COLOR TV:
What's New In The '64 Sets?
Antenna and Booster Facts
Service? It's Not So Hard!
Color's Past and Future

The RCA CTC-15
Circuit Features / See p.4
MODEL 310
World's Largest Selling Volt-Ohm-Milliammeter

MODEL 310-C
World's Newest Volt-Ohm-Milliammeter

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3. EXCLUSIVE SINGLE SELECTOR SWITCH speeds circuit and range settings. The first miniature V-O-M's with this exclusive feature for quick, fool-proof selection of all ranges.

SELF-SHIELDED Bar-Ring instrument; permits checking in strong magnetic fields. FITTING INTERCHANGEABLE test prod tip into top of tester makes it the common probe, thereby freeing one hand. UNBREAKABLE plastic meter window. BANANA-TYPE JACKS—positive connection and long life.

Model 310—$37.50  Model 310-C—$44.50  Model 369 Leather Case—$3.20

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310-C PLUS FEATURES
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2. 15,000 Ohms per volt AC
   (20,000 O/V DC same as 310)
3. Reversing switch for DC measurements

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<table>
<thead>
<tr>
<th>Kit</th>
<th>Frequency</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>AOR-40</td>
<td>Special</td>
<td>$69.00</td>
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<tr>
<td>AOR-41</td>
<td>150 kc — 450 kc</td>
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<tr>
<td>AOR-42</td>
<td>7 mc — 6 mc</td>
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<td>AOR-46</td>
<td>2 meter</td>
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<tr>
<td>AOR-47</td>
<td>Citizens 27 mc</td>
<td>$62.50</td>
</tr>
</tbody>
</table>

*AOR-41 uses a tuned rf circuit with 6BA6

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How big is color TV? Where does it go from here?
David Lachenbruck

Color TV Service Is Simple
Got preconceived ideas? Don’t get a color complex!
John Fitzgibbon

New Tubes for Color TV
Special designs improve performance and reliability
Peter E. Suthein

Antennas and Boosters for Color TV
Practical advice for installers and servicers
Arthur Cunningham

The CTC 15: RCA’s Newest Color Chassis (Cover Feature)
An RCA man takes you on a guided tour
A. Hilderbrand

Corner Speaker Fits Your Home
Build one to please you acoustically, the lady visually
G. A. Briggs

Zener Diode Bias Supply
Simple circuit reduces power losses
Ronald L. Ives

Servicing Sound Movie Projectors
Part 3: Amplifiers and exciter lamps
Jack Darr

Fuses—Are They Resistors?
Actually, yes—in low-voltage circuits
Frank G. Stiver

How Well Do You Know Your Units?
(Answers are on page 77)
Tom Jaski

Handy Log Scales
(Answers on page 70)

Hexnash—Electric Game
Parlor and party fun for kids (and non-kids, too)
Jack Allison

Automatic Announcement Reminder and Alarm
For hams and others bound to sign calls every 10 minutes
Ronald L. Ives

Peewee Attacks Radio
... and graduates from simple TV to fearsome ac-dc 5-tubers
Mike Wayne

Color Test Equipment for 1964
A directory of instruments designed especially for color TV service
Robert F. Scott

A Hybrid Dc Millivoltmeter
Useful instrument measures tiny potentials
Bert J. Hill

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Gold May Superconduct At Lowest Temperatures

Gold may be a superconductor at very low temperatures, according to four physicists of the University of California. They cooled an alloy containing one part of barium to five parts of gold to 0.7° Kelvin (−457.7° F). At that temperature, the alloy became superconductive. The scientists believe that at even lower temperatures pure gold might superconduct, but did not have equipment to reach the necessary low temperature.

The work is part of a research program to determine whether most metals are superconductors. More than half of all metallic elements lose all resistance when cooled to extremely low temperatures, and the scientists are interested in finding out whether this may not be true of almost all metals.

New Standard Stations On Lower Frequencies

Standard broadcast stations WWVB and WWVL have been added to the National Bureau of Standards facilities. WWVB at Boulder, Colo., operates at 60 kc and WWVL at 20 kc. At present, these stations are sending only frequency signals, but time signals will be added later. These signals will be much more stable and accurate than those transmitted by high-frequency stations WWV and WWVH.

Accuracy of the high-frequency signals is affected by changes in the height and density of the ionosphere, since they depend on multiple reflections to reach their destination. In the low- and very-low-frequency regions, the radio waves follow the curvature of the earth. The ionosphere acts as the upper limit of a gigantic duct rather than as a reflector. Thus its variations have little effect on the travel of the waves.

WWVB broadcasts with a radiated power of 5 kw. It is designed to serve the continental United States with more stable coverage at distances up to 2,000 miles, than its sister station WWVL with a radiated power of 1 kw. The 20-ke signal provides intercontinental reception, with a precision of one part in 10 billion in an observing period of approximately one day.

Photoparametric Diode Detects 10⁻⁹ Watt

A single semiconductor diode, which is both a photodetector and a parametric amplifier, can boost receiver sensitivity of laser space communication and radar systems 100 times. Scientists at the Sperry Rand Research Center (Sudbury, Mass.) have detected and amplified less than one-billionth (10⁻⁹) watt of light. It is hoped more advanced electronics for the device may make it possible for it to detect and amplify a quintillionth (10⁻²⁴) watt. As a detector of modulated light, it has a frequency range from direct current to about 2 gc.

New Electronic Pen Improves Oscilloscopes

A new electronic pen that writes a perfect hand at 100 feet a second may greatly improve the frequency range of recording oscilloscopes. Designed by Richard G. Sweet of Stanford University, the new pen squirts fountain-pen ink at the paper in tiny drops only 2/1,000 inch in diameter. With the new pen, signals or electronic impulses that operate as fast as 10,000 times a second can be recorded. Present mechanical stylus equipment used for recording signal impulses on paper can't record oscillations much faster than 100 per sec.
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Exact Replacements are available for tuners unfit for overhaul. As low as $12.95 exchange. (Replacements are new or rebuilt.)

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Radio Pioneer Dies

Emil J. Simon, whose interest in radio began in 1903, died Sept. 14 at the age of 74. During the 1920's, as founder and president of the InterCity Radio Telegraph Co., he established stations in six cities. He was the inventor of the Simon Radioguide, a 30-lb direction finder used in military and commercial aviation in the 1930's. During World War II, he directed manufacture of military radio equipment for the Radio Navigational Instrument Co. After the war he worked as a consultant.

Color TV Owners Like Their Sets

Owners of color receivers are enthusiastic about their sets, according to Sylvania Market Research's Frank W. Mansfield. Sylvania's survey discovered that they were not satisfied, however, about the number of quality television programs.

The average repair bill was about $30.50 per year, which owners found reasonable. They were also satisfied with the ease of tuning, and 92% of the 17,000 families surveyed believed their color reception to be excellent.

Mansfield estimates that 872,500 color sets were sold from the time color TV started to the end of 1962. They expect that between 500,000 and 750,000 will be sold in 1963, and that the number will increase in 1964, with the number of sets sold likely to run over a million in 1966 and 1967.

FM Wireless Microphones Legal

FM wireless microphones have been legalized on the 88-108-mc broadcast band under Part 15.201(e) of the FCC Rules adopted July 1, 1963. They must be type-approved commercial units and shall not be used for two-way communications. Details are covered in Section 15.212.

Emissions must be confined to a 200-kc channel centered on the operating frequency within the band. Field strength shall not exceed 50 µv per meter 50 feet or more from the transmitter. Outside the 200-kc channel, field strength must not exceed 40 µv at 10 feet or more.

Custom-built telemetering equipment for experimenting in educational institutions is also permitted under 15.201(e) of the Rules. Bandwidth, frequency and field-strength limitations are the same as for FM wireless microphones. The educational institutions...
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More Color Sets
Since the closing date for articles in this issue, three more companies have announced new color models.

A new color chassis by Setchell-Carlson—in several cabinet models—features unitized construction consisting of a master chassis with plug-in subchassis. Its plug-in chroma unit can be removed for servicing and the set will continue to produce a black-and-white picture. All maintenance controls are available from the front. All models have push-pull audio and twin front-mounted speakers.

Andrea has a custom professional component color television set that can be installed in any 30 x 22-inch opening with 25-inch clearance behind the mounting surface. The set has 23 tubes plus picture tube (24 in uhf models) and can be fitted with a remote control.

Sylvania has announced the new 21-inch lowboy, model 21LC3, with a suggested list price of $529.95.

Electric Boomerang For Satellite Signals
The quality and quantity of information sent to earth by satellites has been substantially increased by a space communications system developed by Sylvania Electronics Systems. The boomerang is an electronic antenna system that automatically directs its radio signals to any earth station that requests information from the unit. The return signal follows the same path used by the ground station to request the information.

According to Walter Serniuk, director of engineering of Sylvania Electronic Systems, conventional satellite transmission systems must broadcast their signals over a large portion of the earth's surface to communicate with a specific ground station. The new system uses a set of satellite antennas which steer the beams electronically without altering the positions of the antenna or of the satellite. Thus the signals can be directed right at the target, with considerable "power gain." The new system uses tunnel-diode transceivers,
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DECEMBER, 1963
How the signal from the satellite is “boomeranged” back to earth along the same route as the triggering signal is shown in this artist’s drawing.

which are about 100 times more resistant to the high energy of the Van Allen belt than transistorized units. The power required is very low, permitting the equipment to function with only 1/20th the number of solar cells required by conventional systems.

A model of the system, working in the S-band (1,550–5,200 mc), has been constructed for the Aeronautical Systems Division of the Air Force Systems Command at Wright-Patterson Air Force Base, Dayton, Ohio.

Canada Prefers FM To Color TV

The chairman of Canada’s Board of Broadcast Governors, Dr. Andrew Steward, told the EIA of Canada that one of CBC’s chief goals in 1964 was the expansion of its FM network service. Other aims include new FM (and AM) stations for areas not now covered, and expansion of CBC television.

Transistors Step Forward With Multiemitter Units

Transistors have made many advances in a field ruled completely by vacuum tubes up to a few years ago, but in one respect have lagged behind. Almost all transistors have been simple triodes. Now Plessey Co. (England) has introduced a transistor with five emitters. Thus we have multielement transistors as well as multielement tubes.

Not only will it be possible to combine more than one circuit with the multielement transistor as with its opposite number in the tube family, but the new transistor can do jobs not easily performed by multielement tubes. For example, one emitter can be used as it would be in a normal transistor. Another emitter can be used in the avalanche mode to behave, in effect, like a Zener diode connected to the base, while a third would act as a small base input capacitance. The new transistor actually takes over some of the functions of more complex integrated circuits.

Brief Briefs

New laser achieves a high pulse rate by arranging six lasers around a central axis and firing them in sequence like the barrels of a Gatling gun.

General Electric has announced a new rapid-charge nickel-cadmium battery that can be charged in about one hour as against 15 hours for present types. The new battery is expected to be especially valuable as a power source for portable tools.

No less than 5 Japanese TV receiver manufacturers expect to be in full production with 16-inch color receivers early this winter. Most expect to export color sets to the United States, but they are not sure when.

Lasers, not so long ago the “farthest out” instrumentality in the electronics field, can now be bought from your favorite radio mail-order house. Prices are about $450 for calcium fluoride laser crystals, $1,125 for a gallium arsenide injection laser.

Radio WWVH, Maui, Hawaii, has eliminated its 34-minute silence at 1900 UT daily. The silent period from 15 to 19 minutes past each hour is being continued.

IBM scientists report that a new material, europium orthosilicate, is nearly 10 times as effective as previously known materials in rotating the plane of polarization of light when subjected to a magnetic field. This discovery may be very important in such applications as modulating lasers.
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▲ Section II offers Advanced Electronics Training through home study and is designed to assure your advancement after you are on-the-job.

The above program may be taken as a whole, or you may complete only that step which best suits your individual needs!

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For complete listings, get your copy of Catalog C-615 from your Sprague distributor, or write to Sprague Products Company, 81 Marshall Street, North Adams, Massachusetts.
Here is a real "must" for anyone servicing or planning to service color TV sets.

No longer must you send two men to a customer's home to pull in his entire color set. Now, one man can simply remove the chassis and bring it back to your shop for testing, troubleshooting and alignment in your RCA Color TV Test Jig.

Look at some of the extra advantages built into this money-saving unit:

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- **Versatile.** Can be used with CTC-4, 5, 7, 9, 10, 11 and 12 chassis.
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The RCA Color TV Test Jig is available through your Authorized RCA Parts and Accessories Distributor. See him this week to find out how this versatile instrument can help you capitalize on the growing Color TV servicing market.

For information on where you may obtain the RCA Color Test Jig, and for additional specifications, fill out and mail the coupon below.

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DECEMBER, 1963
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Performance has made the LPV first in antenna sales—not claims or words. JFD will gladly abide by that moment of truth that proves the true caliber of any antenna's performance—THE PICTURE IS THE PROOF!
THE FIRST TV/FM ANTENNA BASED ON THE GEOMETRICALLY-DERIVED
LOGARITHMIC-PERIODIC SCALE DEVELOPED BY THE ANTENNA RESEARCH LABORATORIES
OF THE UNIVERSITY OF ILLINOIS FOR SATELLITE TELEMETRY.

No longer must you sacrifice directivity or gain to obtain broader bandwidth, as with single-channel Yagis and “all-channel” Yagi types. Now the new JFD Log-Periodic LPV breaks through the bandwidth barrier to put an end to cumbersome antenna compromises. The reason?...The patented geometric concept - \( \frac{L(n+1)}{L_n} \) - that scientifically formulates individual cells (dipole lengths and spacings) to bring you performance that’s frequency independent for:

- **HIGHER FORWARD GAIN** Element for element you get two to three times more gain than with similar-priced competitive makes. Flat gain across each channel, too, for vivid color rendition. (More driven elements do it.)

- **SHARPER DIRECTIVITY** Because the LPV has bandwidth to spare. Its narrow unidirectional beam does not change with frequency—does not intercept the ghosts and interference picked up by other broad main-lobed competitive makes.

- **LOWER VSWR** Down to 1.2 to 1—derived from optimum impedance match across the VHF and FM Stereo bands.

- **GOLD ALODIZED** Electrically conductive golden anodizing that is part of the aluminum—assures continuous signal transfer—does not insulate contact points like competitive anodizing.

- **HIGHER FRONT-TO-BACK RATIOS** All elements are fed in phase opposition to reinforce signals arriving from the front end. The crossed harness creates a 180 degree phase shift in the signal path from rear—effectively cancelling out rear pick-up of unwanted signals. (e.g., the LPV11 maintains a front-to-back ratio of 35 db on each VHF channel).

Harmonically Resonant V-Elements, Operating on the Patented Log-Periodic Cellular Formula, in the Fundamental and Third Harmonic Modes, Provide Flawless COLOR...Black and White TV...FM Stereo!

ORDER 'NOW FROM YOUR JFD LPV DISTRIBUTOR AND STEP UP INTO THE MODERN LOG-PERIODIC ANTENNA ERA OF PERFORMANCE AND PROFITS!

**ADVERTISED IN LOOK**
One of America's most vital and widely read magazines—now alerting millions to the new Log-Periodic antenna concept.

**ADVERTISED IN SUNSET**
The favorite "home" magazine of millions.

**THE BRAND THAT PUTS YOU IN COMMAND OF THE MARKET**
JFD ELECTRONICS CORPORATION
15th Avenue at 62nd Street, Brooklyn 19, N.Y.
JFD Electronics-Southern Inc., Oxford, North Carolina
JFD International, 15 Moore Street, New York, N.Y.
JFD Canada, Ltd., 51 McCormack Street, Toronto, Ontario, Canada.
401-144 W. Hastings Street, Vancouver 3, B.C.
Andrea
TV component chassis:
Color or Black & White
with or without remote control

Exceptionally slim in dimension, clean in design, the Mercury and the Explorer install in an opening only 29 1/4" wide x 21 3/8" high x 25" deep. The Navigator and the Satellite require even less area. After fast and easy installation, you'll enjoy the matchless, high definition picture that thousands of owners now view with a technician's pride.

Quality and superb circuit design are responsible for the exceptional performance of these component TV chassis. Andrea builds them using only the best: pre-tested, climate-sealed components, bonded picture tubes, high gain Nuvistor turret-type tuners with preset fine tuning, hi-fi detector audio output jack (for simple integration into your own hi-fi audio system), self contained amplifier and speaker and power transformer chassis. Andrea has been respected worldwide for quality in home entertainment, industrial and military electronics for over 30 years.

For specifications on these remarkably trouble-free chassis, fill out and mail the coupon below:

THE NAVIGATOR, Black & White, with Spacemaster Deluxe Remote Control
THE EXPLORER, Color magnificence for custom installation
THE SATELLITE, Star Performer, Black & White
THE MERCURY, Color chassis supreme with Spacemaster Deluxe Remote Control

*Includes 6" tube cap

ANDREA RADIO CORPORATION, DEPT. RE 1
27-01 BRIDGE PLAZA NORTH
LONG ISLAND CITY, N.Y. 11101

Gentlemen: Please send me complete specifications for black and white and color Andrea TV component chassis.

NAME ___________________________
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CITY _____________________________ ZONE ______ STATE ______________

Please check the appropriate box:
I am a [ ] TELEVISION SERVICE ENGINEER [ ] TELEVISION/HI-FI DEALER
[ ] OTHER (Specify) ____________________________

[ ] Please send brochure on the complete Andrea line of television and stereophonic consoles.

New Tricks with Diodes—Revisited

Dear Editor:

I've been getting many letters with requests for further information ever since my article "New Tricks with Diodes" was published (RADIO-ELECTRONICS, July 1963, page 36). One of the most frequent queries concerns the kind of transformers to use for T1, T2, T3 and T4. I recommend the UTC "Sub-Ounce" type SO-13, which has a 500-ohm primary and a split secondary, 50 ohms each winding. It is widely available, one source being Newark Electronics Corp., 223 W. Madison St., Chicago 6, Ill. Its catalog number is 3F597, the price, $4.20 plus postage.

Another question: yes, it is all right to use a negative-ground supply. Only the battery polarity with respect to the transistors matters.

People also ask about parts tolerance. Resistor values are not especially critical, and even 20% tolerance is acceptable.

I suggest you use a 1,000-ohm balancing pot between split windings of the transformer, as shown in the diagram. This lets you compensate for transformer irregularities and other circuit imbalance for complete scrambling.

Leonard E. Geisler
Radio Astronomy Laboratory
University of Michigan

[Also see Mr. A. H. Taylor's letter in the October, 1963 Correspondence column (page 21). He pointed out ways of balancing and gave several references to articles on SSB and balanced modulators.—Editor]

Improved Power Resistor Substitution Box

Dear-Editor:

Mr. H. L. Davidson's article, "Substitution Box for Power Resistors" in your April 1962 issue (page 64) interested me because most substitution...
WHICH WILL YOU PICK?

Now NRI offers you 9 WAYS to train at home in spare time for a career in TV-RADIO ELECTRONICS AUTOMATION.

1. TELEVISION-RADIO SERVICING
Learn to service black-and-white and color TV sets, AM-FM radios, stereo hi-fi, PA systems, etc. A profitable, interesting field for part-time or full-time business of your own.

2. INDUSTRIAL-MILITARY ELECTRONICS
Learn Principles, Practices, Maintenance of Electronic equipment used today in business, industry, defense. Covers Electronic controls and measurement, computers, servos, telemetry, multiplexing, many other subjects you need for a successful career.

3. COMPLETE COMMUNICATIONS
A comprehensive training program for men seeking careers operating and maintaining transmitting equipment in Radio-TV Broadcasting or mobile, marine, aviation communications. Prepares you for your License. First class FCC Radiotelephone License.

4. FCC LICENSE
Prepares you quickly for First Class License exams. Every communications station must have one or more FCC-licensed operators. Also valuable for Service Technicians. You train at home.

5. BASIC ELECTRONICS
An abbreviated, 26-lesson course covering Automation-Electronics, Radio-Television language, components and principles. Ideal for salesmen, hobbyists and others who find it valuable to be familiar with the fundamentals of this fast-growing industry.

6. MATH FOR ELECTRONICS
A short course package of carefully prepared texts that take you from basic arithmetic review through graphs and electronic formulas. Quick, complete and low in cost.

7. AVIATION COMMUNICATIONS
For men who want careers working with and around planes. Covers direction finders, ranges, markers, loran, shoran, radar, landing systems transmitters. Prepares you for FCC License exams.

8. MARINE COMMUNICATIONS
Shipboard transmitting equipment, direction finders, depth indicators, radar are all covered in this course. You prepare for your First Class Radiotelephone License with Radar Endorsement.

9. MOBILE COMMUNICATIONS
Training in installation and maintenance of mobile equipment and associated base stations like those used by fire and police departments, taxi companies, etc. Prepares you for your First Class FCC License exams.

TRAIN AT HOME WITH THE LEADER

NRI training of the 60's is based on nearly half a century of leadership in home study for Radio-TV, Electronics-Automation. Specializing in these fields makes it possible for NRI to provide a variety of courses for ambitious men seeking careers that provide higher pay, more interesting work, better futures. No matter how much or how little education you have, one of NRI's nine courses can help you, just as they have helped tens of thousands of others. Read success stories on the other side of this page. Read about special training equipment NRI provides at no extra cost to make training easier, faster. Then check and mail the postage-free form for FREE NRI CATALOG.

CUT OUT AND MAIL
JOIN THE THOUSANDS
WHO GAINED SUCCESS WITH NRI

Thousands of NRI graduates throughout the U.S. and Canada are proof that it’s practical to train at home for careers in Electronics-Automation, TV-Radio. NRI graduates are in every kind of Electronics work. Here are five typical success stories from NRI files. Catalog tells more about what NRI graduates do and earn. Mail the postage-free form.

AVERAGES $150-$170 A MONTH SPARE TIME.
"My spare time business fixing Radio and TV sets picks up every month," writes William L. King of Yoakum, Texas. "Looks like I’ll have to go into it full time. I wish it were possible to tell every man of the wonderful advantages in this field."

FROM TEXTILE WORKER TO TECHNICIAN.
That’s the story of Harold L. Hughes, 225 Civiley Blvd., Indian River City, Fla. After graduating from NRI he worked in a TV shop, is now employed by an engineering firm as a Senior Electronics Technician. He says, "I shall be eternally grateful to NRI."

HAS SERVICE BUSINESS OF HIS OWN. Don House, 3012 2nd Place, Lubbock, Texas, went into his own full-time business six months after finishing the NRI Radio-TV Servicing course. "It makes my family of six a good living," he states. "We repair any TV or Radio. I would not take anything for my training with NRI. I think it is the finest."

WORKS FOR FIRM BUILDING DC WELDERS.
"Your school helped me get this job," writes Lawrence S. Cook, 529 South Bounds St., Appleton, Wis. He has also done broadcast work, TV repair, and builds custom stereo systems and medical electronic equipment. "I thought very highly of the Communications course. I still use the texts."

ELECTRONIC TECHNICIAN FOR POST OFFICE.
"NRI training enabled me to land a very good job as Electronic Technician with the Post Office Dept.," reports Norman Ralphson, 1947 Lawn Ave., Cincinnati, Ohio. "I finished 6th out of 139. I also have a very profitable spare-time business fixing Radios and TV."

More ambitious men are deciding to train for careers in Electronics-Automation, Radio-TV, because they recognize the opportunities in this exciting field to advance and prosper. But where a man trains and how the school of his choice teaches Electronics...how it encourages him to reach his goals and realize his ambitions...is most important to his success.

In this fast changing world, a school offering Electronics training must keep pace. That’s why NRI—with nearly 50 years of specialized experience—now offers you nine choices of training within the one field of Electronics. Select the course of most interest to you and receive the kind of training that prepares you for a specialized career. NRI’s large staff is always on the job keeping course material up-to-date, helping you earn your way while you train, assisting you with job placement when ready. In short, whatever branch of Electronics you select, NRI is qualified through knowledge and experience to help you grow.

Special Equipment Included

NRI training of the 60’s is built around time-proven “learn-by-practice” methods perfected over nearly half a century of experience in home study training. Most NRI courses include—at no extra cost—special training equipment designed to give you shop and laboratory experience right in your own home. You build and work experiments. Theory you study comes to life in an interesting, easy-to-grasp manner. Your first projects are measuring voltage and current in circuits you build yourself. You use a Vacuum Tube Voltmeter which you construct. Later on, you progress into more involved experiments. And all equipment you build is yours to keep.

Because NRI provides training right in your own home, there’s no time wasted getting to school. You fit study hours to your own spare-time schedule, progressing as fast or as slow as you like. NRI catalog pictures and describes equipment you get, courses you can take, facts about job opportunities, NRI trial plan, convenient terms. Mail the postage-free form today.

NRI TRAINING, Washington 16, D.C.
boxes use only ½- or 1-watt resistors and are limited in usefulness.

I built the unit and added some features to it. The multirange resistors come in pairs. I wired the four sections of the extra MR2 in parallel, bringing each end to a binding post, which gave me a 5.5-ohm resistor. I wired the four sections of the extra MR5 in series for 50,000 ohms and brought the ends to another set of posts. I installed a midget 5,000-ohm 1½-watt rheostat, with its own set of terminals.

These additions extended the range of the unit and provide for an almost infinite variety of resistances, since many terminals can be connected in series or parallel combinations, with or without the rheostat.

