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~/P 75 X70

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Shortwave—Your Ear on the World

PAGE 32 TO 41

Antennas for Mobile Radio

SERVICE

Automatic Chroma Circuits

TV Detector Diodes

How to Get Started in 2-Way Radio

see page 32

200,000 OHMS PER VOLT

$110.00
SUGGESTED U.S.A. USER NET

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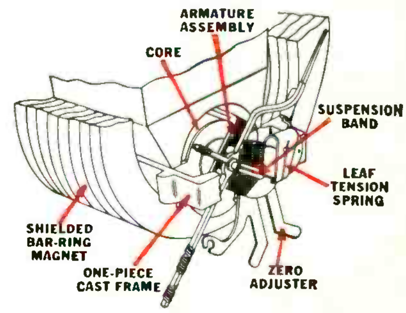
Model 630-NS
VOLT-OHM-MICROAMMETER

TRIPLETT SUSPENSION MOVEMENT

no pivots . . . no jewels . . .
no hair springs . . . thus NO FRICTION.



FACTS MAKE FEATURES

1. 200,000 OHMS PER VOLT D.C. sensitivity for greater accuracy on high resistance circuits. 20,000 OHMS PER VOLT A.C.
2. SUSPENSION METER MOVEMENT. No pivots, no bearings, no hair-springs; no rolling friction. Extremely rugged.
3. 62 RANGES. Temperature and frequency compensated. ± 1½% D.C. Accuracy, ± 3% A.C.

Low voltage ranges and high input impedance make the 630-NS especially useful in transistor circuit measurement and testing. Input impedance, at 55 volts D.C. and above, is *higher than most vacuum tube voltmeters.*

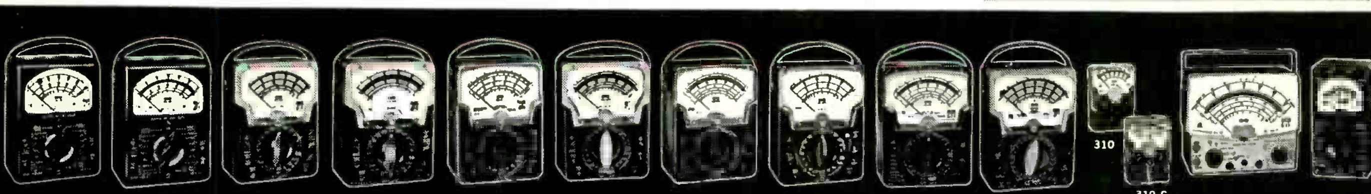
The unit is designed to withstand overloads and offers greater reading accuracy. Reads from 0.1μa on 5μa range. Special resistors are rigidly mounted and directly connected to the switch to form a simplified unit. Carrying cases with stands are priced from $12.60.

TRIPLETT ELECTRICAL INSTRUMENT COMPANY, BLUFFTON, OHIO

62 RANGES

D.C. VOLTS	0-0.6-3-12-60-300-1200 at 100,000 Ohms/Volt. 0-0.3-1.5-6-30-150-600 at 200,000 Ohms/Volt. 0-0.150 at 60μa
A.C. VOLTS	0-3-12-60-300-1200 at 10,000 Ohms/Volt. 0-1.5-6-30-150-600 at 20,000 Ohms/Volt.
DB	-20 to 77 in 10 ranges.
D.C. MICRO-AMPERES	0-5 at 300 MV. 0-60-600 at 150 MV. 0-120 at 300 MV.
D.C. MILLI-AMPERES	0-6-60-600 at 150 MV. 0-1.2-12-120-1200 at 300 MV.
D.C. AMPERES	0-6 at 150 MV. 0-12 at 300 MV.
OHMS	0-1K-10K-100K (4.4-44-440 at center scale)
MEGOHMS	0-1-10-100 (4400-44,000-440,000 Ohms center scale)

OUTPUT: Condenser in series with A.C. Volt ranges.



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LOOKING AHEAD

By DAVID LACHENBRUCH

1969 color set preview

A deluge of portables . . . more solid-state circuits . . . afc in more sets . . . slightly moderating prices. These will be the major trends in 1969 color sets scheduled for introduction this fall.

Most of the changes once again are evolutionary. The speed of costly technological advances has been tempered by the need to keep prices down in the face of mounting costs and intense competitive pressures. The new model year certainly will be the year of the color portable, with every manufacturer offering compact sets which can be toted about. Although most of these receivers will be in the 14" and 15" (diagonal) category, Admiral will phase in two new sizes—a 12" and a 16", both American-made. Some other American manufacturers will be going the import route for portables—notably Magnavox, Motorola and Philco-Ford for their new 14" and 15" models. Sony will offer limited quantities of its brand new 7" Chromatron portable color TV at a price expected to be (believe it or not) over $400!

The industry is headed in the direction of solid-state chassis, but slowly, and most new color sets will be hybrids. Many manufacturers are increasing the number of solid-state components in their receivers—particularly in i.f.'s, tuners, sound systems. But there will be a couple of solid-state sets: Motorola's Quasar 23" series, introduced last year. A new series (non-modular) from RCA, in September, at $875 and above. RCA's solid-state chassis will use a newly developed FET in its tuner.

Despite the addition of 2- and 3-year color-tube warranties, many sets will be priced below comparable 1968 models. This is due, in part, to a surprise reduction of $5 to $10 in manufacturer prices of 18", 20" and 23" color picture tubes. Initiated by RCA, it rapidly spread to other tube makers.

Labor-inclusive warranties

Hottest and most controversial topic in the television industry today is the warranty war. There's an undercurrent of feeling that the extended color-picture-tube warranty, which has now swept the industry, could backfire when the set owner discovers that he has to pay perhaps $50 to $65 for the labor to install his "free" tube. So manufacturers are readying standby labor-warranty plans in case the pressure gets too hot. Although such labor policies in the past have tended to alienate service technicians because they paid a specified fee for a specific job (often not enough for a profit), there seems to be a growing awareness that the technician should be the manufacturer's best friend.

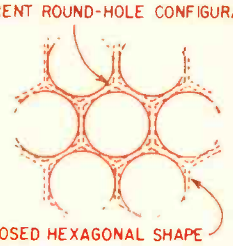
Westinghouse is setting the pace in this area. Its 1969 color sets will include a 90-day labor warranty (including installation and setup) that reimburses the servicing organization at its full posted retail prices. Philco-Ford is offering its dealers a color TV service policy that includes labor warranties of 2 years for picture-tube installation, 90 days for other repairs, at $29.95 per set. The company expects 90% of its 1969 color sets to be sold to consumers with this labor warranty "inboarded" as part of the retail price. More new approaches to labor-inclusive warranties are expected within the next year.

Low bass, low cost

Admiral Corp. has applied for a patent on a unique loudspeaker enclosure which provides extremely good bass response in a compact size and at low cost. The full-range system uses one cloth-edge 5¼" loudspeaker, mounted at the front of the enclosure, firing outward. The nonsealed box is the equivalent of a tuned pipe folded three times, resulting in a quarter-wave resonant tube. Its resonant peak is a low 30 cycles. Admiral has dubbed its speaker the Bull Horn and will feature it in three 1969 stereo consoles listing at $299.95. Because of its economy and compactness—it's only about 6" wide—it would appear to have important future applications in portable stereo phonographs.

More on color brightness

A relatively simple way to achieve a 10% increase in color-tube brightness without changing phosphor formulations or sacrificing resolution has been proposed to manufacturers by Buckbee-Mears Corp., manufacturer of metal shadow masks for color tubes. Buckbee-Mears' proposal is merely to make the holes in the shadow mask hexagonal, rather than round (see illustration), making the mask more transparent to electron beams and thereby permitting more of the electron stream to strike the phosphor dots on the face of the tube. Tube manufacturers are expected to adopt the new shadow-mask.



Mini-music

The teeny-bopper craze for music-on-the-go could popularize this fall a new type of phonograph record and playing instrument—a third system, taking its place alongside the LP and 45-rpm record formats. At least eight record labels, including such leaders as Capitol, Atlantic, ABC, Warner Brothers and Reprise, will release their latest pop tunes on flexible vinyl 3⅞" discs that play at 33⅓ rpm. Although the records can be played on any nonautomatic phonograph, a special instrument is being offered to play them. The battery-operated unit, to be introduced by Symphonic Electronic Corp., will play in any position, even while it is being carried. A model with a built-in AM radio will be priced at $29.95. R-E

Radio-Electronics

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FEATURE

BUILD ONE OF THESE

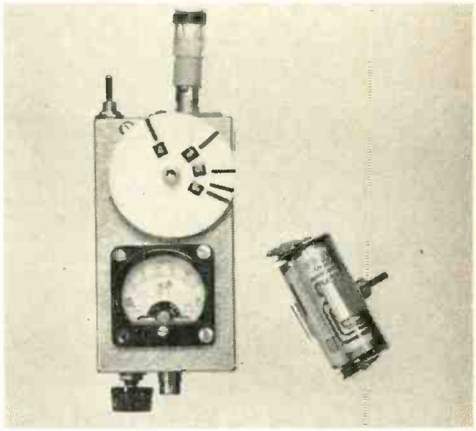
SERVICING

GENERAL ELECTRONICS

DEPARTMENTS

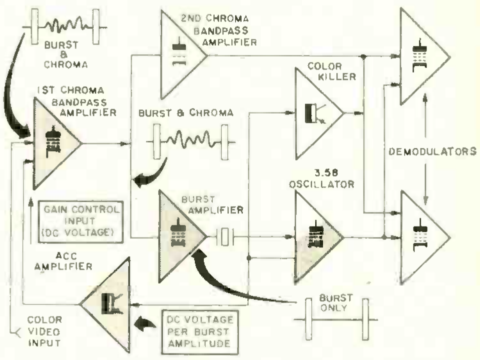
VHF receivers tune in police, fire, aircraft, marine, weather and other broadcasts. Get up to date on what's happening. Listen in on some of the 5-million 2-way radio listeners now licensed by the FCC.

See page 37



Grid dip meter uses a 1-transistor circuit to check resonant frequencies of tank circuits and to test the values of unknown coils or capacitors.

See page 61



17 detector diodes play an important part in the deflection systems of b-w and color TV receivers. Yet they often develop faults that can be hard to find. See how they work and learn how to spot the troubles they can cause.

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RADIO-ELECTRONICS, AUGUST 1968, Volume XXXIX, No. 8
Published monthly by Gernsback Publications, Inc., at Ferry St., Concord, N. H. 03302.
Editorial, Advertising, and Executive offices: 200 Park Ave. S., New York, N. Y. 10003. Subscription Service: Boulder, Colo. 80302.
Second-class postage paid at Concord, N. H. Printed in U.S.A. One-year subscription rate: U. S. and possessions, Canada, $6. Pan-American countries, $7. Other countries. $7.50. Single copies: 60c.

POSTMASTER: Notices of undelivered copies (Form 3579) to Boulder, Colo. 80302.

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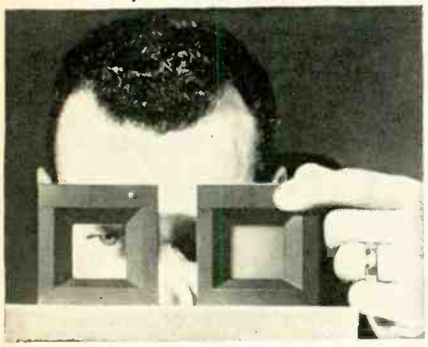
Radio-Electronics is indexed in *Applied Science & Technology Index* (formerly *Industrial Arts Index*)

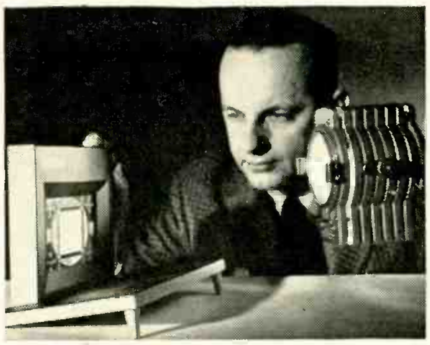
NEWS BRIEFS

See Dec p. 6

LIQUID CRYSTAL DISPLAYS



Clear and frosted. The only difference between the two windows is that an electric field has been applied to the one on the right, causing the liquid crystals to become opaque.

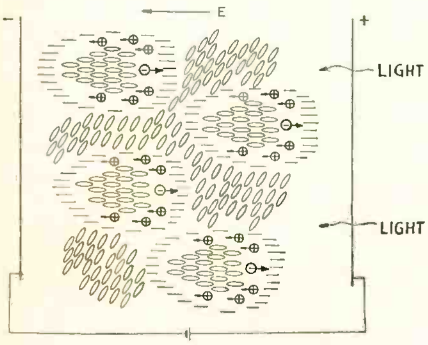


Images are seen by reflection and grow stronger when light shining on the display is increased. The contrasts with most displays, such as CRT's which "wash out" under bright light.

A major step toward flat TV screens and similar display devices has been made by RCA with their announcement of flat, low-power low-cost displays using a newly discovered electro-optical effect of liquid crystals. Displays shown recently by RCA can reproduce any graphic data electronically and can be addressed and driven by integrated circuits.

Liquid crystals are organic compounds having the mechanical properties of a liquid—they can be poured—and the regular molecular arrangements of a solid crystal. RCA Laboratories, Princeton, N.J., determined that certain transparent liquid crystals turned milky white when exposed to electric fields. When the field was removed they reverted to their transparent state.

What actually happens to the liquid crystal is shown in the diagram. When an electric field is set up it creates ions that travel through the crystal material. These traveling ions then produce a turbulence that causes a scattering of light which gives the liquid crystal its milky appearance.



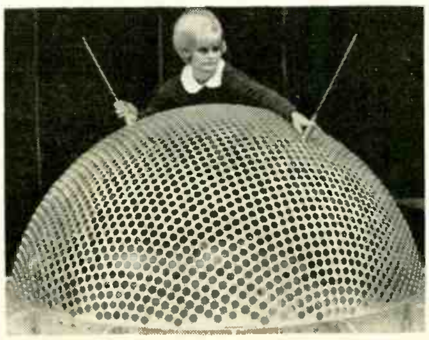
Ions in transit cause disruptions in liquid crystal that result in turbulence that turns liquid white. The ions are created when an electric field is applied to the liquid crystals.

To build a display a film of liquid crystal only 0.001" thick is placed between two sheets of thin glass. The inner face of each glass sheet is coated with an electrode and at least one of these electrodes is transparent. In effect, the display is a parallel-plate capacitor in which the liquid crystal acts as a dielectric. Displays have been built as large as 3 x 4" and there seems to be no reason to prohibit making substantially larger versions.

Little power is needed to operate the display. The gray scale varies with the intensity of the applied voltage, which can range from 6 to 60 volts. Power is 1 mw per square inch, either dc or pulsed. Pulsed power is used when motion is required, the pulses being addressed to individual minute areas of the display in proper sequence.

RADAR "COLANDER"

For draining spaghetti it's not. This radar antenna complete with 16,000 holes is the receiving array for a scaled-down prototype of a new phased array radar system called ADAR (Advanced Design Array Radar) being built by Hughes Aircraft for the Air Force. "Colander Girl" Joyce Molkey is holding two of the 16,000 energy feeds that will extend from the holes.



FCC GETS SUPREME COURT OK TO REGULATE CATV SYSTEMS

In a 7 to 0 decision the Supreme Court has upheld the authority of the FCC to regulate CATV (Community Antenna Television) systems. The Court's statement said that Congress had given the FCC "broad responsibilities" to control the orderly development of local TV broadcasting. It went on to say the FCC was right in taking the stand that "successful performance of these duties demands prompt and efficious regulation" of cable transmission systems.

This decision reversed an earlier ruling by the Court of Appeals and immediately affects cable companies in Los Angeles and San Diego. However, the ruling is likely to affect other cable operations throughout the U.S.

ELECTRIC MINI-BUS

Capable of speeds to 35 mph, this 12-passenger electric bus is powered by two 84-volt Exide industrial-type

lead-acid cells. The vehicle, made by Battronic Truck Corp., Boyertown, Pa., uses SCR controls to provide fast starts, smooth operation and maximum range. Truck versions of this vehicle are also available.

MORE SPECTRUM AVAILABLE

The Federal Government has just announced it is turning back half of the frequency space between 890 and 942 MHz. This space will be reassigned to nongovernment users by the FCC. According to *Television Digest*, TV engineers and broadcasters want to assign this space to mobile radio. The exact frequencies to be made available are still to be determined.

WM. LYON McLAUGHLIN 1900-1968

As our Technical Illustration Director he was primarily responsible for the thousands of circuit diagrams and other illustrations that have graced our pages for the past 24 years. As a friend and artist he will always be fondly remembered. **R-E**

Columbia Stereo Tape Club

now offers you ANY 5 STEREO TAPES FREE

if you begin your membership by purchasing just one tape now, and agree to purchase as few as five additional selections during the coming year, from the more than 300 to be offered

JUST LOOK AT THE FANTASTIC SELECTION of best-sellers the Columbia Stereo Tape Club is now offering new members! The greatest stars . . . the biggest hits . . . and all available in the incomparable stereo fidelity of 4-track reel-to-reel tape! To introduce you to the Columbia Stereo Tape Club, you may select any 5 of the stereo tapes shown here, and we'll send them to you FREE! That's right . . . 5 FREE STEREO TAPES, and all you need do is purchase one tape now at the regular Club price, and agree to purchase as few as five more tapes during the coming year. In short, at the end of a year, you'll have at least eleven brand-new stereo tapes, and you'll have paid for only six!

HOW THE CLUB OPERATES: Each month you'll receive your free copy of the Club's magazine which describes and displays tapes for many different listening interests and from many different manufacturers. You may accept the regular selection for the field of music in which you are primarily interested, or take any of the scores of other tapes offered you, or take no tape at all that month.

YOUR OWN CHARGE ACCOUNT! Upon enrollment, the Club will open a charge account in your name. You'll pay for the tapes you want only after you've received them and are enjoying them. The tapes you want will be mailed and billed to you at the regular Club price of $7.95 (occasional Original Cast recordings somewhat higher), plus a small mailing and handling charge.

YOU GET MORE FREE TAPES! Once you've completed your enrollment agreement, you'll get a stereo tape of your choice FREE for every two tapes you purchase!

SEND NO MONEY NOW! Just fill in and mail the coupon today!

Note: All tapes offered by the Club must be played back on 4-track stereo equipment.

APO, FPO addressees: write for special offer

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SEND NO MONEY—JUST MAIL COUPON

COLUMBIA STEREO TAPE CLUB
Terre Haute, Indiana 47808

Please enroll me as a member of the Club. I've indicated at the right the five tapes I wish to receive FREE. I've also indicated the tape I am buying now as my first selection, for which I am to be billed $7.95, plus postage and handling. Include the self-threading take-up reel FREE.

My main musical interest is (check one):

☐ CLASSICAL ☐ POPULAR

In addition to the first selection I am buying now, I agree to purchase five additional selections during the coming year . . . and I may cancel membership at any time thereafter. If I continue, I am to receive a stereo tape of my choice FREE for every two additional selections I accept.

I AM BUYING THIS TAPE NOW (fill in number)

ALSO SEND THESE 5 TAPES — FREE!

Name ....
(Please Print) First Name Initial Last Name

Address ....

City .... State .... Zip ....

432-5/49

 T-103/F68

Circle 9 on reader's service card

Correspondence

READERS WANT—

Thanks for the informative article, "Operational Amplifiers" by Thomas H. Lynch (May 1968). Keep those solid-state articles coming.

JIM PERLBERG
Racine, Wis.

They're coming, Jim. See "Computerized Lighting System for Cars". It starts in this issue.

I am very happy with RADIO-ELECTRONICS magazine because of the many construction projects, such as "Modern FM Stereo Adapter (November 1967). I would like to see a project on an FM tuner.

HERBERT J. GORMLEY
Howard Beach, N. Y.

OK Herb, we'll see what we can line up. Meantimes, check October for a dandy you-built-it compander.

Your publication is slowly changing to a servicetech type magazine. I question just how many service technicians read R-E compared to those of us who enjoy your projects and construction ideas.

E. A. ORLOWSKY
Garrison, N. Y.

Take a look at our June cover and note that we feature four construction articles. But remember, a good number of our readers are service technicians. We do not avoid good construction projects: on the contrary, we look for them. We try to present the practical side of electronics to servicetechs, installers, engineers, designers, experimenters too.

