26-inch flexible polyurethane hose and 12-inch probe for reaching inaccessible areas. Unlike aerosol electronic cleaners, which must be held vertically, Vibra-Jet sprays efficiently in any position.

Designed to work with all of Chemtronics products, especially "TUN-O-WASH," Vibra-Jet is intended primarily for use with electronic cleaners and degreasers that leave no residue.

To introduce Vibra-Jet, Chemtronics is offering the device to electronic technicians with the purchase of two cans of TUN-O-WASH.

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Solid State Replacement Guide

The 1977 edition of the **RCA Solid State Replacement Guide** is now available. The book, "SPG-202T," is intended for use by engineers, service technicians, experimenters, and others who work with solid-state devices.

The new publication cross references more than 123,000 domestic and foreign solid-state devices which can be replaced with RCA SK-Series types, consisting of transistors, rectifiers, thyristors, and integrated circuits.

It also contains a complete cross reference to other competitive universal replacement devices.

The 195-page RCA Solid State Replacement Guide has a suggested optional list price of $1.50.

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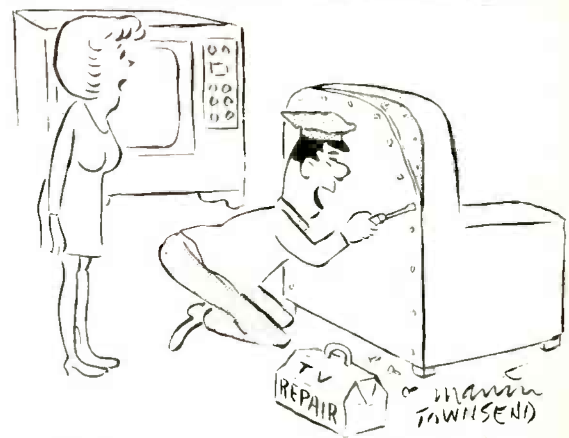

"You'll have to excuse me if I'm a little slow today. I lost my contact lens this morning."

Solution to: LOOK WATTS UP!

1. breadboard
2. ferrometer
3. gradient
4. binaries
5. analyzer
6. selector
7. roentgen*
8. bunching
9. solenoid
10. duodecal
11. panorama
12. blanketing
13. backwall
14. dynaquad
15. keyboard
16. operator
17. Appleton**
18. statvolt
19. actuator
20. parabola
21. calculus
22. capacity
23. blanking
24. molybdenum
25. dynode

*Wilhelm Conrad Roentgen, German physicist. Won 1901 Nobel Prize for discovery of X-ray.

**Sir Edward Victor Appleton, English physicist, born 1892. Won 1947 Nobel Prize for studies of ionosphere which led to development of radar.

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

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60-64 Fair
68-72 Pretty good
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audio systems report

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Power Microphone

A pre-amplified power microphone available from **Kris** is designed to replace original factory CB microphones to provide better performance. The "Big Mike" is housed

in a rugged, molded case with an adjustable gain control on the back to set the modulation level. Included is a coiled cord with factory-wired connector to work with either relay or electronic switching. The microphone element is a dynamic omni-directional type, with preamp gain of 0-26 dB.

For More Details Circle (54) on Reply Card

Record Cleaner

Vac-O-Rec, a vacuum device for cleaning records, is available from **VOR Industries**. Unlike wipes, pads, and cloths, which touch the record surface to remove dirt, Vac-O-Rec creates a vacuum to draw dirt and particles away from the record surface.

For More Details Circle (55) on Reply Card

Horn Speaker

The 5-inch Model 13-505 horn speaker from **Breaker Corporation** increases the volume and intelligibility of voice sounds. It features 8 watts (15 watts peak) power output. A locking-nut base fastener, with 14-inch connecting leads, permits vertical adjustments.

Model 13-505 comes complete with all hardware and sells for $15.95. ☐

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The MARKETPLACE

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advertisers' index

Six important questions to ask of any DMM that claims to be designed for field service.

We give you a choice of 3½ or 4½ digits, manual or autorange.

At Fluke, we've been building DMMs for a long time. We're the leader.

And if there's one thing we've learned over the years, it's that what works for the bench doesn't always work for the field.

But a lot of companies don't understand that. They'd like you to believe their DMM is perfect for field service. Just because they've put it in a different case.

Here's how to tell the difference:

1) Is the size and shape designed for the field?

How do you carry your tools? We designed the 8030A/ 8040A DMMs into an ideal shape after we researched the requirements of field service work. It's sized to fit in a case. And it's rugged, to take the beating field instruments must survive.

If it doesn't fit here, it's not for field service.

2) Does it have true rms ac?

Make sure you get usable accuracy. You'll need true rms ac to eliminate errors when measuring distorted waveforms. (And if you don't understand the importance of true rms, write for our bulletin on True RMS Measurement.)

3) Does it give full performance?

Just because it's a field instrument, you shouldn't sacrifice performance. Demand five measurement functions in 26 ranges. Top specs, like our 8040A basic dc accuracy of ±0.05% or our 8030A basic dc accuracy of ±0.1%. And the specifications are guaranteed for one year. Important extras, like diode test for measurement of semiconductor junctions in-circuit, high voltage protection, and self test feature. And a complete line of accessories: various battery options, and probes for measurement of rf voltages, high current ac, high voltage dc and temperature.

4) Do you have a choice of manual or autorange?

We offer two versions: the 8030A 3½ digit and the 8040A 4½ digit with autoranging. Because we know not all field service applications are alike.

5) What is the price?

A field service DMM is a tool, and should carry a practical price. Our 3½ digit 8030A is $250.* Our 4½ digit 8040A is $440.* Check around and you'll see how practical that is.

6) Do you trust the company that builds it?

We became the leader in DMMs for one reason only. We build digital multimeters that people trust and continue to use, year after year. We've sold hundreds of thousands of DMMs.

And every bit of that experience has gone into the 8030A and 8040A DMMs.

For data out today, dial our toll-free hotline, 800-426-0361. John Fluke Mfg. Co., Inc., P.O. Box 43210, Mountlake Terrace, WA 98043. Fluke (Nederland) B.V., P.O. Box 5053, Tilburg, The Netherlands. Phone: (013) 673-973 Telex: 52237.

*U.S. price only.

The field service DMMs for field service people.

FLUKE®

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