H. FISK TARBOX
Darien, Conn.

Experiments on Horizontal Speakers and Reflectors

Dear Editor:

I have experimented with horizontally mounted speakers and reflecting surfaces and have observed the same improvement Glen R. Travis mentioned in his August 1963 article (“Add Depth to Your Speakers,” page 28). Uncanny as it may seem, I have also developed an enclosure that duplicates, within a few inches, the one in Fig. 5 of his article. The only difference is in the speaker and position of the port.

Mr. Travis concludes that improvement is due to the speaker’s relationship with the internal cabinet dimensions, but I can find no theoretical basis for this. I am convinced from observations that improvement is related to (1) location of the apparent sound source at an optimum point, about the height of the listener’s head, (2) wider dispersion of high frequencies because of the reflecting surface, and (3) increase in the proportion of reflected to direct sound. I think the third condition is responsible for the new sound.

JOHN C. PEARSON
San Pedro, Calif.

Tube Data in Tear-out Form

Dear Editor:

Your New Semiconductors and Tubes section each month is very useful to me in setting up my tube tester and in figuring out new circuits I come across. But I think it would be much more useful if you printed it with perforations so it could be torn out to make a tube data file.

A. M. LACEY
Manito, Ill.

[Thank you for the suggestion, Mr. Lacey. As it is, we can’t perforate our pages because the high-speed presses we are printed on do not allow it. Still, we (Continued on page 24)]

DECEMBER, 1963
Pardon us while we change you into Santa Claus

Do your Christmas shopping early at your G-E Distributor's. He has lots of wonderful gifts that you can get with the purchase of General Electric tubes... gifts for your family, friends and favorite customers. And there're some you'll want for yourself... such as a tube caddy that looks like fine luggage. You can also get Christmas cards designed only for service dealers... to mail to customers and friends.

See your General Electric Distributor and start packing your bag today. You're going to be a sensational Santa!
Be good to yourself this Christmas. You can get these Armor Clad® tube caddies when you purchase G-E tubes. They look like fine pieces of luggage and the special vinyl coverings are longer lasting. They are reinforced with nickel plate at all stress points.

These Kodak Flashfun camera outfits include everything that young photographers need: Hawkeye camera, film, clip-on neck strap, batteries, flash bulbs and instruction manual. They’re yours when you buy G-E tubes.

Little girls will go wild over these Mattel® Sister Belle talking dolls. They’re 17” tall and have a rag body and plastic head. Each one says eleven different things that little girls like to hear... like “Let’s play house,” “Give me a kiss.” No batteries needed.

These Dick Tracy Power-Jet Squad Guns by Mattel® will be a hit with any boys you know. They’re automatic cap-firing guns that shoot a stream of water 35 feet... farther than any water guns ever made. Give one to any boy and then stand clear.

These G-E electric carving knives will make a great gift for the lady of the house. They even slice through hot bread or hot meat with smooth precision. Get several from your G-E Tube distributor.

Get these Christmas cards... prepared especially for you. They’re in color on heavy, high-gloss stock and show a cartoon of you adjusting a TV set to say “Happy Holidays.” 50 cards and 50 envelopes to a box. Get yours now for early mailing.
ASSEMBLE YOUR OWN ALL-TRANSISTOR SCHober ELECTRONIC ORGAN

Announcing the new line of world-famous Schober Organ Kits...

Designed by organists for organists, the new Schober Recital Organ actually sounds like a fine pipe organ. The newly-invented Schober Library of Stops provides you with an infinite number of extra voices so that you can instantly plug in the exact voices you prefer for a particular kind of music. Thirteen-piston, instantly resettable Combination Action makes the organ volume, and you can check the beat note for several minutes, instead of just a few seconds with a tuning fork.

New, All-Transistor Schober Console II

Here's the most luxurious "home-size" organ available today... with the same circuitry and musical design as the impressive Recital Organ. Full 61-note manuals, 17 pedals, 22 stops and coupler, 3 pitch registers, and authentic theatre voicing leave little to be desired. Musically much larger than ready-made organs selling for $1800 and more... the Console II, in kit form, costs only $850.

New Schober Spinet

The Spinet is among the very smallest genuine electronic organs available today... yet it will fit into the smallest living room or playroom, even in a mobile home. Yet it has the same big-organ tone and almost the same variety of voices as the larger Console II. The Spinet far exceeds the musical specifications of ready-made organs selling for $1100 and more. In easy-to-assemble kits... only $550.

Schober Organ Kits are sold in the U.S. only by...

THE Schober ORGAN CORPORATION
43 West 61st Street, New York, N.Y., 10023

Dear Editor:

In "Start Service on a Shoestring" (July, page 46), the Old-Timer forgot one thing: a good TV service handbook that explains circuits and their troubles. He should find out why a tube shorted before he replaces it.

That, and a good electronics dictionary, will get him going. He'll get better use of your TV service notes and under-
"...like switching on the light in a pitch-dark room..."

Come to think of it, this is a pretty good way to describe PHOTOFACT. We didn't dream it up—it's part of a letter that came to us (unsolicited) from a PHOTOFACT user, a letter that goes like this:

"Opening a Sams schematic to me is like switching on the light in a pitch-dark room. It actually pinpoints the 'needle in the haystack'—many times in one minute."

Switching on the light is a great way to find what you're looking for in a hurry. There are over 40 illuminating features in every PHOTOFACT Folder which will help light your way to fast TV-radio troubleshooting. (The greatest, too, for pinpointing the "needle" in those tough-dog jobs.)

Users don't measure PHOTOFACT by its pennies-per-page cost. It's the light—the time-saving, profit-making light that counts.

Of course, you can get along without PHOTOFACT—a few do—and maybe they're making a living. But it's the hard way.

Doesn't it make good sense to see your Sams Distributor today for details on an Easy-Buy PHOTOFACT Library and Standing Order Subscription?

Or use the coupon below.

A PHOTOFACT LIBRARY PAYS ITS OWN WAY—

Now, more than ever, it pays to own PHOTOFACT—the world's finest TV-radio service data. Now, you can start or complete your PHOTOFACT Library this Easy-Buy Way:

- FREE with your order for 186 Sets—a deluxe 4-drawer file cabinet worth $38.95
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- Add-on privilege of a year's advance subscription to current PHOTOFACT on the same Easy-Buy contract
- Save $1.95 price applies on Easy-Buy (instead of the regular $1.25 price).

4 Ways to Select Your PHOTOFACT Library:
1. Complete your present PHOTOFACT Library.
2. Order a PHOTOFACT "Starter" Library—186 Sets (Sets 301 to 480—coverage from 1955 to 1960—only $11.33 per month).
3. Order by brand name and year—see the handy selection chart at your Distributor.
4. Order a complete PHOTOFACT Library—get FREE file cabinets, plus a selection of invaluable books and Electronics Courses.

SEE YOUR SAMS DISTRIBUTOR FOR FULL DETAILS, OR MAIL COUPON ▲
Let's start with scopes—essential for the experimenter. EICO has an excellent variety to choose from. The new full performance 430 General Purpose compact with 3" flat-face CRT; the 427 General Purpose DC scope; and one of the best thought of scopes in the DC wide band field, the 5" CRT 460.

If you work with transistor circuits, EICO has the team for you: the 1020 Power and Bias Supply with 0.005% ripple; and the 680 Transistor & Circuit Tester which combines transistor parameter measurements with a 20kΩ/V multimeter for dc voltage (to 50V) and resistor measurements.

If you're interested in RF you'll need a good, wide coverage RF signal generator with built-in audio modulation such as the EICO 324 (150 kc-435 mc), and a good VTVM such as the EICO 222 or peak-to-peak VTVM the 232. Use either one with RF VTVM probe PRF-11.

For trouble shooting audio, IF, and RF circuits, the 147A Multi-Signal Tracer has both RF & audio inputs with demod & direct probes, noise locator circuit, wattmeter, substitution tests, & eye-tube and speaker monitors. And for testing tubes nothing beats the economical EICO 628 Emission Type Tube tester. The new 667 Dynamic Conductance Tube and Transistor Tester is the best in the field. Both test all the new tube types including Nuvisor, Novar, 10-pin, Compactsors, etc.

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MICROMINIATURE COLOR TELEVISION

...TV on the Micro-molecular Level on the Horizon...

In this new era of microminiaturization, there is no longer any valid technical reason why television—particularly color television—should not benefit by the great electronic shrinking process now becoming well-nigh universal.

Indeed, if television and science keep in step, the next decade will record astonishing advances in TV, medicine, biology, technology and the sophisticated arts—applications undreamt-of today.

As our insight into life processes, down to the molecular and atomic levels, increases rapidly, we need new and exceedingly refined tools to unravel the secrets of nature and understand them.

The X-ray and the electron microscope have already pioneered the way into the micro-unknown, but the black-and-white photographs they produce are no longer sufficient to science, technology and biology. These instrumentalities must be linked to color TV. We need color X-ray and color electron microscopes as well as TV color motion pictures, the combination of which is not in existence today.

We have reported certain phases of microtelevision in an earlier issue.* Here is an excerpt from that issue:

"We can use standard iconoscopes by attaching the recently developed optical cables to them. Made of flexible glass fibers, these standard cables can be less than \( \frac{1}{8} \) inch in diameter and conduct light readily. Each glass fiber, the thickness of a thread, transmits its own quota of light. When they are fashioned into a supple cable of hundreds of glass fibers, a strong light can be conducted around curves and corners.

"Thus we can mount a powerful yet tiny electric light bulb directly behind the end of the light cable and illuminate the inside of an artery, look into the ear or other organ at will, via TV. Urologists urgently need such a tool which, inserted through the ureter, can view the kidney for lesions, stones, or similar disorders.

"For other purposes we also require mini-TV transmitters. For surveillance at a distance, optical cables are useless—here inconspicuous tiny cameras that can be readily concealed are needed.

"In missiles and spacecraft such as satellites, the weight of 1 ounce and the space of 1 square inch are often extravagant, and frequently not permissible. Hence micro-TV transmitters are vital here. How small can a TV camera shrink? No one knows."

To the above can be added important "bloodless" explorations into the human body, via veins, arteries and the various internal organs such as parts of the heart, glands, and even the brain. This can readily be accomplished once our microminiature TV cameras have shrunk down to the size of the opening of a hypodermic needle.

The great advantage of introducing color television cameras into presently inaccessible parts of the human anatomy is obvious. Just imagine color TV enlargements of electron microscopic images from 300,000 diameters upward of, say, an internal starting cancer, or a benign tumor, or other diseases!

Once we have such versatile tools, the entire human body, for all practical purposes, will have become as transparent as if it were clear glass or plastic! This includes not only the "soft" parts of the human anatomy, but the bony structures as well.

The scientist, the biologist, the geneticist, all will work in new light, in color, instead of in abysmal dark as they mostly do now when it comes to the inaccessible parts of the human body.

In technology as well as in biology the probing micro-miniature TV color camera will literally have thousands of new uses. Coupled with the X-ray and the electron microscope, such future cameras will ferret out points of weaknesses in electronic equipment and a high percentage of potential failures, not apparent otherwise.

Take only one example—our present-day rockets, missiles and our various satellites. Today's percentage of failure is intolerable. Its cost is well-nigh astronomical. Often failures occur once the space vehicle has been in orbit for a considerable length of time. But most occur before they are off the ground.

All these potential failures could be anticipated and overcome with miniature color TV probes on the molecular level. They would be cheap at any price.

-H.G.

---

replacing your
FIRST color TV tube?

Do it confidently with this step-by-step procedure

Unhooking leads from yoke assembly so set chassis can be removed.

WHEN A DEFECTIVE COLOR PICTURE TUBE must be replaced, don't throw up your hands in despair and wonder how you'll ever do it. This will be your first reaction—I remember the first color tube I ever replaced and I didn't know how to tackle the job. This article deals with the replacement step by step so that any service technician can do it. The photos show the exact settings of the units on the neck of the color tube and the text follows along the same lines.

Installing a new color picture tube is a five-step procedure:

1. Removing the chassis and picture tube.
2. Removing components from the picture tube.
3. Installing components on the new picture tube.
4. Installing the tube and replacing the chassis in the cabinet.
5. Receiver convergence.

With the chassis removed only the color-CRT and the convergence chassis are left.

With color tube on bench, start removing yoke and convergence assemblies.
The receiver described in this article is a RCA set although replacing most other color picture tubes calls for the same procedure.

**Removing chassis and CRT**

After pulling off all front knobs and removing the rear cabinet cover, disconnect the high-voltage lead going to the picture tube. In older sets, this lead must be unfastened from the metal box before you open the box lid. Push down against the high-voltage connection with a long insulated screwdriver to discharge the high voltage. This lead will pull straight out of a pin socket. In newer sets, the high-voltage lead unplugs from the glass picture tube.

Now remove all wires connected to components on the picture tube. Remove the picture-tube socket and the yoke leads. All the colored wires going to the deflection yoke are marked on the yoke where they plug in. There is little danger of getting them wrong when replacing them. Unhook the blue lead from ground to the blue lateral magnet. Unplug the speaker cable. Unplug the convergence yoke cable from the top of the chassis and loosen the two ¼-inch bolts that hold the antenna assembly to the case. Slide the antenna assembly out and down.

One or two chassis bolts at the top of the chassis and two bolts in the bottom of the chassis must be removed. Now slide the chassis out about 3 inches and loosen the ¼-inch metal screw that holds the small-controls assembly down. Slide the unit back and then lift up. The chassis is now free and can be removed. After the chassis has been removed, it may be wise to turn the cabinet over on its face before removing the CRT—especially if the top and side of the set you are working on are not removable.

Four nuts hold the picture tube in place. Measuring position of elements around CRT neck in relation of base of tube.

Center purity ring is lined up with red stripe on neck of CRT. Closeup shows greater detail of convergence elements.
Fig. 1—Measure component spacing before they are removed from CRT neck. Measurements are approximate, but help when replacing parts on neck of new CRT.

place—two at the top and two at the bottom of the assembly. Loosen the bottom nuts first, then the top two. Two men should work together to remove the picture tube from the receiver cabinet. We have used only one man, but the cabinet starts to crawl and the picture tube is heavy too.

You can remove the components from the tube while it is in the cabinet or on the bench. I left everything on the color tube so pictures could be taken as each was removed.

Removing components from CRT

Place the kinescope face down on a drop cloth or newspaper to protect the face from scratches. To be sure that the components will be replaced on the new tube correctly, measure the settings, with a ruler, from the base of the kinescope. Fig. 1 shows the settings in inches for a tube I removed. When you remove the blue lateral magnet, you will notice that it sits right over a clip inside the picture tube.

The purity ring sets over the red ring marked inside the tube. Notice that the center adjustment magnet and convergence yoke are mounted at the opposite end of the red ring. Note that the blue wires from this yoke are at the top of the picture tube over the blue gun, the red wires at the right side and the green wires on the left going to the green dynamic convergence coils.

The large deflection yoke is loosened with a 1/4-inch nut driver and slid off the end of the tube. It is heavy; don’t be surprised into dropping it. The masking must be removed from the front edge of the picture tube. On older sets, the mask extends several inches down onto the tube. Plastic tape holds or seals the joint of the mask section.

Replacing components

When placing the mask on the new picture tube, be sure that the center of the face mask (there is a mark on the new mask showing the center) is placed in line with the blue gun. The blue gun is always at the top of the screen. Use either plastic tape or masking tape to hold the mask in place. At this time, the new color CRT can be placed in the receiver cabinet.

First, be sure the safety glass has been washed and cleaned. Also, make sure there is no lint or dirt on the face of the new CRT. Then tip the picture tube and push it into the cabinet. Check to make sure that the blue gun is up and set the tube into its plastic holders. Help is needed here. At this time, check to see if any foreign matter has fallen into the front glass. If not, place the four nuts over the metal tube harness and tighten them.

Now slide the yoke into place and tighten the 1/4-inch bolt slightly. You should still be able to push the yoke back and forth on the picture tube neck. Install the other components, making sure they are in proper order and spacing them according to the measurements you made when you removed them from the defective tube. Now replace the TV chassis and reconnect all leads. Once everything is back in place, turn on the receiver and let it run for 15 or 20 minutes before converging the set.

Receiver convergence

Before starting to converge the TV screen, turn the dot-bar generator on and let it warm up thoroughly. While it is stabilizing, take your degaussing coil and demagnetize the set. After degaussing, if you see any color shading anywhere on the screen, purity must be adjusted.

To start the purity adjustment, turn off the set and unplug the i.f. cable going to the tuner. Plug the ac interlock cord back and, after the receiver warms up, short out the green and blue grids through a 100,000-ohm resistor. There are commercial kinescope grid-shorting

DC MAGNET ASSEMBLY LINES UP WITH THIS END OF RED STRIPE ON COLOR CRT

Removing yoke from defective color CRT. Watch out, it’s heavier than you think.
switch boxes on the market for this purpose. Now the screen is red. Adjust the center purity ring for a center red coloring. Then push the yoke back and forth and adjust the purity ring until the entire screen has an even red tint.

If this is done correctly, the green and blue shading will fall in line. It is always best to check each one separately by shorting the other two grids to ground through a 100,000-ohm resistor. If there is still shading or color at the edges, adjust the hairpin magnets at the outside or (on the older sets) bell of the tube to erase them. These magnets are not used on the newer sets. If a little shading persists, try degaussing the kinescope again.

At this point, check two things. Be sure the picture is level and in focus. The temperature and black-and-white adjustments generally are not too far off if these controls did not get bumped. Check receiver operation on black-and-white. If adjustment is required, follow the manufacturer's setup procedure.

On later-model receivers, convergence adjustment is comparatively easy. Connect the dot-bar generator to the antenna terminals and set the generator to the same channel as the TV receiver. Remove the convergence board assembly from the back of the set and place it on the slots at the top and back of the receiver. Tighten the two metal screws so the board is solidly in place. Watch the wires that connect to this board and the yoke assembly so that they do not get hung up.

Do the vertical convergence first. If the receiver was properly converged when the picture tube went out, the dynamic convergence controls will need only a touchup. Put the dots on the screen and check down the center for a white dot. Short out the blue gun with the 100,000-ohm resistor. Bring the red and green dots together in the center of the screen, sliding the green and red beam center magnets to set the dots on top of one another. Check and adjust this setting several times to make sure it is right.

If they won't quite come together, rotate the red magnet a half turn and reinsert it, and the dots will come together. Once they are together in the center of the screen, short the green and red dot bars together in the center of the screen, sliding the green and red beam center magnets to set the dots on top of one another. Check and adjust this setting several times to make sure it is right.

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Now that there are more than just two chassis, you need a scorecard! By WAYNE LEMONS

ONE OF THE OUTSTANDING THINGS ABOUT color TV this year is the spirit of change. There are no longer just two chassis hiding behind a multitude of brand names. And, as in the early days of black-and-white, the color chassis is gaining individuality as each manufacturer incorporates new design ideas. Although there are no revolutionary developments in circuitry this year, the first rectangular color tubes, a 16-inch by Toshiba and a 23-inch by Motorola, are no doubt the harbingers of a new color era.

All chassis except Zenith and Toshiba use X and Z color demodulators followed by R—Y and B—Y amplifiers. The G—Y signal is then derived by picking off and mixing the right amounts of the reversed outputs of the R—Y and B—Y amplifiers.

Zenith uses “switch tube” high-level demodulation (as it has since its entrance into color) with no amplifiers between the demodulator and the CRT grids. Toshiba uses a slightly different method of demodulation than either of the above. They demodulate on the R—Y, B—Y and G—Y axes directly rather than deriving the G—Y signal from the amplifiers. This they do by taking a third phase axis from the 3.58-Mc color oscillator (Fig. 1), and supplying all three of the demodulator grids with selected amounts of the color signal from the second bandpass amplifier. The cathodes of the color amplifiers which follow these demodulators use a common cathode resistor even though the G—Y signal has already been derived. This common connection is necessary so that blanking can be applied through the color amplifiers to all three color grids simultaneously.

The greatest design changes in color chassis this year have been in the black-and-white circuitry; different tuners, i.f. strips, sync circuits, etc. The convergence circuits, except for some refinements and slight rearrangement of controls in some models, are virtually unchanged. Convergence procedures are pretty much what they have been for the last 3 or 4 years.

Many companies are using turret tuners this year, and all but Toshiba (which uses a cascode type) have neutralized triode rf amplifiers. Admiral, Curtis Mathes, RCA, G-E and perhaps others use Nuvisor 6CW4 or 6DS4.

An almost universal design feature for 1964 is the inclusion of some method of controlling video response. Most designers have chosen a three-position switch but at least one (Zenith) has a continuous control. Fig. 3 shows the method selected by Admiral. By switching in different values of capacitance across the contrast control, the high-frequency response of the video amplifier can be reduced or increased at all but the maximum setting of the control.

The switch can be used to compensate for variations in transmission conditions, depending upon where the set is used and the program material that is transmitted. For example, in fringe areas, snow can be reduced by reducing the high frequency response. On the other hand, old films can be “livened up” by increasing the high-frequency response so that outlines stand out better against the background. Fig. 3 shows the continuous “video peaking” control used on Zeniths.

Power supplies
Another feature found on many sets this year is “boosted boost.” This is an added voltage obtained from the flyback and normal boost circuit so that...
several hundred volts more is available for the screens of the color tube. This is said to produce both a brighter picture and somewhat better focus. The circuit used in Packard-Bell and RCA sets is typical. (See the RCA CTC 15 article in this issue, page 00.) A high-voltage selenium rectifier tapped up on the flyback develops an additional 420 volts over the normal boost supply.

One other feature popular this year is a high-voltage selenium diode as a focus rectifier instead of a 1V2 tube. This has the advantage that no sweep power is used to supply the focus rectifier filament. A circuit of this kind is also used by G-E, RCA and Philco.

Mechanical construction

Packard-Bell is building this year what is probably the first vertical "wraparound" color chassis. This is not as bad as it might sound. (See Fig. 4.) All adjustments are located on the rear side of the chassis with the exception of the convergence boards which is mounted separately (upper left). The beauty of this chassis is that, when under chassis service is needed, all you do is remove two nuts on the right and the chassis swings out, over the picture tube to the left, making all parts underneath accessible.

Most manufacturers have at least one or two models of color sets that also include radio, phonograph and hi-fi amplifier. Fig. 5 shows the rear view of a Curtis Mathes combination. This chassis is similar to RCA’s CTC 12 except that no audio output tube is used. (You might think a tube is missing, since the socket hasn’t been removed.) The sound from the quadrature detector is channeled through the radio–phono amplifier. Curtis Mathes markets color sets only in combinations.

Setup and convergence

A setup switch that sets the bias on the picture tube and at the same time kills the vertical deflection for making gray-scale tracking adjustments is a standard feature on all American-built sets. The Toshiba color set does not use this switch but does have individual gun killer switches mounted on the convergence panel (a "why not" feature that would be a welcome addition to any color set). The killer circuit is interesting and is shown in Fig. 6. Note that 100,000-ohm resistors are switched in but not in the control grid circuit. These are switched into the circuit to reduce the voltage on the CRT screens. This permits long leads without the possibility of video deterioration.

Several new sets (and many of last year’s) use an H-bar plastic magnet holder for the dc convergence adjustments and a slightly different design for the blue lateral magnet. These changes are shown in Fig. 7.

Hv regulator changes

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starting to feel the effects of refinement. G-E, Magnavox, Philco and RCA have a "video controlled" circuit. (You'll find a schematic of this, too, in the RCA CTC 15 article.) This circuit tends to reduce blooming when there is a large amount of white in the picture. Compensation is needed because the picture tube draws more current from the high-voltage supply when the white content of the picture increases.

The RCA circuit feeds a monitoring voltage from the plate of the video amplifier to the grid of the high-voltage regulator through a 12-megohm resistor. When white content is high, the plate voltage of the video amplifier is lower. This lower voltage lowers the regulator grid voltage slightly and the regulator tube draws less current, puts less load on the high voltage, and the high voltage rises.

Motorola uses a varistor in series with the boost voltage to the grid of the 6BK4 shunt regulator (Fig. 8). This voltage-dependent resistor tends to accentuate the effects of boost-voltage changes and so provides somewhat better regulation. An ordinary resistor here would pass the boost-voltage change to the grid in a 1-to-1 ratio while a varistor of this kind passes more current with an increase in voltage than you'd expect from Ohm's law. The resistor looks like less resistance in the circuit when the voltage is higher, and like more resistance when the voltage falls.

Pincushion correction

The 23-inch rectangular tubes are not without circuit problems. One major one is the more noticeable effects of pincushioning (lines bent) at the outer edges of the raster. Permanent magnets, as used with wide-angle black-and-white tubes, are not the answer in color because the magnets affect both convergence and purity. To whip this problem, Motorola developed a "Dynamic Pin Cushion Corrector" (DPCC) circuit. Fig. 9 is a simplification explaining how it works. A pulse from the plate of the vertical output tube is shaped and fed to the grid of the DPCC tube. In addition, a horizontal pulse is fed into both sides of the primary of the DPCC transformer (one side by way of the cathode of the DPCC tube). The secondary of this transformer is in series with the vertical yoke windings. The combinations of these voltages provide a method of speeding or slowing the scan at the upper and lower edges of the tube.