TIPS FOR TAPE FANS

My tape recorder makes it possible for me to enjoy the friendship of tape enthusiasts throughout the world, and the article, "Tape Recorder Tips and Techniques" by Earl Snader (March 1968), interested me very much. Apparently, other "voicepon-

(continued on page 12)

Radio-Electronics

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RADIO-ELECTRONICS is published by
Gernsback Publications, Inc.
200 Park Ave. South
New York, N.Y. 10003
(212) 777-6400

President: M. Harvey Gernsback
Vice President-Secretary: G. Aliquo

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UNITED KINGDOM
Publishing & Distributing Co., Ltd, Mitre House, 177 Regent St., London W.1, England

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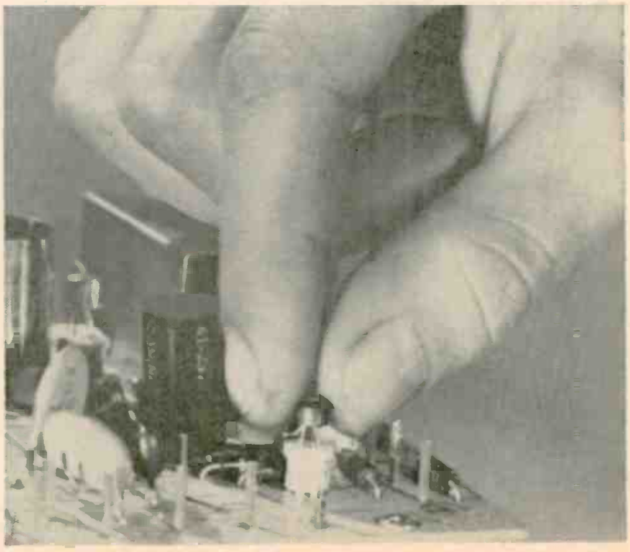
WHAT'S NEW

Electronic eyeball is flea-size eye for laser communications and rangefinding gear. Light passes through the glass opening and strikes a chip of light-sensitive material inside the laser detector, triggering an "avalanche" flow of electrons. The Texas Instruments device is said to be 200 times more sensitive than presently available units. Its bandwidth is great enough to cover vhf and uhf TV bands.

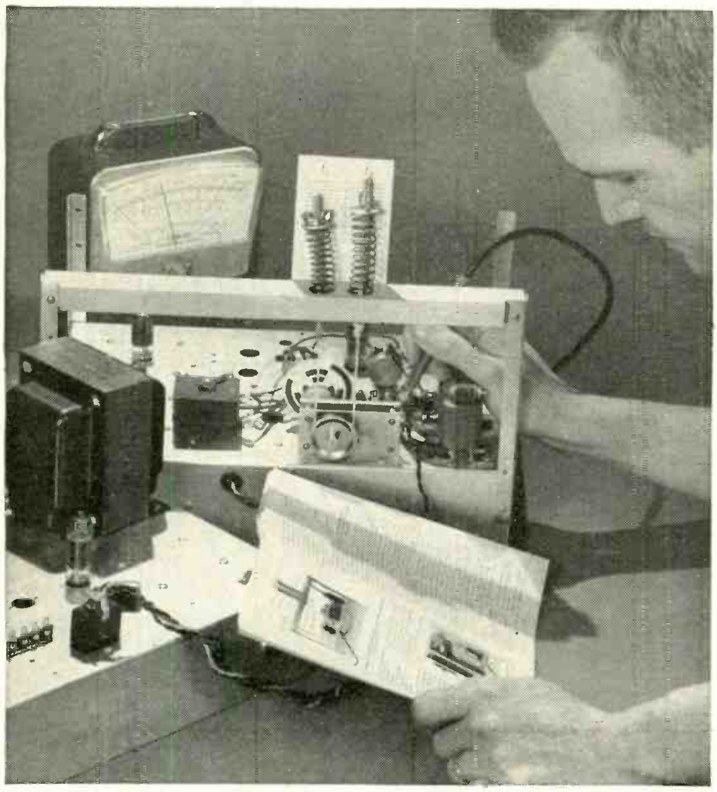
Hip-Pocket records play at 45-rpm, but measure a mere 3⅞" in diameter and are just a few flexible mils thick. They're made out of unbreakable pure vinyl and you can easily stuff a dozen or more into your pocket. Philco-Ford makes the records and the player.

Executive "View Phone" will soon connect top executives at Tokyo Shibaura Electric Co. (Toshiba) in Japan. The experimental system will enable Toshiba executives to confer face to face without leaving their offices. The phone has a 3⅜" x 4½" screen with 315 scanning lines for a 500-kHz video bandwidth.

Plug-in transistors speed servicing in Sylvania's new Gibraltar color TV chassis. It contains 27 transistors in all; 23 of which plug in. There are also 22 diodes, an integrated circuit and 9 receiving tubes. The plugability concept also includes the tuner cluster, deflection yoke, convergence section, automatic degaussing section, speakers and remote control unit.



EXPERIENCE IS STILL YOUR BEST TEACHER



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Read opposite page.

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CORRESPONDENCE
(continued from page 6)

dents" found it of interest, for although I originally read it in RADIO-ELECTRONICS, two of my "voicepondents" have since told me about it on tape. One of these, by the way, is from Toronto, so I guess you do get around.

Mr. Snader's statements about the important aspects of compatibility in tape recorders is very true, and it is even more essential in conducting "voicepondence" as I do. This is why the Voicespondence Club, in compiling its directories of members, is careful to list the type of recorder owned by each member, including the speeds at which it will operate. The club's members are cautioned to pay strict attention to this data when selecting prospective contacts. People prefer to "voicepond" at different speeds. One of the greatest pleasures of "voiceponding" with tape friends is exchanging ideas and opinions.

Your tape friend may have a better way of building something, of a method of making a piece of equipment operate more efficiently, or of experimenting with a new idea. Regardless of the subject, it is always a pleasure to hear from a distant friend through the medium of magnetic tape. So why not put that tape recorder to good use and discover the unique hobby of "voiceponding"?

The Voicepondence Club, Noel, Virginia, has a membership of 2,000 voicespondents all over the world who are eager to cultivate friendships through the medium of the tape recorder and magnetic tape. If your readers would like to join, they can write to the club. Since it is a nonprofit organization, please include a stamped return envelope.

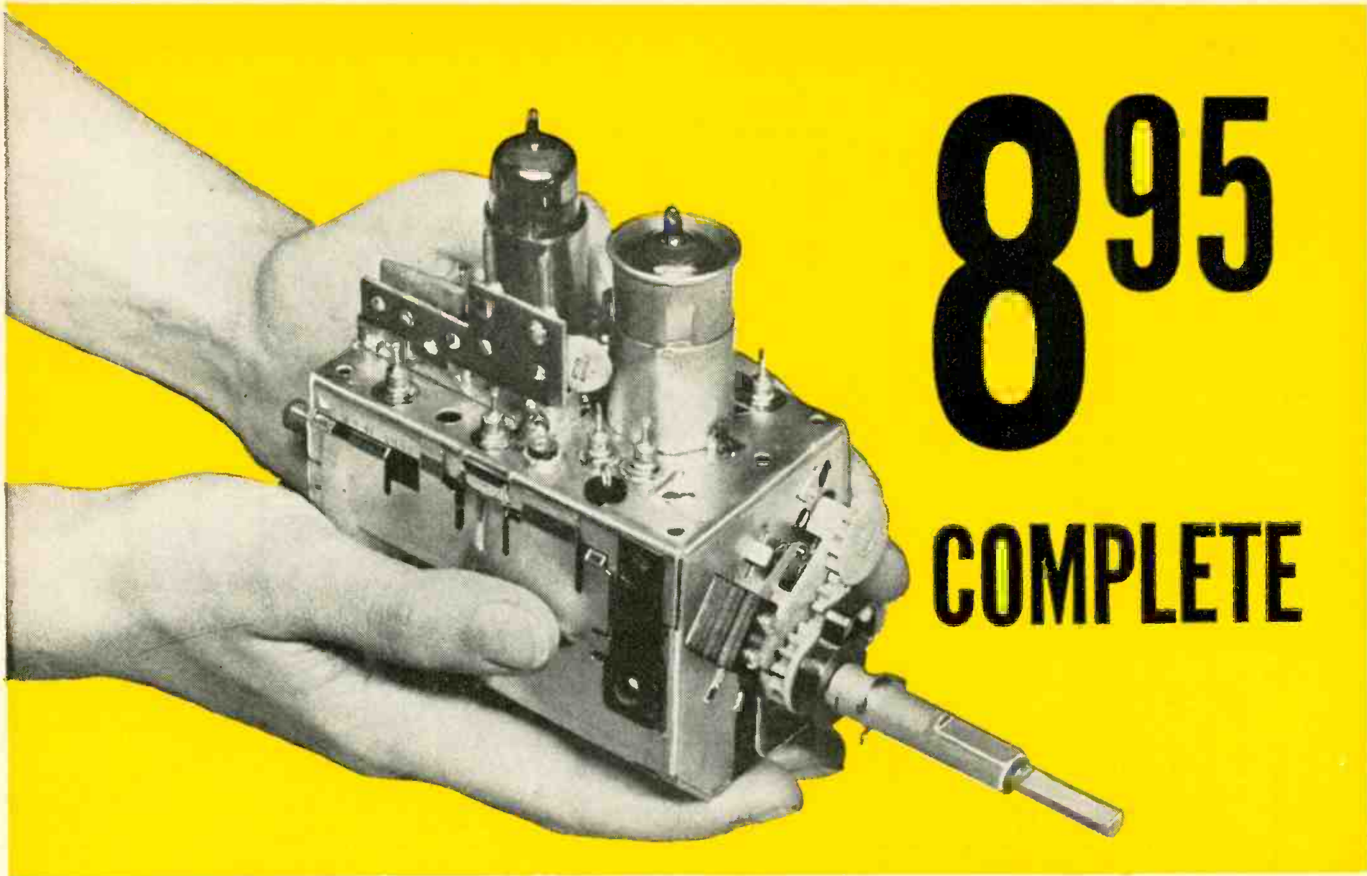
GERALD J. PAICE
Arlington, Mass. 02174

THE PRICE YOU HAVE TO PAY

RADIO-ELECTRONICS is an interesting and versatile publication. However, my one complaint is that I find it difficult to build by your instructions. The cause is the high price of parts. One example is Fairchild's μL 914 which costs about $6 here. Do manufacturers control prices of their components abroad?

RIKU MAKI
Aura, Finland

Manufacturers do not control prices overseas. Costs of shipping and foreign import taxes tend to raise prices. This
(continued on page 14)



Castle, the pioneer of television tuner overhauling, offers the following services to solve ALL your television tuner problems.

● **OVERHAUL SERVICE** — All makes and models.

VHF or UHF tuner	$9.95
UHF-VHF combination (one piece chassis)	$9.95
TRANSISTOR tuner	$9.95
COLOR tuner (Guaranteed color alignment . . . no additional charge)	$9.95

Overhaul includes parts, except tubes and transistors.

Simply send us the defective tuner complete; include tubes, shield cover and any damaged parts with model number and complaint. Your tuner will be expertly overhauled and returned promptly, performance restored, aligned to original standards and warranted for 90 days.
UV combination tuner must be single chassis type; dismantle tandem UHF and VHF tuners and send in the defective unit only.

And remember—for over a decade Castle has been the leader in this specialized field . . . your assurance of the best in TV tuner overhauling.

● **CUSTOM REPLACEMENTS**
Exact replacements are available for tuners that our inspection reveals are unfit for overhaul. As low as $12.95 exchange. (Replacements are new or rebuilt.)

● **UNIVERSAL REPLACEMENTS**

Prefer to do it yourself?

Castle universal replacement tuners are available with the following specifications.

STOCK No.	HEATERS	SHAFT Min.*	SHAFT Max.*	I.F. OUTPUT Snd.	I.F. OUTPUT Pic.	PRICE
CR6P	Parallel 6.3v	1¾″	3″	41.25	45.75	8.95
CR7S	Series 600mA	1¾″	3″	41.25	45.75	9.50
CR9S	Series 450mA	1¾″	3″	41.25	45.75	9.50
CR6XL	Parallel 6.3v	2½″	12″	41.25	45.75	10.45
CR7XL	Series 600mA	2½″	12″	41.25	45.75	11.00
CR9XL	Series 450mA	2½″	12″	41.25	45.75	11.00

*Selector shaft length measured from tuner front apron to extreme tip of shaft.

These Castle replacement tuners are all equipped with memory fine tuning, UHF position with plug input for UHF tuner, rear shaft extension and switch for remote control motor drive . . . they come complete with hardware and component kit to adapt for use in thousands of popular TV receivers.

Order universal replacements out of Main Plant (Chicago) only.

CASTLE TV TUNER SERVICE, INC.

MAIN PLANT: 5715 N. Western Ave., Chicago, Illinois 60645
EAST: 41-96 Vernon Blvd., Long Island City, N.Y. 11101

Circle 13 on reader's service card

CORRESPONDENCE

(continued from page 12)

would be comparable to a US citizen buying a foreign car. It stands to reason that prices rise when products are imported. We hope you'll find our magazine so enlightening you won't mind paying a little more for parts.

AC/DC CALIBRATOR

Regarding the article, "Build Ac/Dc Calibrator for Scope and Voltmeter" by Peter E. Sutheim (February 1968), I have just finished putting my version of this unit together. It works fine, just as he said it would. I also have the slight tilt of the top of the chopped square wave, as the article mentioned. Thanks for a fine, well-written article. I can't quite figure where you got those crazy values of precision resistors. I couldn't find them listed in any of my catalogs so I used the old trick of paralleling a batch of 5% jobs. Worked nicely.

HERBERT L. FOSTER
Kalaheo, Kauai, Hawaii

The resistors, neat-valued though they are, are not standard 1% values. But Aerovox makes them, and they are listed in the Newark Electronics Corp. catalog (their address is 500 N. Pulaski Rd., Chicago, Ill. 60624). Newark has a $2.50 minimum-order policy, so you may want some other items along with the resistors.

NEEDS A HANDBOOK

Can any of your readers sell or loan me a handbook and/or schematic diagram for a DuMont cathode-ray oscillograph, Type 241? DuMont can no longer supply the manual and it is unobtainable in England. I will be grateful if your readers can help me and I will, of course, meet any expenses incurred.

JAMES BARTON
21 A Conrad Close
Worsley Mesnes
Wigan, Lancashire, England

MODIFIED RADIO FOR INTERCOM

My curiosity caused me to alter a radio to double as an intercom, after reading "Noteworthy Circuits" (January 1968). I must say that I am amazed with the results. I have seen many conversion layouts, but most called for more extensive modifications. I was able to convert my radio without spending one cent. I used spare parts from what I call my catch-all box. Only one thing, why the de-

(continued on page 16)

CORRESPONDENCE
(continued from page 14)

tector connection? I found the reception much better without this connection.

WILLIAM H. BELLE
New York, N.Y.

You need the detector connection to enable the radio to function as a radio. If the intercom worked better without this connection, it is possible that you were picking up hum and other interference from unshielded leads or from leakage across the switch that came out of your catch-all box.

IGNITION SCOPE PROJECT WANTED

As a faithful reader of yours since September, 1953, (I have the magazines to prove it) I have watched for an article in vain. Most readers have cars and a good many have oscilloscopes. How about an article showing how to use a regular scope to check ignition. I would like to get a single display on the scope showing all cylinders in action. I am getting a good electronics education from your fine magazine.

FRED L. STRICKER
Springfield, Mass.

Will do, if we can get one of our authors to write this up. Waveforms and their meanings would be an essential part of such an article.

CB SOUPER UPPER

I bought your RADIO-ELECTRONICS magazine just recently and liked it very much, especially the construction projects. I would like to see you publish instructions on how to build a radio frequency preamplifier for a 5-watt CB transceiver.

JOHN E. RIVERA
Bronx, N.Y.

No can do, John; it isn't legal.

AUTHOR, AUTHOR

Please send address of James A. Gupton, Jr., author of "Battling Bollworms with Ultrasound" (March 1968). I would like to build similar equipment for our experiments.

JACK FRISBIE
Supt. Electric Dept.
City of Richland, Wash.

As a matter of courtesy to our authors, we do not release their addresses, but we do forward letters such as yours and leave it up to them to respond. **R-E**

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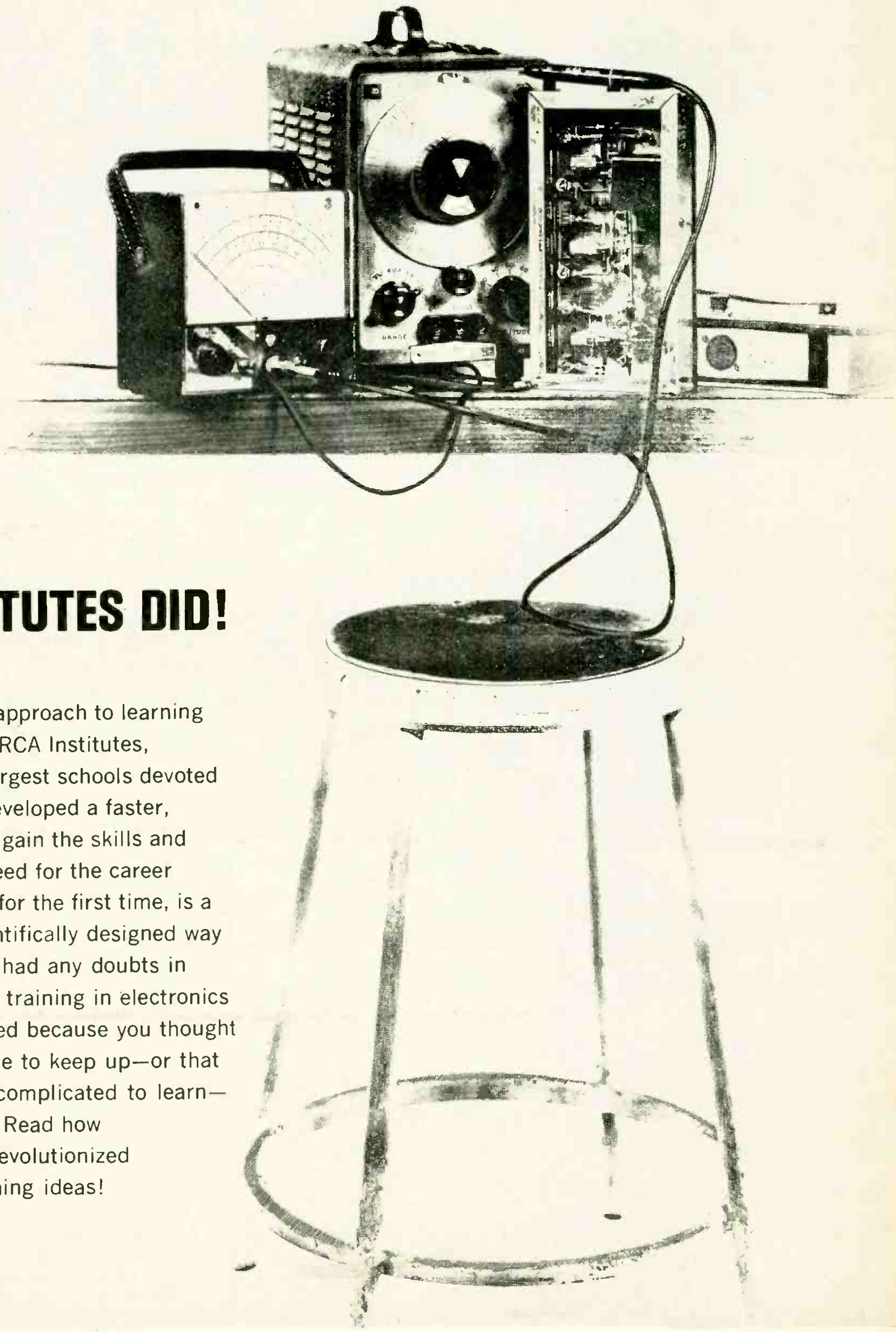

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In the Shop . . . With Jack

By JACK DARR

TRANSISTOR TV POWER SUPPLIES

JUST AS IN TUBE RECEIVERS, POWER supplies are one of the major trouble sources in transistor TV's. The power-supply circuits used in these sets may look complicated, but they're really not. You'll find a few unusual applications of standard circuits, but the only difference will be higher currents and lower voltages.

A lot of supplies will be "straight" rectifier–filter circuits. Fig. 1 shows the power-supply circuits of the Magnavox 908 series transistor TV chassis. The bottom circuit has a standard full-wave rectifier. The only difference is in polarity; formerly the ends of the transformer secondary were hooked to the rectifier anodes. Now they're connected to the rectifier cathodes and the anodes are grounded. So, B+ comes out at the center tap of the secondary winding.

This B+ output feeds a divider circuit. Part of it goes through a π-section filter, and comes out as a +14.5-volt supply for the horizontal driver stage. The other part goes through its own π-section filter, and comes out as a 12-volt supply for sync, i.f. and other stages. This is regulated by a 12-volt Zener diode.

One key to the condition of these circuits is current drain, which is shown in Fig. 1. If any circuit is "out of order," it will show up as drawing too much or too little current.

In actual servicing, there seems to be a fairly wide tolerance. Some voltages and currents can vary widely before they cause trouble and some can't. In critical circuits, such as agc or sync clippers, specified voltages had better be exactly right.

Now look at the upper part of the diagram. Rectifiers A and B, with the center-tapped transformer secondary, form a full-wave rectifier circuit with a standard π-section filter. This is the highest-current circuit, and a filter choke is used for better regulation.

An ordinary *half-wave rectifier* is at E. They could have used one more secondary winding, but why? Input ac voltage is picked up from one end of the secondary winding, rectified, filtered and divided into the +110-volt and +140-volt supplies for audio and video outputs. Looking at the circuit *in sections*, then, you can see there's nothing unusual.

The power-supply circuits in Fig. 2 are used in RCA's KCS-153 transistor TV. There are only two voltage supplies: a +140-volt source for the

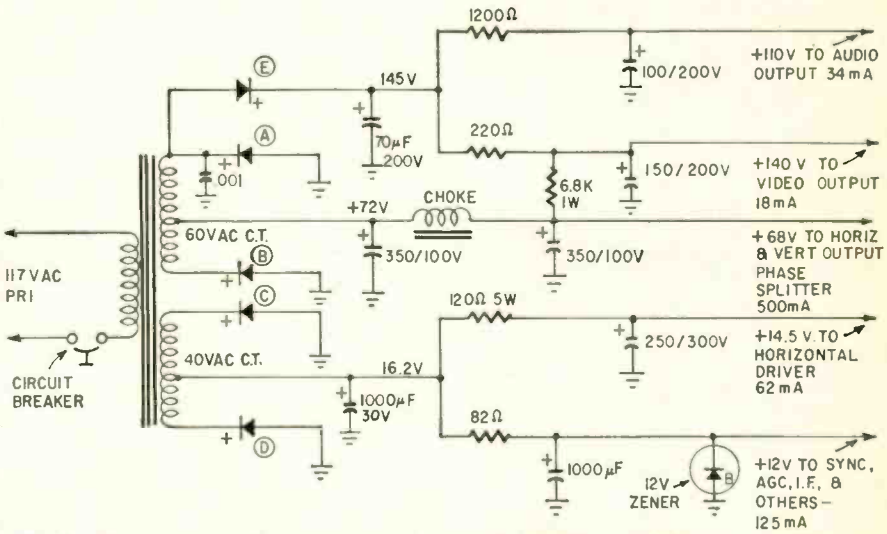

Fig. 1—Magnavox supply transformer is tapped for full- and half-wave rectification.

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Check this chart for the FINCO "Signal Customized" Antenna best suited for your area.

STRENGTH OF UHF SIGNAL AT RECEIVING ANTENNA LOCATION	Strength of VHF Signal at Receiving Antenna Location				
	NO VHF	VHF SIGNAL STRONG	VHF SIGNAL MODERATE	VHF SIGNAL WEAK	VHF SIGNAL VERY WEAK
NO UHF		CS-V3 $11.50	CS-V5 $18.50 / CS-V7 $25.95	CS-V10 $37.95	CS-V15 $50.95 / CS-V18 $59.50
UHF SIGNAL STRONG	CS-U1 $10.50	CS-A1 $19.95	CS-B1 $31.50	CS-C1 $45.95	CS-C1 $45.95
UHF SIGNAL WEAK	CS-U2 $15.95	CS-A2 $23.95	CS-B2 $41.95	CS-C2 $54.50	CS-D3 $73.50
UHF SIGNAL VERY WEAK	CS-U3 $22.95	CS-A3 $32.50	CS-B3 $52.50	CS-C3 $62.95	CS-D3 $73.50

All Prices Subject to Change

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NOTE: In addition to the regular 300 ohm models (above), each model is available in a 75 ohm coaxial cable download where this type of installation is preferable. These models, designated "XCS", each come complete with a compact behind-the-set 75 ohm to 300 ohm balun-splitter to match the antenna system to the proper set terminals.

THE FINNEY COMPANY

34 West Interstate Street · Dept. RE · Bedford, Ohio 44146

Circle 19 on reader's service card

video output, etc., and a regulated 30-volt source for the other stages.

Here, we can see what looks very much like one of the "stacked" circuits used in two-way FM transmitter power supplies. The takeoff point for the +140-volt supply is not returned to ground, but to the positive output of the full-wave bridge rectifier at X. This makes no difference in the operation of the circuit.

If the lower end of the 115-volt ac secondary winding had been returned to ground, the output would be about +105 volts dc. By returning the upper circuit's B− point to the +35 volts, they save that much winding. This is exactly like connecting two 4.5-volt batteries in series to get 9 volts.

Transistorized "filter"

The only other unusual feature in this supply is the transistor voltage regulator. It is marked "Power Filter" on this schematic. In other sets, you'll find the same circuit called "Capacitance Multiplier".

This type of circuit is very fast-acting. It can hold the dc output voltage so nearly constant that it *does* act as a "filter." (It "regulates" so quickly that it takes out the ripple, as all filters do.) The "capacitance multiplier" name comes from the fact that it multiplies the size of the control transistor's base capacitor, C3. A 50-μF capacitor here will provide as much filtering as an electrolytic capacitor of several thousand microfarads. Regulator action, of course, comes from controlling the emitter–collector current of the upper (series) transistor, by varying the base voltage of the lower, or control, transistor.

When you're working on transistor supplies, look for familiar signs of power-supply trouble: bends and wiggles in the picture, narrow raster, hum in the sound, vertical instability, etc. Look for any sign of ripple on the dc voltage-supply lines with a scope.

With these elaborate filters and regulator circuits, ripple must be very, very small, if not nonexistent. So, if you go poking around in the voltage supply, say, to a video amplifier or sync-separator stage, and find about 2.5 volts p-p of ripple, look out!

Other symptoms will be the same. In a KCS-153, I had a very odd-looking raster: only the lower half of the screen was covered, with the upper part a wild mess of lines. Also, there was a slight bending in of the raster sides, and a few other symptoms. The power transformer was very warm, as was the 20—40-μF electrolytic (C2) on the +140-volt supply.

The half-wave rectifier was shorted. This applied almost pure ac to the electrolytic, which got very hot from leakage current. The 1000-μF input filter capacitor on the bridge rectifier was almost open. Since the shorted rectifier should have supplied the video stage, and the low-voltage supply the vertical stages, we had a mess. Replacing the bad parts cleared up the whole thing, restoring normal operation.

Some parts may be hard to get at, like the half-wave rectifier. This was concealed on the PC board under a bracket. Most of the parts are in the open, though, and are no harder to replace than their counterparts in tube-model receivers.

For a definite check, measure voltages and currents, and check the ripple voltage on the main dc voltage-supply lines. These three tests will quickly debug any kind of transistor power-supply problems, in television, radio or stereo. **R-E**

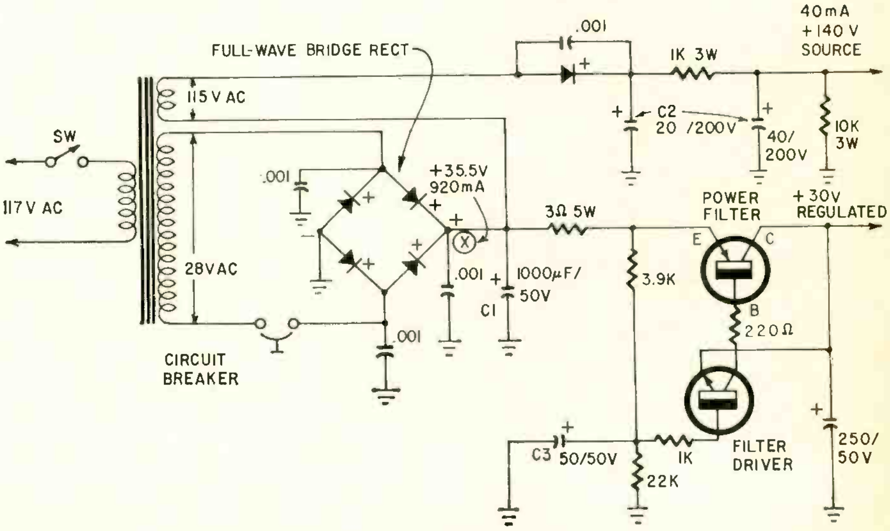


Fig. 2—RCA circuit regulates +30-volt supply with fast-acting transistorized "filter."

Starlight Scope Sees In The Dark

Light amplifier gives images a 40,000 times boost

By ERIC LESLIE

THE ARMY ELECTRONICS COMMAND has revealed details of its Starlight Scope, now being effectively used in Vietnam. Equipped with this scope—a true light amplifier—United States forces and allied and Vietnamese units equipped by the US can turn the darkest jungle night into greenish daylight.

During a recent demonstration at Fort Monmouth's Hexagon Building, press representatives heard movements on a darkened auditorium stage. The hall was pitch black and you couldn't see your hand before your face. But looking through the Starlight Scope, a jungle night scene sprang into life.

An American soldier with a scope-equipped rifle "captured" a Viet Cong guerrilla, while a girl in Vietnamese costume walked demurely by at the rear of the stage.

The scene was illuminated, but the light intensity was much dimmer than starlight—darker in fact than a foggy midnight. Even heavy overcast, said Army specialists, lets enough light through for the scope. Under heavy jungle cover, luminescence from decaying vegetation—invisible to the naked eye—is often enough to illuminate a scene.

What is this new device that in the words of one foot soldier has "taken the night away from Charlie?" We've had night-vision devices before; the original Snooperscope was first described in this magazine in June, 1946 (*Radio-Craft*, page 603). But those devices required an infrared light source mounted with the scope. The "black light" was beamed at the target, the Snooperscope picked up the reflected light, converted it first to electrons, then to visible light on the face of a phosphor-coated tube. The device was limited in range, bulky and heavy; had a narrow field of vision and could be discovered by the enemy with a simple infrared detector.

The new instrument is a true light amplifier. Its gain of 40,000 produces from weak starlight a clear picture that looks like a miniature TV

Starlight scope easily brings out details of tank on the darkest overcast jungle night.

display on a tube face coated with greenish phosphor.

How is it done? The key words are "image intensifier." Two innovations make this intensifier much more effective than anything developed to date: *cascade amplification* and *fiber optics*. The instrument is a three-stage light amplifier.

The faintest light from the target is focused through an objective lens onto a photocathode, which emits electrons that strike a phosphor screen and produce brighter light (see diagram). This light is focused on a second cathode, and the process is repeated with a third. The light on the third phosphor screen is viewed through an eyepiece. The greenish appearance of the screen image is due to

Rifle-mounted Starlight Scope has a 3" objective lens and ¼-mile effective range.

its high-sensitivity phosphor, much like that on the face of an oscilloscope tube.

In earlier night-vision instruments, any attempt at cascading would have been impractical, since a lens system with usable resolution and low distortion at the edges of the field of view would have been too long. Fiber optics solved that problem.

Fiber-optic lenses can be placed much closer together than can ones of ordinary optical glass. Light beams are trapped inside individual fibers, and designers can construct lenses with almost any desired characteristic.

Manufacture was further simplified by making each light-amplifier stage as a module, then joining them optically and mechanically to form the three-stage scope.

A solid-state power supply provides 45,000 volts to the three units, which are connected in series, 15,000 volts each. So little power is used that a 6.75-volt, heavy-duty mercury battery with a life of 72 hours can be used.

Three types used

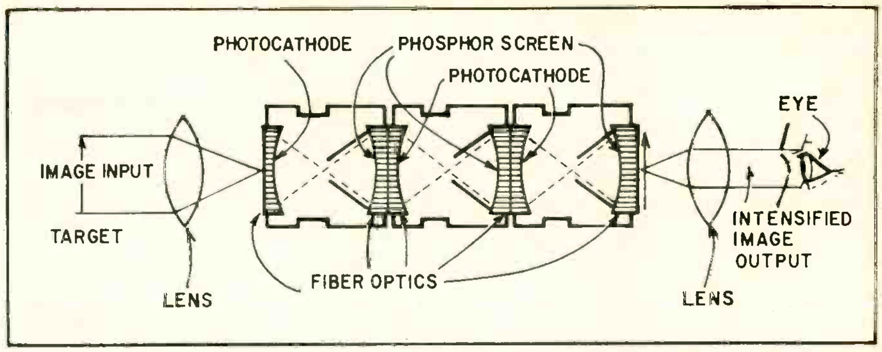
Presently, three versions of the scope are being issued to military forces. The large Night Observation Device has a 9″ objective lens, a range of 1200 meters (about ¾ mile), a 9° field of view and an optical magnification of 7 times. It weighs 38 pounds.

The Crew-Served Weapon Sight weighs 16 lb, has a 6″ objective lens (magnification also 7 times) and a 5.6° field of vision. It is used on a variety of machineguns and light field pieces.

The Small Starlight Scope is intended for rifle mounting. This scope's range is about 400 meters, a little less than ¼ mile. The field of view is wide, 10.4°, but the optical magnification is only 4 times, with a 3″ objective lens. It weighs 5.75 lb.

Developing and getting the new devices into soldiers' hands was a triumph in itself. The Army Electronics Command devoted a whole laboratory (the Night Vision Lab at Fort Belvoir, Va.) to the development, and it was rushed through production by an all-industry effort in which Raytheon and its subsidiary, Machlett Labs, RCA, Varo, Electro-Optical Systems and ITT participated. Complete units cost between $2000 and $5000, depending upon their size.

With the equipment declassified, numerous civilian applications appear to be in sight. Raytheon believes they will be used by law enforcement officials, naturalists, behavioral psychologists, underwater explorers, marine navigators, airline pilots and others who need to see in the dark. It's unlikely, however, that any tubes will be available for civilian use while hostilities continue. **R-E**



Three-stage light intensifier consists of separate but similar modules for each stage.

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GETTING

Save time and dollars with mobile communications

By GEORGE WURTSWORTH

A GOVERNMENT COMMUNICATIONS expert recently predicted the market for two-way radio at 25 million units. That would place a mobile radio in one out of every four vehicles in the US. The estimate may take years to materialize, but the odds that it will are favorable. Ten years ago, some 1½ million transmitters were licensed. Today the number exceeds 5 million. Mobile radio, as they say, must be doing something right.

It is—not only for the giants who operate complex networks of more than 1000 units, but also for the small businessman with one rig in the store, one in a car. In both cases, two-way radio is often a spectacular performer when judged on the basis of dollars and cents. Manufacturers are armed with convincing evidence that two-way equipment can pay for itself, and provide additional benefits.

Another important factor is that it is easier than ever to obtain a license. Thanks to a number of postwar developments, the license structure is vastly broadened. A scant dozen years ago, eligibility was limited to police, fire, taxi, petroleum and a sprinkling of other specialized services.

But in 1958, the FCC introduced the Business Radio Service. It extends the benefit of two-way radio to any legitimate business activity. The same year saw the introduction of a new Citizens band on 27 MHz, the first practical band for US. citizens engaged in any lawful business or personal activity. Virtually no one is now excluded from mobile communications.

Will it pay?

To decide whether two-way radio can deliver its promise, consider the classic arguments. Manufacturers usually lead off by citing the twin evils of "deadheading" and "backtracking." The radio-equipped vehicle in Fig. 1 makes fewer returns to the shop for the next call or instruction. Drivers are reassigned new stops while en route, or efficiently redeployed for emergencies. One hidden benefit is eliminating phone calls. It's been shown that the accumulated time it takes for a driver to find phones, plus the cost of the calls, can exceed the cost of a two-way system. Then there's the intangible benefit of faster service to the customer.

Whatever the basis—more stops per day, fewer miles traveled, less gasoline consumed—two-way radio is a success because it's a moneymaker. Some users figure they reduce vehicle mileage by 35%; others calculate that three vehicles do the work of four. But a rough, overall estimate is that, for systems of all sizes, an average 20% saving may be realized in operating costs for the user.

To see how this looks on paper, consider a sample situation worked out by Kaar (Fig. 2) for a system based on four vehicles and a base station. It's estimated that two-way radio could reduce daily operating costs by 10%, or $24.10 per day. The cost of the radio system is slightly more than $1000. Kaar estimates this is carried over a 5-year period, but during that time there would be a net savings each day of $22.81 over a non-radio system. The company also reports that most businesses expect radio equipment to pay for itself within the first year of operation.

So if two-way radio holds possibilities, the next step is scanning the services and arriving at certain deci-

STARTED IN 2-WAY RADIO

sions to balance cost and performance. Consider the major options confronting a prospective user of mobile radio.

The medium is broadly grouped under an FCC division of "Safety and Special Radio Services," which regulates police, fire, aviation, marine and a multitude of other familiar users. Unless the newcomer is already in one of those classes, he can narrow down his choice to two divisions: the Industrial and Citizen Radio Services. If you can find your special business activity in the chart of Industrial Radio Services in Fig. 3, it's probably the one used by others in your field. Anyone not fitting into a special group can be covered by the Business Radio Service, a subsection in the broader category of the Industrial Radio Service.

The second class to consider is the Citizens Radio Service, or CB. It is governed by a completely different set of rules, but shares certain features with the Industrial service. The principal similarity is frequency. As charted in Fig. 4, there are three major frequency bands for mobile operation: two vhf bands (low and high) and a uhf band. CB is assigned portions of the low and uhf bands. What are some of the important differences?

CB vs. Industrial radio

The choice between these services by the small businessman is determined by cost, range and amount of interference. Consider, first, CB's merits and disabilities. Leading the list is initial cost; CB equipment is generally priced at somewhat over $100 for a typical unit. A mobile whip costs about $15, a base station antenna about $25. The license form is extremely simple to fill out and equipment installation may be done by anyone. There are no engineering calculations to offer in evidence to the commission, no significant antenna restrictions other than a 20-foot-height rule over a natural or manmade formation. The simplicity and low cost of CB help account for the fact that it's now the FCC's largest single division, with some 1 million licensees throughout the country.

On the other hand, CB is defined as a short-range service. With restricted antenna height and low input pow-

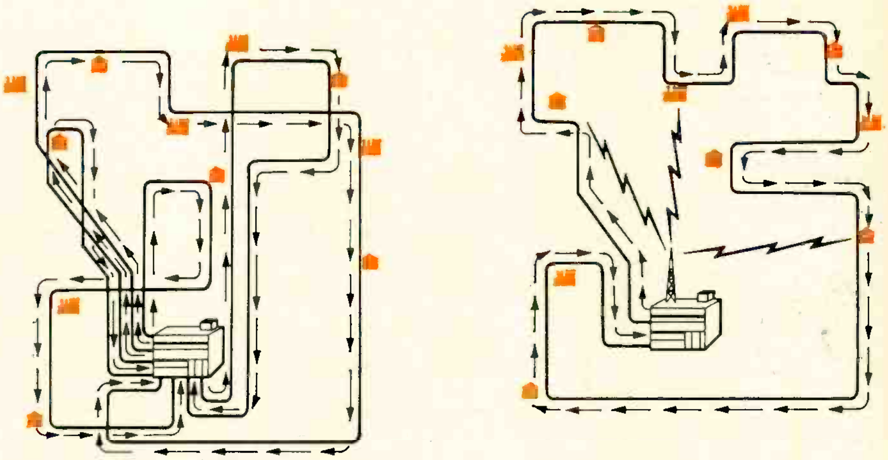


Fig. 1—Installation of two-way radio in a vehicle can eliminate problems of "deadheading" and "backtracking." Part a *shows costly return trips between stops of vehicle without two-way radio. Radio-equipped vehicle* b *travels same route economically.*

Savings Estimate For Two-Way Radio

Gross savings on radio-equipped units

No.	Type	Est. Hourly Cost to Op. Inc. Salary of Operator	Avg. No. Hours Used Per Day	Avg. Cost Operate All Units Per Day	Estimated Efficiency Increase W/Radio	Gross Savings Per Day
1	Stn. Wagon	6.00	8	$48	10%	4.80
1	Jeep	6.00	8	$48	10%	4.80
2	Pickups	6.00	10	$120	10%	12.00
Anticipated savings through direct communications (Telephone calls eliminated)						2.50
					Total gross savings per day	$24.10

COST OF RADIO SYSTEM	
Captial investment:	
1 Base-station unit at $219.90	219.90
4 Mobile units at $192.90 each	771.60
Accessories:	
Base-station antenna, w/cable (1 at $46.05)	46.05
Paging speaker kit (2 at $15.00 each)	30.00
Other: Special crystals at $5.90 per pair	29.50
Total capital investment	$1097.05
Amortized cost per month (5-year life—60 months)	18.28
Maintenance contract (optional)—after first 2 years guarantee	10.00
Total cost of system per month	28.28
Daily expense for system at 22 workdays per month	1.29
Net daily savings with radio	22.81

Pay off time (days): $\frac{1097.05}{22.81} = 48$

Most industrial users estimate savings at from 10% to 30%. You should project increased efficiency in your own operation in terms of time saved: i.e., 10% of 10-hr day as 1 hr, 5% of 10-hr day as 30 min.

Fig. 2—Manufacturer's estimate of savings for small businessman adding mobile radio.