"Color" indicator lights

Motorola and Magnavox have lights to indicate that the set is receiving a color program. Fig. 10 shows how Magnavox modified the RCA CTC 15 chassis to provide an indicator. When no color program is being received, the color killer keeps the bandpass or "color i.f." stage cutoff; this means there is no drop across R and the neon does not light. During a color program, the bandpass tube is on and the drop across the 47,000-ohm resistor exceeds the firing voltage of the NE-2E, which then glows.

The "1964 Color Facts Chart" shows you how the sets compare. Check it over to see what new tubes you may need to stock. [Too late to work it in here, we learned that Motorola has introduced a new chassis, the TS-912A-00, which has several new tubes and simplifying features. We hope to describe it in an early issue.-Editor]
COLOR TV

Today & Tomorrow

By DAVID LACHENBRUCH

Color television's first decade—and a look at its future

The saga of RCA's unflagging persistence, and its investment of more than $130 million in color, is a familiar one. As a result of this almost single-handed effort, the shadow-mask tube and associated circuits represent the only commercially accepted method of obtaining a color TV picture in the home to this very day.

The decade's real turning point came in 1954, when the 21-inch color set was born. It had a round tube, with 70° deflection, similar in appearance and principle to today's color tubes. Not only RCA, but Admiral, Emerson, General Electric, Magnavox, Motorola, Sylvania and others began color set production, some using RCA's 21-inch tube and others using 21- or 19-inch shadow-mask tubes produced by other makers.

Public response continued listless. Word spread that color sets were difficult to tune, almost impossible to keep in adjustment and that all you could see on them was purple people-eaters. By 1956, RCA cut list prices on its color sets to a low of $695 and then to $495, but color had a bad name. Most other set manufacturers—although affirming their faith that color was inevitable—ended production and liquidated their color inventory for what it would bring.

From 1956 through 1959, color sales leveled off at between 75,000 and 90,000 sets per year, as compared with 6 to 6.5 million black-and-white sets. In 1958, CBS ended all regular color broadcasts. Those were color's bleakest years. Nevertheless, NBC continually expanded its color broadcast schedule, and RCA engineers continued to engineer improvements into the color chassis and tube. These improvements were slow and gradual—there were no dramatic breakthroughs.

Color sales showed signs of more life in 1960, when they broke through the 100,000-set barrier, while network programs exceeded 1,000 hours for the first time. RCA and Packard-Bell were actually the only ones making color sets at the time, but Admiral was having some success in marketing sets built for it by RCA. The increase in programming and the improvements in color sets, together with RCA's advertising campaign, were beginning to influence the industry, particularly at the dealer level.

Color's real turning point came in
1961, with the dramatic announcement that RCA's arch-rival, Zenith, was preparing a line of color sets at the request of its dealers, to give them a "full line" to compete with anything other manufacturers had to offer. The remainder of the set manufacturers quickly fell in line. Most of them, however, had once been burned by heavy losses on color, and were unprepared—or unwilling—to set up for their own production. RCA was only too willing to help them by supplying complete color chassis or kits of essential parts.

The same year, RCA introduced a new version of its 21-inch round 70° color picture tube. Sulfide phosphors—of the same type used for black-and-white—increased brightness and contrast, and reduced color smearing and trailing. Sales more than doubled in 1962. The ABC television network edged into color broadcasting, although CBS was (and still is) holding out.

But color was still highly controversial. Manufacturers began to dust off and re-evaluate old color receiver systems they had developed in the early 1950's and shelved. Among major set manufacturers, Motorola was one of the few which had not re-entered color, insisting that the bulky, round 21-inch 70° picture tube made color cabinets too ungainly for most living rooms.

While color set sales boomed, the picture-tube controversy accelerated. Working with National Video Corp., a Chicago picture-tube manufacturer, Motorola developed and demonstrated prototypes of a 23-inch rectangular 90° picture tube, about 6 inches shorter than RCA's round tube. RCA countered with the announcement that it would change over to a new shorter color tube, still a 21-inch round, but with 90° (instead of 70°) deflection. Then, as 1962 neared an end, RCA Tube Div. told its set-making customers that it would be unable to deliver the new short tube because of "technical difficulties" and reliability problems.

Color roared into 1963, and sales this year are expected to end up between 650,000 and 850,000. Among these will be some using the new 23-inch Motorola rectangular 90° tube, which is based on the same shadow-mask principles as the RCA 21-inch. The glass bulb is basically the same as that used for 23-inch black-and-white tubes, but re-formed to color's more exacting tolerances.

This year saw the first reductions in the base price of color sets in 7 years. Admiral shocked the industry by introducing a table model at $399.95, and the rest of the industry came down to $449.95. Meanwhile, the year closes with three new manufacturers of color tubes—Sylvania, Rauland (Zenith) and National Video—in addition to RCA.

The old Apple tube, developed by Philco around 1956. Somewhat similar principles have been used in later inventions, including the recently announced Goodman tube.

Perhaps this year's most significant color action was RCA's decision to discontinue the manufacture of color chassis and kits for its competitors by the end of 1963. It needed the production capacity for itself. So, as 1963 ends, virtually every American TV manufacturer is building its own color sets.

Today there are probably 1.7 million color sets in use—about 70% of them sold within the last 2 years. (Since no color TV sales statistics are released, all figures in this article are unofficial estimates by the author.) Color sales are generally expected to exceed one million next year, with color sets in use passing the three-million mark early in 1965.

What of the future?

The current color TV set, despite many refinements and improvements, is basically a highly reliable and somewhat simplified version of the receiver built by RCA in 1955. What are the prospects for significant changes and completely new concepts in color receivers in the near future?

There's no question that the first important change will be in the picture tube. The 70° round tube is nearing the end of its cycle. Now being built by RCA, Rauland and Sylvania, it has perhaps another year or so to run. The industry is expected to standardize on a new color tube of the square-cornered rectangular type, with 90° deflection and measuring 25 inches diagonally. There may be an additional small color tube—a 19-inch rectangular, also with a 90° angle.

Glass bulbs for these new-size color tubes are being developed by Corning Glass Works. The new 25-inch rectangular color sets could reach the market in spring 1965—possibly as early as late 1964—completely supplanting the current round tube. (Motorola's 23-inch color sets are built to accommodate the 25-inch tube as a replacement.)

The 25-inch tube won't be new in its operating principles. It will use the same shadow-mask concept featured in all production color tubes since 1954. It will require relatively minor changes in chassis design. In fact, the new color chassis (CTC 15) introduced by RCA last summer already goes a long way toward accommodating this new 90° tube.

Revolutionary developments

Of all the other color TV tubes and receiving systems proposed in the early 1950's, the Chromatron, or Lawrence tube, has been the most durable. Paramount Pictures, which owns the rights to the tube, has periodically demonstrated to set manufacturers two versions—the single-gun Chromatron, claimed to make possible a color set at only 25% more than the cost of black-and-white, and a three-gun version, which provides more brightness than present color tubes.

No American manufacturer has recently shown an overwhelming interest in Chromatron. But Sony Corp., of Tokyo, has taken out a license with an eye to developing a portable color set using Chromatron principles. Sony offi-
An exploded model of Chromatron. Fine wire grid that deflects electrons onto correct color strip is held by center section, and cannot be seen in photo.

Another projection system, developed for theater use, may eventually have potential for the home. It’s G-E’s Talaria light-valve projector, whose giant-screen version sells in the $50,000 range. Instead of cathode-ray tubes, this projector modulates a thin layer of fluid with two electron guns (one for green, the other for red and blue). A xenon light, beamed through the fluid, produces a color TV image of movie brightness. It’s believed G-E is developing a smaller version of Talaria, but its cost probably will be well up in the thousands of dollars for some time, precluding use in the home.

The plain fact is that introduction of a radically new color receiving system is unlikely in the near future. The reasons are economic as well as technical. The tremendous costs of development and tooling of completely new systems would outweigh many of the advantages.

Today’s receiving system is far more than adequate. Any new system would have to promise markedly better performance or much lower cost to receive serious consideration. Even a system which could be proved to be slightly better or slightly cheaper would probably be rejected—and, to the best of our knowledge, nothing of this kind is in sight.

Nevertheless, you can expect many changes and improvements within the present approach to color TV reception. For the first time, color TV is competitive. “Ghost manufacturing” is past; every manufacturer makes its own sets. Finally there’s a strong incentive for each to develop its own proprietary circuits and cost-reduction systems for better, more economical and more reliable receivers.

Color’s decade of pioneering is coming to a close. The era of color TV in the home has begun.
COLOR

TV SERVICE

IS SIMPLE

It's like black-and-white plus a few new circuits -- and they are not that new

By JOHN FITZGIBBON

I'm going to make a controversial statement: Color TV is no harder to service than black-and-white! You do not need a Master's degree in electronic engineering and thousands worth of test equipment. You can even service color at the same service charges as black-and-white--and make money! Prove it? OK, I will!

Pause and consider this indisputable fact--each circuit in a color set uses tubes, resistors, capacitors and transformers. How many other kinds of parts are there? If you can find a leaky coupling capacitor in a black-and-white set, you can surely find one in a color set!

The really "complicated" troubles seldom occur. From your own experience, how many really tough jobs do you run into in black-and-white--percentage-wise, I mean? About 5%, just like everyone else. All the rest are easy. Dead tubes, burned resistors, leaky capacitors, bad filters and so on. If you serviced nothing but color TV, you'd find exactly the same proportions; after all, they're TV sets, aren't they?

Example: one set's picture suddenly turned a bright green. Picture good, sound OK. Give me a diagnosis? Sure! Trouble in the green amplifier tube. Heater-cathode short, no bias, tube ran wide open, and the green drowned out the other two colors. Tube replacement and cure took less than 3 minutes. Many others are equally simple.

In black-and-white servicing, what do we look for in the way of symptoms? What is there, and what isn't there-sound, video, sync, etc. From this, we make our first diagnosis and then proceed to check it out. We use the process of elimination to find out just which one of the many possible causes is responsible.

The same process will work in color. You're going to find that the great majority of troubles in color sets are the same as those in black-and-white--sound, sync, horizontal sweep, and so on--and you've been fixing those for years. There are only a few extra circuits, just as simple as the rest, and they will give you a very definite set of symptoms when they're not working right!

Color vs black-and-white

Are there any new circuits in a color TV receiver? Circuits that you've never seen before? Let's start at the video detector. Up to this point, the circuits are exactly the same as those in black-and-white: tuner, i.f., sweeps, sync, age, power supply, etc. Let's go down the line and examine each color circuit.

1. The burst amplifier (Fig. 1). This is a standard pentode tube, with normal plate and screen voltages. The grid is keyed by a pulse from the flyback transformer, so that the tube actually conducts only during horizontal blanking intervals. So, what does it do? It amplifies the burst signal, which is on the back porch of the horizontal sync. How is this burst separated from the sync, video, etc. signal? How do we separate a 4.5-msec sound signal? Feed it through a sharply tuned transformer! See it in the plate circuit? This transformer has a center-tapped secondary, which feeds the...

2. Phase detector, sometimes called rfpc and other complex names (Fig. 2). Don't let 'em fool you--it's just a plain old ratio detector, discriminator or whatever you want to call it! Compares the phase of the burst signal from the transformer with the signal being developed by the local oscillator, and develops a d.c. correction voltage to apply to the...

3. Reactance tube (Fig. 3), which certainly should be familiar to all the old-timers. The same circuit is used in lots of older TV sets, to control the horizontal oscillator! Afc, in other words.

The small d.c. control voltage from the phase detector is applied to the grid. This controls the phase angle of the control tube's plate voltage and current, making it behave like a reactance. Thus we can make the tube control the oscillator circuit automatically, by varying the amount of reactance it appears to be.

The control comes from the correction voltage, which is in turn developed by the color signal itself. So, we keep the...
from the reactance plate, leaving the real plate free to take it, is a Pierce, the original version. This shifted 3.58-mc voltage.

Have two signals to use in our color secondary. This shifts the phase of part from. Note the tiny rf choke across the provides a place to get the output signal on the operating frequency; it merely. The coil in the plate circuit has no effect on the oscillating thing that can keep a Pierce circuit from oscillating if it's zero or positive, it isn't. About the only 4-5 volts, the circuit is oscillating; if it's above 220-pf coupling capacitor. Just enough is needed too badly comes.

How do we get the colors separated? Notice that a combination signal, with all colors in it, is applied to both grids. This signal comes from the bandpass amplifier, which we'll get to in a minute. The color signals are all in there, in the form of different phases of the basic 3.58-mc color subcarrier (which was removed at the transmitter to save postage—the 3.58-mc oscillator puts it back in at the receiver).

So, with all of the colors on the grids, we put a 3.58-mc signal from the oscillator on the cathodes. Now, each tube passes only the part of the color signal that's in phase with its cathode signal. Same principle as keyed age. In the output, we get red in one plate circuit and blue in another, “Wait a minute!” somebody says. “Where's the green?” OK, we make it in the...

The 3.58-mc oscillator right on frequency.

4. The 3.58-mc oscillator. This is usually a standard crystal oscillator circuit. Sometimes it's even a Pierce, which is about as simple as you can get. Tube, crystal, and a few oddments like plate voltage and stuff. Fig. 4 shows a typical oscillator circuit, which, come to think of it, is a Pierce, the original version. This uses the screen grid as the oscillator plate, leaving the real plate free to take off the 3.58-mc signal. (Is this unusual? How about the oscillator circuit in some small radios where a pentagrid tube is used as mixer-oscillator? The screen's the oscillator plate, and the i.f. signal is taken from the real plate. Same thing.) Control for this oscillator, which isn't needed to badly, is taken from the reactance tube through the 220-pf coupling capacitor. Just enough to keep it right on frequency at all times.

Servicing? Measure the negative voltage on the control grid. If it's about 4-5 volts, the circuit is oscillating; if it's zero or positive, it isn't. About the only thing that can keep a Pierce circuit from oscillating is a dead tube or crystal! The coil in the plate circuit has no effect on the operating frequency; it merely provides a place to get the output signal from. Note the tiny rf choke across the secondary. This shifts the phase of part of the 3.58-mc output so that we can have two color signals to use in our color detectors (one in phase with the burst and another 90° out). These signals are fed to the cathodes of the...

5. Color demodulators (Fig. 5). You'll find these called X and Z, I and Q, R and G, you name it—any combination of letters. They all do the same thing: separate the color information from the video signal. How? Phase detection. A good example is the quadrature-detector circuit used in sound detectors with the 6DT6 or 6BN6.

How do we get the colors separated? Notice that a combination signal, with all colors in it, is applied to both grids. This signal comes from the bandpass amplifier, which we'll get to in a minute. The color signals are all in there, in the form of different phases of the basic 3.58-mc color subcarrier (which was removed at the transmitter to save postage—the 3.58-mc oscillator puts it back in at the receiver).

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6. Color Amplifiers (Fig. 6). Three simple triode amplifier stages. But, you still want to know how, come from? We're putting our red and blue signals onto the grids of the top and bottom tubes. The cathodes are all tied together. So, the cathode voltage on the green amplifier is a combination of the other two colors. Now, the whole color signal is red + blue + green, isn't it? So, what would we have left if we subtracted red and blue? Green?

This is what takes place in this tube, because of the arrangement of the cathode and grid voltages. It becomes a sort of backward adding machine, and subtracts the red and blue signals, leaving the green. These are amplified and fed on to the green gun of the color picture tube.

Let's back up and get a few things we had to leave while we were following the color signal through the circuit to the picture tube. One of these is the bandpass amplifier we mentioned as feeding the color demodulator stages.

7. Bandpass amplifier (Fig. 7). Actually, this is hardly worth illustrating. If you've ever seen an i.f. stage in a radio or the sound i.f. in a TV set, you've seen the same circuit. Color signal goes to the grid from the color takeoff coil, and the plate feeds the "bandpass" transformer. This is used to clean up the color signals and keep out interference from other circuits. On the secondary of the transformer is a control usually called saturation, but which I think ought to be called a "color volume control," since that's how it works. It simply regulates the amount of color signal.

Since this stage handles the whole color signal, it's a good place to put the...

8. Color Killer (Fig. 8). What's this for? Its only purpose is to cut off the bandpass amplifier during black-and-white transmissions. Some men have had trouble understanding the thing, because it "works backward," in a way. During color reception, the killer is cut off, and the bandpass amplifier works. During black-and-white reception, the killer works (conducts, that is) and the bandpass amplifier's cut off.

This is basically a keyed stage; see the pulse being applied to the plate from the flyback. So, this tube conducts only during horizontal retrace time. Notice the "balance" circuit in the grid. We get —45 volts from the phase detector by connecting this to one end of the two 470,000-ohm resistors.
Fig. 8—Color killer. It, too, is keyed by pulse from flyback.

While a color signal is being received, a negative voltage is developed there. During black-and-white reception, this voltage disappears, because there's no color burst to make it show up. The other end of the 10-megohm resistor goes to a source of +45 volts (the burst amplifier cathode in this case—all we need is a source of positive voltage at the right level). This is fed through the killer threshold control so that we can adjust the grid voltage on the killer stage.

If the killer tube is not conducting, we don't get any voltage drop across the 150,000-ohm resistor in the plate circuit. So, the bandpass amplifier is allowed to pass the signal, which is color. (Killer cut off, bandpass amplifier working.)

When the killer tube is conducting, the drop across the plate load resistor puts a negative voltage on the grid of the bandpass amplifier. (Killer working, bandpass amplifier blocked.) So, it can't pass any signal at all because it's biased to cutoff. This keeps the whole color circuit from operating, since all of the color signals have to come through the bandpass amplifier. So, during black-and-white reception, we don't have colored snow on the screen, or "confetti," as they used to call it. This stage is as simple to service as any keyed stage (You can fix keyed age stages, can't you?)

9. The blanking tube (Fig. 9). Because there are so many signals going in so many directions around here, we don't want any trouble with retrace of either kind. So, we add the blanking amplifier stage, Fig. 9. This is nothing but amplified retrace blanking. Same circuit used in uncounted jillions of black-and-white sets, except that we are using a tube to be sure that the picture tube stays cut off during horizontal and vertical retrace times.

The delay line

The video signal (that is, the one we use in black-and-white containing only brightness signals) goes straight to the picture tube grids. The poor little color signal, on the other hand, gets chased around through all sorts of phase-shifting networks and stuff before it is allowed to reach the picture tube. We have to give the video a little "handicap" so that everybody will reach the finish line at the same time. Actually, this isn't much—usually about 1 microsecond!

The theory of a delay line is very complicated, but a practical delay line may be nothing more than an 8-inch piece of coaxial cable! It takes a signal slightly longer to get through the cable than it does in free space. (The velocity of propagation is lower.) If a greater delay is needed, sometimes a small coil is used inside the delay line, slowing the signal down still more. Only two possible troubles: a broken wire or a short to ground, both fairly easy to find. It isn't possible for the time constant to be changed by any defect.

So, there you have it. We've taken a black-and-white TV receiver and added the color circuits. (Up to the video detector, the circuits are exactly the same as in black-and-white, and subject to the same faults.) While we discussed nine functions, one popular function makes them all with only seven tubes.

"But!" somebody says, "they don't all work that way!" So? How about black-and-white sets? Are they all alike? If they were, you could carry your Sams Photofact file in your shirt pocket! Naturally, there are differences. Circuits are changed and simplified all the time, just as in black-and-white. The earliest practical color set was a fat 24 inches on each side, weighed about 75 pounds and used 44 tubes. The latest is half that volume, uses 24 tubes and you can carry it in one hand.

Natural differences in approach are trivial. RCA, for example, uses a three-stage video amplifier. Zenith uses a single high-gain tube. What's the difference? Both circuits work, and work very well, and are equally easy to service.

Test equipment

"But," comes that same plaintive voice from the back row, "You've got to have so much equipment to service color TV!" Are you in again? I thought you'd left. Well, let's see. On how many black-and-white sets do you use a scope, sweep generator, marker-adder, flyback tester, capacitor tester, pattern generator? About 5% or less. Most of the troubles are simple: dead tube, bad capacitor and the like. You're going to find color exactly the same.

So you can use your present test equipment to service color. Later on, you can add color bar generators, etc. You must have them if you want a completely equipped shop. However, if you can service 95% of the simple troubles, what better percentage do you want? The most useful piece of test equipment in the shop is that mass of gray mud between your ears!

Service information

Fortunately for us, a mass of service information and help is available. Set manufacturers have spent millions printing color training courses, holding service meetings, and doing everything they could to get the basic idea of color over to us. We ought to be grateful to them, and most of us are.

While I have been mildly critical of them at some times in this discussion, it was intended to be helpful. Although they were the culprits at first in complicating things, they have begun to use the "simplifying" approach to the subject, and it is showing up in the increasing number of men who are happily and profitably servicing color TV.

I am firmly convinced, from associating with them for the past 35 years, and from being one myself, that the US electronics technicians are unequalled in all the world. From the simple circuits of radio, they tackled the infinitely more complicated apparatus of television, FM, hi-fi, etc., and mastered it. The difficulties we have had with color in the past have not been due to any lack of either ability or capability, but simply to that subconscious fear, the block set up by the apparent complexity of the circuits.

Once we realize that color television is not as complex as it might seem, we're well over the hump. After all, and always remember this—we're not designing these circuits: we're just repairing them! They did work once, and they can be made to work again. All we have to do is locate the defective part and replace it. Let's go!
NEW TUBES for COLOR TV

Why all the new numbers? What's been improved?

WHEN COLOR SETS FIRST APPEARED ALMOST a decade ago, most of the tubes in them were familiar to anyone who had worked with TV. As in the earliest days of black-and-white, existing tubes were pressed into service—sometimes even strained to their limits—for new applications. Remember when the only damper tube was a 5V4-G? When 6L6's and 807's were used as horizontal output tubes?

But increasing demands brought special tube types for special needs, and now it sometimes seems that manufacturers develop a new type at the slightest provocation. Let's take a ramble through this bewildering welter of new tubes designed for color TV, and see if we can make some order out of it.

Rf and i.f. tubes

Since the signal requirements for color TV are stricter than for black-and-white, there has been a trend toward higher-transconductance, lower-noise rf amplifier tubes. The Zenith 25LC20 chassis is using two recent Amperex types: the 6HA5 and 6GJ7, as rf amplifier and mixer-oscillator tubes. They are among the highest-transconductance tubes today—20,000 mhos for the 6HA5 and a conversion transconductance of 5,000 for the 6GJ7. The front-end gain with these two tubes is something over 200, with a low noise figure.

Though RCA has made no changes in its front-end complement, there is a new tube in the first i.f. amplifier socket—a stage that demands high gain with low noise and wide bandwidth. Where the CTC 12 used the 6BZ6—already a pretty "hot" tube—the CTC 15 has the new 6JH6. Similar to the 6BZ6 in most ways, it has a tightly controlled cutoff point intended to provide headache-free interchangeability with others of the same type. According to RCA engineers, there were problems with certain 6BZ6's in the agc'ed first i.f. stage, which is critical about its bias voltage. The new 6JH6 is said to introduce less cross-modulation distortion in areas where channels 6 and 8 are strong.

The newly introduced Heath color TV kit also uses the 6JH6 as first i.f. amplifier.

Deflection tubes

The husky 6DQ5 in the RCA CTC 12 chassis has been replaced in the 15 by the still-more-rugged 6JE6. Heath is using it, too. It has a nine-pin "novar" button base instead of a cemented-on bakelite base, to dissipate heat better than before and to eliminate soldered connections between elements and base—a always a potential failure spot. Dual connections to control and screen grids raise the dissipation rating to 25 watts total. It has a lead-glass bulb, which reduces electrolysis and eventual gas contamination, and a copper-core plate structure to prevent "hot spots."

The Zenith 25LC20 chassis uses a 6HF5 compactron as horizontal output. Its plate and screen dissipation ratings are 28 and 5.5 watts, respectively, and it can withstand a peak cathode current of 1.1 amperes. Designed for a plate supply voltage (boost plus dc power supply) of 990, it should stand up well to the demands of high-energy deflection in color circuits.

In the vertical department, a 6GF7 makes its debut with RCA, replacing the older 6EM7 octal. The new tube is simply a novar-base version of the 6EM7—electrical characteristics are the same. A high-mu section is the oscillator, and the low-mu section is the vertical output stage.

A 6U10 triple-triode compactron is used in the Zenith chassis this year to simplify the horizontal oscillator and afc wiring.

Zenith uses a 6HE5 compactron as vertical output. It has a 12-watt plate and a 2.75-watt screen dissipation, and is more or less a compactron version of the 6EZ5 octal. The compactron base again offers greater reliability, like the novar. (The construction of the two base types is similar.)

The vertical oscillator in the Zenith
is the triode of a 6BA11 compactron that also works as sync separator and age amplifier. Besides the triode, it contains a dual pentode of the 6HS8–6LU8 type, with independent No. 3 grids and plates. Related functions were merged into one envelope to reduce wiring. According to Zenith, this made it possible to use the separate 6HE8 vertical output tube without increasing complexity.

**Color circuits**

A 6GH8-A has replaced last year’s 6EA8 as bandpass amplifier and color killer in RCA’s circuitry, to give higher drive levels to the color demodulators. The pentode section, used as bandpass amplifier, has higher gain than the earlier type. Base connections and ratings are identical for both. The 6GH8 has been around, and really only the “A” is new; it denotes the use of RCA’s “dark heater,” to increase tube life and stability.