Industrial Radio Services

Name	Remarks
Power radio service	For public utilities in emergency and routine maintenance of electrical service.
Petroleum radio service	For petroleum and natural gas industry.
Forest products radio service	Private timber and logging companies.
Motion picture radio service	For motion picture companies on location.
Relay press radio service	For newspapers and press associations.
Special industrial radio service	For use in farming, heavy construction, mining, fuel oil companies, ready-mix concrete firms.
Business radio service	For any lawful commercial activity, educational, philanthropic, clerical hospital, clinical and medical organizations.
Manufacturers radio service	For materials handling, plant security and production control.
Industrial radio location service	For persons who need radio to establish a position, distance or direction by radiolocation devices (excluding navigation).
Telephone maintenance radio service	For common carriers.

Fig. 3—Services available for industry, as in Vol. 5, "FCC Rules and Regulations."

Major 2-Way Radio Bands

Name	Freq.	Max. Power (RF Input, Watts)
Low band	25–50 MHz	500-Industrial; 5-Citizens Class D
High band	136–174 MHz	600-Industrial
UHF	450–470 MHz	600-Industrial; 60-Citizens Class A

Fig. 4—Although maximum power is shown in this chart of two-way radio bands, transmitter wattage is generally lower in Industrial Radio Service to prevent interference.

er, operating range averages 10 miles between base and mobile stations. CB's second potential liability is interference levels. Although all two-way services operate on a shared-frequency basis, the sheer number of personal users on CB aggravates the problem. It is especially true during evenings and weekends. Since interference tends to wane during regular business hours, many commercial activities can be conducted on CB with no other limit than that of operating range.

Several of these disadvantages may be overcome by choosing the Industrial category or Business Radio Service. Higher power and antenna height are available to boost range, often to a 50-mile radius. Traffic on business channels tends to be less than on CB, and transmissions are generally shorter. These benefits, however, must be weighed against the higher cost of what is considered a more professional type of two-way service.

Moreover, equipment must adhere to tighter technical specifications (and appear on an approved FCC list). This factor, plus higher input power, boosts equipment price to about two to four times that of CB gear. And the initial filing of an application in the Industrial category will almost certainly require assistance from professionals familiar with its re-

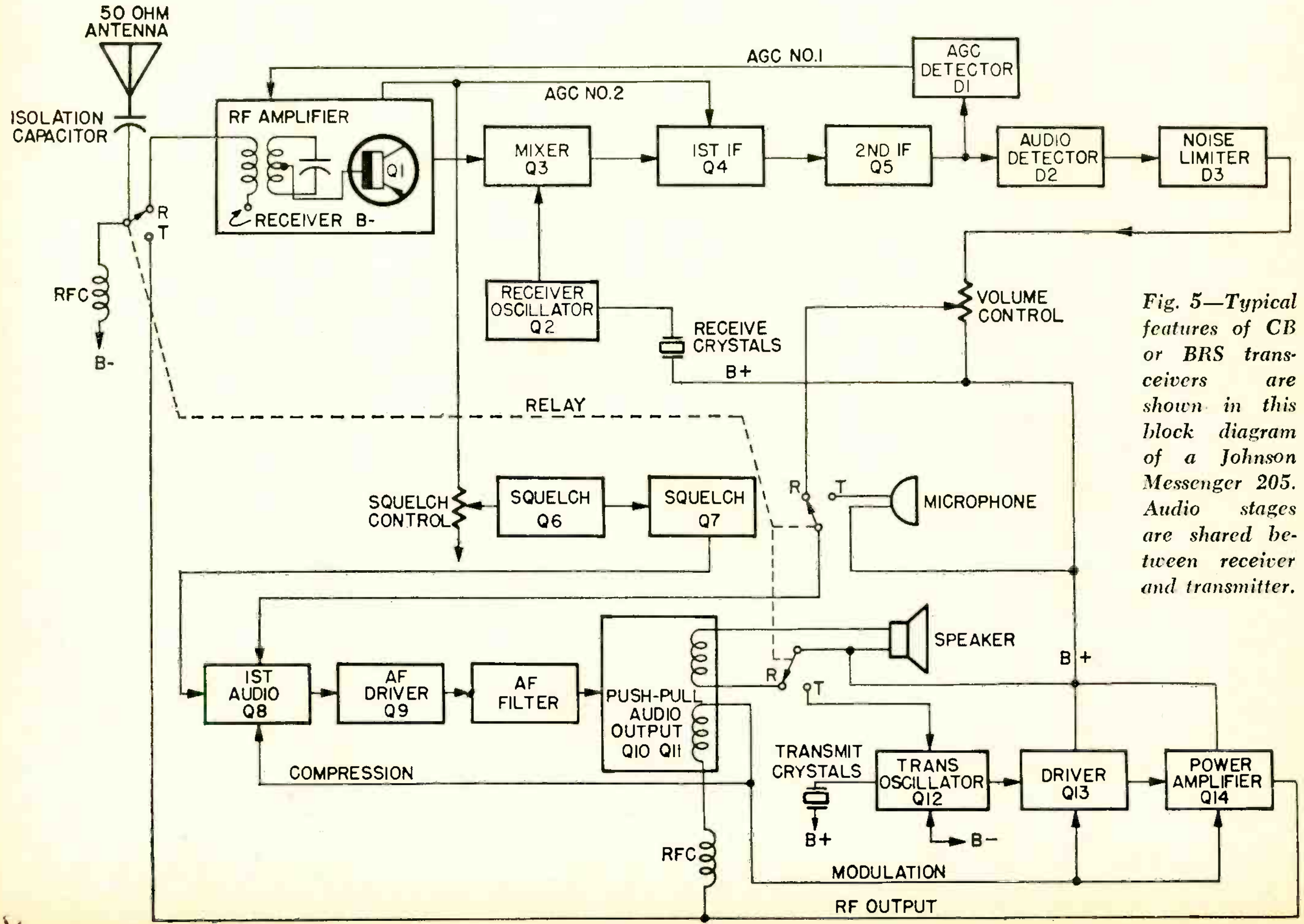


Fig. 5—Typical features of CB or BRS transceivers are shown in this block diagram of a Johnson Messenger 205. Audio stages are shared between receiver and transmitter.

Fig. 6—Johnson Messenger 205 ($189.50) has set frequency.

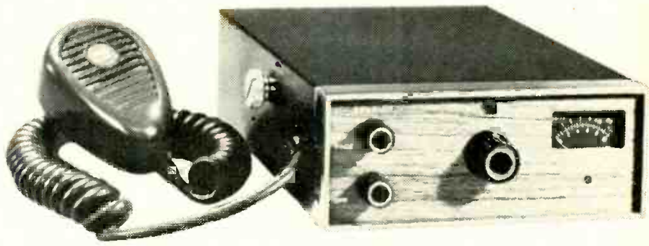


Fig. 7—Solid-state Karr Skyhawk II ($199.95, with 6 crystals).

quirements. You may need a construction permit, services of a surveyor (to pinpoint antenna location) and a field study to determine frequency and power with regard to other stations operating in the immediate area.

To investigate CB and the Industrial Radio Service in great technical detail, a good place to begin is with a copy of the rules. Both sets of regulations are available from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402. For CB, order a copy of "Volume VI, FCC rules and Regulations." The cost is $1.25. For the Industrial Radio Service, order "Volume V, FCC Rules and Regulations." Price is $2.50.

If you want to examine application forms for either service, they're available, free, from the FCC. A phone call to the nearest field office will do, or address a request to: Federal Communications Commission, Washington, D.C. 20554. The CB application is "Form 505"; the Industrial application is "Form 400." You'll find that CB appears on both forms. It's Form 505, however, which covers the important Class D band (27 MHz), where virtually all CB operation occurs. The amount of activity on CB's Class A (uhf) is negligible due to higher frequency and costly equipment.

CB and Business Radio equipment (AM Type)

These two categories represent the lowest-cost approach to two-way radio. Several factors scale down prices. One is low transmitter power: 5 watts for CB and about 5 to 15 watts for the Business band. Low frequency is another factor, since both services may operate in the low band. Low frequencies eliminate multiplier stages and critical circuits needed for higher bands. Further, CB and BRS may operate with A3, or amplitude modulation. Most other two-way services are FM, for which equipment becomes more elaborate. To illustrate a typical low-power CB or BRS unit, a block diagram of a Johnson Messenger 205 appears in Fig. 5. Priced at $189.50, it may be specified for Business operation at an assigned frequency between 25 and 50 MHz. In its CB version, the set would operate on one of CB's 23 channels in the 27-MHz region.

The block diagram of Fig. 5 illustrates basic features common to much low-cost gear. The set is a transceiver in that audio stages are shared between receiver (for loudspeaker output) and transmitter (for AM modulation). Circuitry is solid-state throughout to form a compact, self-contained package that fits under a dashboard. A squelch circuit silences the speaker except when in incoming carrier trips open the audio stages. The receiver section, along the top, is a single-conversion type of superheterodyne circuit.

A significant difference between a low-cost CB and a BRS set is the number of channels. The BRS user may be assigned a single frequency in the low band which requires no channel selector (Fig. 6). The CB unit, however, is generally a multichannel transceiver with a manual switch that selects up to 23 channels assigned to the 27-MHz band of frequencies.

Although sets are offered in versions of from 1 to 23 channels, recent rules changes suggest the set should have more than one channel. To reduce interference, the FCC has set aside seven channels (9–14, 23) for interstation units (of different call signs). The business user should avoid these channels since they tend to have highest activity. Yet, the multichannel rig permits switching to those channels for emergency calls, route instructions or other instances where contact with other stations (outside his system) is desirable. An example of such a transceiver is the Kaar Skyhawk, shown in Fig. 7. It has a 23-channel selector switch, and may be ordered with any number of crystals up to that number.

High adjacent-channel selectivity in this set is achieved by a dual-conversion receiver, and ignition noise is minimized by a series-type impulse limiter. As in most solid-state CB transceivers, this model operates directly from a car's 12-volt battery, or as a base station with the addition of an ac adapter to the unit.

Industrial and FM gear

If the business user wishes to step up in rf power and range, he confronts the other class of two-way equipment: Industrial FM radio. This category is higher in price and circuit complexity. Higher-frequency FM circuitry means significantly more stages in both trans-

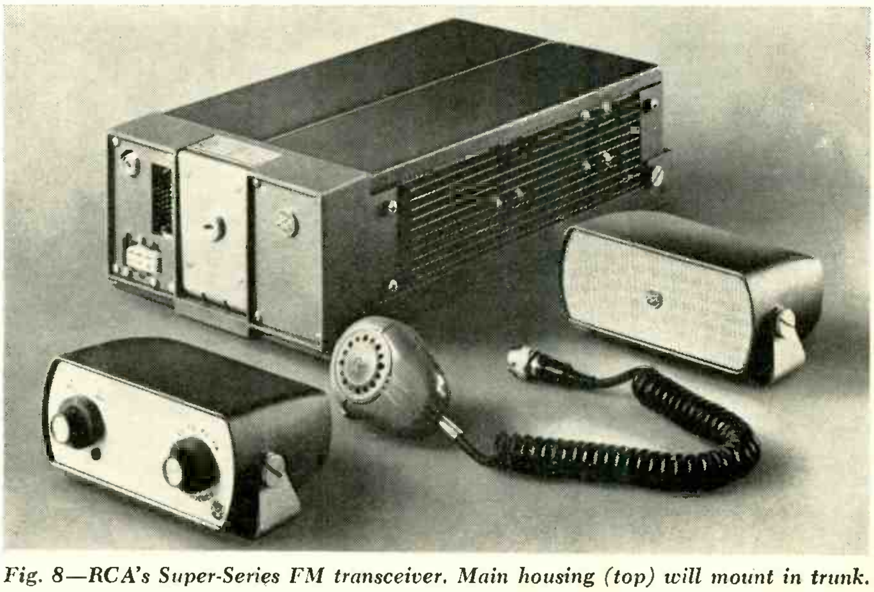


Fig. 8—RCA's Super-Series FM transceiver. Main housing (top) will mount in trunk.

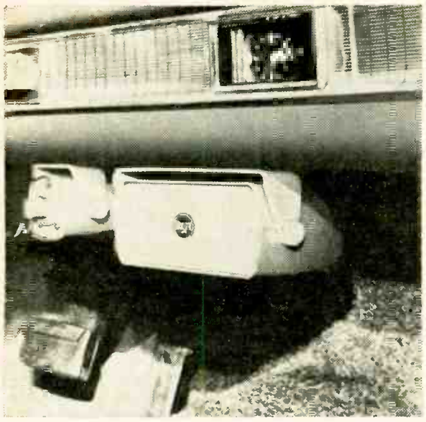


Fig. 9—Dashboard mounting of RCA Super-Series units. Control head is at left.

Fig. 10—Two-way FM base stations are often self-contained, like this RCA model.

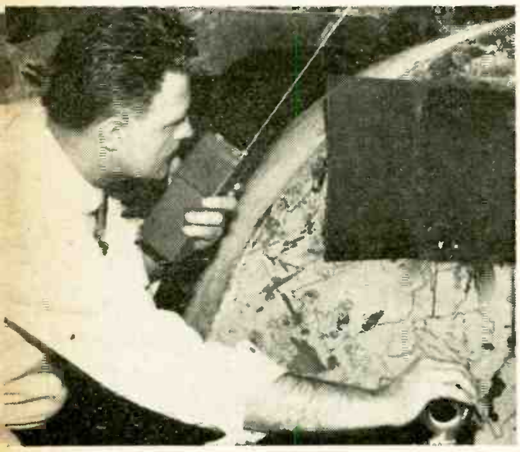


Fig. 11—Motorola's HT Handie-Talkie provides highly mobile communications.

Fig. 12—Comco's Ultra Basecom is a uhf desk-top station with 20–25 watts output.

mitter and receiver sections. Tighter frequency tolerances and electronic protection against accidental overload assume importance. A recent narrowing of FM modulation standards, from 15-kHz deviation to 5 kHz to conserve spectrum space, calls for more critical design. Elaborate crystal filters in early i.f. stages are used to assure good adjacent-channel selectivity and resistance to receiver desensitization. Consider some typical examples of two-way FM equipment.

One of RCA's Super-Series is shown in Fig. 8. Note that it is divided into separate cabinets: a main housing containing most receiver and transmitter circuitry, a control head and separate speaker. By physically dividing components, it is easier to mount the main housing in a car trunk or truck cab and operate remotely at the dashboard through the control head. Covers on the main housing strip off for servicing and internal circuitry in this model is modularized.

Although the set is transistorized, an exception may be the transmitter output stage. To obtain high ouput power in some models, the transmitter utilizes tubes. They are, however, instant-heat types which require no filament warmup so that transmission is virtually instantaneous from a cold start.

The RCA Super-Series is packaged in a variety of transmitter output powers for mobile use: 50 and 100 watts on the low band, from 30 to 100 watts in the high band, and 15 to 60 watts on uhf. Price range for these mobile units is $600 to $900, depending on model and accessories. How the unit might mount at the dashboard is shown in Fig. 9. The base station is often housed in a single, self-contained transceiver that can fit on a desktop (Fig. 10).

Two of Motorola's entries in the industrial field are the MOCOM and MOTRAC lines. The MOCOM, aimed at the small businessman, features a small, self-contained, solid-state FM transceiver. Output power is 5 watts. (MOTRAC is the high-power line, with cabinetry that divides into main housing, speaker and control head.)

One versatile unit is Motorola's HT Handie-Talkie. As shown in Fig. 11, it is a portable set that can be carried to the job for on-site communications. This 32-ounce unit will operate in any of the three major mobile bands and intercommunicate with any other FM set within range. Output power of these sets ranges up to 2 watts, depending on the band. More recently, the company introduced the PT400, a portable unit that puts out 10 watts in the high band while suspended

Fig. 13—G-E's Royal Executive FM transceiver operates in low or high bands.

from a shoulder strap. It can also slide into a dashboard rack and double as a mobile unit, using the vehicle's externally mounted whip antenna.

Comco's Ultra Basecom (Fig. 12) is a uhf desk-top station with 20-25 watts output. It can be operated in Industrial, Business and CB (Class A).

General Electric aims its Royal Executive toward the businessman. It's built as a one-piece set (Fig. 13) and operates at 50 watts in the low band, 35 watts in the high band. Inside the set, receiver and transmitter are divided into separate plug-in modules. Since they're interchangeable from mobile to mobile, one set serves as spares for the rest of the mobile system. A complete two-way system can

(continued on page 70)

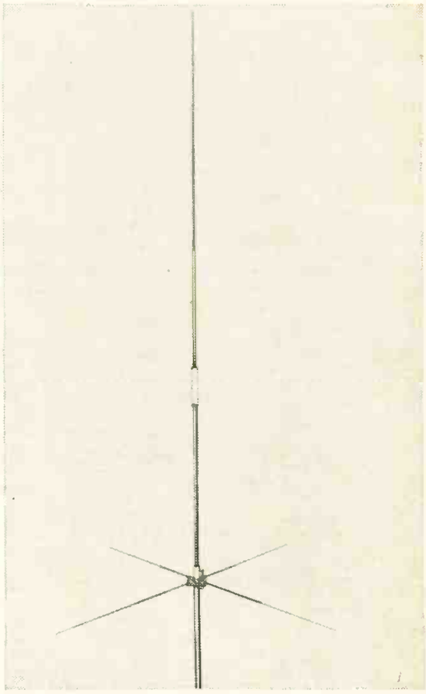


Fig. 14—Comco 37' base-station antenna (30 MHz) rated for 500 watts operation.

Eavesdrop On Aircraft, Fire & Police

By LEN BUCKWALTER

HEARING POLICE, FIRE, AIRCRAFT and a multitude of other two-way radio services once required costly, specialized equipment. But the current crop of communications receivers sharply changes the picture. Now it's possible to monitor the bands on a range of equipment that's wide enough to suit anyone from the casual listener to the serious professional.

One reason for the upswing is that two-way services have all but abandoned their original sites in the medium- and high-frequency bands below 30 MHz. Pressures of a shrinking spectrum have driven them to wider regions of vhf and uhf. Thus the traditional short-wave receiver, which rarely tunes above 30 MHz, is becoming increasingly barren of two-way radio communications. It's still possible to eavesdrop on a fishing boat between 2 and 3 MHz, or hear long-haul aircraft on hf bands, but conventional short-wave bands are now largely populated by international broadcasters and transoceanic common carriers. The new equipment enables the listener to follow radio's upward shift.

Cost is another reason for rising popularity of communications receivers. With sharp price reductions in high-frequency transistors, the new equipment often exploits inexpensive solid-state circuitry. The starting point appears to have been the introduction of the inexpensive FM broadcast portable with coverage of 88 to 108 MHz. Since much two-way activity is, not only FM, but situated just above and below the FM broadcast band, it was only a matter of time before front ends were retuned to cover communications frequencies.

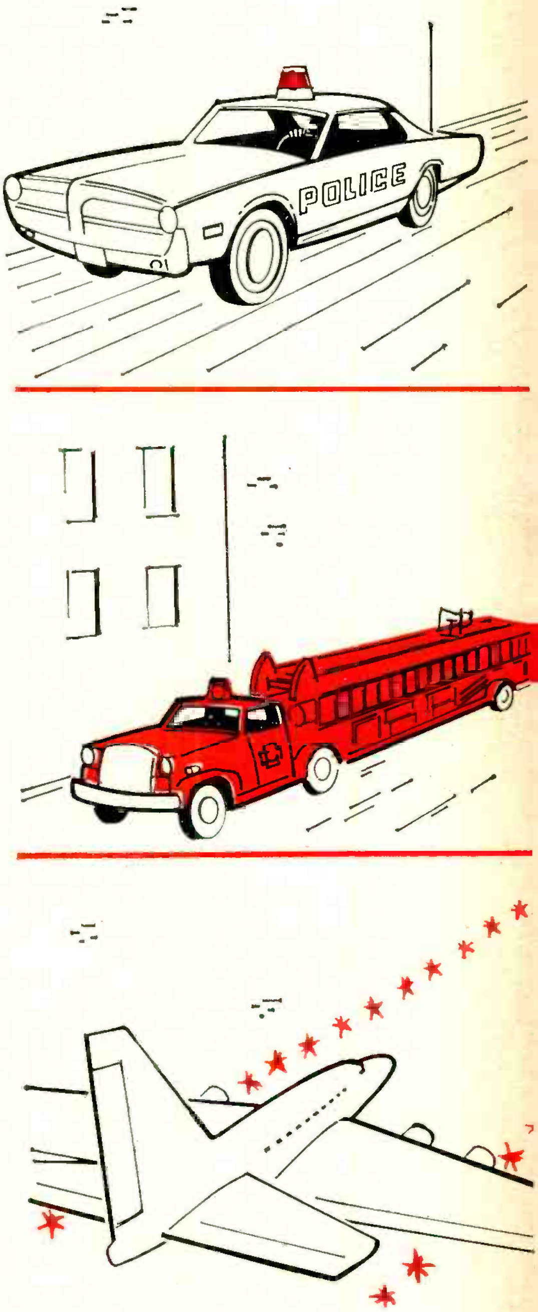
There are more listening opportunities on the bands than ever before. The FCC now licenses over 5 million users of two-way radio, and the medium is growing at a remarkable rate. Even the marine band, long a resident of 2–3 MHz, is partially relocating to vhf (approximately 150 MHz) to relieve congestion and interference. Many of the larger cities have already shifted their public-safety services to the higher bands; the smaller towns are following this shift.

Why listen?

The earliest user of the vhf receiver was the two-way operator himself. Look into the offices at a commercial airport and chances are there'll be a "monitor" on the shelf tuned to the company frequency. This ability to monitor radio traffic has been widely adopted by people who have some link to a communications activity. Auxiliary police, volunteer firemen and private pilots, for example, use the receivers to gain direct access to their area of interest. Boat owners hear vhf marine forecasts or monitor professional captains to discover where the fish are biting. Thus the equipment is attractive if an activity on the air coincides with an existing interest.

Promise of excitement is another lure. Eavesdropping on police or firemen may provide the fascination sought by the short-wave listener on lower bands. Listening on vhf, it should be noted, usually brings routine traffic with only an occasional emergency. One interesting frequency is in the aircraft band (approximately 120 MHz), where persistent listening has snared pilots being led out of a dangerous situation by an air-traffic controller. Nevertheless, even humdrum communications on the band could prove interesting to rocking-chair pilots.

Is it legal? This question confronts any prospective purchaser of a receiv-



Monitor police, fire, aircraft and other two-way bands with the latest equipment

MAJOR COMMUNICATIONS BANDS		
Frequency (MHz)	Name	Remarks
25-50	Low Band (VHF)	Most types of two-way services, Citizens class D.
108-135	Aircraft (VHF)	All types of aircraft, airports, ground control.
150-175	High Band (VHF)	Most types of two-way services, new marine VHF band, continuous weather reports.
450-470	UHF	Most types of two-way services, Citizens class A

Fig. 1—Chart shows principal two-way bands.

CONTINUOUS WEATHER REPORTS ON VHF (162.55 MHz)		
Atlantic City	Hartford	New York
Boston	Honolulu	Norfolk
Brownsville	Jacksonville	Portland
Charleston	Kansas City	Providence
Chicago	Lake Charles	San Francisco
Cleveland	Los Angeles	Seattle
Corpus Christi	Miami	Tampa
Galveston	New Orleans	Washington

Fig. 2—Cities broadcasting continuous weather information on vhf.

MAJOR SERVICES ON VHF COMMUNICATIONS BANDS	
SERVICE BAND	WHO IT'S FOR
Aviation	Aircraft, airports, air traffic control
Public Safety	Local governments, police, fire, highway maintenance, forestry-conservation, special emergency (hospital, ambulance, physicians, disaster relief, school buses, beach patrols), state guards.
Industrial	
Power	Public utilities
Petroleum	Petroleum and natural gas industry.
Forest Products	Timber and logging industry
Motion Picture	Movie companies 'on location'.
Relay Press	Newspapers and press associations
Special Industrial	Farming, heavy construction, mining, fuel oil, ready-mix concrete.
Business Radio	Any lawful commercial activity, educational, philanthropic, church, hospital, clinical and medical organizations.
Manufacturers	Materials handling, plant security, production control.
Industrial Radio-location	Determining position, distance or direction by radiolocation devices (excluding navigation).
Telephone Maintenance	Common Carriers
Land Transportation	Railroads, taxicabs. automobile emergency, motor carriers
Citizens	For any lawful business or personal activity requiring two-wav communications.

Fig. 3—Chart of services on two-way bands.

er that can monitor police bands. It is generally believed there are no FCC restrictions on owning and operating such equipment; the commission is mainly concerned with transmitting gear. There is a Federal regulation, however, which relates to "secrecy of communications." It states that anyone hearing information over the air may not disclose it to a third party. This applies to transmissions not broadcast to the general public.

An important legal restriction may occur on the local level. Most states place no limits on listening at home to public-safety services (like police). Several states, however, have statutes which prevent such listening while in a car. When police arrived on the scene of a recent bank robbery in New York City, they discovered a portable receiver tuned to their frequency. Whether the robbers, if caught, can be prosecuted for operating the set is still an interesting legal question.

The bands

There are numerous routes to vhf bands. Equipment is packaged in several formats; frequency coverage is variable, and operating features differ. None of the popular equipment covers every two-way frequency and some include AM or FM broadcast. Before examining these differences, consider the services and how they're allocated by the FCC. It can help avoid the problem, for example, of buying a "police" receiver, then discovering that it's designed for the wrong band in a particular listening area.

As Fig. 1 shows, there are four major bands for two-way communications. A particular service may be assigned almost anywhere in these bands. One exception is aviation: air traffic in this country is conducted mostly between 108–135 MHz. Another exception is the newly added marine band at the lower end of 150-175 MHz. Here also are found government stations that broadcast weather reports continuously. All the stations operate on 162.55 MHz and are located in the cities listed in Fig. 2. (Most are now on the air; several should be completed this summer.) Their signals should be within range of anyone located on any of the three coasts or in the Great Lakes region.

Highest activity is in the two vhf mobile bands popularly known as the low band and high band. It is usually not possible, as mentioned earlier, to pinpoint a particular service on a specific frequency or even band. The mobile radio licensee is assigned frequency and band on an availability basis. It is possible, though, to judge which band a specific service is using in a given area by estimating the antenna length used by units in that service. If a police car in your area has a whip that measures about 6 to 8 feet, chances are it is operating in the low band. Services using high-band frequencies usually have a whip about 1½′ long mounted in the center of the car roof. A uhf antenna is a stubby wire just a few inches in height and is normally located atop the vehicle.

In general, police and fire are concentrated in the high band, especially in larger cities. The uhf band is less populated, but there is a trend toward these higher frequencies as lower bands become crowded. So, choosing the right bands will require some investigation, with mobile antenna length providing one valuable clue. The major services that can be heard on communications bands are listed in the chart of Fig. 3.

Receiver categories

It's possible to group communications receivers into three general classes. One is the *monitor* type. It usually carries the highest price tag and includes the most advanced circuitry. A second classification is the *vhf portable*, a carry-about receiver. The portable may include a nonrelated band, such as AM broadcast, to increase its usefulness to the casual listener. The final approach to the upper bands is the *converter*. It's an add-on device which must play through a conventional AM broadcast receiver. Consider examples in each category and what they offer.

Monitor. Among the professional monitors is the Sonar FR-105 shown in Fig. 4. It is aimed primarily at the user of two-way radio who needs a receive-only function. Tuning is done with a six-position crystal selector switch. The receiver contains a dual-conversion circuit with dual FM limiters. At $140, a receiver of this design is strictly for professional use in a specific two-way system and is not intended for casual listening.

Sonar, however, does offer one model that could appeal to the general listener. It's the FR-101 (Fig. 5), which covers the low band from 25–50 MHz (a similar model covers the high band). A key feature is that the receiver is continuously tunable over the band. There is also an option for one receiving crystal, switchable at the front panel. Thus you can choose a specific frequency of interest in the band for precision control of at least one channel. With this kind of receiver, a volunteer fireman might obtain a crystal on his firehouse frequency, but also eavesdrop on neighboring towns. Circuits are solid-state and operation may be mobile with 12 volts dc.

The kit builder hasn't been overlooked either. Allied Radio offers monitor receivers in both low- and high-band versions for the vhf listener. Each is a tube circuit, with the low-band model pictured in Fig. 6. The sets are continuously tunable through their respective bands and differ mainly in front ends. (Only the high-band model contains an rf stage.) Both front ends, incidentally, are preassembled and aligned at the factory to eliminate the problem of constructing tricky vhf tuned circuits. There are two i.f. stages on 10 MHz followed by a ratio detector for FM reception.

An example of a mobile monitor is the Lafayette PB-150 illustrated in Fig. 7. This model covers the high band, with another model for low-band operation. A mounting bracket is supplied for under-dash mounting and the power source is 12 volts dc. Although the receiver circuit is single conversion, four IC's provide a total of 20 transistors in the i.f. amplifier. Frequency coverage is continuous throughout the band, and one crystal may be installed for fixed-frequency reception on any one channel. If a crystal is ordered, instructions are given in the manual for peaking the crystal oscillator circuit for maximum performance on the chosen frequency.

The receivers described so far share a common feature: they're restricted to a single band. Band switching, common on lower-frequency receivers, is difficult due to the wide frequency spread between vhf bands and the critical behavior of above-30-MHz signals. Yet, multiband vhf models are becoming increasingly available.

Dual front ends

The technical problem may be solved by the receiver layout shown in Fig. 8. Completely independent front ends are used for tuning high- and low-band vhf. Each tuner has a separate antenna connection at the rear of the chassis. Aside from frequency coverage, the tuners also differ in the crystal oscillator stage: the high-band section requires an additional multiplier stage to produce sufficiently high output at the operating frequency. Both front ends feed a common i.f. strip and audio section.

A mobile monitor just introduced is the Squire-Sanders Ultra-Monitor (Fig. 9) that allows simultaneous reception on two or more channels in one or two bands. Six frequencies are pushbutton-selected from either the 30–50-MHz band or the 152–174-MHz band. A number of stations can be received at the same time by actuating

Fig. 4—Sonar FR-105 is a solid-state monitor receiver for professional use on six crystal-controlled frequencies. $140.

Fig. 5—Sonar FR-101 is a tunable monitor with one receiving crystal. One model is for low band, another covers high band.

Fig. 6—Allied's Knight KG-220 is a vhf monitor in kit form. Two models cover low and high bands. Continuous tuning.

Fig. 7—Lafayette PB-150 operates on 12 volts dc car battery. Continuous tuning or one crystal-controlled channel. $70.

Lafayette PE-175 contains two separate front ends (see Fig. 8), which cover 30-50 MHz and 152-174 MHz. Price is $100.

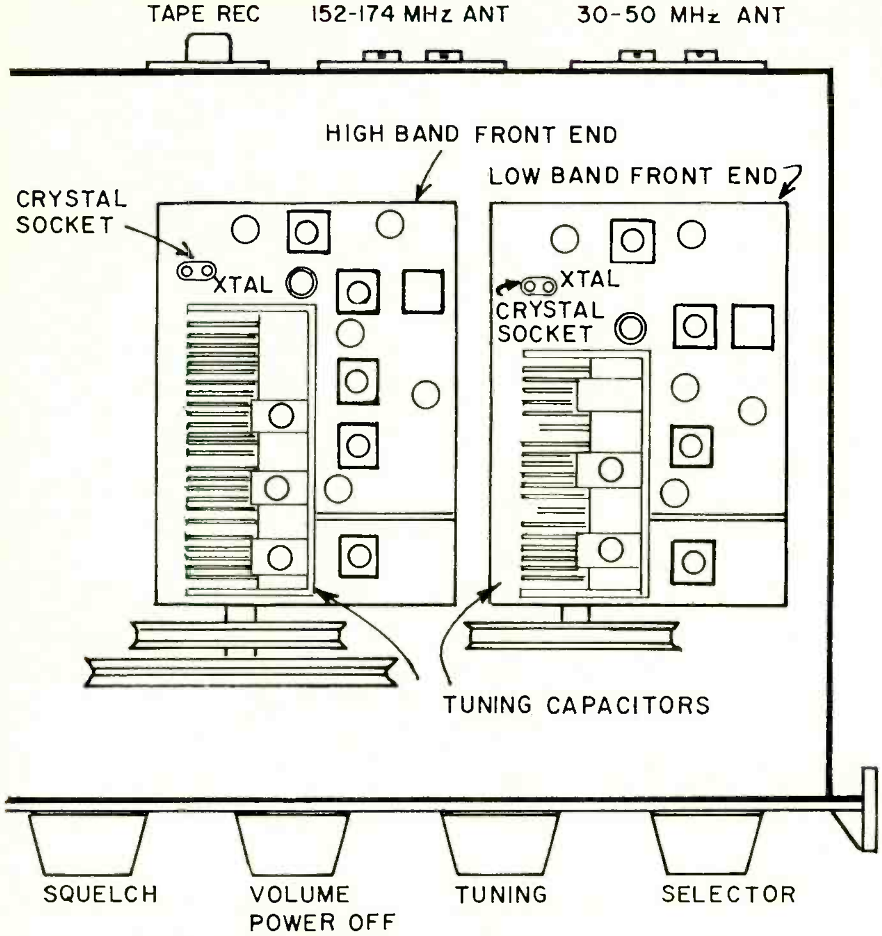


Fig. 8—Separate front ends on Lafayette's PE-175 permit low- and high-band coverage.

several buttons at once. In addition to provisions for 12 volts dc and ac line operation, it can be operated as a portable unit with an accessory nickel-cadmium battery.

Thus the first category, the monitor receiver, generally means a set with coverage exclusively on one or more vhf bands. The monitor may be mobile-mounted or serve as a tabletop model. Since solid-state construction is common, sets often operate on either dc or house current (with an extra ac adapter in some cases). There are enough tuning options—continuous or crystal control—to satisfy nearly any monitoring application.

Regency manufactures a 24-transistor "Monitoradio" (Fig. 10), that can receive up to six channels if all crystals are installed. The monitor operates on ac or dc, and an emergency battery pack activates automatically if 117 Vac power fails. An optional kit provides a tone alarm function that turns on the monitor when it receives an alerting signal of two sequential tones of the right frequency.

A final example of this category is the Hallicrafters Civic Patrol. It is a series of single-band transistor sets with continuous tuning for house-current operation. The 30–50-MHz model is pictured in Fig. 11; the others are the same except for coverage: aircraft signals (108–135 MHz) and high band (152–174 MHz) reception.

Vhf portable. Sets in this category include a variety of hand-carried models, usually with self-contained batteries. Typically they have a telescoping whip, although some may also connect to an external antenna for improving range. One set in this category is similar to the larger monitor receivers in that it functions solely on vhf. Hallicrafters' Portamon series, for example, is a line of three models (Fig. 12) for coverage on any of the three major vhf bands. Each model is continuously tunable through one band.

Multiple-band models

The Sonar Sentry uses a somewhat different approach in its portable series. As shown in Fig. 13, the set is actually a two-band receiver. The second band is standard broadcast. Further, vhf tuning is limited by two crystals, which may be switched to receive two vhf channels. Since continuous tuning is not provided, the set is intended, not for casual vhf listening, but mainly for use with an existing two-way system (where it could serve as a paging receiver).

One of the most versatile portables now available is the Nova-Tech five-band Action receiver (Fig. 14). The single model simultaneously covers low band, from 30–50 MHz, and high band, from 150–175 MHz. It also includes the marine band and other short-wave frequencies (1.5–4.5 MHz), as well as standard broadcast and weather frequencies below 400 kHz. The two vhf bands permit monitoring police and fire broadcasts in various towns without regard to their allocation in high or low bands.

Another feature is a mode switch that allows a choice of AM or FM reception. (Although most vhf services utilize FM, a few use AM.) For aviation enthusiasts, a second Nova-Tech model, the Pilot II, substitutes aircraft (108–136 MHz) for the low and high bands of the Action set.

Converters. The final category (Fig. 15) is a device that has enjoyed wide popularity among mobile hams

Fig. 9—Squire-Sanders Ultra-Monitor FM receiver can monitor six frequencies on low or high band. Fixed or portable.

Fig. 10—Regency Monitoradio receives up to six crystal-controlled channels. If ac power fails, battery is activated.

Fig. 11—Hallicrafters Civic Patrol receiver. Models cover low, high and aircraft bands. Continuous tuning. Price is $50.

as a simple method for tuning high frequencies on a regular car receiver. The converter is an add-on device that mixes the incoming vhf and heterodynes it down to the broadcast band. The car radio handles it as a regular broadcast signal. Most converters operate through a portable or home AM radio (Fig. 16), as well as the car receiver.

Demodulating an FM signal on an AM radio is solved by slope detection. By tuning the AM set so the incoming signal lies on the slope of the set's i.f. response curve, frequency deviation is converted to voltage swings approximately those of AM signals.

Converters are offered in two types. The simpler is the crystal-controlled version that generates a local signal, say, 1500 kHz removed from the incoming vhf signal. As local oscillator and air signals mix in the converter, the 1500-kHz difference is applied to the broadcast-coverage set. The BC receiver is tuned to 1500 kHz (usually by presetting one of the radio's pushbuttons). This system, which uses the BC receiver as an i.f. amplifier, is low-cost since the converter needs no tracking or continuously variable tuning circuits. The least expensive converters include no rf amplifier and contain little more than a transistor oscillator and mixer.

More sensitive units may use a three-transistor front end for improved performance. In any of these converters, the desired vhf must be known and a suitable crystal ordered from the manufacturer. It's possible in these units to tune the BC dial over its full span (about 1 MHz) and pick up vhf signals that lie adjacent to the frequency nominally selected by the crystal. For this reason, the BC receiver is sometimes termed a "variable i.f."

The other converter type is the *tunable* model. Equipped with a more elaborate front end, it contains tuning circuits that can track a complete vhf band. Converter output is fixed at a constant frequency (1500 kHz, for example) and the BC receiver is tuned to that value. The tunable converter, therefore, provides wider frequency coverage than the crystal-controlled models that are available.

Since communications services operate on vhf, their signals are mainly propagated line-of-sight. Range is thus influenced by the horizon, transmitter power and antenna height. The services may transmit upwards of 500 watts at a base station and 50 watts from mobile units. It's difficult to predict receiving distance but, as a rule of thumb, you could pickup signals up to a range of about 50 miles.

Antenna selection

For mobile receivers, the car's regular BC antenna might also serve for vhf reception (with a suitable switch between BC and vhf). If the low band is tuned (30–50 MHz), the whip is extended to full length. For high-band reception, the whip should be telescoped down to about 1½′. Alternatively, separate vhf whip antennas are available for coverage of each band of the converter.

If a mobile receiver is brought into the home, a length of hookup wire may be inserted directly into the coax connector to serve as the antenna. For low band, use a 6′ length; for high band, about 1½′ will serve. Both antennas should be run vertically to agree with the antenna polarization used at the transmitters.

Much greater range is usually possible by installing an outdoor low- or high-band antenna, with coaxial cable lead-in. Appropriate antennas are available with ground planes and other designs.

Most portable vhf sets operate with a built-in telescoping antenna. The manufacturer usually recommends full length for low band, and about 1½′ for high band. High-band reception is quite sensitive to whip length, but it's easily possible to adjust length manually for strongest received signals. The converters follow the same general approaches described above with one exception. These units are usually provided with a built-in switch that changes over the car's antenna to the converter input during mobile operation. **R-E**

Fig. 12—Hallicrafters Portamon series also covers three major vhf bands and is portable. Has continuous tuning. $40.

Fig. 13—Sonar Sentry is crystal controlled on two channels in vhf band. Includes broadcast reception. Price $40

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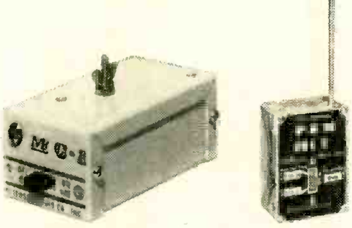
Fig. 14—Nova-Tech "Action" receiver is 5-band portable covering low, high, marine/shortwave and beacon/weather.



Figs. 15, 16—Peterson Radio MC–1 mobile converter (left) enables car radio to receive either low- or high-band vhf (2 crystals). Price $30. At right is model PRM vhf converter that will operate through a broadcast receiver when placed nearby. Two channels.

Buyer's Guide to Receivers for Eavesdroppers

Allied Radio Corp., 100 N. Western Ave., Chicago, Ill. 60680
Burstein-Applebee, 3199 Mercier St., Kansas City, Mo. 64111
Hallicrafters, 600 Hicks Road, Rolling Meadows, Ill. 60006
Lafayette Radio Co., 111 Jericho Turnpike, Syosset, L.I., N.Y. 11791
Nova Tech Inc., 630 Meyer Lane, Redondo Beach, Calif. 90278
Olson Electronics, Inc. 260 S. Forge St., Akron, Ohio 44308
Peterson Radio Co., Inc. 2800 W. Broadway, Council Bluffs, Iowa 51501
Radio Shack, 2727 West 7th St., Fort Worth, Texas 76107
Regency Electronics Inc., 7900 Pendleton Pike, Indianapolis, Ind. 46226
Sonar Radio Corp., 73 Wortman Ave., Brooklyn, N.Y. 11207
Squires-Sanders, Inc., Martinsville Rd., Liberty Corner, N.J.

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See OCT P22

Part I—Build a low-cost electronic tattle-tale that tells all about your car's lighting system

COMPUTERIZE YOUR CAR LIGHTS

By R. M. MARSTON

HOW WOULD YOU LIKE A MINIATURE computer built into your car to keep a permanent check on your lighting systems? A computer that will tell you automatically if any of your car lamps have burned out, or if you've forgotten to switch your lights on at night, or to turn them off at dawn? And how would you like it if you could have such a computer for as little as $20?

If you're not yet sold, consider the following: Throughout the world, an average of 15% of all automobiles are being driven with defective lighting systems. Thousands of people are killed each year in night-driving accidents caused through faulty tail lamps, side lamps, stop lamps and turn indicators. Prosecutions resulting from lighting defects run into the hundreds of thousands each year.