The red and blue amplifiers are the two sections of a 6GU7 nine-pin miniature, and the green amplifier and blanker are the two halves of another. The 6GU7’s have replaced the 6FQ7’s of the CTC-12 because the new CRT in the CTC-15 has higher drive limits. To take advantage of that, RCA engineers designed a tube with higher plate current, and point out that the combination of new CRT and new amplifiers gives better color brightness and contrast.

Zenith uses two color amplifier stages before demodulation: the pentode sections of a 6KT8 and a 6HL8. Both pentode sections feature transconductance of 10,000 μmhos and up, and are otherwise similar except for basing. Both are paired with triode sections in the same nine-pin miniature envelope. The 6HL8 triode section is a medium-mu pentode, used as bandpass amplifier, and color killer. The new 12GN7 pentode is used in both Zenith and Heath chassis as video output. It has very high transconductance (36,000) and was chosen to give adequate drive with good bandwidth.

**Sound detector**

The RCA CTC 15 uses a new gated-beam limiter and sound demodulator, the 6HZ6. Heir to the noble tradition of the 6BN6, which started it all about 10 years ago, the new tube offers greater audio recovery for the same FM deviation. Unlike the 6DT6 and 6GX6, both similar types, the 6HZ6 has a special screen-grid shielding construction to suppress uhf parasites that cause trouble during uhf reception. This same tube is also used, incidentally, in RCA black-and-white sets with uhf.

**High voltage**

A new high-voltage rectifier is the 3AT2, used in the Zenith 25LC20 chassis as main high-voltage rectifier. It’s a compactron with a heater-cathode and multiple connections for heater and cathode to simplify wiring. The tube has an internal corona shield connected to cathode and heater (which are electrically common to each other). In the Zenith, it produces 25 kv with no apparent strain.

Zenith also uses a new focus rectifier interchangeably with the 1V2, the 1AU2. It is a more rugged tube, and has a 1.1-volt 0.19-amp filament.

New color-TV tubes will be described as they appear, in the “New Semiconductors and Tubes” department of RADIO-ELECTRONICS.

So—there are reasons for these new tubes. The differences are often subtle and slight, but they are part of an overall trend toward refinement, “de-bugging” and greater reliability. Improvements like these help turn color TV from a risky, temperamental “plaything of the idle rich” into a practical, dependable home-entertainment medium. Stick around!
A COLOR TV SET WITHOUT THE RIGHT antenna is usually a color TV set without color. The cliché about the Cadillac that won't run without gasoline applies equally well to color TV. A thousand-dollar set can't make satisfactory color pictures without the right antenna.

The color antenna must have three things: good gain, ample bandpass and complete freedom from parasitic resonances. This last includes the entire system: antenna, transmission line and booster, if one is used. Pattern shape and front-to-back ratio are very important, in some applications, for maximum freedom from ghosts and interference.

These requirements are not hard to fill. Any good antenna will. Ordinarily, if an antenna gives really good pictures on black-and-white, it will be suitable for color.

Antenna troubles

The symptoms of antenna trouble in color reception are definite. 1. Excessive snow or confetti indicates that the signal level is too low. 2. Intermittent drift or sudden shift in colors is usually caused by parasitic resonances, called "dropouts" or "suckouts", in the antenna system. These cause standing waves on the lead-in, and cancel the color burst or shift its phase.

A good quick-check for this last condition is to disconnect one side of the lead-in as you watch a color program. If the color returns, though the picture goes down into the snow, standing waves are probably cancelling the burst. Wrap a small piece of tinfoil around the lead-in and slide it back and forth while watching the color. If you find a point where the trouble disappears, tape the foil there. This point may not be the same for all channels— you'll have to experiment.

A third trouble, found mainly in fringe areas, is multipath reception from distant stations. The delayed reception of the second signal causes wavering colored ghosts and color shifts because of phase differences between the two bursts. There is no foolproof remedy for this, but it is almost always temporary, lasting 2-3 minutes at most.

Primary-area troubles

Primary areas also have their share of antenna troubles. If rabbit-ears or built-in antennas are used for color reception, field interference caused by people walking between set and station, reflections from steel-framed buildings or similar objects, can cause color trouble. This is usually in the form of a sudden loss of color. If the set can be placed on the wall of the room nearest the station, the effects will not be so noticeable.

A better remedy is to relocate the antenna. Mount the rabbit-ears on the wall above the set, or use a window or attic antenna. The method depends on the circumstances. A simple dipole in an interference-free area up in the eaves, for example, will often help. This should be cut to channel, of course.

In suburban areas, attic antennas are very useful. They are made in several types, some quite directional, with rotators, and are fastened to the underside of roof rafters. An easier installation can be made with the small roof-mount antennas such as the one of Fig. 1. They are made in several sizes, depending on the needs of an installation. The model shown has medium gain and directivity. Others have more elements, to give you a narrower pattern if you need it. This is often necessary to eliminate ghosts caused by reflections from nearby objects.

Signal levels

Too much signal can cause as much trouble as too little. Tuners in color sets are very sensitive, and very high signals can cause curve shift to the point where...
you to check out suspected overload

DECEMBER, 1963

45

Fig. 3—Carry a few clip-on pads with you to check out suspected overload problems.

<table>
<thead>
<tr>
<th>Area (miles)</th>
<th>Antenna type</th>
<th>Booster?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary: 0-10</td>
<td>Rabbit ears, built-in, simple dipole, window-mount, attic-mount.</td>
<td>Under some circumstances. Test for improvement in picture.</td>
</tr>
<tr>
<td>Deep Fringe: 100-150</td>
<td>&quot;Long&quot; broad-band Yagi; multiple elements, with built-in booster. Individual Yagis, each with built-in booster, plus matching network</td>
<td></td>
</tr>
</tbody>
</table>

The answer is to reduce the signal.

The simplest way is to add a resistive pad in series with the input. Fig. 2 shows resistance values for three typical pads. These will cover most situations. A quick way to find out which one you need is to make up one of each, attached to clothespin antenna clips (Fig. 3). These can be clipped in series with the lead-in.

After you hit on the right pad, make up a permanent one and attach it to the antenna terminals. A handy place for this is inside the cabinet. Unsolder the lead-in to the tuner, and connect the pad in series (Fig. 4).

The formula for computing other values of attenuation pads is shown in Table II. However, those in Fig. 2 will cover almost every situation, since the agc action of the receiver gives a great deal of latitude.

[Several manufacturers make printed-circuit resistor pads in several attenuation values, and some have "substitution box" devices, permitting you to switch in different amounts of attenuation before deciding on an optimum value. Check catalogs or your distributor.—Editor]

Table II

The diagram shows a balanced H-pad which can be used to attenuate too-strong TV signals. The two formulas are used to figure the two resistor values:

A is the number of times the input signal is to be decreased

—-not the number of db. That is, to get an output equal to half the input, you decrease the input two times. Hence A = 2.

In the 20-db pad of Fig. 2, the formula works out this way:

R1 = 150 x \( \frac{10}{10+1} \) = 150 x \( \frac{9}{11} \) = 123 ohms

R2 = 300 x \( \frac{2 \times 10}{(10 + 1)(10 - 1)} \) = 300 x \( \frac{20}{99} \) = 60 ohms

The nearest EIA 1/2-watt, 10% values are satisfactory for these pads. In our example, these would be 120 and 56 (or 68) ohms.

Fig. 4—Once you determine how much attenuation an overloaded set needs, wire the pad permanently inside the set, in the tuner input line.

Fig. 5—Best place for booster is at the antenna. Most boosters draw power through signal lead-in.

nals, misorientation and many other troubles show up. The signal strength must be checked before making the color installation final.

In cases where the existing antenna is fair but signal levels are low, the remedy is a booster. The newer transistorized boosters can be very helpful in these cases. Many of the later antennas include "built-in" transistor boosters, with gains up to 14 or 16 db, as in the type shown in Fig. 5. The best location for these is at the antenna terminals, as shown, but they can be used at the back of the set (Fig. 6) to avoid the time and expense of lowering and raising a tall antenna.

The simplest way to find out whether a booster will help is to try one. Many technicians carry one of the small transistor boosters, fitted with clothespin connectors, in their service kits. It may be snapped into circuit instantly to see how much improvement results. Performance will be slightly better with the booster installed at the antenna.
Precautions: No booster can make a picture; this is the purpose of the antenna. Boosters can improve any picture, but a fair amount of signal must be there to start with. The major purpose of the booster is to clean up marginal signals, remove snow and give more positive color lock.

Fringe areas

The precautions needed in secondary areas are also necessary in fringe areas. Antennas must be the highest-gain types available, and the powerful boosters are also a must. Antennas of the type in the head photo may give reception over distances up to 150-175 miles under good conditions.

Absolute height is not the important factor that it was once thought, although it is decisive in some areas. In many fringes today, antennas are about 30 feet in height, instead of 100 feet or even more. Field testing disclosed that this was about the optimum height for good reception. Very careful installation techniques are necessary to keep these taller, heavier antennas up.

Amplified distribution systems

Color sets are often connected to amplified signal distribution systems. These may be community antenna systems in small towns, or systems in large apartment houses or hotels. The very broad-band amplifiers used with these systems give good reception, for there is no chance of clipping color bursts, as was once thought possible.

However, in high-signal areas, one peculiar trouble has been found: undesired direct pickup at the receiver. Since the signal suffers some delay in traveling through the coaxial cable of the distribution system, the direct pickup will be slightly out of phase. This phase delay results in color trouble, as usual showing up as cancellation of burst and sudden dropouts of color.

To test for this condition, remove the antenna connection and connect a temporary dipole or rabbit-ears antenna to the set. If there is enough signal to make even a snowy picture, there is a possibility of interference. The remedy is to shield the antenna connection. Use shielded 300-ohm two-conductor cable between the distribution system terminal box and the set. It may be necessary to replace the short link between the terminal board and tuner with the shielded wire.

Just as in all other branches of TV work, selection and installation procedures will vary with individual technicians. There are no hard and fast rules for success. Thorough field testing, with a careful evaluation of the results, will be the most helpful single factor. There is no such thing as the "one right antenna" for any area; there will always be a choice between types and makes. Select a well built, well designed one, and the chances of success are much improved.

Handy Log Scales

Frequency response and other curves that use a wide range of units are generally constructed on semi-log paper. However, semi-log paper with more than 2 cycles is not always available. Here is a simple method to make your own. The table shows the logarithms of integers. Using an engineer's scale, or any scale with decimal units (a cm scale will also work), you can measure off the distances in the table. The result will be a log scale, and the number of cycles on the paper will depend on the divisions used. For example the 4-cycle scale below was made with 1/40-inch divisions and the 3-cycle scale with 1/30-inch divisions. Using 1/50-inch divisions would allow 5 cycles on 8 1/2 x 11 paper. Having drawn the scale on one side of the paper, you can then draw your graph by using a T-square and triangle. These scales can be used under a piece of tracing paper to make a piece of log or semi-log paper quickly. For log-log paper use the same scale for both vertical and horizontal divisions.—Tom Jaski

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The sections of log scales above can be traced to make scales 10 inches long. The top drawings show two cycles of a 10-inch, 3-cycle scale. On the bottom line we have two and one-half cycles of a 10-inch, 4-cycle log scale.
The CTC 15:

RCA'S
NEWEST
COLOR
CHASSIS

IN THE CTC 15, RCA'S NEWEST COLOR chassis, a great deal of emphasis has been placed on serviceability. Controls and circuit elements are precisely identified. Novar-base tubes offer high reliability, and special attention is given to chassis ventilation and heat dissipation.

The physical layout conforms generally to previous RCA color receivers. All circuit boards are mounted for good ventilation and easy access to all components and connections on either side of the board. The rf tuner can be mounted on the rear apron whenever necessary to transport the chassis.

The high-voltage compartment is designed to permit full accessibility to the components. The upper portion is well louvered for increased ventilation.

In the circuit

The horizontal output tube in the CTC 15 is a 6JE6, a tube with a novar base and a separate suppressor grid connection. A positive voltage applied to the suppressor grid in uhf versions minimizes the possibility of high-frequency radiation that could interfere with uhf reception.

This voltage is critical. Best results are obtained in the 40-50-volt range. Below 30 volts, the snivets are still present. Above 70 volts, the efficiency of the tube is impaired somewhat.

In the vhf chassis, the vertical output cathode is returned to ground through 3,900 ohms. In the uhf chassis, the resistor is removed and replaced by two series resistors of 2,200 and 1,800 ohms with the 1,800 ohm resistor connected to ground. The junction of these two resistors provide the necessary suppressor grid voltage at low impedance.

The 6JE6 has higher power sensitivity than previous horizontal output tubes and runs cooler. The socket for this tube is mounted on a raised portion of the chassis which provides additional ventilation by a "chimney" effect (Fig. 1). The tube operates almost 40°C below its maximum allowable operating temperature.

*Product Performance, RCA Sales Corp., Indianapolis, Ind.
Another circuit refinement in the CTC 15 is the high-voltage regulation system (Fig. 4).

In addition to the usual shunt regulator circuit, the CTC 15 has a connection between the third video amplifier plate circuit and the shunt regulator grid. Normally, white areas of the picture load the high-voltage supply because of the additional beam current drawn by the picture tube. To compensate for this, video of the same polarity as appears at the picture-tube cathodes is coupled to the shunt regulator grid through a 12-megohm resistor. This tends to keep the high voltage at the same level when large white areas are displayed on the picture tube. The long time constant formed by the 12-megohm resistor and the 0.1-µf capacitor in the regulator grid circuit insures that only long-term video variations are coupled to the shunt regulator.

Another refinement in the CTC 15 is the video peaking switch (S103), mounted on the rear chassis apron. Three positions of the switch permit selecting three degrees of video peaking (Fig. 5).

The peaking switch is in the contrast control circuit in the cathode of the third video amplifier. It has maximum effect when the contrast control is near the three-quarters clockwise position. The peaking results in better transient response and sharper transition from black to white.

In Fig. 5, the upper position gives highest peaking. The combination of R720, C750 and C716 is connected (through points 1 and 2 of the switch) across the contrast control, and C125 is connected (through points 7 and 8) to the tap of the contrast control. In the middle position of the switch, C125 is out of the circuit (points 7–8 are open), and only the resistor–capacitor combination is connected. In the lowest position (least peaking), that combination is also out, leaving only the contrast control and C124-d in the circuit.

Color circuits

Complementing the high detail of the black-and-white picture, the CTC 15 produces higher color definition also. This is achieved largely by the same circuit refinements that improve the black-and-white picture, since the picture detector and first video amplifier are common to both black-and-white and color information. Additional peaking of the G–Y signal further enhances color performance (Fig. 6).

The picture-tube bias switch (Fig. 7) is provided on the CTC 15 to adjust for differences in picture tube characteristics. This three-position slide switch selects three values of plate load resist-

Fig. 2—Solid-state focus rectifier simplifies circuit and generates less heat than tube.

Fig. 3—Diode boost adder provides "boosted boost" level for vertical output and CRT screens.

Other novar-base tubes employed in the CTC 15 include the vertical oscillator-output tube, a 6GF7, and the damper, the 6DW4.

Another circuit arrangement for reliability and heat reduction is the use of a solid-state focus rectifier (Fig. 2). It has extremely long life and, since no filament voltage is required, there is less loading on the high-voltage transformer and less heat.

One of the most noteworthy features of the CTC 15 is its high picture detail. A very sharp raster is produced by operating the picture-tube screen circuits at a higher positive voltage than in previous chassis.

A new adder circuit, shown in Fig. 3, supplies to the picture-tube screens the higher voltages essential for the smaller spot size and the sharper raster. The 500-volt pulse produced by the collapsing field of the horizontal output transformer during flyback time is applied to CR101, the "boost diode adder", and effectively added to the normal B-plus boost of 800 volts. The higher "boosted boost" voltage of 1,200 is used for the vertical oscillator. A voltage divider derives the 1,100 volts for the picture-tube screens.

Fig. 4—Tie-in from vertical stage helps high-voltage regulator adjust to heavy current drain during "white" picture portions.

Fig. 5—Three degrees of peaking adjust picture to customers' tastes.

Fig. 6—Color amplifiers are very similar to CTC 12's. Note new tube type 6GU7 and extra peaking coil in G–Y amplifier.
and-white tracking over the entire usable brightness range.

Converging the CTC 15 is also simple. The effects of each convergence control are easily identified when you watch a dot or cross-hatch pattern. The entire top row of controls is adjusted by watching horizontal lines of a cross-hatch pattern, and the entire second row by watching vertical lines on the pattern (Fig. 8). Blue vertical amplitude and tilt controls behave very much like the familiar height and linearity controls. And blue horizontal left and right controls influence the blue raster in their respective areas so that the proper setting is obvious.

Some of the sets using the CTC 15 chassis include RCA’s Wireless Wizard remote-control feature. This is an all-transistor ultrasonic system providing up-and-down control of tint, color and volume, channel selection, and a “full off” position.

The rf tuners used in the CTC 15 chassis vary according to the cabinet style. However, all tuners use a 6DS4 Nuvistor rf amplifier and a 6EA8 oscillator-mixer. All 1964 RCA vhf color receivers are adaptable to uhf with a field conversion kit. Factory-built uhf models are also available.

A low-voltage overload circuit breaker, easily reset by the set owner, eliminates the need for service calls because of harmless momentary surges.

Complete details of the CTC 15 chassis including specifications, setup procedures, alignment procedures and circuit diagrams are available in RCA Victor Service Data file number 1963 No. T6, published by the RCA Sales Corp., 600 N. Sherman Drive, Indianapolis, Ind.

DECEMBER, 1963

Fig. 7 (above) — Simplified schematic of switchable CRT bias, to compensate for different characteristics.

Fig. 8—The convergence controls and their effects on a crosshatch display.
In the Big Year For Color, the right test equipment is going to be more important than ever. As usual, your regular test equipment will take care of most jobs, but it'll be the specialized color equipment that'll make the difference. Here are photos and brief descriptions of the latest.

The "bar-dot-crosshatch-color bar" generator is going to be the "vtvm" of color service. Both key and rainbow and countdown types are crystal controlled for accuracy. They're a necessity for installations, and a big time-saver for home and bench service work. A scope can trace the easily-recognizable color-bar signal through all color circuits, making this job a lot easier. By showing the customer "colors", you won't have to waste time waiting for a color program to come on!

**B & K Model 850 Color Analyst**

Produce dot patterns, crosshatch, vertical lines, horizontal lines, burst signal and individual colors for fast, easy receiver tests and adjustments. Crystal-controlled and produces NTSC type signals. Pattern to be displayed on screen is shown in viewer on front panel for visual comparison and quick and easy setup of color set.

Automatic deconvergence feature eliminates need for continual static convergence adjustments. Automatically deconverges a white dot into color-dot trio or white vertical or horizontal lines into red, green and blue parallel lines for rapid dynamic convergence adjustments. Has 15,750-cycle output jack for scope sweep during demodulator adjustments. Provides 4.5-mc sound signal for receiver tuning and sound-trap adjustments.

**Model 1074 Television Analyst**

A compact, lightweight version of the 1076. Useful for black-and-white and color TV servicing in the home or shop. Has 15,750-cycle output for scope sync. Tests yoke and output transformer for shorts, opens.

**Model 36-610 Color TV Test Pattern Generator**

A low-cost, lightweight instrument designed especially for color convergence adjustments in the home. Not a replacement for the more elaborate color pattern generators used for troubleshooting and bench work. Feeds video pattern signals direct to CRT.

**GC ELECTRONICS Model 36-610 Color TV Test Pattern Generator**

Color-gun killer switch disables any combination of the three color guns for fast purity and convergence checks without upsetting receiver's color controls. Bar and dot patterns locked in sync with signal from local TV sta-
HEATH

Model 1G-62 Color Bar and Dot Generator

Designed for linearity, color and convergence adjustments. Color bars produced by offset-carryer method may be used for phase, afc and matrix adjustment.

Specifications

- **Test patterns:** 582 small dots for static convergence, 21 vertical or 23 horizontal bars for dynamic convergence adjustments.
- **Power:** 117 volts, 50-60 cycles, 20 watts.
- **Size:** 13 in. wide x 81/2 high x 71/4 deep.
- **Weight:** 10 lb.
- **Price:** $39.95.

**Crosshatch:** Choice of 20 vertical or 15 horizontal bars or both (less those lines lost in blanking region). 300 dots per frame (less those lost in blanking region). Minimum size of dots and lines, 2 scanning lines.

**Rf output:** 0-125 volts, 60 cycles, 40 watts.

**Price:** $549.50.

Model 660 White Dot-Bar Color Display Generator

Similar to model 656XC, but designed for fast in-the-home servicing of TV color receivers. All color signals crystal-controlled.

Specifications

- **Test patterns:** Dots and crosshatch (see model 656XC).
- **Rf output:** Channels 2-6, modulated with choice of color signals.
- **Video output:** 0.4 volts p-p across 300 ohms, block positive or negative.
- **Burst output:** 1 volt p-p.
- **Test patterns:** Six crystal-controlled color bars. Dots and crosshatch (see 656XC).
- **Ratio of sync to video:** Variable 10% to 90%.
- **Burst output:** Video plus sync 2 volts.

**Price:** $345.00.

**Model 800 Color Bar-Dot Generator**

New pushbutton-operated, crystal-controlled instrument for purity, gray-scale, convergence and demodulator adjustments. Generates dot and crosshatch patterns, horizontal and vertical lines and eight individual color bars similar to NTSC specifications. Pushbuttons marked with pattern or color that will appear on CRT screen.

Gun-killer switch disables the color guns singly or in combination. A jack is provided for connecting a scope to view the waveform at each of the color grids.

Video signals without carrier are available with variable amplitude and polarity for signal tracing and injection.

Specifications

- **Rf impedance:** 300 ohms.
- **Rf output:** Channels 3, 4 and 5.
- **Video impedance:** 1,000 ohms.
- **Video output:** 0-1.25 volts; video plus sync 2 volts.
- **Test patterns:** Crosshatch, vertical and horizontal lines, dots and yellow, red, B-Y, magenta, blue, B-Y, cyan and green bars.

**Price:** $239.95.

**Model G-36 Color-Bar White-Dot Generator**

Paco

Specifications

- **Rf output:** Channels 2-6, 0.05 volt max .001 volt min.
- **Rf output:** 0.2 volts p-p across 300 ohms, black positive or negative.
- **Burst output:** 1 volt p-p.
- **Test patterns:** Six crystal-controlled color bars. Dots and crosshatch (see 656XC).
- **Ratio of sync to video:** Variable 10% to 90%.
- **Power:** 105-125 volts, 60 cycles, 40 watts.

**Price:** $245.00.

**Model 661 Chrom-Aligner**

A white-dot and crosshatch generator that generates individual NTSC 100% saturated color adjustments in the home.

Specifications

- **Rf output:** Channel 3 or 4.
- **Video output:** 0-1.5 volts p-p across 75 ohms.
- **Test patterns:** Dots and crosshatch (see model 656XC).

**Price:** $59.50.

**Model 656XC Color Bar/White Dot-Bar Generator**

Versatile generator producing the standard fully saturated NTSC color bar pattern and chroma alignment. Also provides a choice of: crosshatch (20 vertical and 15 horizontal lines), horizontal lines only, vertical lines only and a dot pattern. All color signals locked to 315-kc crystal oscillator. Sound carrier permits correct adjustment of receiver's local oscillator frequency.

Specifications

- **Rf output:** Channels 2-6, modulated with choice of color signals. Separate output from 3.58-mc burst oscillator.
- **Video output:** 0-0.2 volts p-p, open circuit, across 100 ohms with positive or negative output.
- **Test patterns:** 3 primaries, 3 complementaries, plus black-and-white. All standard alignment signals.

- **NTSC color signals:** (1). Yellow—chroma 13°—luminance 0.59. (2). Red—chroma 13°—luminance 0.39. (3). Magenta—chroma 13°—luminance 0.49. (4). Cyan—chroma 13°—luminance 0.39. (5). Black—chroma 13°—luminance 0.39.

**Price:** $94.95.

**Model E-450 Color Generator**

Displays 15 horizontal bars, 10 vertical bars or both in combination, and dot pattern for static and dynamic convergence. Ten color bars spaced at 30° intervals for checking and servicing color circuits in re-
ceiver. Provides white raster for color purity adjustments.

**SPECIFICATIONS**
- **RF output:** Prealigned on channel 3 with video carrier of about 20,000 µV and sound carrier (unmodulated) of about 2,000 µV. Tunable to channel 4.
- **Output impedance:** 300 ohms.
- **Test patterns:** Color bars, dots, cross-hatch, dots and white raster.
- **Powers:** 105-125 volts, 60 cycles, 55 watts.
- **Size:** 13 in. wide x 12 in. high x 6 deep.
- **Weight:** 13 lb.
- **Price:** $197.00

**CA122 Color Circuit Analyzer**
- **Manufacturer:** Precision Apparatus Co., 8000 Cooper Ave., Glendale 27, N. Y.
- **Weight:** 133/4 lb.
- **Size:** 131/2 in. wide x 10 in. high x 8 in. deep.
- **Power:** 105-125 volts, 60 cycles, 40 watts.
- **Output impedance:** 300 ohms.
- **RF output:** Preset to channel 3 with video carrier of about 20,000 µV and sound carrier (unmodulated) of about 2,000 µV. Tunable to channel 4.