The computer system described here detects virtually all lighting faults. Building it to suit your car can be a lot of fun. When it's built, it could save you from a heavy fine. It could even save your life.

Lamp-failure detection

The basic principle of lamp-failure detection is quite simple, and is illustrated in Fig. 1-a. Circuit operation relies on the fact that the forward voltage developed across a heavily conducting silicon junction, such as diode D1 or D2, is about 800 mV to 900 mV, while the forward voltage developed across a conducting germanium junction, such as the emitter–base junctions of Q1–Q3, is only 250 mV to 300 mV.

Let's follow the action of this circuit, assuming that all lamps are in good order. When switch S1 is closed, the +12-volt supply is connected to the circuit. Current flows through lamp LP1 via D1, through LP2 via D2, and both of these lamps come on. A forward voltage of about 900 mV is developed across D1, and is applied via R2 to the base of Q1. Since Q1 is a germanium transistor, any forward voltage greater than about 250 mV drives it on. If the value of R2 has been chosen right, the forward voltage of D1 will be enough to saturate Q1 so its collector goes to −12 volts. Similarly, the D2 forward voltage drives Q2 to saturation, and its collector goes to −12 volts.

Transistor Q3 has its base held at −12 volts via R7, so, in the absence of an input signal, this transistor is cut off and LP3, a warning lamp mounted on the car's dashboard, is off also. Since the collectors of both Q1 and Q2 are at −12 volts, no forward bias is applied to Q3's base via D3 or D4 and R8 under the conditions outlined above. Thus, when LP1 and LP2 are working correctly, LP3 stays off.

Suppose next that LP1 burns out. No current flows through D1, so no forward voltage is developed across it. Transistor Q1's base is therefore clamped to the −12-volt line via R1 and R2, and Q1 is cut off. Under this condition, transistor Q3's base is connected to ground via R3, D4 and R8, and, if the values of R3 and R8 have been chosen correctly, Q3 is driven into saturation and LP3 switches on, indicating the failure of one of the lamps. Lamp LP2 operates in the normal way. As D4's cathode goes positive relative to Q2's collector, D3 is reverse-biased and prevents changes in Q1's collector potential from affecting Q2's collector potential.

Although this circuit is very simple, it uses the same techniques that are used in full-size digital computers. Transistors Q1 and Q2 are used as digital inverter switches, and are either full ON or full OFF. Transistor Q3 acts as a digital switch that is operated in the OR logic mode by gate diodes D3 and D4.

This system can be expanded to operate from any number of lamps by simply wiring a D1–R1–R2–Q1–R3 circuit to each bulb and connecting its Q1 collector to R8 via a gate diode such as D4. In the circuit, R8 is a safety resistor to keep the base current of

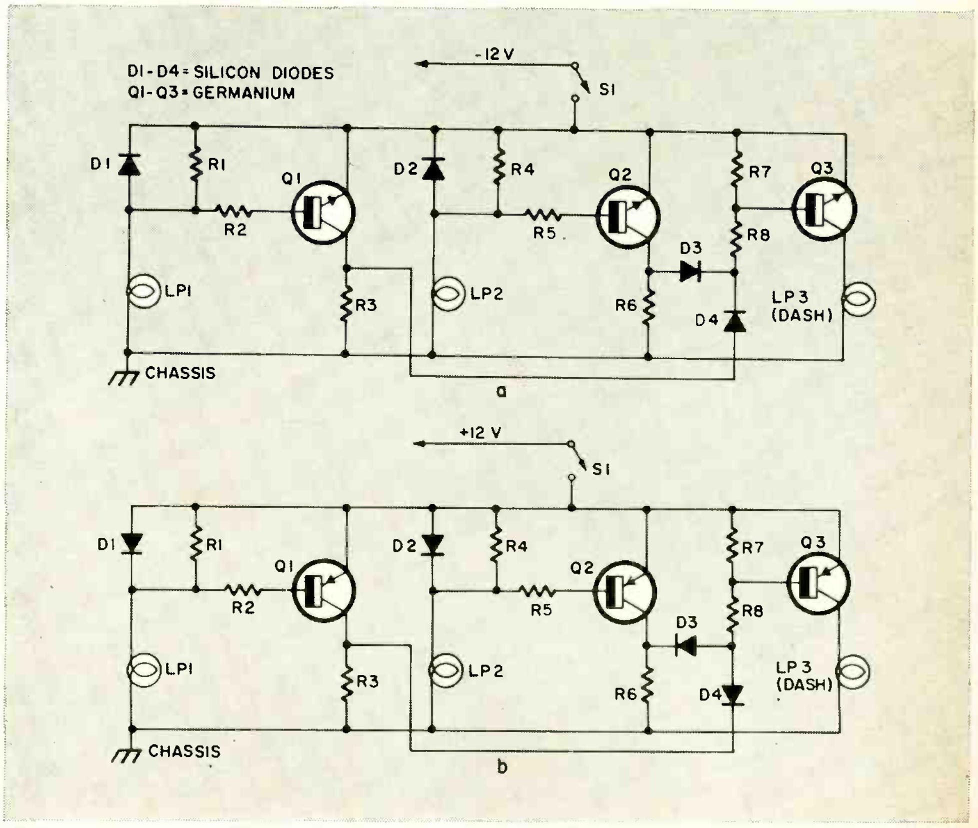


Fig. 1—Basic light-failure and warning system. Circuit a is for cars with positive-ground batteries, b for negative ground.

Q3 within safe limits in the event of more than one lamp burning out.

The circuit of Fig. 1-a is designed to work with a positive-ground lighting system. If your car is fitted with a negative ground, you can adapt the circuit by reversing the polarity of all diodes and replacing all npn transistors with pnp types, as in Fig. 1-b. The same rules apply to the rest of the circuits in this article, so from now on we'll discuss only *positive*-ground systems, and assume that you will modify to negative ground if necessary.

One other point: About 1 volt is lost across D1 and D2 when the circuit is operating, so there is some loss in lamp brightness. With a 12-volt system the loss is very slight and can be ignored. With a 6-volt system the loss is more significant, but still not enough to worry about.

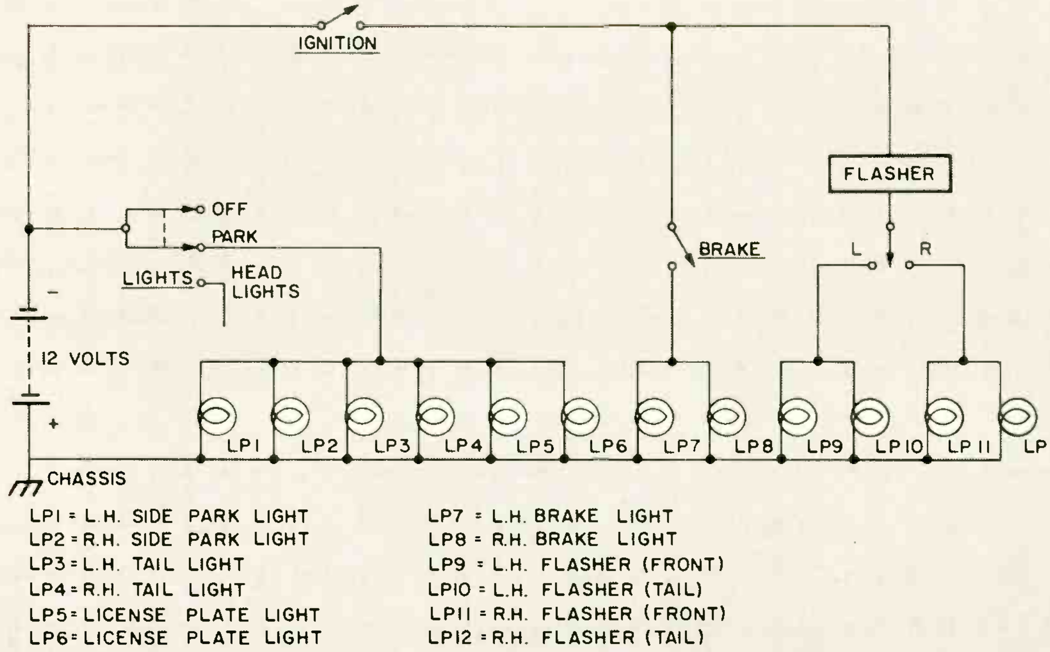
Lamp failure detector systems

A typical car lighting system is shown in simplified form in Fig. 2. Flasher and brake light systems are inoperative until the ignition switch is closed. There are, ignoring the headlight circuits, four main circuits in the system:

	No. of lamps in parallel
Main Circuit	6
Brake Circuit	2
Flasher (left)	2
Flasher (right)	2

Thus, most cars have a total of at least 12 external lamps, not counting the headlights, and all these should be monitored by the detector system. There is no need to monitor the headlights because you can see their beams from the driver's seat and will usually be aware of a lamp failure as soon as it occurs. (Drivers along bright city streets may not notice headlamp fail-

Fig. 2—The four main automotive lighting circuits monitored by the computer.



ure for some time.)

No two car models seem to have identical lighting systems, though most of them are similar to that in Fig. 2. What we'll do now, therefore, is describe a lamp-failure detector system to suit Fig. 2, and leave it to you to modify this to suit your car, after checking out your wiring system in the manufacturer's handbook.

Fig. 3 shows the full circuit needed to monitor all the lamps shown in the basic lighting system of Fig. 2. A total of 16 transistors is used. In spite of its apparent complexity, the circuit is really very simple since it actually comprises only two basic circuits and a lot of duplication.

Each lamp in the system is wired to a simple D1–R1–R13–Q1–R25–D13 type of electronic "switch," which forms one of the two basic circuits. The second basic circuit is the R37–R41–Q13–D25 gate section, which drives the LP13 dash-panel lamp. There is one of these gate sections to each of the four main lamp circuits in the system—main lighting, brake, flasher (left) and flasher (right). Thus, if you have more (or fewer) lamps or main-lamp circuits in your particular car, you simply add (or take away) an electronic "switch" circuit for each lamp, and a gate section for each main-lamp circuit.

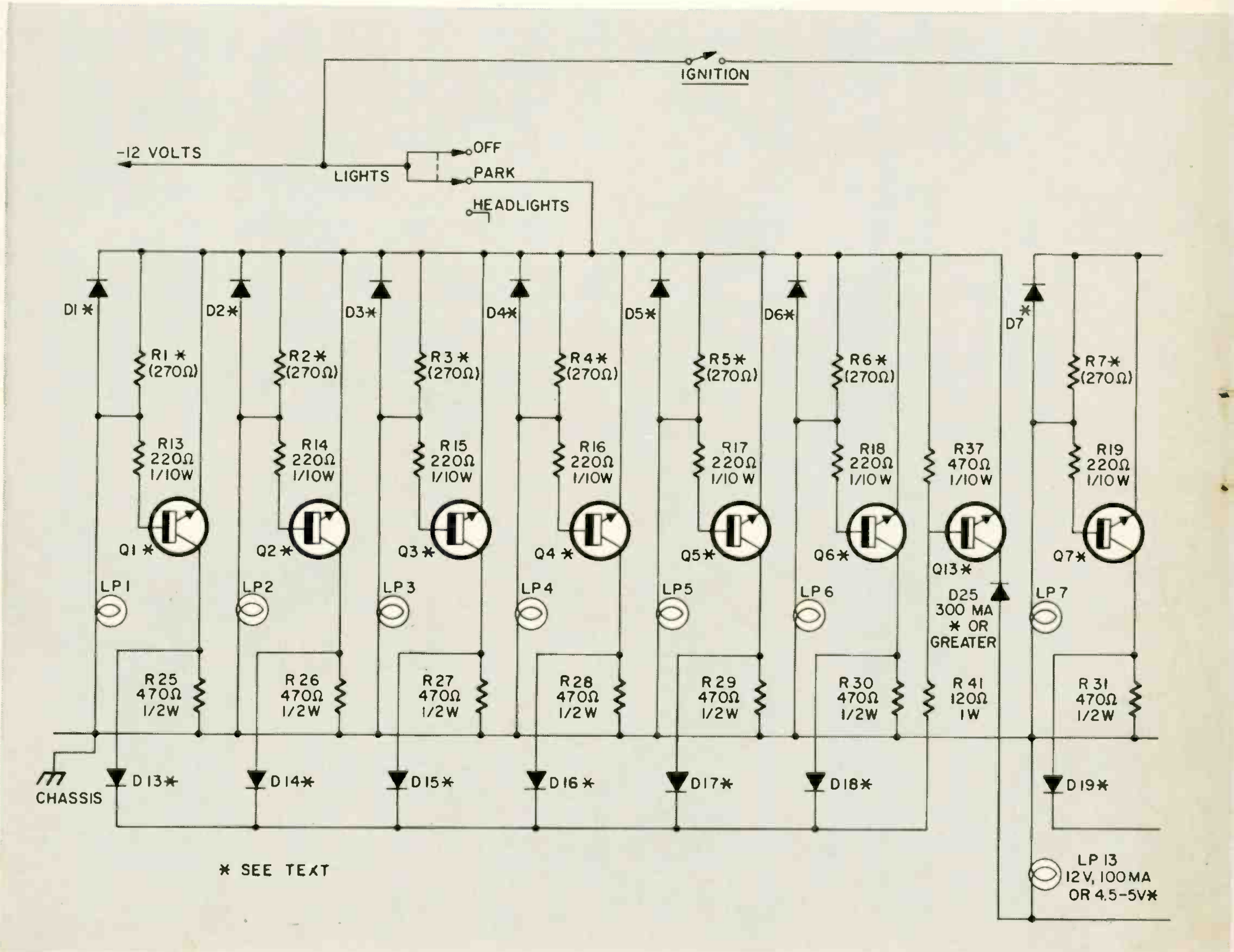
Actual component values are not critical in this circuit, and the following is a guide to component selection:

D1–D12: These must be silicon rectifiers. Most car lamps (other than headlamps) have wattage ratings between 6 and 36 watts, so that in a 12-volt system operating currents are between 0.5 and 3 amps. Thus, in most cases these rectifiers can be low-voltage, 3-amp types. Check lamp wattages before selecting these components and increase the current ratings of the rectifiers if necessary.

Q1–Q12: These can be any npn small-signal af germanium transistors with a current gain greater than 20 and reasonably low leakage currents. Most, but not all, npn silicon transistors will work in this circuit as well, but, if you decide to use silicon types, check that each transistor will switch hard on (saturate) with an emitter–base voltage of less than 700 mV, and that at least 900 mV is developed across each D1-type rectifier under operating conditions. (A differential voltage of at least 200 mV is needed for correct circuit operation.) I have used both silicon and germanium transistors in versions of the circuit with equal success.

Q13–Q16: Any npn transistor with a current gain greater than 20 and

Fig. 3—The circuit used to monitor the twelve automotive lamps in Fig. 2. The monitor is not nearly as complex as this circuit makes it appear because it consists of only two very simple circuits—each of which is duplicated four times.



an $I_{c(max)}$ rating of 500 mA or greater will do here. Germanium transistors are preferred, but not essential.

D13–D24: Any general-purpose silicon diodes.

R1–R12: 270 ohms if Q1–Q12 are germanium: 470 ohms if silicon. 1/10 watt or greater.

R13–R24: 220 ohms, 1/10 watt or greater.

R25–R36: 470 ohms, ½ watt.

R37–R40: 470 ohms, 1/10 watt or greater.

R41–R44: 120 ohms, 1 watt.

D25–D28: silicon or germanium rectifier with forward-current rating greater than 300 mA.

LP13 (*dash lamp*): 12 volts, 1.2 watts (100 mA).

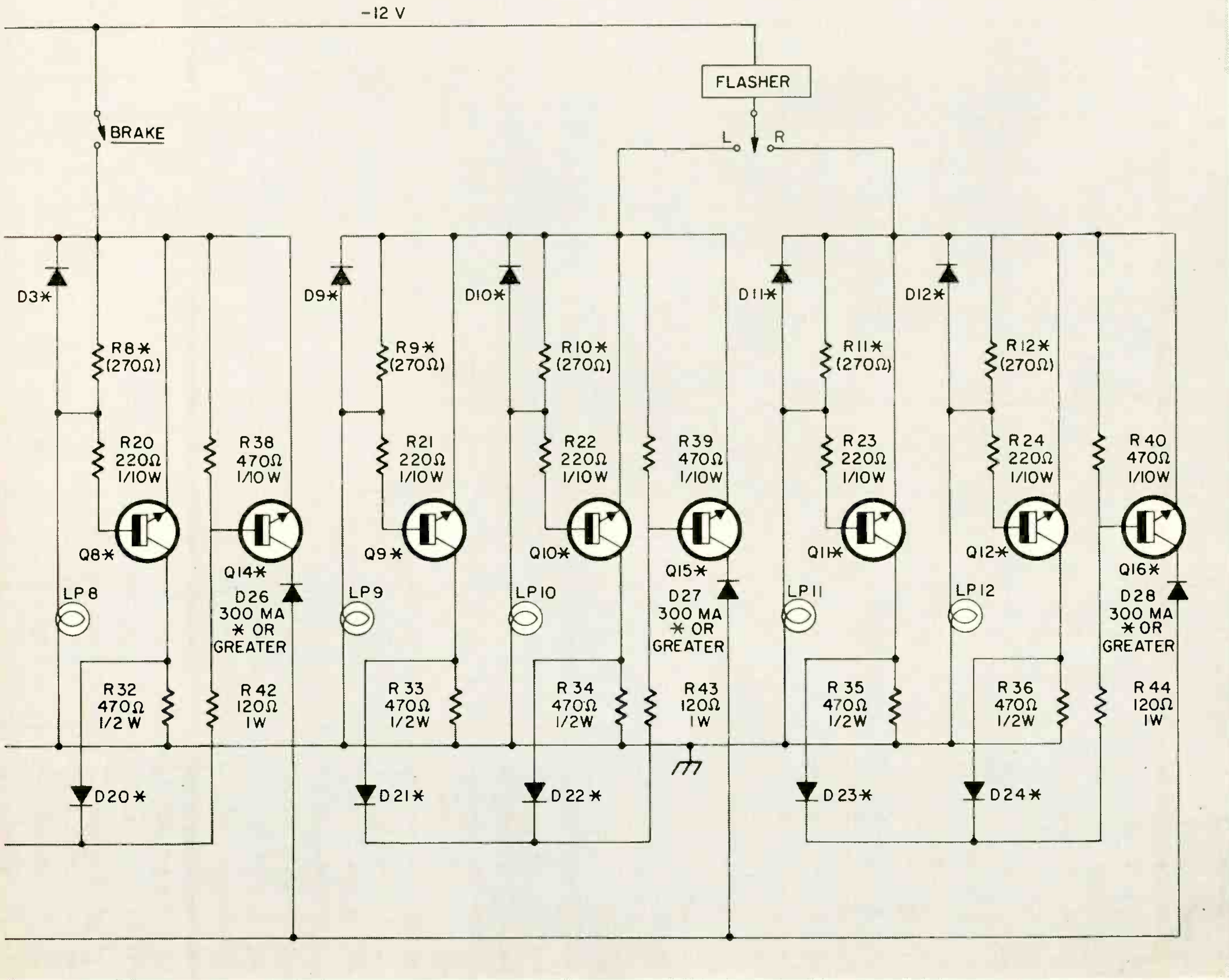
The above notes apply specifically to 12-volt positive-ground systems. In 6-volt systems, Q13 to Q16 should have *minimum* current gains of 40, and LP13 should be a 4.5- or 5-volt bulb with an operating current of less than 300 mA. No other component changes are needed. In negative-ground systems, replace all transistors with pnp types, and reverse all diode polarities.

In use, the dash-panel warning lamp lights only when a light fails to come on when it is supposed to. In other words, if you have a burned-out tail lamp, the dash light won't indicate the fault until the light switch is turned on. All main circuits operate independently, i.e., if a brake light is burned out, the fault will show up on the warning lamp as soon as the brake pedal is pressed (assuming that the ignition is turned on), even if the main light switch is not turned on at the same time. Many foreign cars have the ignition switch connected ahead of the brake switch, and the ignition switch must be on for the brake lights to operate correctly.

In effect, the simple computer system described above is constantly fed with two input questions, automatically figures out a logical answer, and passes that answer on to the driver. The questions are: "Has the driver decided to switch any of the lamps on?" and "Have the right lamps come on?" If the answer to both questions is "yes" or "no," the computer figures that everything is all right and just keeps quiet. If the answer to the first question is "yes," but to the second it is "no," the computer decides that something has gone wrong and then gives the driver a visual "nudge."

Note that in the above case the computer has to work on a decision made by the driver, the weakest of links in all accident chains. Think how much more useful the computer would be if we could give it a "brain" of its own, so that instead of accepting the driver's decisions about what lights should be on or off, it could decide these questions for itself and give the driver a nudge if he hasn't come to the same decisions.

Such a "brain" can in fact be built quite simply, using only seven transistors. For lack of a better name, I'll call the brain a Lighting Mode/Driving Mode Correlator. This is described next month. **To Be Continued**



Trouble Shooting TV Detector Diodes

Helpful hints for understanding and testing solid-state diodes

By **MATTHEW MANDL**
CONTRIBUTING EDITOR

SOLID-STATE DIODES PLAY AN IMPORTANT part in the detection systems of black-and-white and color receivers. Because of their two-terminal simplicity one might expect to have little trouble with these miniature units, yet they often develop open circuits or changes in characteristics that seriously affect picture quality or sound. Testing a diode is almost as easy as measuring a resistor's ohmic value, but localizing a faulty diode or the troubles contributed by associated circuitry requires a little knowledge of diode function and characteristics and possible effects of circuit deficiencies.

Diode identification

Diode symbol and unit identification is often confusing because of the methods that have been used to depict them. The basic symbol (Fig. 1-a), for instance, often has a plus sign at the cathode side and the actual unit itself may be so marked. Don't liken this to the cathode of a tube that emits electrons and has a negative polarity. Instead, think of the diode cathode end as that part which is connected to the plus end of the electrolytic capacitors in power supplies. This will tie in with the plus marking of the diode.

Electrons flow into the cathode of the diode and out from the anode, as shown in the half-wave power supply

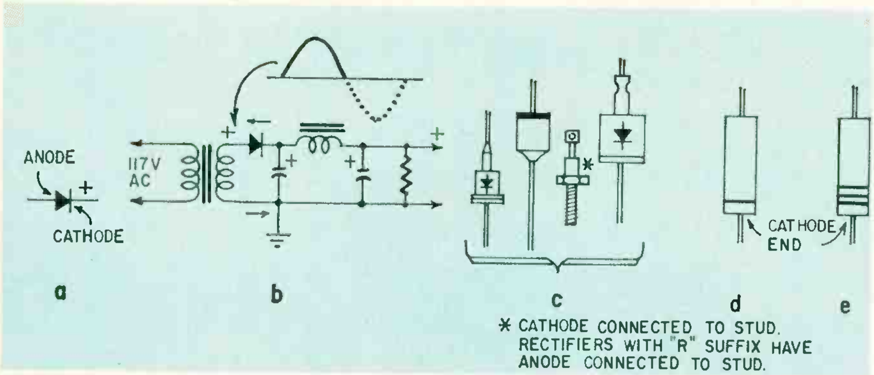


Fig. 1—All ordinary diodes used as detectors and rectifiers are indicated by symbol at a. Arrows in b show direction of current flow in rectifier and detector circuits. Silicon diodes in power supplies are usually shaped like those in c with the diode symbol identifying the elements. Tiny glass, ceramic and epoxy packaged diodes may identify the cathode end and type number with colored bands as in drawings d and e.

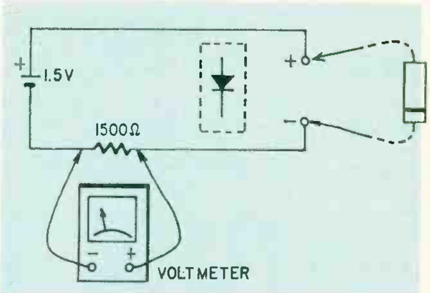


Fig. 2—Simple diode tester checks diode quality and identifies elements. Complete details of how to perform test are in text.

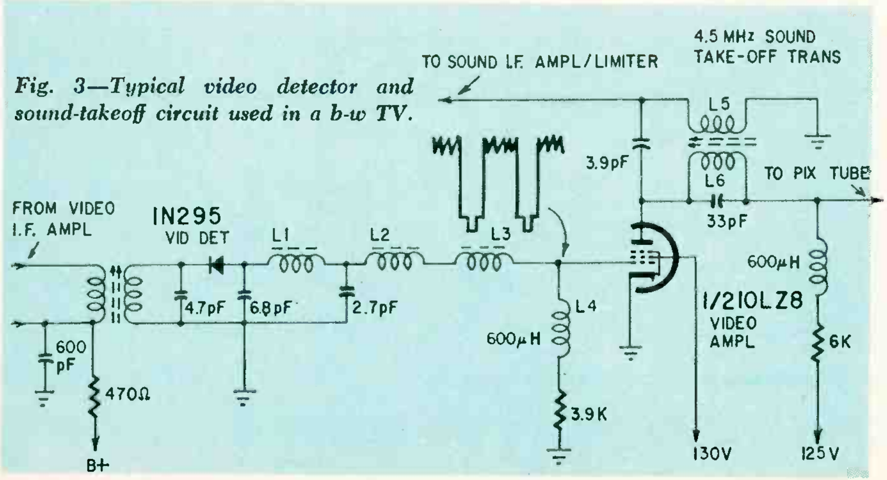


Fig. 3—Typical video detector and sound-takeoff circuit used in a b-w TV.

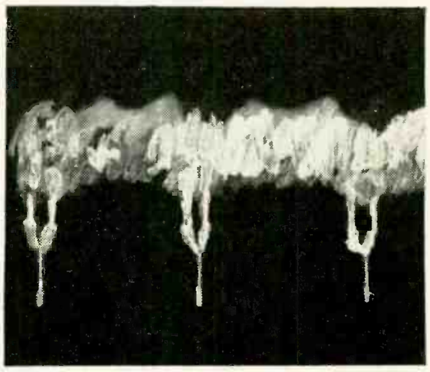


Fig. 4—Composite video signal as seen on an oscilloscope whose sweep oscillator is set to show three horizontal lines.

in Fig. 1-b. The diode conducts on positive half-cycles of the transformer voltage. Electron flow is in the direction shown by the arrows and provides dc of the polarity indicated.

The silicon-type diodes used in power supplies usually have a housing like one of those in Fig. 1-c. The diode symbol may be printed on the case to help identify the leads, or the cathode may be marked with a plus sign.

Lower-current and small-signal silicon and germanium diodes used in detectors are usually shaped like those in Figs. 1-d and 1-e. A band at one end identifies the cathode. Additional color bands near the cathode end (Fig. 1-e) identify the diode type. The initial bands at the top identify the significant figures and the bottom band indicates the letter. Since the prefix "1N" indicates a solid-state diode this is not a part of the color code. The code is as follows:

Black	0	—
Brown	1	A
Red	2	B
Orange	3	C
Yellow	4	D
Green	5	E
Blue	6	F
Violet	7	G
Gray	8	H
White	9	J

Thus, if we have four bands and the colors (in proper sequence) are yellow, yellow, green and red, the unit is a 1N445B diode. The "1N" is understood, the yellow bands represent 4's, the green band is 5, and the right-most band is the letter band, and hence, being red, is B.

Testing diodes

When a positive voltage is applied to the anode and a negative voltage to the cathode, a diode is *forward*-biased, and its internal resistance is low. Most diodes have a resistance of about 1,500 ohms when forward-biased. With reverse bias (negative ohmmeter lead to the anode and plus to the cathode) internal resistance is high (above 500,000 ohms). Thus, if an ohmmeter check gives no reading in either direction the unit is open. A low resistance in both directions shows that the diode is defective.

If you need to identify the cathode and anode ends of a diode, don't depend on ohmmeter leads for polarity identification. In some vom's the battery polarity does not conform to the black-negative and red-positive meter leads. A better system is to mount the parts shown in Fig. 2 on a small panel, and pencil in the diode symbol at the test points, with the cathode side toward the minus terminal. With a diode placed across the terminals correctly, voltage appears across the resistor. With the diode reversed, no reading is obtained on the meter.

In addition to identifying terminals, the tester will also show defective diodes. A full battery-voltage reading for either way the diode is placed across the terminals, or no reading in either direction indicates a defective diode is under test.

Video detectors

A typical video detector for black-and-white tube-type sets is shown in Fig. 3. The circuit is from the Westinghouse V-2490 chassis. A defective detector diode can cause total loss of picture or a washed-out picture. Sound also will be affected because the detector must mix the sound and picture i.f. signals to produce the 4.5-MHz sound i.f. signal.

In-circuit testing of the crystal is difficult, because of the shunting effect of the 3900-ohm detector load resistor. A scope can be used to see if the composite video signal appears at the grid. The pattern obtained should appear approximately as shown in Fig. 4, depending on the settings of the scope controls. Either a 60-Hz or 15,750-Hz rate will produce the pattern.

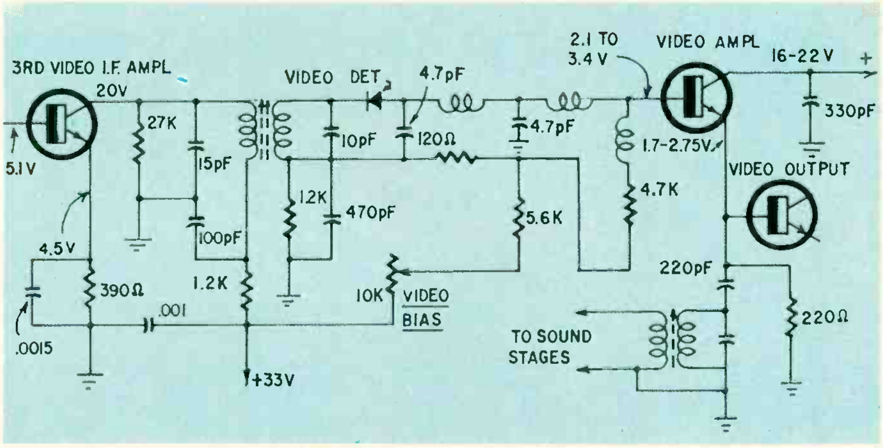


Fig. 5—Video detector and sound takeoff in the Motorola TS-458 solid-state TV.

In transistor TV sets, the various bias voltages will also be present in the video detector in addition to the rectified video carrier signals, as shown in Fig. 5. Hence, voltages should be checked before suspecting the diode detector because incorrect values will affect detection. Again, in-circuit testing should not be attempted. If voltages check out all right and no video signal is present at the detector output, try a new diode.

Note the sound takeoff in the emitter circuit of the video amplifier. As also shown in Fig. 3, the takeoff also forms a 4.5-MHz trap to keep this signal from getting to the picture tube. If interference patterns are present in the picture as shown in Fig. 6, the fault will be a misadjusted sound-takeoff trap and not the fault of the diode detector. Try trap adjustments before checking out the diode detector circuitry in the receiver.

When replacing the detector diode in transistor receivers, keep all power off to avoid transistor damage. With solid-state diodes, as with transistors, avoid prolonged exposure to the heat of the soldering iron. Clean all terminals first and solder the connections as quickly as possible.

Color TV pix and sound detection

In color sets the sound-trapping circuitry must be more effective than in black-and-white sets, and a separate sound detector is usually used to prevent an abnormal decrease in the sound i.f. signal. Thus, in color sets we find two detector diodes, one for the video and the other for the sound, as shown for the Admiral H10 color TV receiver in Fig. 7.

Hence, while a defective detector in a black-and-white receiver affects both picture and sound, in a color set

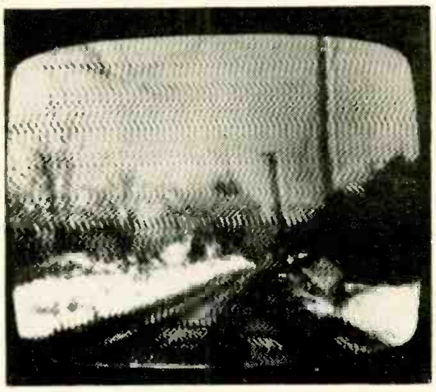


Fig. 6—Misadjusted sound trap permits the i.f. sound carrier to enter the video amplifier and interfere with picture

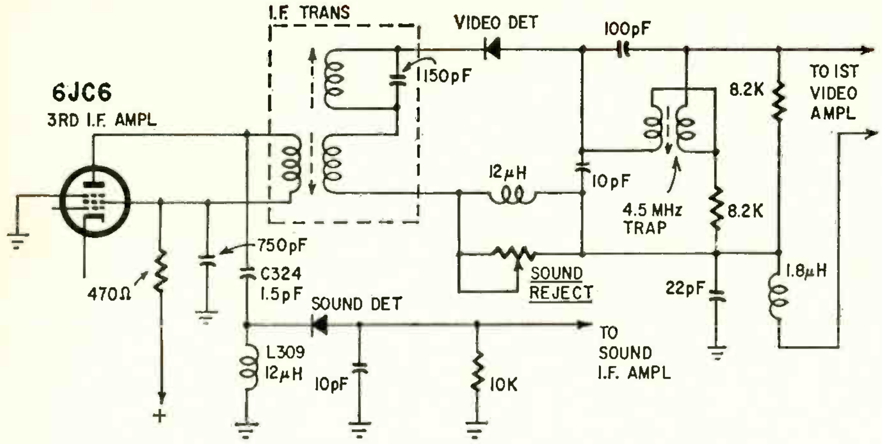


Fig. 7—Color television receivers employ separate circuits for video and sound detection. Either circuit may fail without affecting the other's performance.

either the sound alone or only the picture could be lost. In Fig. 7 the sound detector circuit taps the network composed of the series circuit C324 and the 12-μH inductor (L309). If the capacitor shorts, plate voltage is impressed across the sound detector diode and the inductor. Both units will be damaged and sound output lost. With a short on the third i.f. amplifier plate, picture too is lost. If the sound detector diode alone fails, however, only the sound is affected. Scope patterns again are useful for checking for signals at the output of each diode detector.

Failure of both picture and sound calls for a check of the 6JC6 and the i.f. stages preceding it. It is unlikely that both the video and sound detector diodes would become defective at the same time, but this has happened on rare occasions and should not be overlooked. In one such instance the sound was still missing after the diodes had been replaced; the new sound diode itself was defective. A quick check of new diodes with the tester of Fig. 2 might save you some trouble. It will never hurt to locate a bad "new" diode before you install it.

FM detection

Solid-state receivers usually use a ratio detector (Fig. 8) to demodulate the sound. Some tube sets use this system instead of the more popular gated-beam FM detector. Good ratio-detector performance depends on fairly well-matched diodes. The greater the differences in diode characteristics, the higher the distortion and lower the maximum audio output voltage. If one diode opens or shorts, of course, loss of sound or very severe distortion results. If one of the ratio-detector diodes fails, replace both with a matched pair.

In the ratio-detector system, short-duration static bursts are eliminated by the electrolytic capacitor (1–10 μF) shown in Fig. 8. Since no high dc voltages are used in the detector system, little trouble will be experienced with shorted units. On occasion, however, leakages develop in the capacitors during the aging process (or because of slight manufacturing defects) and static will be heard from the FM sound. A leakage check of the capacitors bridging the diodes will localize this fault.

The output from the FM detector is fed through a de-emphasis network to the volume control. If intermittent high-pitched whistles and overaccented high notes are present, the series resistor and shunting capacitor of the de-emphasis network should be checked for a change in component value.

Sweep phase detector

A circuit that calls for a more critically matched pair of diodes is the horizontal phase-detector system. A typical circuit is shown in Fig. 9. Poorly matched diodes here will make horizontal hold adjustments more critical than usual. If either diode becomes defective, horizontal sweep is unstable.

With solid-state circuitry it is generally felt that, because of the low voltages present, fewer troubles occur. Actually, however, circuit capacitors also have low voltage ratings and hence troubles may occur as often as in higher-voltage tube-type circuits. In particular, check the coupling capacitor between the sync separator and the phase-detector diodes. Even a small leakage here can upset horizontal phasing and cause sync lock-in troubles. Before replacing suspected diodes, observe the waveform at the output of the horizontal oscillator, because the latter may be defective and contributing to trouble symptoms in the set.

If the waveform shown in Fig. 10 is present at the output of the horizontal oscillator, sweep signals are being generated. If sync stability can't be obtained, however, the sweep signal may not be locked in properly by the phase-detector system. If voltages are normal at the sync separator stage, replace the phase-detector diode. Some phase-detector diodes come as a package unit containing factory-matched diodes. Separate diodes can, of course, be used if their forward resistance is closely matched in value. **R-E**

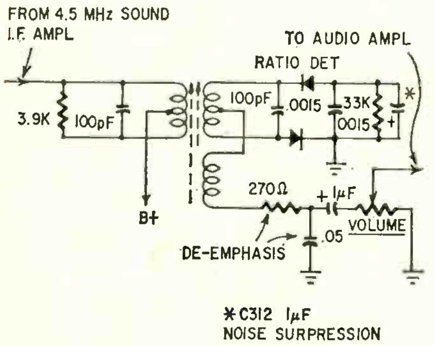


Fig. 8—Ratio detector for TV sound is used in nearly all solid-state TV sets and but a few late tube-type models.

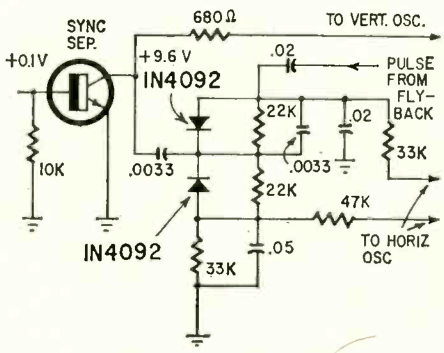


Fig. 9—Horizontal phase detector in the Sylvania A04-1 solid-state TV chassis. Tube sets use almost identical circuits.

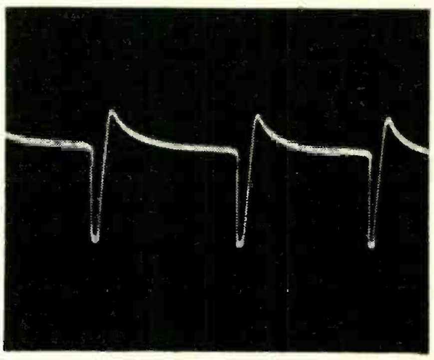


Fig. 10—A typical waveform developed by a TV horizontal sweep oscillator, indicating generation of sweep signals.

SHORTWAVE—Your Ear On The World

Tune in international news . . . language lessons . . . propaganda . . .

By CHARLES J. VLAHOS

SHORT-WAVE RADIO HAS BEEN BRIDGING distances between continents—electronically—for decades. The popularity of short-wave listening (SWL) continues to grow as greater numbers of low-cost, quality receivers are marketed, and interest in other nations develops.

Today, some 3000 short-wave stations beam their broadcasts to the world. Operating at powers up to 500 kW, they fill the airwaves around the clock with a variety of programs that will suit anyone's taste.

At the right frequency and time you can hear Hanoi's interpretation of the war news from Vietnam. Twist the dial to another frequency and you'll hear world news reports from Switzerland—a different viewpoint from the American press and Hanoi. Take the trouble to learn Morse code and you can monitor press broadcasts while news services are receiving them.

Interested in propaganda? Radio Moscow, Radio Peking, Havana or East Berlin will provide all you want. Their broadcasts are slanted to give their viewpoint, not only on world affairs, but on how they feel people should live and govern themselves.

Many stations offer language courses. Tune in Radio Tokyo twice a week for a course called "Let's Talk Japanese," specifically slanted to English-speaking audiences. You can listen to a talk on West Indian wrestling, guided tours of foreign lands, folk music and opera. You'll find much of the SW programing is in English—particularly broadcasts beamed to the States.

For those with a spirit of adventure, there's excitement, too, in SWL. Hundreds of SWL'ers heard the distress call of the Andrea Doria when she went down off the New England coast in 1956. Police, fire and marine calls, airport control towers, government stations—all are within range of many short-wave receivers.

Then there's amateur radio. Amateur or ham radio stations are operated by private citizens in more than 250 countries. Amateurs talk to other amateur operators for personal pleasure or for experimentation. Listening to their chatter can be informative and educational. Commercial business transactions are not permitted over ham bands.

Logging stations

But there's more to SWL than keeping your ear to a loudspeaker. Experienced listeners record what they hear. Log records can be set up in various ways. Typically, the arrangement includes columns for the date, time, call (station), frequency, quality of reception and remarks.

Reception quality is often logged with the SINPO code (*s*ignal *s*trength, *i*nterference, *n*oise, *p*ropagation disturbance and *o*verall merit), which rates reception from 5 (excellent) to 1 (very poor).

Logging is a complete record of the signals heard at the SWL'er's station. Like a ship's log, it should be comprehensive and well organized—what you heard over your receiver. A log book can be an invaluable aid in your search for rare DX (distant stations), and can serve as a guide to quickly locate favorite stations.

In addition to logging, SWL'ers collect verification reports from SW stations. These highly prized confirmation reports are called QSL cards. To obtain a QSL card, the listener must of course first hear the station and log program details. This information is then sent to the station so it can check the report against its transmitting record.

What should you include in the report? Deutsche Welle (Germany Radio) asks that you submit at least these details: 1. Date and time of reception in Greenwich Mean Time, or your local time. 2. Frequency in kHz, MHz and/or meter band. 3. Program details that cover at least 10 minutes of broadcasting time. 4. Language of transmissions. 5. Quality of transmission. 6. Description of your receiver and antenna.

Most international broadcasting stations don't require return postage, but your best bet is to include an International Reply Coupon, obtainable at any post office.