**Crosshatch Generator**
- **Model:** WR-64A Color Bar/Dot
- **Manufacturer:** Precision Apparatus Co., 8000 Cooper Ave., Glendale 27, N. Y.
- **Price:** $189.95
- **Weight:** 12 lb.
- **Size:** 13 in. wide x 12 in. high x 8 in. deep.
- **Power:** 105-125 volts, 60 cycles, 60 watts.
- **Test patterns:** Color bars, vertical bars, horizontal bars, 10 vertical crosshatch bars, 9 vertical and 13 horizontal bars, white dots, crosshatch of 9 vertical and 13 horizontal bars.

**SENCORE**

**Model 434A Varidot White-Dot Gen.**
- **Manufacturer:** Sencore, Inc., 426 S. Westgate Dr., Addison, Ill.
- **Price:** $99.50
- **Weight:** 9 1/2 lb.
- **Size:** 14 in. wide x 9 1/2 in. high x 7 5/8 in. deep.
- **Audio signal:** 900 cycles, 3 volts p-p.
- **Rf output:** Channels 2-6 on fundamentals, 7-13 on harmonics.
- **Modulation or video output:** Y, chroma, standard NTSC color pattern, I, Q, Y, I, Q, R - Y, B - Y, I, Q, Y (90° phase), burst/sync.
- **Test patterns:** Red, yellow, green, cyan, white, magenta, blue, black. Color chroma phase accuracy ±3°.
- **RF output:** Preset to channel 3 or 5. Tunable to channel 3 or 5.
- **Output impedance:** 300 ohms.
- **Dots:** 10 Red, 12 Green, 12 Blue, 12 White.
- **Size:** 13/3 in. wide x 10 in. high x 6 deep.
- **Weight:** 13 lb.
- **Price:** $199.35

**RCA Electronic Components & Devices, 415 S. 5th St., Harrison, N. J.**

**SENCORE**

**Model 250 Color Convergence Dot Generator**
- **Manufacturer:** Simpson Electric Co., 5200 W. Kinzie St., Chicago 44, Ill.
- **Price:** $395.
- **Weight:** 21 lb.
- **Size:** 14 in. wide x 17 1/2 in. high x 19 1/4 in. deep.
- **Chroma attenuator:** Fixed -6, -15 db. Variable -15 to +5 db.
- **Dot Generator:** 14 vertical or 14 horizontal.
- **Dot size:** One line high and one line wide.
- **Dot height:** Variable from 0.2 to 0.8 mil.
- **Dot width:** Variable from 0.2 to 0.8 mil.
- **Output impedance:** 300 ohms.
- **RF output:** Channels 2-6 on fundamentals, 7-13 on harmonics.
- **Modulation or video output:** Y, chroma, standard NTSC color pattern, I, Q, Y, I, Q, R - Y, B - Y, I, Q, Y (90° phase), burst/sync.
- **Test patterns:** Red, yellow, green, cyan, white, magenta, blue, black. Color chroma phase accuracy ±3°.
- **RF output:** Preset to channel 3 or 5. Tunable to channel 3 or 5.
- **Output impedance:** 300 ohms.
- **Dots:** 10 Red, 12 Green, 12 Blue, 12 White.
- **Size:** 13/3 in. wide x 10 in. high x 6 deep.
- **Weight:** 13 lb.
- **Price:** $197.00

**CG126 Color Generator**
- **Manufacturer:** Sencore, Inc., 426 S. Westgate Dr., Addison, Ill.
- **Price:** $99.50
- **Weight:** 9 1/2 lb.
- **Size:** 14 in. wide x 9 1/2 in. high x 7 5/8 in. deep.
- **Audio signal:** 900 cycles, 3 volts p-p.
- **Rf output:** Channels 2-6 on fundamentals, 7-13 on harmonics.
- **Modulation or video output:** Y, chroma, standard NTSC color pattern, I, Q, Y, I, Q, R - Y, B - Y, I, Q, Y (90° phase), burst/sync.
- **Test patterns:** Red, yellow, green, cyan, white, magenta, blue, black. Color chroma phase accuracy ±3°.
- **RF output:** Preset to channel 2, but can be retuned to any channel 2-6.
- **Output impedance:** 300 ohms.
- **Dots:** 10 Red, 12 Green, 12 Blue, 12 White.
- **Size:** 13/3 in. wide x 10 in. high x 6 deep.
- **Weight:** 13 lb.
- **Price:** $197.00

**Winston Model 250 Color Convergence Dot Generator**
The service data will tell you what the correct current is. In this set, it's 215 ma. If this current is very low, but B-plus voltages are normal, the horizontal output tube is weak and will have to be replaced. Leave the meter in place until you get the new tube in and working. Always check this cathode current whenever the output tube is replaced, just to be sure. It takes only a little while, and it's a big help in avoiding a callback!

Regulator action can be checked at this same terminal strip. In other chassis, test-points will be provided. Normal cathode current on this tube, with high voltage set at the correct value, about 24-24.5 kv, should be about 0.9 ma. In this circuit, you can read the dc voltage across the 1,000-ohm resistor in series with the cathode. In others, the meter is hooked into the cathode circuit, and the resistor opened. Follow the procedure given in the service data for whatever set you're working on.

If the current is low or high, adjust something. If the high voltage has been set at the rated value, and the current's too low, reset the horizontal efficiency coil (horizontal linearity) to bring it up. The horizontal-output tube's cathode-current meter should still be in the cir-

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Fig. 1—High-voltage regulation circuit can have some critical values. Regulation depends on voltage divider in grid circuit of 6BK4.

the regulator tube opens up, or isn't working, the high-voltage will go up, since there will be no control on it at all.

In these flashovers, it is not the high voltage that is doing the arcing; it's usually the boost. In color circuits, this runs about 800 volts. The 6BK4's plate is connected directly to the 25-kv line (Fig. 1). It usually draws a preset amount of plate current, thus shunting the high voltage. The more plate current this tube draws, the lower the high voltage, because the tube acts as a shunt-load across it.

Now, we have to have a "signal" voltage on the grid, to tell the tube when to draw more current. This is the boost voltage. The total boost is fed to a voltage divider, and the regulator grid is tapped off that. B-plus goes to the cathode. If something happens (say, an increase in line voltage) the boost rises (goes more positive). This increases the positive voltage on the grid of the 6BK4, and it draws more plate current, reducing the high voltage because it makes more load across it. Simple, huh?

Now, in some sets (for instance the Zenith 25LC20 chassis), they have thoughtfully provided a spark gap in this circuit. This is just one of the regular solder-terminal boards used on these and several other makes—see Fig. 2. (This particular one is set close to the base of the 6BK4 tube, for obvious reasons.) Other terminals on the same board can be used to make tests; more on this in a minute.

Normally, flashovers should take place between 1 and 2 on this board. Most of the time, they will. However, in some cases, you'll see flashovers at the high voltage control on the back apron of the chassis. Because of the high voltage present, you'll find an arcing from the end of the resistance element to chassis. If this is allowed to go on too long, a carbon path will form, and you'll have to replace the control to avoid a rollback.

Most of these troubles start with a bad 6BK4. For example, if the heater burns out, we lose all regulation. This can cause a flashover, but if the air is pretty dry, you may see loss of focus, too much brightness, and similar symp-
cuit when this is done, of course, to keep the tube from getting too much current.

Check all resistors in the 6BK4 grid circuit. Since the two 1.5-megohm resistors and the high-voltage control form a voltage divider, they're pretty critical. An increase or decrease in any of them can throw the circuit beyond the range of the control. For a horrible example, if the upper resistor decreased in value, the 6BK4 grid would go highly positive. This would cause a great increase in its plate current, and the result could easily be a burned out 6BK4 and a melted-down flyback! So check 'em!

Vertical retrace lines

In a G-E color TV chassis CW, it looks to me as if the retrace lines are too prominent. Shouldn't they be well blanked, especially in a color set?—R. G., Donville, Ill.

Yes, indeed, as in all sets, color or black-and-white. In this particular chassis, try reducing the series resistance in the vertical blanking network. This will raise the amplitude of the blanking pulse. Also, check the capacitor for any small leakage, since this will tend to broaden the pulse and at the same time reduce its peak amplitude.

Fig. 3 shows the location of these parts.

Vertical blanking in this chassis is fed from the vertical output plate, pin 2 of the 6EM7, through a two-resistor network to the plate of the video output tube, the 12BY7A. Reduce the 100,000-ohm resistor in small steps until blanking is OK.

Bad color sync

In RCA CTC 5 chassis, I can't get any color sync; bars or program material just "run" all the time. Color seems to be pretty good—that is, it's bright enough, but no color lock action. Tubes and voltages all look pretty close.—M. G. A., Watkins Glen, N. Y.

Check the .022-µf bypass capacitor at the bottom of the grid winding on the burst keyer transformer. This is shunted across a 1-megohm resistor. If it opens up, the grid impedance rises and seems to cut off the burst amplifier tube. At any rate, no color sync, or very badly reduced color sync, gets through to the color circuits. Fig. 4 shows where this capacitor is located.

Bloomin' highlights

We're getting a bad blooming in the highlights on an RCA CTC 7 color chassis, and we can't seem to find a setting on the color temperature adjustments that will stop it. Voltages all seem to be normal, and we have plenty of high voltage.—D. G., Bronx, N. Y.

This is most likely due to too much current in the 6BK4 high-voltage regulator. Try adding about 470,000 ohms to the grid resistor. This is a 1.8-megohm 1-watt resistor between the 6BK4 grid and boost voltage (R133 in the RCA's 1957 T18 manual and R131 in Sams 399-3). See Fig. 5.

Check the 100-megohm resistor between grid and cathode of the 6BK4, also the 1.5-meg in series with the high-voltage adjust control. Be sure that the voltages on the regulator tube are OK, and check the current as specified in the instructions. This could also apply to any of several later chassis like the CTC 9, 10 and 11.

Weak picture and age

While I was checking a CTC 12 color TV for what looked like age trouble, all of a sudden I lost a lot of rf gain. Now my picture is weak, and the age doesn't have as much effect. I thought I smelled a resistor burning, but I can't find one! Tubes all substituted, no change in gain.—H. G., New York, N. Y.

You did smell a resistor! This is a little bit "wild", but you'll have to watch out for it, in this, in the CTC 15 chassis and in all sets (even black-and-white) using frame-grid tubes in the video if.

In this chassis, a 6EJ7 frame-grid tube is used as the last video if amplifier. If the age tube is pulled with the set on, this tube draws a very heavy plate current, because of the loss of bias. This overheats its plate dropping resistor, as shown in Fig. 6. These always seem to rise in value when this happens, cutting the plate voltage and, of course, the gain. Then you wind up with a weak picture.

So, always turn the set off when checking the age or first or second video if tubes.

Low brightness

I don't think the brightness is high enough in this RCA CTC 12, although it makes a pretty good picture. Can you suggest anything?—W. B., Huntsville, Ala.

You might check, and, if possible,

change the grid resistor of the third video amplifier tube, near the brightness.
control. This 330,000-ohm resistor is marked R158 in RCA's 1962 T7 service data, and R63 in Sams 640-3.

Try about 100,000 ohms here and see if it doesn't give you a bit more control over the brightness, and perhaps a little more total brightness. See Fig. 7.

**Insufficient vertical tilt**

I'm having trouble getting convergence on a CTC 10 color chassis. The worst thing seems to be a lack of range in the vertical tilt controls. The vertical amplitude could be OK, but I can't get enough tilt to cover the lines all the way down.-L. S., New York, N. Y.

This is probably due to low amplitude of the convergence waveform itself.

Fig. 8—Insufficient vertical tilt range can be fixed by moving ground on vertical output transformer.

This comes from the vertical output transformer, T104 in RCA's 1960 T5 service data.

Look at the transformer. If the green-black wire is grounded, change this ground to the black-red wire. This will give you a higher-amplitude waveform for application to the vertical convergence circuits, and should help out. Fig. 8 shows the change.

**Poor horizontal hold in CTC 9**

The horizontal hold action in this RCA color TV isn't very good. I get a pretty severe horizontal bend, and the picture isn't as stable horizontally as it should be. Tubes check OK and the voltages are almost normal. Grid voltage on pin 7 of the horizontal oscillator is low about -80 volts.—W. R., Okla.

Check some of the resistors around the horizontal oscillator and afc circuits.

Fig. 9—Check these parts in tracking down poor horizontal stability in CTC9.

I think you'll find that one of them has drifted pretty badly (Fig. 9). The most likely suspect with the voltage readings you have would be R114, the 270,000-ohm; R115, the 1-megohm, or R112, the 680,000-ohm. Don't try to read these in-circuit (too many parallel paths). Lift one end of each and measure, to be sure.

Check the 390-pf capacitor for leakage. Even a very small leak here will throw your oscillator far off frequency.

**Low brightness again**

I'm not satisfied with the brightness I'm getting in an Admiral 25UD6 color set. My high voltage and everything else seem to check out OK, but I'm afraid to take it back to the customer unless I can get more brightness.—P. S., Short Islands, Neb.

This is probably due to incorrect bias on the video amplifiers, which, in this circuitry (with the dc coupling), can control the brightness directly. Check

the voltage on the blanker grid, pin 2 of the 6CG7, V707B in Admiral's service data. If this is more than -150 volts, make the changes shown in Fig. 10 and you'll probably see some improvement. If we have too much negative bias on the second video amplifier grid, we reduce brightness.

**Poor definition**

We have an RCA CTC 12 chassis on the bench, and are not satisfied with the picture definition. While the picture is almost all right, it's one of those annoying things: we feel that it could be better! Any ideas?—F. S., Newark, N. J.

RCA's field engineers recommend changing the i.f. alignment curve on this chassis, from that shown in the original service data (Fig. 11-a). The "hay-

stack" curve doesn't seem to give the best picture definition.

Fig. 11-a—Original CTC 12 i.f. curve can be improved for better definition as in (b) below. The adjustments do interact, and it may be necessary to line up each transformer a couple of times.

Fig. 11-b shows the recommended curve. Set the first i.f., T302, to put the 45.75-mc marker at the 50% point on the left; the second i.f., T303, to get the 42.17-mc subcarrier marker at the 50% point on the right side, and the third i.f., T304, to get the proper tilt to the top of the curve.

These adjustments all interact as usual, but you can get the proper curve with careful alignment. Be sure to set the 45.0-mc markers and the 42.73-mc markers at 90%, as shown on left and right shoulders of the curve.
AN INCREASING NUMBER OF NON-BROADCAST COMMERCIAL STATIONS, and some amateur stations, frequently get little
When detected by the FCC monitor, will repeated delays of an hour or so, if and utes more is technically a violation, and means, in general, that a slight delay is soon thereafter as convenient." This classes of stations, call letters must be announcement reminder and alarm
This article describes an automatic announcement reminder and alarm that will help end this problem. It turns on a blinking reminder light every 10 minutes, and keeps it on until a release button is pressed. If the release is not pressed within 45 seconds, a buzzer goes off and stays on until the release is pressed. Although operators do not love "the %"!:!: devil box," it effectively eliminates troubles caused by "forgetting to sign."
The unit consists of a repeating timer, an alarm lamp, a buzzer and an assortment of relays, indicators and power supplies. All components fit into a standard 5 × 6 × 9-inch utility case. The circuit is straightforward (Fig. 1). Power supplied by the line operates the 10-minute repeating timer continuously.
Every 10 minutes, a microswitch cam follower is actuated, energizing a self-holding relay. This, in turn, switches off the operating (power) pilot, energizes a flasher circuit and the reminder lamp. It also energizes the heater of a 45-second thermal time delay. If the operator presses the reset button before 45 seconds have elapsed, the self-holding relay releases, the reminder lamp goes out and the operating pilot is re-energized. If, however, the operator is busy, negligent or asleep, the thermal time delay switches on a buzzer which operates until the reset button is pressed.
At first glance the buzzer circuit appears somewhat nonstandard, and seems to contain a lot of unnecessary components. Because the contacts of the thermal time delay used do not snap closed, they are backed up with a small double-pole relay, so no energy reaches the buzzer until the circuit is permanently complete. Because the rectified ac buzzer supply has poor regulation, the buzzer is shunted by a Zener diode, which stabilizes the applied voltage and prevents "yooping." Buzzer tone is lowered to prevent confusion with other annunciators by soldering a loading weight onto the armature. Rf output of the circuit is minimized by shunting a
.02-nf disc ceramic capacitor across its contacts.

The reminder lamp is housed in a meter case, which facilitates mounting, placement of the legend and arrangement of the light diffusers. Details of the lamp housing are shown in Fig. 2. The legend “Announce Call Letters and Time” is a film negative in which the letters are transparent. Reminder lamp and thermal flasher are operated from a separate low-voltage transformer.

**How to build it**

Construction of this announcement reminder is fairly simple and noncritical, as neither high frequencies nor high voltages are involved. The chassis is a 5 x 7 x 2-inch unit, which exactly fits the case. All power connections are brought out to the rear. The photos show the parts layout. Other arrangements can be used, but be sure to arrange components so the relay contacts, timer cams, etc. are easily accessible for cleaning and adjustment. Also, bolt all components firmly in place, using lock washers, to prevent loosening in service and trouble.

To prevent connection pileups and to firm up the wiring, tie points are used at strategic locations, and wiring is cabled. Leave enough slack so that any component can be demounted and swung out of position for testing or servicing without disconnecting it. Bolt the buzzer firmly to the end of the chassis so it will resonate, enhancing the tone and volume. Use insulated sleeving liberally to protect and isolate the various terminals and connections. Use grommets in all chassis holes to prevent abrasion of insulation and resultant shorts to chassis.

Labels indicate the function of each control and exposed component, and the proper replacement information for those likely to fail (fuse, pilot lamps) is cemented to front and rear panels.

Operation is simple. Place the unit in a convenient location and turn it on. Every 10 minutes, the reminder light starts flashing. At the first transmission break after the operator observes the light, he announces the station call and time, and presses the reset button, which extinguishes the light until the next announcement interval comes up. If the operator disregards the light, the buzzer sounds 45 seconds after the light starts flashing, and stays on until he presses the reset button.

Servicing and maintenance are minimized as all components except the power pilot have a rated service life of more than 10,000 hours. Life of the power pilot is extended by using a series resistor so it has to be replaced about every 2,500 hours. Life of the reminder lamp (G-E 88) in flasher service is problematical. The only one tested lasted more than 20,000 hours, which is far in excess of the manufacturer’s continuous service rating.

If you have a problem with forgetting to sign, this automatic reminder and alarm, or any one of a number of rather obvious modifications of it, should solve the problem and effectively shut off the flow of pink tickets. END
If I were asked to name the two pioneers in corner-sounder development, my reply would be: the two Pauls. Paul Klipsch in the US and Paul Voigt in the UK. It is now about 30 years since I first heard the Voigt corner horn, and the famous Klipschorn was fully described in a 1946 issue of the Journal of the Acoustical Society of America.

My own efforts to corner the speaker market began, so to speak, in 1948, when we built our first 9-cubic-foot brick corner enclosure at a cost of 35 shillings — (say five dollars in real money). I can honestly say that the structure is as sound today as it was then.

The corner horn designs were very efficient and would give ample domestic volume level with a 5-watt amplifier. But it has been found to be much cheaper to increase amplifier output than to concentrate on speaker efficiency, although I still favor high flux density for good transient response. Then stereo records in 1958 showed that two speakers produced more bass than one of the same size, and the large corner systems suffered a decline in popularity.

But it is still true that for optimum bass the corner is the best position in the average room, and — provided room shape is oblong rather than square — two corners at a narrow end usually give the best stereo.

The fact that two small corner cabinets can look very attractive and quite unobtrusive in a nicely furnished room is illustrated by a photograph taken from my recently published book More About Loudspeakers.

Britain’s top authority on speakers says “corner position is best,” shows how to build one that looks and sounds good from my recently published book More About Loudspeakers.

In this case, the lady of the house wanted to have the speakers in the corners, but limited to a height of 30 inches because of other furniture (hence the shortened legs).

There could well be a revival of interest in corner positions and the editor of this journal has invited me to give full details of the model referred to, so here we go:

The main considerations are these:

1. The corner speaker plays into the longest air path in the room and reflections from two walls and floor help the low-frequency radiation.
2. As the enclosure shown is only 2 cubic feet in volume, the bass assistance from No. 1 is an advantage.
3. Diagonal facing is generally best for stereo in the average room, and distances of 8 to 12 feet between speakers are satisfactory with room lengths proportionately longer.
4. The cabinets can be placed a few inches out from the corner if there is too much bass resonance, or to reduce the distance between them for natural stereo.
5. The triangular shape is good acoustically because the only two reflecting parallel surfaces are the base and top.

---

**Speaker Types**

<table>
<thead>
<tr>
<th>Wharfedale Model No.</th>
<th>Nominal size (inches)</th>
<th>Resonance (cycles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Super 8/RS/DD</td>
<td>8</td>
<td>50-60</td>
</tr>
<tr>
<td>Super 10/RS/DD</td>
<td>10</td>
<td>38-43</td>
</tr>
<tr>
<td>Super 12/RS/DD</td>
<td>12</td>
<td>25-32</td>
</tr>
</tbody>
</table>

RS = Roll Surround; DD = Double Diaphragm
DIMENSIONS and ASSEMBLY

Material: 3/4-inch plywood or chipboard (chipboard better acoustically but harder to cut). 1-inch lining of absorbent wadding (glass wool, ozite, etc.).

Volume: 2 cu. ft.

Weight: approx. 30 lb without speaker.

Front panel: 27 1/2 x 26 1/8 in., beveled 2 sides at 45°.

Backs: One 26 3/4 x 16 3/4 in.
One 26 3/4 x 17 3/4 in.
Both beveled on one long edge at 45°. Drill 4 holes for screwing to front panel.

Top: 18 3/4 x 18 3/4 x 26 3/4 in. Front edge veneered or covered with strip of solid wood.

Base: 17 3/4 x 17 3/4 x 26 3/4 in. Vent opening as in Fig. 1.

Duct: 3/8-in. plywood 17 x 7 1/2, beveled on 2 edges 45° to fit to backs. (For 10- and 12-inch speakers only.)

Glue blocks, etc.: 2 long corner blocks for holding front panel to sides; cut diagonally from 1 piece 26 3/4 long x 1 1/2 in. sq. One rail for fixing front panel to base: 19 3/4 long x 5/8 in. sq. Two rails for fixing top: 13 1/2 long x 5/8 in. sq. White pine.

Assembly: Glue and screw backs together at right angles (butt joint—see Fig. 1). Glue and screw base in position. Glue top to fit flush with sides.

Legs: Suitable 6-inch legs can be bought and fitted without difficulty. Set rear as close to vent as possible.

which are small in area and farthest apart.

Construction details

The drawing of Fig. 1 shows the overall dimensions of the cabinet, and the photograph gives an inside view with 12-inch unit and absorbent material fixed in position.

The details in the "Dimensions and Assembly" box will help in constructing the cabinet, which must be firmly glued and screwed together to provide an airtight enclosure, apart from the vent near the back. The last assembly job is to screw the front panel in position.

To facilitate lifting, two hand holes 3 1/2 x 1 inch can be made, one in each back panel 4 1/2 inches from the top and 4 1/2 inches from the front. The openings must be covered with a piece of plywood on the inside to make them airtight.

Damping materials

The material shown in the cabinet interior photo is bonded acetate fiber in sheet form. Other suitable absorbents are glass fiber and cotton wool. Completely filling the corner cabinet with absorbents improves the reproduction of speech but takes some of the warmth out of music.

As a rule, the amount of absorbent treatment can be reduced when smaller speakers are used, because less internal resonance is heard through the cone.

Speakers

This enclosure gives very good results with wide-range single speakers, 8, 10 or 12 inches, provided the open baffle resonance is not higher than specified with the test units. The long, ducted vent suits both the 10- and 12-inch types, but for 8-inch units the simple open vent is best.

Reasonable response down to 40 cycles is possible, but the larger units will obviously give bigger and better low-frequency output from cone and vent.

All that remains is to fasten the front panel in place. Note how padding covers all interior except back of panel. Though speaker is 12-inch model, duct is shown in this photo.
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The tests of Fig. 2 indicate the performance at 40 and 90 cycles, using the Wharfedale speakers listed in the table. These are available in the USA. The oscillograms were taken with the microphone close to the cone and also close to vent opening. The input level was set as high as possible at 40 cycles without running into noticeable distortion. The power ratings are in rms watts. (The figures would be doubled for peak watts.) Separate tests were made for vent output. As expected, there is less distortion here as the power is increased than there is at the output direct from the cone. This is one of the benefits of reflex loading.

Finished appearance

We now come to that hi-fi department to which it is usually necessary to admit the ladies. If I take a speaker cabinet home and my wife says she does not like its appearance, I tell her to close her eyes and listen to it, but few men could get away with this sort of behavior in England (and possibly fewer in the US).

The two cabinets shown in the Ilkley photograph were fitted with a veneered plywood frame (1/8 inch thick) after the grille cloth had been fixed to the front panel, but this needs some skill to avoid the use of panel pins to hold the frame in position. We therefore tried a simpler method. The two side edges of the front panel were rounded off slightly with a plane to avoid sharp corners, and the grille cloth was taken round the edges and fixed at rear of panel with glue and staples.

Should any American readers try this design and assemble a cabinet, I hope the Mrs. American Readers will approve.

In conclusion, I should like to acknowledge the help I have had from our technical manager, Mr. K. F. Russell, A.M.I.E.E., and his assistant, Mr. W. Jamieson, who have done all the experimental work and testing involved in the production of this compact corner speaker system, well suited to the home constructor.
The meter being calibrated from a dc millivolt source. If your vtvm or vom is accurate, rig up a 2-volt or 20-volt dc source with a 100:1 or 1,000:1 resistive divider to calibrate the millivoltmeter.

**A HYBRID DC MILLIVOLTMETER**

Nuvistor-transistor meter finds use in many labs. Reads 20 mv full scale  **By BERT J. HILL***

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The instrument consists of two nuvistors in a balanced input circuit whose output feeds a single p-n-p transistor in a common emitter configuration. Self-contained batteries power the unit.

Nuvistors were chosen for their low drain, stability and low-voltage operation. The triodes tested were the 6CW4 and the industrial version, the 7586. The 7586 performed better.

The circuit is shown in the diagram. The input signal is fed to the grid of V1 which, in conjunction with V2, forms the usual balanced input stage. This circuit is often used to minimize the effects of voltage supply changes, temperature variations, etc. The 90-volt battery (batt 2) supplies plate voltage for both nuvistors. The 1,000-ohm balance potentiometer (R6) is used to...
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**The circuit of the millivoltmeter. Familiar dc vtm bridge is augmented by high-gain transistor amplifier stage.**

The 6-volt battery (batt 1) powers the transistor stage as well as the nuvistor heaters. The unit functioned well with the 6-volt battery, but I got less drift and better stability after warmup with a 4.5-volt battery as batt 1. In addition, the current drain decreased by about 40 ma, increasing battery life.

Linearity was excellent and there was no trouble in calibration. Drift is negligible for short-term measurements, but reverting is required for repeat longer-term measurements. This is no disadvantage as long as you make simple nonrecording voltage readings.

The input resistance is more than 4 megohms—practically no load to low-voltage dc sources such as thermocouples, electrodes used in pH measurements, or biological potential sources.

This instrument, while not designed to compare with expensive chopper-stabilized microvoltmeters, certainly gives us a simple unit for measuring dc millivolts effectively. It has proved its value in general laboratory work on more than one occasion.

---

**Couplers May Kill Color**

In many cases the color set does not supersede the old black-and-white receiver, but makes the home into which it comes a two-set household. If the two sets are used with a TV coupler, it is necessary to be sure that the coupler is one that will pass color. If two black-and-white sets are already in use in the household, the color coupler may be an old type which may "suck out" the 3.58-mc frequency on which color depends.

In any case, where a coupler or dual outlet booster is used and there is trouble with color but not with black-and-white, try the color set on the antenna alone without a coupler before deciding that the trouble is somewhere inside the set or in the antenna.
Peewee Attacks Radio

Can a 5-lug oscillator coil with an open winding be the trouble? Peewee thinks so.

“WHAT ABOUT THIS RADIO?” I asked Peewee, my diminutive assistant. It was a five-tube ac-de job that had been sitting on the bench with its innards exposed for 2 or 3 days.

“It’s got a bad oscillator coil,” he replied. “I’ve been meaning to tell you, so you could order a new one.”

“We have a lot of universal oscillator coils. Why can’t you use one of them?”

“Well, this one’s sorta special. It has five terminals.”

“Five terminals?” I questioned. “One of ‘em must be a tie point.”

“Nope,” he declared, “I looked. There is a lead going into the coil from each terminal.”

“Oh, I begin to understand. You cut your repair teeth on TV. I’d forgotten that you’re not up on radio repair— it is a lot more complicated.” Peewee must have noted the sarcasm in my voice. He asked, “Just what do you mean by that?”

“First, let me ask you a question. Just how did you come to the conclusion that the oscillator coil was defective?”

“Well,” Peewee began, “I checked the 12BE6 oscillator—mixer and all the voltages. Then I decided to check the oscillator coil with the ohmmeter. That’s when I found it.”

“Found what?” I asked.

“The open winding. One of the windings wasn’t connected to any other terminal on the coil.”

“Did you say the voltages on the 12BE6 were OK?” I asked. “What about pin 1, the oscillator grid?”

“It was 6 or 8 volts negative, as I recall,” said Peewee.

“Then it’s obvious that the oscillator was working.”

“Yeah, I thought so too, maybe, but with that winding open I figured it must be off frequency or something.”

I looked at the coil connections before answering. “You know how this coil came out?”

“If you mean, can I hook it back up, the answer is yes. I made a drawing here on this scratch pad.”

Hook it up again

“Well, then, get it hooked back up. I want to check this set myself. I’m tired of it cluttering up the bench.”

“But . . . ,” he began.

“No buts,” I interrupted. “Put it back!”

He did. In 15 minutes he was through. “Well, there it is,” Peewee muttered unhappily.

“Fine. Turn the set on.”

There appeared to be no stations but there was an unusual amount of noise, very similar to atmospheric static.

“How do you know?” Peewee asked.

“Well, that’s pretty simple. Listen. Hear that station? Recognize the announcer?”

“Sure.” He nodded. “That’s Joe Slattery on KWTO.”

“Look at the dial,” I said.

“I’ll be darned!” exclaimed Peewee. “Right on 560. Just where should it be?”

“So?”

“So, like you say, t’aint the oscillator stage, I reckon,” I stated.

“I reckon not,” I gibed.

“Well, then, what is the trouble?” he wanted to know.

“I’m not certain,” I said, “but I’ll bet a milkshake that we have a bad i.f. transformer.”

“How come you think so?”

“Mainly the staticlike noise. I’ve run into this trouble a jillion times before, and because it doesn’t look like rain, I’ll bet I win the milkshake.”

“OK,” Peewee said. “I’ll go along. It’ll be worth the milkshake to get you off my back. How do we tell for sure if it is an i.f.?”

(Continued on page 68)
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DECEMBER, 1963

67
Fig. 1-Leakage between the i.f. windings caused positive voltage on the detector plate, pin 5 of the 12AV6.

And the audio stages?

"Couldn't it be further on—in the audio stages?" asked Peewee.

"Well, yes it could be," I agreed. "I'm glad you're thinking, for a change. But we can eliminate that possibility. See—when I turn the volume down, the noise is gone. The trouble has to be located before the first audio tube. Right?"

"Seems that way," he agreed.

We pulled the 12BA6 i.f. amplifier. The static noise continued.

"Now," I said, "for the final check. Lemme have the vtvm again."

"What range?" Peewee asked, with his hand on the function switch.

"Any low range. Just so it's dc and positive," I answered. "Now take the probe and touch it to the diode plate terminal of the 12AV6 socket. The one connected to the second i.f."

He did. "It's about 0.5 volt positive."


"Then I guess we trapped our culprit—the second i.f. transformer."

"What's it doing?" he asked. "Leaking between windings?"

"Well, that's about it," I agreed. "Actually, this type of small i.f. usually breaks down between the fixed capacitors that are connected across the windings. The capacitors are molded in plastic at the bottom of the i.f. The connecting lugs are extensions of the capacitor plates. Anyway, the leakage is from the primary to the secondary."

"Do the capacitors short, or what?"

"Very seldom," I replied. "The leakage is usually in the megohms. Most likely caused by moisture or dirt collections."

Fig. 2—The converter circuit with 5-lug oscillator coil that threw Peewee for a loss.

And when you tie a positive voltage to a diode plate—what happens?"

"It'll conduct."

"Right. And a conducting diode has very little resistance. So most of the positive voltage is shunted to ground—especially since the leakage in the transformer is a high resistance. When we pulled the tube, the shunt was removed, and the voltage rose tremendously."

"But what if it had been the first i.f. transformer?"

"Same thing holds true," I said. "The grid of the 12BA6 would act as a diode and shunt the positive voltage to ground."

"Isn't the voltage always negative at these points?"

"Right," I agreed.

"Then if there was any positive voltage at all on the 12BA6 grid or the detector diode plate—we could be pretty sure that the i.f. is bad?"

"Well, at least we would know we had trouble and just about where it is—so it wouldn't be too hard to find. The sure-fire way to find a leaky i.f. is to disconnect all wires from the secondary winding and check for any positive voltage on the secondary with a vtvm. With practice, though, simply pulling the tube and measuring the voltage is sufficient. Partially open windings can be spotted with a quick resistance check."

"Does a defective i.f. always make this noise?"

"Certainly not. Although I'd say about 70% to 80% do. But the set invariably has low sensitivity."

"I'm ready to buy the milkshake if you'll explain the oscillator coil," he said. "How come it's working with an open winding?"

"Elementary, my dear Peewee," I said condescendingly. "That's how it's made."

"You mean they make it with an open winding?"

"Yep. If you ever bothered to glance at the schematic (Fig. 2), you'd see."

He looked and it was there. A winding with an open end tied to the oscillator grid.

"It's a gimmick," I said. "That capacitance couples the feedback voltage to the oscillator grid. It's cheaper for the manufacturer than the separate capacitor it replaces."

Peewee was appalled. "You're darn right it's a gimmick," he said. I could see he was serious.

END
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What's the impedance?

Actually, a lattice section is just a fancy way of drawing a common bridge circuit. If the first lattice section is redrawn as a bridge, it is seen that since the bridge of the first section is balanced, all subsequent sections have no effect. So the total impedance is 2 ohms.

Complex Black Box

Since the current through the 100-ohm resistor is 1 ampere, that must also be the current through the black box. Therefore, the black-box impedance is 100 ohms. The impedance of the circuit, containing both the resistor and the black box, is 150 ohms. Since the first guess is that the object in the black box is a complex impedance, an inductance or capacitance (probably the former), we can say:

\[ 100 = \sqrt{R^2 + X^2} \]  

(for black box alone)

\[ 150 = \sqrt{(R + 100)^2 + X^2} \]  

(for whole circuit)

With these two simultaneous equations, we find that \( R = 12.5 \) ohms and \( X = 99.2 \) ohms. The impedance could be an inductor or capacitor, but from the ratio of resistance to reactance, it would seem reasonable that we have a coil with a reactance of 100 ohms and a resistance of 5.5 ohms. The supply voltage is, of course, sine-wave ac.

Mixed-up Currents?

The 100-ohm resistors make up a perfectly balanced bridge circuit. As a result, the resistors provide a load for the ac generator and the battery, while simultaneously preventing the flow of current between the two sources. No dc flows through the ac ammeter, and no ac through the dc ammeter.
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Part 3: Sound and Lamp Troubles

By Jack Darr
Service Editor

Last month we learned a bit about how projectors work, how to thread and run them, and how to make some adjustments. This time, we'll examine the electronics peculiar to movie projectors and talk about some of the more common electrical and mechanical troubles.

Disassembly for servicing

Fig. 1 shows a projector partly disassembled to allow the amplifier to be removed. Here, the amplifier chassis is vertical, with bolts holding the top, while the bottom end of the chassis sits on a spring-loaded metal plate, to provide a little shock mounting. Screws through the bottom of the case hold the projector unit. The plugs connecting the exciter lamp and input power can be seen. At the right bottom side of the amplifier are the coaxial cable and Amphenol plug used to connect the phototube, which is on the projector chassis in this machine.

Fig. 2 shows the bottom of a different projector. The four outside screws are removed to let the amplifier chassis slip down and out. In this model, the entire amplifier chassis is inside the projector housing. The inner screws allow the bottom shield to be removed (Fig. 3). Fig. 4 is a top view of the amplifier. Notice the large phototube mounted on the right end of the amplifier chassis. The beam of light from the exciter lamp is reflected onto the tube by a mirror inside the sound-head drum.

Amplifier servicing

The amplifiers used in these projectors are "conventional" (much as I dislike that word) after you get past the phototube input. Power output runs 7–10 watts for the ac-powered amplifier of Fig. 4, and 3–5 watts for the ac/dc amplifier of Fig. 1. There is one other novel feature, the method of lighting the exciter lamp, which we'll get to in a minute.

Phototubes used in the older models are mostly 923's, a four-pin type, seen in Fig. 4. This has been replaced in many circuits by the newer 930. Some machines use the smaller three-pin 927.
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Checking photocell inputs

There is a good "quick-check" for sound troubles: simply turn the amplifier on and shine the beam of a penlight on the sound head, so that some of the light can get through the slot to the photocell at right front corner.

Checking for weak sound

The first thing that must be checked on a complaint of weak sound is the alignment of the various parts of the sound head. Exciter lamps often have shields with holes in them. If the hole is turned so that its edge is partially blocking the light, the volume will be reduced. If the tiny slot in the sound head is full
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of lint, the same thing happens. Phototubes, too, are sometimes shielded by a round metal cover, with one small hole for the light. If this has been removed and replaced improperly, the light may be partially blocked. Always check all of these things before tearing into the amplifier!

Also, most projectors have a microphone input jack. (One can be seen on the control panel in Fig. 4.) Plug a mike in and check for volume. While it seldom happens, phototubes can weaken. So if the mike input shows ample volume, but film sound is weak, try a new phototube.

Some projectors use the brilliance of the exciter lamp as a volume control. The more light, the higher the volume. With this "volume control" turned all the way down, the exciter lamp is out. This has caused the replacement of quite a few perfectly good exciter lamps!

By threading the light-colored semi-opaque "leader" of a film into the machine, you can get a good check of the focus and position of the spot of light on the film. The lens and slot should always make a clean, sharply defined bar of light on the film, not just a blur. The slot can be cleaned with an old toothbrush.

Exciter lamp and power supply

The exciter lamps used in these machines resemble automotive types, but have a longer bulb. Filament voltages between 4 and 6 are common, at fairly low direct currents (ac would cause hum).

In one circuit, the exciter lamp is simply tapped across the last few volts in the B-plus (Fig. 6).

Another circuit, used in a very popular make of projector for many years now, uses an ultrasonic oscillator for lighting the exciter lamp. This circuit uses the same type tube as those in the power output stage. Notice the three 6V6’s on the amplifier in Fig. 4? One of these is the oscillator. Fig 7 shows the oscillator transformer. The circuit of

6V6-GT

OSC TRANS EXCITER LAMP

Fig. 8—Exciter lamp oscillator.

this is shown in Fig. 8. The frequency is around 20–30 ke, but isn’t too important as long as it is above audibility.

Incidentally, if the exciter lamp refuses to light, and all the tubes check good, try swapping the 6V6’s around! We’ve found a few that didn’t want to oscillate, but worked perfectly in the amplifier stages. TO BE CONTINUED
Sorptive surface. It is a measure of sound absorption, the number of code elements transmitted used by telegraph engineers. It represents instead (see question 10).

The oersted is now used unit of magnetic induction -1 maxwell per square centimeter. Before 1932, it was used equal to .0795 ampere turn per cm. An erg is also equal to 10' Joule or to of second. An erg is the work done by a force to accelerate a1 gram mass 1 centimeter per second unit of force. It is the force that will 0.7376 x 10' foot-pounds.

A myriavor is simply 10,000 watts or 10 kw.

A weber, as you may have guessed by now, is also a unit of magnetic flux. It is a very large unit, 10" maxwells (or lines), and a more practical measure to use in calculations.

A dyne is the centimeter-gram-second unit of force. It is the force that will accelerate a 1-gram mass 1 centimeter per second. An erg is the work done by a force of 1 dyne acting through a distance of 1 cm. An erg is also equal to 10" Joule or to 0.7376 x 10" foot-pounds.

Back to the magnetic field to find that an oersted is the same as a gilbert per centimeter, a measure of magnetizing force, equal to .0795 ampere turn per cm.

This could be tricky. A gottas is a unit of magnetic induction—1 maxwell per square centimeter. Before 1932, it was used as a unit of magnetic field intensity, a meaning now obsolete. The oersted is now used instead (see question 10).

A baud is a unit of signaling speed used by telegraph engineers. It represents the number of code elements transmitted per second.

A sabin is something for hi-fi fans. It is a measure of sound absorption, the absorption of 1 square foot of perfectly absorptive surface.

Answers to the “Units” Quiz

1. A volt is the difference in potential between two points of a conductor carrying a constant current of 1 ampere when the power dissipated between the points is 1 watt. But you can call it right if you said that it is the potential required to give 1 ampere current in a resistance of 1 ohm.

2. An ampere is defined as that current which, if maintained through two parallel wires of infinite length 1 meter apart in a vacuum, causes a force between the wires of 2 x 10^-7 newton per meter of length. A more practical definition says the ampere is the current which, from a carefully specified solution of silver nitrate, deposits .001118 gram of silver per second.

3. We can now say that an ohm is defined by the current from a 1-volt source, but such a definition would be circular, because of our “volt” definition above. An ohm is the resistance of a column of mercury at 0°C, 14.4521 grams in mass, of a constant cross-section and 106.300 cm long.

4. A maxwell is a measure of magnetic flux, and defined by the answer to No. 8, or you can say it is the magnetic flux giving a density of one line of force per unit area (cm').

5. A gilbert is a measure of magnetomotive force equal to the magnetomotive force produced by 0.7958 ampere-turn (ampere in one turn).

6. A joule is a unit of work or energy equal to 0.2389 gramcalorie, or the heat required to raise 0.2389 gram of water at 4°C 1°C in temperature.

7. A myriavor is simply 10,000 watts or 10 kw.

8. A weber, as you may have guessed by now, is also a unit of magnetic flux. It is a very large unit, 10" maxwells (or lines), and a more practical measure to use in calculations.

9. The dyne is the centimeter-gram-second unit of force. It is the force that will accelerate a 1-gram mass 1 centimeter per second. An erg is the work done by a force of 1 dyne acting through a distance of 1 cm. An erg is also equal to 10" Joule or to 0.7376 x 10" foot-pounds.

10. Back to the magnetic field to find that an oersted is the same as a gilbert per centimeter, a measure of magnetizing force, equal to .0795 ampere turn per cm.

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12. A baud is a unit of signaling speed used by telegraph engineers. It represents the number of code elements transmitted per second.

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The Most Trusted Name in Electronics
HEXNASH - electric game

Keep the junior engineer out of your laboratory equipment

By JACK ALLISON

A game that has a very fancy background! It's based on a game devised by Claude Shannon of Bell Labs and often played between a researcher and an electronic brain. You don't have to be an electronic brain to win at it, but, as you read on, you'll see it takes a little more head-scratching than its ancestor, Tic-Tac-Toe.

The unit is really a number of small switch-resistor combinations made up as shown in the bottom-view photo and Fig. 2. The switch-resistor units are mounted on a 7 x 11-inch sheet of cardboard or Masonite. In the author's breadboard hookup, the potentiometer was connected in the battery lead and was hand-held. A neat job would include fastening the sheet to a wood chassis or base (or over the open top of a shallow box) mounting the pot on the base and the battery inside.

If you are willing to sacrifice the logically preferable 1,500-ohm center position, you can use dpdt center-off slide or toggle switches. (See Fig. 3 for wiring details in that case, and note that the center position is the open one.) Otherwise use one of the switches given in the parts list. The Stackpole is the "official" switch, but the others all achieve the same result by different means. The perspective drawing (Fig. 2) is good for the Stackpole switch.

Rules of the game

1. Close the switches to get a 1 reading and, using the pot, set the needle at 1 on the nose.
2. Set all switches to the middle position and you are ready to play.
3. As each game is played, each player must alternately choose to take either the "close" or "open" strategy. Players take turns on who goes first.
4. The first player throws a switch, depending on whether he is "opening" or "closing." The other player then moves a switch in his direction.
5. Once a switch has been opened or closed, it cannot be touched again.

Fig. 2-This is how author wired switches he used. If you use different kind, find out which terminals are jumped to which in various positions.

Fig. 3-If you can't find 3-position slide switches, try spdt or dpdt center-off's. Wire as here, "Neutral" (resistor in) will not be in center, however.
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fuses—
are they RESISTORS?

Their resistance has to be considered in low-voltage circuits

The study of transistors is still constantly filled with comparisons and contrasts with vacuum tubes. One of the important differences between the two is that transistors are basically low-voltage, high-current devices while tubes work with low currents and high voltages. This basic difference has made it necessary for us to change some of our preconceived vacuum-tube ideas.

Recently I ran into two separate but identical situations that emphasized this basic difference. The problem in both was a transistorized regulated power supply that had poor regulation. One was designed for use in a laboratory, with several distribution points. When constructed and tested it provided over 4 amperes at 12 volts with better than 1% regulation. The other was rated at 6 volts, ½ ampere, with better than 1% regulation.

In both cases the cause of the voltage variation was not in the regulator. The poor regulation was due to a large (for transistors) voltage drop across a ½-amp fuse in the distribution line. At first when I measured a drop of over ½ volt across the ½-amp fuse, I thought there must be a bad solder joint at the holder. A measurement directly across the fuse quickly eliminated that possibility. My next thought was a bad internal connection in the fuse, but replacing the fuse resulted in an even larger voltage drop.

I finally got around to applying Ohm’s law and found that ½ volt at the 400-ma test current I was using made the fuse resistance around 1.2 ohms. (After all, a fuse is a heat-operated device and must generate enough FTR to activate it.)

I decided to investigate the resistance of fuses with other current ratings. Written material on the subject was very scarce; the best way of finding what I wanted to know was actually to measure the resistance of various fuses.

The results of my measurements on five fuses of each current rating are recorded in Table I. All fuses except the one ½-amp Slo-Blo group were the medium-lag type most commonly used in electronic equipment. Notice that resistance varies among fuses with the same current rating. I made no measurements on the high-speed fuses used in delicate test equipment. However, Table II lists the resistances quoted in the catalog of one of the leading fuse manufacturers.

It is interesting to note from Table I that the product of fuse resistance times rated current will give a drop centering around ½ volt across all fuses. It is also evident that, for any given current, a fuse with higher current rating will cause a smaller voltage drop.

Perhaps the easiest solution to the fuse resistance problem is to keep fuses out of low-voltage circuits where good regulation is important. Instead, where ever possible, such as in power supply circuits, let’s put the fusing in the primary. If we must put fuses in the low-voltage circuits, let’s be sure to use fuses with the largest fuse rating consistent with adequate protection, and remember that each fuse is a small resistor.

In conclusion: Low-voltage, high-current circuits, so common with transistors, force us to think of sources of resistance that can often be ignored in vacuum-tube circuits. Vacuum tubes operate at such high voltages and relatively small currents that the small voltage drop across fuses and meters can normally be ignored. In low-voltage, relatively high-current transistor circuits we must be very watchful of these small resistances. Otherwise even our good friend the fuse may become one of our problems.

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<tr>
<th>Amp Rating</th>
<th>Measured Resistance (ohms)</th>
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<tr>
<td>½</td>
<td>8.5</td>
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<tr>
<td>¼</td>
<td>5.2</td>
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<tr>
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| S-B        | 1.9 | 1.8  | 2.0 | 1.7       | 2.0       |
RCA Color-Bar/Dot/Crosshatch Generator

Low-cost, lightweight, portable instrument that provides all essential Color-TV test patterns. Simple to operate: only 3 controls. RF output leads connect directly to antenna terminals of receiver, no external sync leads required. Crystal-controlled signals assure rock-steady patterns, free from "jitter" and "crawl." Extra-wide-range chroma control. Generates patterns, free from "jitter" and "crawl." Extra-wide-range chroma control. Generates:

- Color-bar pattern: ten bars of color, including R-Y, B-Y, G-Y, and Q signals spaced at 30° phase intervals for checking phase and matrixing, and for automatic frequency and phase alignment. Permits accurate alignment of the "X" and "Z" demodulators which are used extensively in RCA Victor and many other makes of color TV receivers.
- Crosshatch pattern: a grid-like pattern of thin sharp lines for adjusting vertical and horizontal linearity, raster size, and overscan.
- Dot pattern: a pattern of small sized dots facilitating accurate color convergence adjustments.

*RCA 5-Inch Oscilloscope for Color-TV

A wideband scope excellent for checking colorburst signals and general troubleshooting of wideband color circuits and other electronic equipment. Multiscale calibrated graph screen makes measurement of peak-to-peak voltage as easy as with a VTVM.

- New 2-stage sync separator assures stable horizontal sweep lock-in on composite TV signals.
- Dual bandwidth: 4.5 Mc at 0.053 volt rms/in. sensitivity, 1.5 Mc at 0.018 volt rms/in. sensitivity.
- Continuously adjustable sweep frequency range: 10 cps to 100 Kc.
- 3-to-1 voltage-calibrated, frequency-compensated step attenuator for "V" amplifier.
- Simplified, semi-automatic, direct voltage calibration for simultaneous voltage measurement and wave-shape display.
- Vertical polarity reversal switch for "upright" or "inverted" trace display.

RCA Television FM Sweep Generator

Specifically designed for visual alignment and troubleshooting of color and black-and-white TV receivers, and FM receivers. The RCA WR-69A has pre-set switch positions for all VHF TV channels, FM broadcast band, and TV video, chrominance, and IF frequencies. The WR-69A has these important features:

- IF/Video output frequency continuously tunable from 50 Kc to 50 Mc.
- Sweep-freqeuncy bandwidth continuously adjustable from 50 Kc to 20 Mc on IF, Video and FM; 12 Mc on TV channels.
- Output level -0.1 volt or more.
- Attenuation range: TV channels, 60 db IF, Video, 70 db FM, 60 db.
- Return-trace blanking.
- Two adjustable bias voltages on front panel.

*RCA RF/VF/IF Marker Adder

Designed for use with a marker generator (such as RCA's WR-99A) and a sweep generator (such as RCA's WR-69A), this instrument is used for RF, IF, and TV sweep alignment in both color and black-and-white TV receivers. In visual alignment techniques, it eliminates distortion of sweep response pattern.

- Choice of four different marker shapes provided by front panel switch for different types of sweep responses.
- Provides very high-Q markers of high-amplitude and narrow bandwidth.
- Complete front panel control of marker shape, marker amplitude, marker polarity, sweep amplitude, and sweep-trace polarity.

$74.50* complete with cables.

RCA Crystal-Calibrated Marker Generator

Supplies a fundamental frequency RF carrier of crystal accuracy for aligning and troubleshooting color and B&W TV receivers. FM receivers and other electronic equipment in the 19-250 Mc range. Combines functions of multiple-marker generator, re-broadcast transmitter, and heterodyne frequency meter.

- Highly stable output.
- May be calibrated at 240 separate crystal check points-accurate calibration provided at 1-Mc and 10-Mc intervals.
- Matched-impedance pad-type attenuator and double shielding of the oscillator provide effective attenuation of all frequencies.
- Most-used IF and RF frequencies are specially indicated on the dial scale.
- Sound and picture carrier markers available simultaneously.

$425.50* complete with output cable and phone tip.

*User Price (Optional)

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Plug TV set into any AUDIO-PIX outlet. Run one or more sets simultaneously from a single antenna.

Run a HI-FI (record player, FM or AM, or tape recorder) and feed the sound into the system to be picked up at any AUDIO-PIX outlet.

Plug an FM receiver into the AUDIO-PIX. The AUDIO-PIX serves as an FM antenna signal source, and at the same time automatically feeds the FM sound back into the system to the extension speakers.

Turn on the HI-FI record player in the family room . . . listen to records on an AUDIO-PIX extension speaker plugged into the AUDIO-PIX outlet in the bedroom.

All this electronic entertainment can go on simultaneously over a single wire without interference! That's the amazing new AUDIO-PIX system by Winegard.
AUDIO-PIX delivers TV, FM or HI-FI
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Audio-Pix comes beautifully packaged in a Winegard selling display carton with built-in carrying handle.

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Transistor Circuits for Magnetic Recording
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Broadcast Engineering Notebooks, Vol. 4: TV Broadcast Operations & Maintenance
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New Semeconductors and Tubes

THE TWO SEMICONDUCTORS SHOWN IN these photographs are top candidates for the Littleness prize this month. If you aren't careful, they may get swept off your bench along with the solder droplets and wire cuttings.

The first is one of a series of miniature silicon planar transistors produced by Nippon Electric Co., Ltd. They are inexpensive, and intended for ordinary radio and TV applications. The one in the photo is about 1/16 inch thick, and is shown next to a perfectly ordinary 1/4-inch diameter platinum thermometer next to it.

with leads. Made by G-E, it is .043 inch in diameter and has .004 inch-diameter platinum leads. It is useful up to 400°C for control, measurement and time delay. That's an ordinary fever thermometer next to it.

The second photo shows a bead thermistor that is like a piece of dust linear over a wide operating range, according to Raytheon.

The tube can also be used as a wide-band power amplifier in other applications. Salient points:
Plate volts (max) 300
Screen volts (max) 250
Plate dissipation 8 w
Plate resistance is 20,000 ohms and screen and screen voltages of 150 and 100, respectively, and with a cathode bias resistor of 33 ohms. Plate current under those conditions is 28 ma, screen current 3.5 ma.

The 6HA6 has four series-string siblings: the 8HA6, 10HA6, 15HA6 and 29HA6.

6HJ5
This husky compactron is a horizontal-deflection amplifier (horizontal output, that is) for low-B-plus black-and-white TV sets. Its high transconductance (20,000 µhos), sharp cutoff and low plate knee characteristic make it very risky to use more than 30 volts dc or peak ac between those elements. Watch your tube tester!

Maximum plate voltage is 135 v, and the tube oscillates quite comfortably at 90 volts. At that voltage, and with a cathode resistor of 180 ohms, the tube draws 10.4 ma.

6DY4
Here is a video amplifier pentode made specially for low-B-plus black-and-white TV sets. Its high transconductance (20,000 µhos), sharp cutoff and low plate knee characteristic make it very risky to use more than 30 volts dc or peak ac between those elements. Watch your tube tester!

Maximum plate voltage is 135 v, and the tube oscillates quite comfortably at 90 volts. At that voltage, and with a cathode resistor of 180 ohms, the tube draws 10.4 ma.

6HA6
Here is a video amplifier pentode made specially for low-B-plus black-and-white TV sets. Its high transconductance (20,000 µhos), sharp cutoff and low plate knee characteristic make it very risky to use more than 30 volts dc or peak ac between those elements. Watch your tube tester!

Maximum plate voltage is 135 v, and the tube oscillates quite comfortably at 90 volts. At that voltage, and with a cathode resistor of 180 ohms, the tube draws 10.4 ma.

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ON PAGE 83.

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Plate volts (B-plus and boost) 770
Screen volts 220
Plate dissipation 24 w
Avg. cath. current 280 ma
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Raytheon is the manufacturer.

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5. The average number of copies each issue during the preceding 12 months are: (A) Total number copies printed (net press run): 224,292; (B) Paid circulation: (1) To term subscribers by mail, carrier delivery or by other means: 78,772; (2) Sales through agents, news dealers, or otherwise: 69,087; (C) Free distribution: 2,242; (D) Total number of copies distributed: 158,602. The number of copies printed (net press run) was 224,292; (2) Paid circulation: (1) To term subscribers by mail, carrier delivery or by other means: 78,772; (2) Sales through agents, news dealers, or otherwise: 69,087; (C) Free distribution: 2,242; (D) Total number of copies distributed: 158,602. The number of copies printed (net press run) was 224,292; (2) Paid circulation: (1) To term subscribers by mail, carrier delivery or by other means: 78,772; (2) Sales through agents, news dealers, or otherwise: 69,087; (C) Free distribution: 2,242; (D) Total number of copies distributed: 158,602. The number of copies printed (net press run) was 224,292; (2) Paid circulation: (1) To term subscribers by mail, carrier delivery or by other means: 78,772; (2) Sales through agents, news dealers, or otherwise: 69,087; (C) Free distribution: 2,242; (D) Total number of copies distributed: 158,602. The number of copies printed (net press run) was 224,292; (2) Paid circulation: (1) To term subscribers by mail, carrier delivery or by other means: 78,772; (2) Sales through agents, news dealers, or otherwise: 69,087; (C) Free distribution: 2,242; (D) Total number of copies distributed: 158,602. The number of copies printed (net press run) was 224,292; (2) Paid circulation: (1) To term subscribers by mail, carrier delivery or by other means: 78,772; (2) Sales through agents, news dealers, or otherwise: 69,087; (C) Free distribution: 2,242; (D) Total number of copies distributed: 158,602.

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<table>
<thead>
<tr>
<th><strong>M</strong></th>
<th>Major Improvements for Short-Wave Reception (Churchilli)</th>
<th>Jul 20</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Marker Adder for Sweep Generator* (Willes)</td>
<td>Jul 62</td>
</tr>
<tr>
<td></td>
<td>Measure Dwell Angle* (Bryce)</td>
<td>Sep 32</td>
</tr>
<tr>
<td><strong>Medicine</strong></td>
<td>Analgesic, White-Noise (Pat)</td>
<td>Aug 96</td>
</tr>
<tr>
<td></td>
<td>Brain Waves Cross Ocean (NB)</td>
<td>Aug 95</td>
</tr>
<tr>
<td></td>
<td>Hearing Aid in Tooth (Pat)</td>
<td>Sep 87</td>
</tr>
<tr>
<td></td>
<td>Larynx, Artificial (Pat)</td>
<td>Dec 108</td>
</tr>
<tr>
<td></td>
<td>Nurse, Electronic (WN)</td>
<td>Jan 35</td>
</tr>
<tr>
<td></td>
<td>Pat Power Runs Radios (NB)</td>
<td>Nov 60</td>
</tr>
<tr>
<td></td>
<td>Transmitter Fits in Tooth* (Gillings)</td>
<td>Aug 12</td>
</tr>
<tr>
<td></td>
<td>TV for Blind Forecast (NB)</td>
<td>Jul 40; Oct 18</td>
</tr>
<tr>
<td></td>
<td>Metronome, Unjunction* (Lederer) (Corres)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Microwelliont, Thin-Film Approach (Simmons)</td>
<td>Nov 38</td>
</tr>
<tr>
<td></td>
<td>Minimizing Vtm Pointer Shift (Centerville)</td>
<td>Nov 48</td>
</tr>
<tr>
<td></td>
<td>More Signals-Less Space (McDaly)</td>
<td>Aug 34</td>
</tr>
<tr>
<td></td>
<td>More Talk-Power for CB Rig (Scott)</td>
<td>Oct 48</td>
</tr>
<tr>
<td></td>
<td>Movie Projectors, Servicing Sound—see Servicing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Music All Over House Without Wires (Scott) (Corres)</td>
<td>Aug 21</td>
</tr>
<tr>
<td></td>
<td>Mystician in Output Matching (Ravenswood)</td>
<td>Aug 37</td>
</tr>
<tr>
<td><strong>N</strong></td>
<td>New Tricks with Diodes* (Gesler)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>New Tubes for Color TV (Sutheim)</td>
<td>Dec 42</td>
</tr>
<tr>
<td></td>
<td>1964 Color TV Roundup (Lemons)</td>
<td>Dec 32</td>
</tr>
<tr>
<td></td>
<td>100-Kc Crystal Calibrators* (Queen)</td>
<td>Aug 77</td>
</tr>
<tr>
<td></td>
<td>Organs, Electronic, Tuning Made Easy (Korte)</td>
<td>Jul 58; Dec 24</td>
</tr>
<tr>
<td></td>
<td>Our Policy on Freebies (Margolis)</td>
<td>Oct 76</td>
</tr>
</tbody>
</table>

**P**

<table>
<thead>
<tr>
<th><strong>P</strong></th>
<th>Pattern Depends on Probe (Cunningham)</th>
<th>Nov 31</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Peeve Attacks Radio (Wayne)</td>
<td>Dec 65</td>
</tr>
<tr>
<td></td>
<td>Photography</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Backroom Thermostat, Electronic* (Karn)</td>
<td>Oct 60</td>
</tr>
<tr>
<td></td>
<td>Just Plain Flats* (Henry) (Corres)</td>
<td>Aug 21</td>
</tr>
<tr>
<td></td>
<td>Power Amplifier, Transistor, Circuit (Gesler)</td>
<td>Oct 32</td>
</tr>
<tr>
<td></td>
<td>Power Dissipation in Resistors or Transistors (Todd)</td>
<td>Aug 31</td>
</tr>
<tr>
<td></td>
<td>Power Supply</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low-Cost Transistor Regulated (Powell)</td>
<td>Jul 48</td>
</tr>
<tr>
<td></td>
<td>Unusual (NC) (Corres)</td>
<td>Jul 92; Nov 24</td>
</tr>
<tr>
<td></td>
<td>Vibrator, Transistorized (NC)</td>
<td>Aug 83</td>
</tr>
<tr>
<td></td>
<td>Precise Inductance Bridge* (Krueger)</td>
<td>Sep 44</td>
</tr>
<tr>
<td></td>
<td>Prefab Transistor Amplifiers End (Building Headsaches (Turner)</td>
<td>Sep 74</td>
</tr>
<tr>
<td></td>
<td>Pushbuttons Add Ohms or M's (Fred) (Corres)</td>
<td>Sep 20</td>
</tr>
</tbody>
</table>

**R**

<table>
<thead>
<tr>
<th><strong>R</strong></th>
<th>Radar, Jamming Suppressor (Pat)</th>
<th>Oct 104</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Helicly Antenna (WN)</td>
<td>Aug 47</td>
</tr>
<tr>
<td></td>
<td>RATAH in N. Y. Harbor (NB)</td>
<td>Jul 8</td>
</tr>
<tr>
<td></td>
<td>Short Pulse, Has High Resolution (NB)</td>
<td>Sep 15</td>
</tr>
<tr>
<td></td>
<td>Weather, Makes Frying Safer (Bown)</td>
<td>Jul 50</td>
</tr>
</tbody>
</table>

**RADIO(S)**

<table>
<thead>
<tr>
<th><strong>RADIO(S)</strong></th>
<th>Booster, Audio, for Transistor* (Adamek)</th>
<th>Oct 62</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CB, Frequency Synthesis Improves Coverage (Scott)</td>
<td>Aug 44</td>
</tr>
<tr>
<td></td>
<td>Operator, Illegal, Faces Several (NB)</td>
<td>Sep 34</td>
</tr>
<tr>
<td></td>
<td>Servicing with CB Set (Sands)</td>
<td>Dec 108</td>
</tr>
<tr>
<td></td>
<td>Talk-Power, More for Rig (Scott)</td>
<td>Aug 51</td>
</tr>
<tr>
<td></td>
<td>Code Oscillator and Monitor (NC)</td>
<td>Aug 51</td>
</tr>
<tr>
<td></td>
<td>FM in Fringes (Marshall)</td>
<td>Aug 51</td>
</tr>
<tr>
<td></td>
<td>Investors of (Barlett)</td>
<td>Aug 51</td>
</tr>
<tr>
<td></td>
<td>Lodge, Sir Oliver Joseph</td>
<td>Aug 51</td>
</tr>
<tr>
<td></td>
<td>Popoff, Alexander Stepanovitch</td>
<td>Aug 51</td>
</tr>
<tr>
<td></td>
<td>Millimeter Communications System (NB)</td>
<td>Aug 51</td>
</tr>
<tr>
<td></td>
<td>More Signals-Less Space (McDaly)</td>
<td>Aug 51</td>
</tr>
<tr>
<td></td>
<td>Rat Power Runs (NB)</td>
<td>Aug 51</td>
</tr>
<tr>
<td></td>
<td>Remote-Control Receiver, 6-Channel* (Cole)</td>
<td>Aug 51</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th><strong>NEW YORK COLISEUM</strong></th>
<th>All 4 floors!</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ELECTRONICS EXHIBITS</strong></td>
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</tr>
<tr>
<td><strong>CONVENTION PAPERS</strong></td>
<td>Buses to the N.Y. Hilton every few minutes</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>PRODUCTS</strong></td>
<td><strong>PAPERS</strong></td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>-------------------------------------------------</td>
</tr>
<tr>
<td><strong>RADIO-ELECTRONICS</strong></td>
<td></td>
</tr>
</tbody>
</table>
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TRANSISTOR INDOOR ANTENNA, Spiro Transistor model TR-11. Black-and-white, color TV; mono, stereo FM. Adjustable; calibrated coarse and fine tuning. Foldaway dipoles; printed circuit; directional. Plugs into ac line. 9 x 7¾ x 2½ in. —Spiffing Products Co., Inc., Hicksville, N. Y.

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10-SYNCHRONIZED TUBES...

10-25A6, 12AV6, 5005, 12BL6 TUBES...

5-12BA6, 12BL6 TUBES...

10-SYLVANIA 1U4 TUBES...

10-2-$3 TELEX EARPIECES...

20-BUS LINE CORDS...

20-GE #NE -2 TUBES...

10-ASSORTED TUBES...

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10-SAPPHIRE NEEDLES...

3-TOP BRAND 35W4 TUBES...

10-ASSORTED TUBES...
80-WATT STEREO AMPLIFIER, model 2992. Front-panel headphone output for private listening without speakers; center-channel output for driving independent speaker system without separate power amplifier. HIF power, 40 watts per channel; power band, ±1 db, 19-25,000 cycles; harmonic distortion 0.8%; hum level 80 db. Strain-gage rating 32 watts per channel.—H. Scott Inc., 111 Powderville Rd., Maynard, Mass.

FM STEREO TUNER SEMIKIT, model 2290. Front-end, 13 f.i. strip containing 4 f.i. stages and ratio detector. Rotary tuning dial, bar type electron-ray tuning indicator, stereo defeat switch; Input: 300 ohms; sensitivity 3 µv (30-db quieting); signal-to-noise ratio 45 db; harmonic distortion 0.6%; audio output 1 volt; ratio detector bandwidth 1 mc; output impedance 5,000 ohms.—EICO Electronic Instrument Co. Inc., 35-00 Northern Blvd., Long Island City 1, N.Y.

STEREOCORDER, Sony model 600, 4-track stereo and mono recorder. Vertical or horizontal operation, mike and line mixing, source and tape monitoring, 2 VU meters, sound-with-sound, sound-with-tape, separate monitor level controls, hysteresis-synchronous drive motor. 7½ and 3½ ips. Frequency response 30-18,000 at 7½ ips; signal-to-noise 55 db; harmonic distortion 0.6%; audio input 1 volt; ratio detector bandwidth 1 mc; output impedance 5,000 ohms.—EICO Electronic Instrument Co. Inc., 35-00 Northern Blvd., Long Island City 1, N.Y.

100-WATT STEREO AMPLIFIER, all-transistor, 19 transistors, 8 diodes. Stereo headphone; 2-position record-monitor switch; circuit breaker. 100 watts HIF power output; response, ±2½ db, 20-25,000 cps; harmonic distortion, 1.0% at full rated output; sensitivity, 0.1 volt, tuner and aux; 2.5 mv, tape; 2.0 mv, phono inputs for full rated output power. Outputs: 4, 8, 16 ohms per channel.—Allied Radio Corp., 109 N. Western Ave., Chicago, Ill. 60610.

PHONO CARTRIDGE, model U-11R Soft Touch. Lifts stylus automatically if abnormal pressure is applied to tone arm; brings soft plastic guard nib into position between cartridge and record so stylus cannot contact record until abnormal pressure is removed. Frequency response 20-20,000 cycles. Compliance 8 x 10^{-6} cm/dyne. Capacitance 1,100 pf per channel. Separation 25 db at 1,000 cycles. Output 0.5 volt at 5 cm/sec. 0.007 diamond stylus, .003 synthetic sapphire stylus. Photo was shown upside down in October issue.—Euphonies Corp., Guaynabo, Puerto Rico, USA.

BREADBOARD KITS for experimental component assembly; conversion into operational unit.

Vertical or horizontal, separate monitor level controls, hysteresis-synchronous drive motor. 7½ and 3½ ips. Frequency response 30-18,000 at 7½ ips; signal-to-noise 55 db; harmonic distortion 0.6%; hum and noise: Mag phono, 50 db below rated output, aux inputs 65 db below rated output. 5-position selector switch, 3-position mode switch; dual tandem volume, bass and treble controls; phase switch, input level controls; push-on, push-off switch, 20 transistors, 10 diodes.—Health Co., Benton Harbor, Mich.

COMPACT MIKE, model 561. Attached cable and standard 9½-27 thread for mounting on flexible gooseneck or fixed pole. Frequency response 40 to 10,000 cycles with rising characteristic to 4,500 cycles. Output level — 56.0 db; impedance 50 to 250 ohms. 5 oz.—Shure Brothers Inc., 222 Hartrey Ave., Evanston, Ill.

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UPRIGHT REED RELAYS, series 800 and 900, multi-circuit applications; space saver on printed board or chassis. Anodized aluminum housings; magnetic shielding; varnish-impregnated coil assemblies for moisture, shock-resistance. Series 800: 3A x 23/4 in. Coil voltages: 6, 12, 24 dc at 250 ma. Contact systems in gold, tungsten, mercury-wetted; ratings 15 va, 15 watts dc, 1,000 volts. Series 900: 1/2 x 1/2 x 23/4 in. Coil voltages: 6, 12 dc at 250 ma; 48 dc at 1 watt. Contact systems gold, rhodium, silver, tungsten or mercury-wetted. XXXP, epoxy paper, epoxy glass in .093- or .062-in. holes.—Allen Kits Inc., Marketing Dept., PO Box Y4, Anaheim, Calif.

VERTICAL OUTPUT TRANSFORMERS. Exact replacement for all TV sets, including current models. VO-120 replaces Zenith, Silvertone; VO-122, Silverstone; VO-123, Airline and Westinghouse; VO-124, 15 times working life of former load 50 db below rated output, aux inputs 65 db below rated output. 5-position selector switch, 3-position mode switch; dual tandem volume, bass and treble controls; phase switch, input level controls; push-on, push-off switch, 20 transistors, 10 diodes.—Allied Radio Corp., 109 N. Western Ave., Chicago, Ill. 60610.

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SILICON DIODES AND RECTIFIERS de-
scribed in 36-page General Catalog include Zener, Varicap diodes. Descriptions mention men.
ufacturers’ lines of circuit modules and four pages of dimen-
sion data.—TRW Electronics/Semiconductors Inc.,
14520 Aviation Blvd., Llffelaw, Calif.

TV PICTURE-TUBE REPLACEMENT CHART
includes interchangeability guide and de-
tails of 575 tube types. Can be mounted for ready
reference. Available through authorized General
Electric tube distributors.

NEW MAGNETIC TUBE HEADS, 4-track, 4-
channel, for record-reproducer on 16-inch tape,
described in data sheet No. 7146. Includes full spec,
outline drawings.—Nortronics Co., Inc., 8101 18th Ave.
Nw., Minneapolis 27, Minn.

TV-FM AIDS FOR HOME RECEPTION de-
scribed in 4-page, illustrated catalog DC-2052. Contains spec on 2-transistor, mast-mounted TV
preamplifier; Powermate; vhf preamplifiers; Silver vhf preampulators, amplifiers. TV coupler and
other, Prices included.—Jerold Electronics Corp., Distributor Sales Div., 15th & Lehigh Ave.,
Philadelphia 32, Penna.

3 NEW MERCURY-WEPTED CONTACT
RELAYS described in 16-page JM catalog, in-
cludes other previously offered relays. Table lists available ranges of the relays. Full specs and
data. More than 300 relays categorized by
and wire turners.—Potter & Brumfield, Princeton, Ind.

PEDESTAL HEIGHT ADJUSTMENT in tape
recorders described in 3-page bulletin, Sound
Talk No. 39. Examinations and technical corrections
for any make of recorders.—JM Co., Dept. 23-499, 2501 Hudson Road, St. Paul
19, Minn.

COMPLETE EXPERIMENTAL LABO-
RATORY described in 8-page catalog. Lists instru-
ments available separately and in package, for use
as lab portion of Malmstam-Eke book-course
Electronics for Scientists (See New Books, RADIO-
ELECTRONICS, May 1963, p. 97). Describes idea
behind book and lab, gives detailed specs on chart recorder, amplifier, oscilloscope, sine-
square generator, operational amplifier, substitu-
tion boxes, other lab equipment.—Heath Co.,
Benton Harbor, Mich.

VHF AND UHF ANTENNAS, mobile and
fixed, described in 4-page illustrated brochure. Full
specs and details, radiation patterns.—GAM Elec-
tronics Inc., 138 Lincoln St., Manchester, N. H.

TV ACCESSORY LINE described in 40-page
brochure. Includes mast strap standoffs, U-bolts,
turnbuckles, roof, wall and chimney mounts, poles,
antennas.—Parker Miller Goods Co., 85 Prescott St.,

RMS VOLTMETER/AMPLIFIERS detailed
4-page illustrated spec sheet. Contains block dia-
gram of instruments, description, related models,
applications and test setups, accessories and full
specs.—B&K Instruments Inc., 3044 W. 106th
St., Cleveland 3, Ohio.

SECTIONAL DELAY LINES. 4-page catalog
includes delay lines. Specification data. More than
300 relays categorized by
and wire turners.—Potter & Brumfield, Princeton, Ind.

MINIATURE STRIP-CHART RECORDERS,
manufacturer’s full product line, accessories, leads,
advantures, included in 4-page, illustrated catalog. Spec,
dcriptions and prices given.—Amprobe
Instrument Corp., Dept. AADD6, 630 Merrick
Road, Lynbrook, N. Y.

5-AMP ALTERNATOR SYSTEM described in
4-page floor display. Gives complete performance data.
Charts and tables. Photos.—Somotech Corp., Batavia Ave., Elgin, Ill.

PACKAGED ELECTRONIC CIRCUIT
GUIDE No. 7. 8-page booklet contains complete
testing of packaged electronic circuits, full
deployment data, plus information on how to select,
test and replace PEC’s used in radio, TV and hi-fi.

1964 HEATHKIT CATALOG. 100-page illus-
trated book contains wide selection of elec-
tronic kits, including home entertainment and radio
receivers, and many other products. Product lines include: stereo, hi-fi; color and black-
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SCOPE AND CAMERA CATALOG. 12-page illus-
trated brochure describes complete line of instru-
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**Special Color Notes**

The items in this month's column were all contributed by Mr. Arthur R. Richman, and all deal with color TV troubles. Each item names the chassis, lists the complaint and points out parts to check. The partial schematics help you locate the correct portion of the circuit. Codes (such as R701, C212, etc.) are from RCA manuals.

**CTC9: poor horizontal range**

![Diagram of CTC9: poor horizontal range]

**CTC9: horizontal tearing**

![Diagram of CTC9: horizontal tearing]

**CTC9: poor width, no focus**

![Diagram of CTC9: poor width, no focus]
CTC9N and P (with remote control): volume will not lower

CTC9: low contrast

CTC9: no high voltage

CTC9: intermittent contrast

CTC10: vertical roll

CTC10: brilliance blooms out

CTC10: no color sync

CTC10: weak or no color

CTC10: no brilliance

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DECEMBER, 1963

107
noteworthy Circuits

Heathkit CT-1 and IT-22

Most in-circuit capacitor testers of this type have separate B-plus rectifiers, oscillator and electron-ray indicator tubes. In these two testers the 1629 indicator tube performs all three functions. (The circuit of the CT-1 is shown.) When testing a capacitor for opens, the triode section of the tube is used as a self-rectifying 19-mc oscillator. Coupling to the tank circuit is tight enough to stop oscillations.

When a good or shorted capacitor is connected to the test terminals, the circuit is detuned, developing a bias that closes the eye. For the short test, the capacitor is connected between the grid and ground. A shorted capacitor short-circuits the bias and opens the eye.

---

Listening-Aid Amplifier

Recently a co-worker purchased a Telex model LCP90 TV Listener for his hard-of-hearing daughter. While the unit worked quite satisfactorily, there was one drawback in this particular application. The youngster's hearing is 80% restricted in one ear and 60% in the other. Consequently she required an inexpensive CW monitor. Its pivot rating must be higher than the open-circuit voltage across the transmitting key. The pivot rating of the 1N2070-A is 400 and is high enough for most transmitters. If you will use the unit exclusively for code practice, replace the diode with a short.

Almost any p-n-p transistor will work. I tried Poly-Paks' 15-for-$1.00 transistors and most of them worked in this circuit.

The oscillator's volume is adequate for the ham shack but falls short for group code practice. A larger speaker and 3-volt battery will solve this problem.

I constructed the unit in a small interlocking utility box. You can build it into your transmitter. When using it as a CW monitor, be sure that the positive lead from the transmitter connects to the diode's cathode. Improper polarity will key the transmitter and burn out the transistor.—Earl Palmer, W7POG

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Code Oscillator and Monitor

This simple unit provides the amateur with an inexpensive CW monitor and the prospective ham with a code-practice oscillator. The transistor oscillator is a simplified version of the modulator in the tunnel-diode R-C transmitter in the June 1963 issue. A Bourns trimpot salvaged from a surplus printed-circuit board is used for R, the pitch control. A fixed resistor of 1,000 to 5,000 ohms that gives the desired tone can be substituted. C also affects the frequency and may be changed to get the desired frequency range if you use a pot.
the Telex TV Listener, there is ample room to build the entire amplifier and battery inside the bakelite case. The only physical change was replacing the original 100-ohm volume control with a small 10,000-ohm pot. Component values are not critical and may vary over a wide range. Transistors may be almost any inexpensive general audio types such as the 2N170, 2N107.

At high audio inputs, there is some tendency to overload, in which case the input can be loaded down with a 3-ohm resistor. Where less amplification is required, or desired, the input stage may be eliminated and the audio input fed to the 2N107.—Domenic Ripani, W9JVIQ

Constant-Current Regulator

Fig. 1 shows a regulator circuit that delivers a steady current at any preset level between 1.5 and 30 volts. The unit may be connected simply between the supply and load (see Fig. 1-a).

![Constant-Current Regulator Diagram](image)

Circuit operation (Fig. 1-b) is based on the flat constant-current characteristic of a small power transistor in the common-base connection. The output current level is set by adjusting the rheostat and read from the milliammeter. The 1.5-volt battery may be replaced with a midget transformer-rectifier unit, if desired.—Rufus P. Turner

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Fig. 1

The MODEL 213 saves you time, energy, money. It checks for shorts, leakage, intermittents, and quality. It tests all tube types including magic eye, regulator, and hi-fi tubes. It checks each section of multi-purpose tubes separately. It gives long, trouble-free life through heavy-duty components, including permanent-magnet panel. It keeps you up to date with FREE, periodic listings on new tubes as they come out. Your best dollar value in a tube tester. Available in high-impact bakelite case with strap: $28.90 wired; $18.90 in a tube tester. Available in high-impact bakelite case with strap: $28.90 wired; $18.90 in

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118 East 95th St., 88kmy. 12, N.Y.
Mass. License Bill Goes Through

After several years of work, the radio-TV technicians' licensing bill sponsored by the Massachusetts Electronic Technicians Guild has passed the legislature and been signed by the governor.

The act establishes a board of radio and television technicians empowered to license applicants upon proof of competence and payment of the required fees. There will be two license grades: Master Technician License, issued to persons 21 years old and over, who have had at least one year's experience in radio-TV repair, and a Technician License, issued to persons at least 18 years old and employed by a service dealer or working under a Master Technician's supervision.

No one is permitted to do service work for pay without a license.

The licensing board created under the new law will examine applicants. In the words of the act, “the board shall require proof that the applicant has the knowledge, practical experience and skill necessary for the proper maintenance and repair of television and radio receivers and shall require a practical demonstration of the applicant's skill.”

Licenses expire after a year and may be renewed without examination within 1 year from the expiration date, on payment of the renewal fee.

Initial exam fee is $15, as are the license fees for the Master grade. Subsequent examinations cost $10. The issuance fee for the Technician grade is $10, and $5 for renewal.

Penalties are stiff. For doing service work without a license there is a maximum fine of $500, or a prison term of up to three months, or both.

The new law includes a “grandfather clause.” Any applicant who files before June 30, 1964, and is actively engaged in service work will be granted a license on payment of the fees, but without examination.

Chairman of the ETG Licensing Committee was Nicholas A. Averinos, who announced with justifiable pride that the total cost of getting the bill through was under $1,500— which includes legal fees, car expenses, stamps, stationery, but, he says, “No expensive lunches, dinners or any other frills.”

Ohio TSA Elects

Jack Fain of Lorain, Ohio, was elected president of the Television Service Association of Ohio at the group's two-day annual convention recently. He succeeds John Graham of Columbus.

Also elected were Arthur Clough, Akron, secretary, and Arthur Spahr, Cincinnati, treasurer. Regional vice presidents are Carl Hepp, Youngstown; northern zone; Robert Hammond, Columbus, central zone, and Harry Hansen, Cincinnati, southern zone.

New Mexico TESA Told Service Vital to Color

TV service technicians have a key role in the rapidly blossoming field of color television, said Lysle O. Shanafelt, RCA's manager of distributor sales coordination, speaking to TESA—New Mexico's annual convention.
You receive all that is outlined in the "Edu-Kit." The "Edu-Kit" also includes Code Instructions and the Progressive Code Oscillator, in addition to F.C.C.-type Questions and Answers for Radio Amateur License training. You receive special tube sockets, hardware and instructions. You also receive a useful set of tools, a professional electric soldering iron, and a self-powered Dynamic Radio and Electronics Lab. You receive coils, hardware, tubing, punched metal chassis, Instruction Manuals, hook-up wire, solder, electrolytic, mica, ceramic and paper dielectric condensers, resistors, "breadboard" experiments, but genuine radio circuits, constructed by means of professional wiring and soldering on metal chassis, plus the new method of radio construction known as Printed Circuitry. You will learn how to build radios, using regular schematics; how to wire and solder in a professional manner; how to service radios. You will work with the professional Signal Tracer, the Progressive Signal Injector, the Progressive Signal Oscillator, the Progressive Dynamic Radio, the Square Wave Generator and the accompanying Instruction Manuals, your printed circuitry, and procedures. You will learn the fundamentals of electronic circuitry, not merely plugged in and soldered to terminal strips. The various parts are carefully designed, step by step, so that you cannot make a mistake. The "Edu-Kit" allows you to teach yourself at your own rate. No instructor is necessary.

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The Progressive Radio "Edu-Kit" is the finest educational radio kit in the world, and is universally accepted as the standard in the field of electronics training. The "Edu-Kit" uses the modern educational principle of "Learn by Doing." Before you construct, you learn schematics, study theory, practice trouble-shooting—all in a closely integrated program designed to provide an easy-learning, thorough and interesting experience. The "Edu-Kit" will provide you with a basic education in Electronics and Radio, worth many times the complete price of the entire Kit.

THE "Edu-Kit" is COMPLETE

You will receive all parts and instruction necessary to build 20 different radio and electronics circuits, each guaranteed to operate. Our Kit contains tubes, tube sockets, variable, electrolytic, mica, ceramic and paper dielectric condensers, resistors, the strips, coils, hardware, tubing, punched metal chassis, Instruction Manuals, hook-up wire, solder, selenium rectifiers, volume controls and switches, etc. In addition, you receive Printed Circuit materials, including Printed Circuit chassis, special tube sockets, hardware and instructions. You also receive a useful set of tools, a professional electric soldering iron, and a self-powered Dynamic Radio and Electronics Test. The "Edu-Kit" also includes Code Instructions and the Progressive Code Oscillator. In addition, you receive a "Radio-Quiz" for Radio and TV troubleshooting, and a Quiz Book. Your membership in Radio-TV Club, Free Consultation Service, Certificate of Merit and Discount Privileges. You receive all parts, tools, instructions, etc. Everything is yours.

UNCONDITIONAL MONEY-BACK GUARANTEE

At no increase in price, the "Edu-Kit" now includes Printed Circuitry. You build a professional Signal Tracer and Signal Injector Circuits, a Printed Circuitry unique servicing instrument that can detect and locate radio and TV troubles. This revolutionary new technique of radio and television construction is now becoming popular in commercial radio and TV sets.

A Printed Circuit is a special insulated circuit board which has been deposited with conducting material which takes the place of wire. The various parts are merely plugged in and soldered to terminals. Printed Circuitry is the basis of modern Automatic Electronics. A knowledge of this method is a necessity for anyone interested in Electronics.

PROGRESSIVE "EDU-KITS" INC.
1186 Broadway, Dept. 215G, Hewlett, N. Y.
CSEA Sets Service Advertising Standards

The California State Electronics Association has drawn up a list of 10 principles to be followed for honest TV service advertising. Each item of the list mentions a particular type of claim that CSEA considers "misleading, untruthful" or a part of "bait" or "come-on" advertisements.

The list was apparently intended to be distributed to newspapers and periodicals. It closely points out that "No honest, legitimate businessman, willing to represent his product or service fairly and openly to the public, should have the slightest fear of these standards."

New NATESA President Lists Gripes

The newly elected president of the National Alliance of Television & Electronic Service Associations, Larry Dorst of Milwaukee, has three pet peeves.

1. Be careful with business names that closely resemble established trade names or that use service marks much like type of claim that CSEA considers "misleading, untruthful" or a part of "bait" or "come-on" advertisements.

2. Words or phrases like "guaranteed" or "no fix, no pay" are permitted if the ad states clearly the nature and extent of the guarantee, and who the guarantor is—manufacturer or retailer.

3. Phrases like "24-hour service" should not be used unless such service is actually available to the public 24 hours a day.

4. Words "manufacturer" or "laboratory" should not be used unless such service is actually available to the public 24 hours a day.

5. If an ad uses an expression like "repaired in your home," it should state that there is a charge if the work cannot be completed in the home to the customer's satisfaction.

6. If the price of picture tube is quoted, the ad should state whether the price is for a new or used tube, and whether the work can be completed in the home to the customer's satisfaction.

7. "Free" should not be used unless the article or service is actually free. This also applies to phrases like "without cost or obligation," etc.

8. Phrases like "factory-trained," "authorized," "licensed," etc., should be based on demonstrable facts.

9. Avoid "price ads." Artificially low prices quoted in ads lead to dishonest practices such as hidden charges, padded bills or hurried, sloppy work.

10. Be careful with business names that closely resemble established trade names or that use service marks much like type of claim that CSEA considers "misleading, untruthful" or a part of "bait" or "come-on" advertisements.

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First, he says, is captive service. Running close behind are manufacturers' built-in warranties and the lack of licensing of TV service dealers.

Philco Forms Technicians' Councils

Philco Corp. will form councils of independent TV service technicians to put the company in immediate touch with any problems that develop in the field.

Charles Hakimian, Philco's director of distribution and customer services, announced at a meeting of the Ohio TSA that "these councils will meet with us, at our expense, to work on any and all problems that affect our relationship."

Hakimian also told the state meeting that Philco will resume introducing its new lines to service technicians at the same time the merchandise is displayed for dealers.
Protective Covers for Shafts and Switches

To keep calibrating potentiometer adjustments from being disturbed, cover the shaft with the empty can taken from an old bathtub type capacitor. These cases are easily salvaged with a soldering iron. Lined with insulating paper they make neat covers for hot terminal screws or fuse clips. They can also keep crucial switches from being hit on or off accidentally.—Hugh Lineback

Clip-in Holder for Vom Battery

I own a vom that uses a Z-cell (penlight size) as an ohmmeter current source. Every time I wanted to replace it I had to unsolder the old cell and solder in the new one.

So I mounted a battery holder (Lafayette stock No. MS139) in the case and soldered the two battery leads to its terminals. Much better.—Bernard J. Singer, Jr.

Bicycle Spokes Make Test Prods

When I had trouble getting probes into tight wiring without shocking myself or shorting something, I made my own probes from an ordinary test-prod shank and some bicycle spokes.

The drawings will show you how easy it is. All you have to do is drill out
Now you have a perfectly safe shorting strip to stub between the oscillator-section plates.—Nicholas B. Cook

Handy Service Tool

If you have a worn-out nutdriver lying around the shop gathering dust, try this. Cut off the socket with a hacksaw and make a ¼-inch cut at the end of the shaft. You now have a handy tool for twisting the mounting tabs on filter capacitor cans, tab-mounted controls, tab-mounted tuner shields, tab-mounted transformers, etc. It will do a much better job than long-nose pliers, it will reach tight spots where pliers will not fit, and it will handle heavier material than long-nose pliers.—Albert J. Krakowski.

[The nut driver must have a solid —not a hollow—shank.—Editor]

Loose-leaf Binder Keeps
Magazine Contents Pages

I file my issues of Radio-Electronics in order in boxes for future reference. But first I clip out the contents pages and file them in a loose-leaf notebook. Your system of arranging articles in categories makes searching for a particular article very easy. If I want to build a preamp, I look in my notebook under “audio—high fidelity—stereo” until I find what I want. Then I look at the top of the page to see what month’s issue the article is in and get the magazine from the box.—Bernard A. Bernsen

[As an additional aid, try clipping and filing away the annual (now semiannual) indexes in the December and June issues, respectively.—Editor]
Temperature-Compensated Zener Bridge
PATENT No. 3,087,109

By making one arm of a Wheatstone bridge a Zener diode (D) and the other arms fixed resistors, the bridge becomes voltage-sensitive. Balance occurs only with a definite input voltage. Temperature error may be eliminated by adding R1, R2 across D (see diagram). R2 has a positive temperature coefficient. To preserve balance in spite of changes in temperature, we must choose the proper temperature coefficient. The current through R1 must not change.

Flaw Detection
PATENT No. 3,097,337
Herbert S. Polia, Vevey (Geneva) Switzerland (Assigned to Hoffman Electronics Corp.)

To check for possible cracks or flaws in a metal casting, a nonconducting phosphor powder is dusted over the metal. A fixed electrode and a movable probe are connected across high voltage ac (at least 100 volts). Where the powder has penetrated the surface, it acts as a dielectric with respect to the adjacent metal. The alternating field excites the phosphor, causing it to glow. This points out the location and size of the flaw.

Solar-Cell Battery Charger
PATENT No. 3,089,070
Eugene L. Ralph, Skokie, Ill. (Assigned to Hoffman Electronics Corp.)

A combination of a solar cell and battery may be used to supply radios or other low-power equipment. An ordinary solar cell has low impedance in both directions, however, so the battery discharges through it when the sun is hidden.

Automatic Illumination
PATENT No. 3,093,744
Michael Tabet, Norfolk, Va.

This lamp goes on automatically as darkness approaches, and off with the coming of dawn. The drawing shows a heater in series with a photocell across the line. Daylight reduces cell resistance and permits a large current to heat the bi-metal bar. It bends away from the fixed contact to open the lamp circuit. During darkness, the bar cools, closing the contacts.

Mercury
SELF-SERVICE TUBE TESTERS are BIG INCOME PRODUCERS

NEW MODERN EYE-STOPPING TESTERS... TOPS in PERFORMANCE... QUALITY... and VALUE

Here is everything you want in self-service tube testers at down-to-earth prices. MORE VERSATILITY—Tests emission, shorts and gas of over 1200 tube types including the very latest NUVISTORS, NOVARS, COMPACTRONS, etc.... Also tests fuses, pilot lights, 6 and 12 volt auto radio vibrators, all type batteries under load. SMARTER LOOKING—Modern cabinet design finished in a rich green and white color combination with gold trim... Eye-stoppers in any location—will attract do-it-yourself customers as never before and sell tubes in a big way. MORE QUALITY FEATURES—Completely self-service... Only two easy-to-use controls are required to test any tube... Easy-to-read quick flip tube charts list over 1200 tube types... Engineered to accommodate new tube types as they are introduced... Etched aluminum panel always retains its handsome appearance... 63 phosphor-bronze beryllium tube sockets assure positive contacts and long life. Replace old self-service tube testers with Mercury testers and spark-up your present locations... place them in new locations and be assured of the greatest profit results.

MERCURY ELECTRONICS CORPORATION, 111 ROOSEVELT AVENUE, MINEOLA, NEW YORK

DECEMBER, 1963

115
“Electronic Breakthrough”

Transistor

First Transistorized Indoor TV & FM Antenna

TV & FM Signals up to 35 times more powerful

For: Black & White • Color • FM • Monaural • Stereo

No more need for costly outdoor installations in fringe areas, up to 60 miles!

See and hear this scientific fact with your own eyes and ears...

The results of three years research by Spico—the electronic breakthrough that introduces the first transistorized indoor antenna for Television, Black and White, Color, FM, Monaural or Stereo. TV and FM signals are boosted up to 35 times more powerful through transistor amplification, which guarantees the strongest, clearest pictures. Snow and ghosts go on TV. It delivers as much volume and clarity on weak, distant FM and Stereo stations, as desired, without distortion. Equipped with adjustable, calibrated Radar Probe, for preliminary tuning and Adjasta-Knob for final, micro-fine tuning. The TRANSISTAR plugs into any AC line. No Couplers needed for multiple operation of TV, FM and Stereo sets.

The Most Revolutionary Indoor Antenna Made Since the Advent of Television.

Spirling Products Co., Inc. • Hicksville, L.I., N.Y.

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Issues?

Back numbers of most issues of Radio-Electronics are available upon request

This year’s issues

50¢

Last year’s issues

55¢

Previous year

60¢, etc.

Maximum

$1.00

Radio Electronics • 154 West 14th Street, N.Y., N.Y. 10011

ELECTRONICS

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Bachelor of Science Degree, 30 Months

Save Two Years’ Time

Radio-Television Plus Color Technician (12 Months)

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Mechanical Engineering (B.S. Degree)

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Write for Catalog and Registration Application. New Term Starting Soon.

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State

HEALD’S

Engineering College

Est. 1863—100 Years

Van Ness at Post, Re

San Francisco, Calif.

New Books


A detailed text with a number of examples of reports reproduced exactly.

TV Troubleshooter’s Reference Handbook, by Stuart Hoberman, Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis 6, Ind. 5 1/2 x 8 1/2 in., 128 pp. Paper, $1.95

A systematic approach for interpreting symptoms, isolating troubles, and repairing in shortest time. Color problems are included.

Electronic Devices and Networks, 217 pp.


These volumes cover theory, with math, of tubes, transistors, and the circuits that use them, including amplifiers, oscillators, pulse generators, etc. Written particularly for scientists and engineers who work in other fields, but must know how to use and operate electronic instruments.


You can build these test equipment projects and accessories to get more out of CB radio.


Introduction to (nonelectronic) dc and ac circuits using high school math up to trig functions and complex numbers. Many numerical problems are supplied with answers.

ABC’s of Electronic Drafting, by Howard W. Sams Engineering Staff, Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis 6, Ind. 5 1/2 x 8 1/2 in., 98 pp. Paper, $1.95.

Covers the subject extraordinarily well for its small size. The chapter on symbols is especially useful.


These two books tend to complement each other in their coverage. Mathematical Aspects of Physics is slanted toward the physical side with chapter heads and subheads such as “The Significance of Physical Measurement,” “Motion of Earth Around the Sun,” “Mechanical Vibrations,” “The Fields of Coils,” etc., while Mathematics and the Physical World uses such chapter
JOIN THE TECHNICIAN'S BOOK CLUB.

Make more money by joining the Technician’s Book Club. Read helpful electronics books by leading authors—at tremendous savings. Books sent on approval. Write for free bulletin.

GERSNBACH LIBRARY, Inc.
Dept. 123C, 154 West 14th Street, New York, New York 10011

MISCELLANEOUS 

ANTIQUES, ETC. 

BOOKS, MUSICAL 

RADIO - ELECTRONICS 

ADVERTISING INDEX 

Radio-Electronics does not assume responsibility for any errors appearing in the index below.

F.A.D. Andrea Radio Corp. .18 
Anglo American Acoustics Ltd. .60 
Apple Electronics, Inc. (RFC Div.) .21 
Atlas Sound Div. of American Trading & Investment Corp. .113 
ATR Electronics, Inc. .12

B & K Manufacturing Co. .103 
Brooks Radio & TV Corp .90, 100-101

Edward Applebee Co. .105 
Cintho Industries Corp. .74

Capitol Radio Engineering Institute .

test VTC Tivler Service播报

CBS 1000 PARTS SURPRISE, wide variety

$25 00 
2 Amp SCR 
SILICON CONTROLED RECT.
+ STU D only

FRE GIFT PAK 
Radio & TV Parts—Add 25c for handling 

CHOOSE ANY $1 ITEM FREE 
Both "Gifts" Free with $10.00 Orders

SILICON PLANAR
ANY TYPE $100 AND MESA TRANSISTORS IN TOS CASE

50 WATTS NPN TO-10 (like 2N642)

POWER TRANSISTORS TO3 CASE 


SILICON MESA HIGH 

50 WATTS POWER TRANSISTORS, 2N319, 2N642, etc.

WORLD'S MOST POPULAR 

$1 PARTS PAKS 

10 TRANSISTOR ELECTROLYTICS, to 1000uf 925 Radio - TV SURPRISE, wide variety

50 COILS & CHICIES, etc., etc., etc., etc., etc., etc., etc., etc., etc., etc.

10 AMP DROSSER TRANSISTORS

10 MEGA OHM RESISTORS, 100,000 ohms

10 25 AMP SILICON STUD RECTORS

50 WATTS NPN TO-10, 2N642, etc.

SILICON POWER TRANSISTORS 

10 AND MESA, PLUS OTHERS

10 2N319, 2N642, etc.

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THE SAME ENGINEERING, SAME PLANT THAT PRODUCES AMERICA'S GREATEST SATELLITE-TRACKING AND TELEMETRY STATIONS, HAS CREATED

The revolutionary new PARALOG
TV/FM ANTENNA

...Unparalleled performance because it has ALL 5:
- HIGHEST GAIN
- SHARPEST DIRECTIVITY
- EXTREMELY LOW VSWR
- BEST FRONT-TO-BACK RATIO
- RUGGED CONSTRUCTION

HERE IT IS—the space-age TV/FM antenna from the only manufacturer with actual experience in making space-probing antennas!

All new, the PARALOG is the first home antenna that really comes through with log-periodic design plus a unique parasitic-element system for maximum all-channel gain and pinpoint directivity. Exclusive Cycolac insulating mounts assure constant impedance, eliminate troublesome cross-feed design. Extremely rugged construction.

There are fourteen PARALOG antenna models, listing from $19.95, including four electronic PARALOGs with Super Powermate preamplifier, and three special FM stereo models. See your Jerrold-TACO distributor now, or write Jerrold Electronics, Philadelphia 32, Pa.
TRAP FOR FAULTY PICTURE TUBES

RCA Guards Against Callbacks 26 Ways

Under the watchful eyes of trained inspectors, RCA Silverama® Picture Tubes are carefully scrutinized for screen quality and focus.

All Silverama replacement picture tubes as well as those destined for original equipment undergo a battery of 26 automated tests. These include: warm-up, emission, gas, leakage, electron-gun performance, and other critical factors that can spell the difference between long-term performance or costly callback. Tubes failing a single test are automatically tagged and rejected. In addition to automatic testing, every tube lot leaving the RCA plant has been sampled by Quality Control.

Nothing is left to chance; part by part, inside and out, from base to faceplate the quality of each tube has been carefully controlled and assured prior to assembly. Even the Silverama envelope is carefully inspected prior to reuse, and is internally scrubbed, buffed, and restored to the peak of its optical capabilities. Result: a superior picture tube, an RCA Silverama. Make it your next installation choice.

RCA ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

The Most Trusted Name in Electronics

CARRY EACH SILVERAMA FACTORY-FRESH INTO YOUR CUSTOMER'S HOME. New Foam-Lined RCA Picture Tube Tote Bag makes scratched, marked, or scuffed faceplates a thing of the past. Makes carrying both easier and safer. Two sizes: one for 16" to 19" tubes, one for 20" to 24" tubes.

SEE YOUR AUTHORIZED RCA PICTURE TUBE DISTRIBUTOR FOR DETAILS