Short-wave receivers

Receivers are often designed for reception only on certain types of broadcasting—such as two-way business radio or amateur-band receivers. A "short" wave is less than 187 meters, crest to crest, compared to about 200–550 meters for standard broadcast waves.

There are 14 international and domestic short-wave bands. The least expensive receivers cover three or more of these bands, and often include the AM or standard broadcast band and sometimes FM. The better receiver models offer continuous coverage from 550 kHz to 30 MHz, and usually designate this coverage in *frequency* rather than radio wavelengths. When wavelength is known, frequency can be determined by the formula $f = 300/\lambda$, where λ = the wavelength in meters and f = frequency in megahertz.

A short-wave band, say 25 meters, covers wavelengths that vary less than 1 meter (25.05–25.7), or from 11.7–11.975 MHz. Thus the 25-meter band covers frequencies in this 11-MHz range on the receiver dial. Short-wave bands will be discussed later in more detail.

First, let's look at some of the criteria that determine the quality of a receiver. Selectivity, sensitivity, stability and image rejection are a few—all, of course, are related to selling price. Expensive models offer the best of each of these characteristics.

Selectivity means just that: the inherent ability of a receiver to select a particular station from a crowded frequency band and reject all others adjacent to it. A receiver's overall selec-

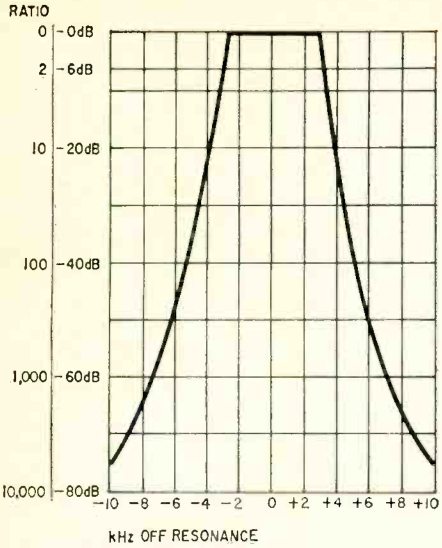


Fig. 1—Typical receiver selectivity curve. Bandwidth is usually given for points on these curves where signal attenuation is 6 dB and 60 dB down. See text for an explanation of the voltage scale.

tivity depends on the selectivity of its individually tuned circuits. In superheterodyne receivers, this selectivity is achieved in the i.f. amplifiers, and the higher the Q of these circuits (and their corresponding sharp resonance curves), the greater the selectivity.

Figure 1 shows a typical selectivity curve for a quality receiver. Although manufacturers seldom supply these curves, when two or more *bandwidth* figures are provided for receiver functions (AM, CW, SSB) the approximate *shape factor* of the curves can be determined.

Bandwidth figures are usually stated for the points on the selectivity curve where signal attenuation is 6 dB and 60 dB down. Shape factor is determined by dividing the former into the latter. Thus, for the curve shown in Fig. 1, bandwidth at −6 dB and −60 dB is 5 kHz and 15 kHz, respectively, and the shape factor is 3.

The voltage scale also shown in Fig. 1 indicates the ratio of signal strength off resonance to signal strength at resonance to provide constant output.

When your receiver has a narrow selectivity curve, it's clear you'll have less interference from adjacent stations. But the bandwidth at −6 dB must be wide enough to pass AM signal sidebands or fidelity will be poor. With the aid of crystal and mechanical filters, receiver selectivity can be made very sharp for code and phone reception where fidelity is not so important. Many quality receivers can be varied in selectivity on all functions with variable selectivity filters.

Sensitivity determines how well a receiver responds to weak signals. When a signal originates from a distant transmitter, its strength is greatly diminished by the time it reaches your listening station—sometimes to a few hundredths of a trillionth of a watt. Your receiver must be able to pick up such signals and amplify them over the receiver's internal noise.

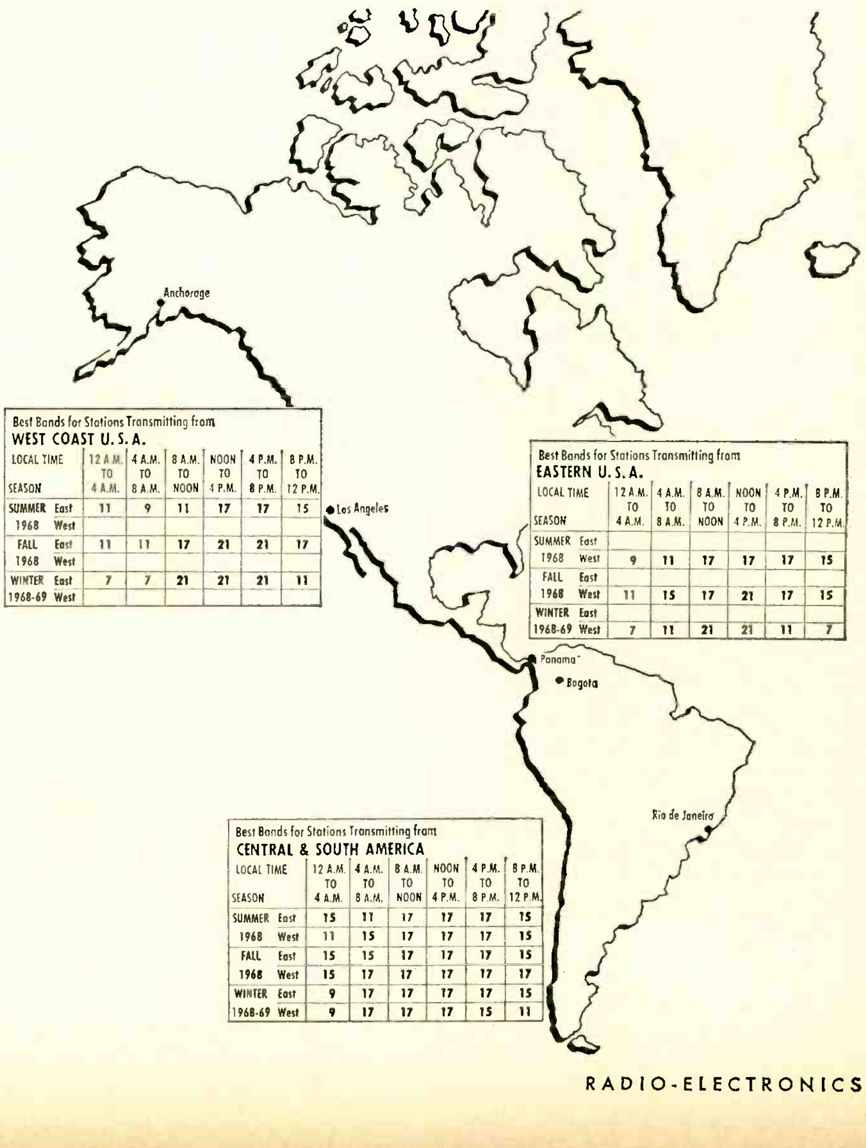
Specifications for sensitivity are given in microvolts in relation to the signal-to-noise ratio. That is, the input signal necessary to give an output signal at a specified ratio above the set's noise. A figure of about 5 to 6 μV at 10 dB S/N is an acceptable sensitivity level, although it's not spectacular. A microvolt value cannot be given for the entire frequency range of a receiver, since sensitivity varies from one band to another, and from the low side of the dial to the high.

A method for testing sensitivity is to turn on the set with the antenna attached. Turn off the avc and set the antenna trimmer to maximum response. Listen for background noise as you rotate the dial. Then disconnect

Facts About the Map ►

Short wave bands are shown in megahertz for the listener's local standard time. The map applies only to listeners in the continental U.S., and is broken down for readers in the EAST and WEST. Example: A Chicago listener wanting to tune in Formosa this winter at 10 p.m. should check the EAST row in the Far East block and try the 15-MHz band. Predictions are for the best band, but at any time reception may be equally good one or two bands above or below the band shown. Where two bands are given in a time period, a sharp transition occurs within the 4-hour period.

World Map To Best



Best Bands for Stations Transmitting from
WEST COAST U. S. A.

SEASON	LOCAL TIME	12 A.M. TO 4 A.M.	4 A.M. TO 8 A.M.	8 A.M. TO NOON	NOON TO 4 P.M.	4 P.M. TO 8 P.M.	8 P.M. TO 12 P.M.
SUMMER	East	11	9	11	17	17	15
1968	West						
FALL	East	11	11	17	21	21	17
1968	West						
WINTER	East	7	7	21	21	21	11
1968-69	West						

Best Bands for Stations Transmitting from
EASTERN U. S. A.

SEASON	LOCAL TIME	12 A.M. TO 4 A.M.	4 A.M. TO 8 A.M.	8 A.M. TO NOON	NOON TO 4 P.M.	4 P.M. TO 8 P.M.	8 P.M. TO 12 P.M.
SUMMER	East						
1968	West	9	11	17	17	17	15
FALL	East						
1968	West	11	15	17	21	17	15
WINTER	East						
1968-69	West	7	11	21	21	11	7

Best Bands for Stations Transmitting from
CENTRAL & SOUTH AMERICA

SEASON	LOCAL TIME	12 A.M. TO 4 A.M.	4 A.M. TO 8 A.M.	8 A.M. TO NOON	NOON TO 4 P.M.	4 P.M. TO 8 P.M.	8 P.M. TO 12 P.M.
SUMMER	East	15	11	17	17	17	15
1968	West	11	15	17	17	17	15
FALL	East	15	15	17	17	17	15
1968	West	15	17	17	17	17	17
WINTER	East	9	17	17	17	17	15
1968-69	West	9	17	17	17	15	11

the antenna and check for inherent noise. With the volume turned up, some low-level noise is acceptable.

Also look for an rf gain control. If there is one, you have an added feature to help prevent overloading by strong signals.

Another criterion of a good receiver is *stability*. This refers to the frequency stability of a receiver, or its ability to prevent a tuned signal from creeping along the dial. Stability is gained through sound electrical and mechanical design, and all manufacturers do their best to achieve it.

One way to check stability is to set the receiver at some known frequency standard (such as WWV, at 2.5, 5, 10, 15, 20 or 25 MHz). Let the receiver warm up, and after 30 minutes or so (if it is a tube set), it should cling pretty close to WWV.

Image rejection is still another important receiver characteristic. The high-frequency oscillator of a superheterodyne can produce the receiver's i.f. from either of two incoming signals, one above and one below the oscillator frequency. One of these responses (twice the intermediate frequency away from the desired signal) is an *image* and can cause serious interference. The ability of a receiver to reject such images depends on its *image ratio*. This is the ratio of the receiver's output voltage from the desired frequency to that from the image frequency. A high image ratio can be achieved with good selectivity in the set's rf circuits (before the signal is heterodyned).

More expensive receivers achieve higher image ratios by using a high i.f. (such as 3 MHz) or two i.f. amplifiers, one of which has a high i.f., since increasing the i.f. increases the separation between the desired frequency and the image frequency.

There are other features to look for in a quality short-wave receiver, and all are evident by studying the front of the set where the controls are. For example, look for:

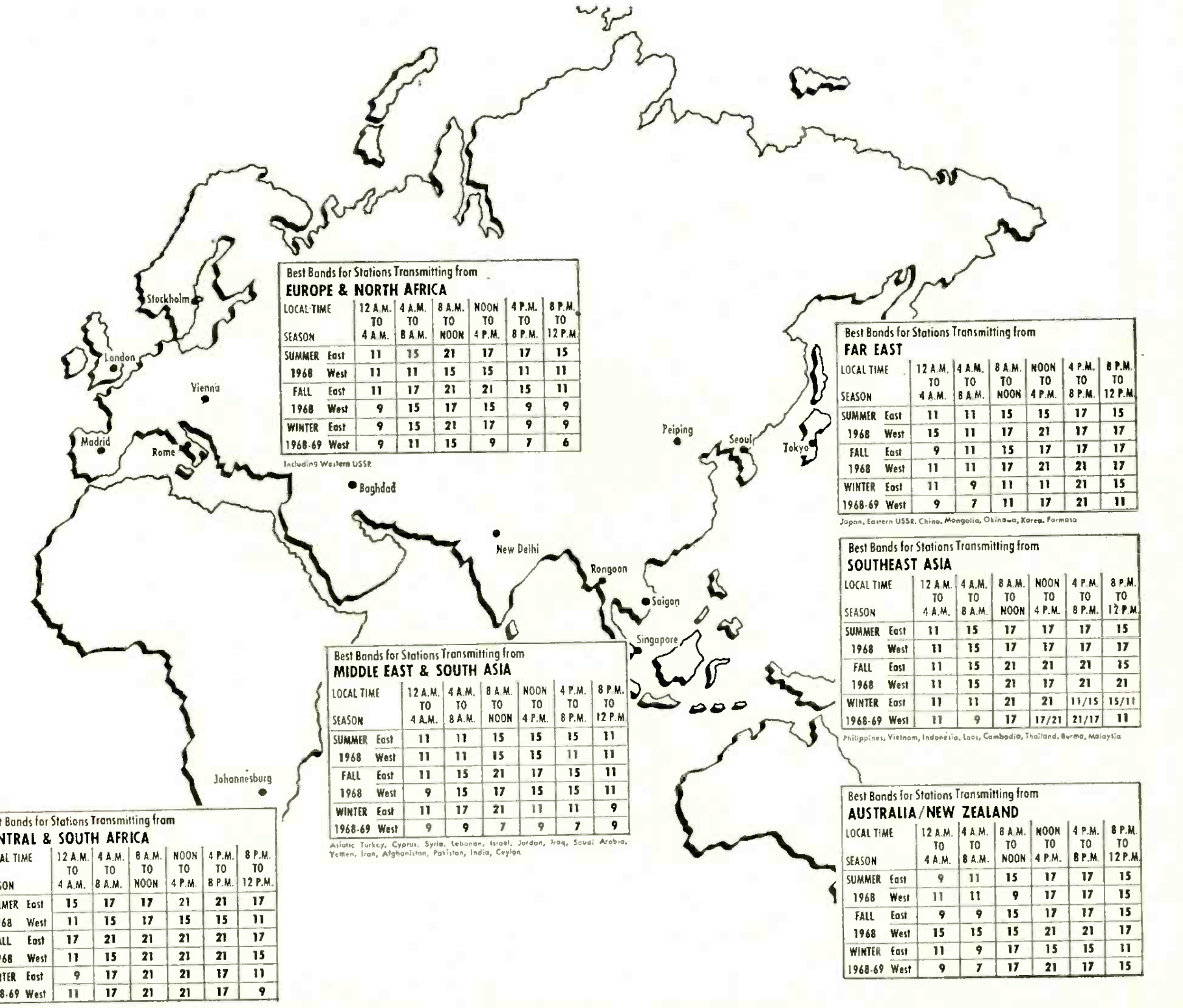
Bandspread Dial. This extremely important feature is found on all good receivers. A separate control which may be described as ultra-fine tuning, it allows you to pick out and isolate stations impossible to separate with a conventional tuning control. In better-quality receivers, this dial is a geared affair. In many SW receivers the bandspread scale is labeled with arbitrary numbers and not in actual frequencies.

S-Meter. A useful feature which measures for the listener the relative strength of the signal, the S-meter serves as a useful tuning aid. It can also be used for reporting signal strength to SW stations, since the meter face is marked off in S-units and decibels, both of which are universally accepted and understood.

Antenna Trimmer. Mentioned before, this control helps peak the first (antenna) tuning stage in the receiver. You peak this stage by rotating the antenna trimmer to a point where the

Short Wave Listening

By Stanley Leinwoll, Radio Free Europe



Best Bands for Stations Transmitting from
EUROPE & NORTH AFRICA

LOCAL TIME / SEASON		12 A.M. TO 4 A.M.	4 A.M. TO 8 A.M.	8 A.M. TO NOON	NOON TO 4 P.M.	4 P.M. TO 8 P.M.	8 P.M. TO 12 P.M.
SUMMER	East	11	15	21	17	17	15
1968	West	11	11	15	15	11	11
FALL	East	11	17	21	21	15	11
1968	West	9	15	17	15	9	9
WINTER	East	9	15	21	17	9	9
1968-69	West	9	11	15	9	7	6

Including Western USSR

Best Bands for Stations Transmitting from
FAR EAST

LOCAL TIME / SEASON		12 A.M. TO 4 A.M.	4 A.M. TO 8 A.M.	8 A.M. TO NOON	NOON TO 4 P.M.	4 P.M. TO 8 P.M.	8 P.M. TO 12 P.M.
SUMMER	East	11	11	15	15	17	15
1968	West	15	11	17	21	17	17
FALL	East	9	11	15	17	17	17
1968	West	11	11	17	21	21	17
WINTER	East	11	9	11	11	21	15
1968-69	West	9	7	11	17	21	11

Japan, Eastern USSR, China, Mongolia, Okinawa, Korea, Formosa

Best Bands for Stations Transmitting from
SOUTHEAST ASIA

LOCAL TIME / SEASON		12 A.M. TO 4 A.M.	4 A.M. TO 8 A.M.	8 A.M. TO NOON	NOON TO 4 P.M.	4 P.M. TO 8 P.M.	8 P.M. TO 12 P.M.
SUMMER	East	11	15	17	17	17	15
1968	West	11	15	17	17	17	17
FALL	East	11	15	21	21	21	15
1968	West	11	15	21	17	21	21
WINTER	East	11	11	21	21	11/15	15/11
1968-69	West	11	9	17	17/21	21/17	11

Philippines, Vietnam, Indonesia, Laos, Cambodia, Thailand, Burma, Malaysia

Best Bands for Stations Transmitting from
MIDDLE EAST & SOUTH ASIA

LOCAL TIME / SEASON		12 A.M. TO 4 A.M.	4 A.M. TO 8 A.M.	8 A.M. TO NOON	NOON TO 4 P.M.	4 P.M. TO 8 P.M.	8 P.M. TO 12 P.M.
SUMMER	East	11	11	15	15	15	11
1968	West	11	11	15	15	11	11
FALL	East	11	15	21	17	15	11
1968	West	9	15	17	15	15	11
WINTER	East	11	17	21	11	11	9
1968-69	West	9	9	7	9	7	9

Asiatic Turkey, Cyprus, Syria, Lebanon, Israel, Jordan, Iraq, Saudi Arabia, Yemen, Iran, Afghanistan, Pakistan, India, Ceylon

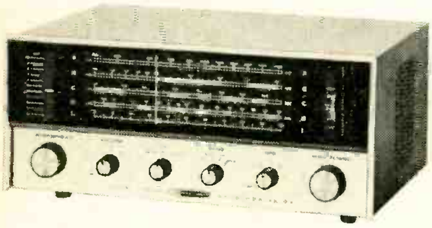
Best Bands for Stations Transmitting from
CENTRAL & SOUTH AFRICA

LOCAL TIME / SEASON		12 A.M. TO 4 A.M.	4 A.M. TO 8 A.M.	8 A.M. TO NOON	NOON TO 4 P.M.	4 P.M. TO 8 P.M.	8 P.M. TO 12 P.M.
SUMMER	East	15	17	17	21	21	17
1968	West	11	15	17	15	15	11
FALL	East	17	21	21	21	21	17
1968	West	11	15	21	21	21	15
WINTER	East	9	17	21	21	17	11
1968-69	West	11	17	21	21	17	9

Best Bands for Stations Transmitting from
AUSTRALIA/NEW ZEALAND

LOCAL TIME / SEASON		12 A.M. TO 4 A.M.	4 A.M. TO 8 A.M.	8 A.M. TO NOON	NOON TO 4 P.M.	4 P.M. TO 8 P.M.	8 P.M. TO 12 P.M.
SUMMER	East	9	11	15	17	17	15
1968	West	11	11	9	17	17	15
FALL	East	9	9	15	17	17	15
1968	West	15	15	15	21	21	17
WINTER	East	11	9	17	15	15	11
1968-69	West	9	7	17	21	17	15

General-Coverage Receivers to $100

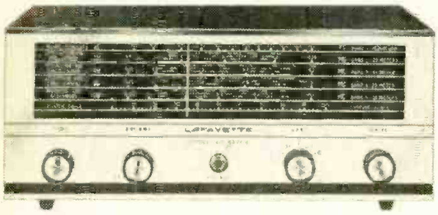


HEATHKIT GR-64
4-BAND RECEIVER KIT

Tuning range: 550 kHz-30 MHz. **Selectivity, Sensitivity:** NA. **Antenna input:** Connections for external systems. **Controls:** Main tuning, bandspread, bandswitch, volume, bfo, ANL, function with AM, STBY, and CW positions, S-meter. **Circuitry:** Vacuum tube; built-in speaker. **Price:** $39.95.

KNIGHT STAR ROAMER
5-BAND RECEIVER KIT

Tuning range: 200 kHz-30 MHz. **Selectivity:** 8 kHz at 6 dB down. **Sensitivity:** 10 μV for 10 dB S/N. **Antenna input:** Connections for external systems, unbalanced, 300 ohms nominal; internal loopstick for BCB. **Controls:** Main tuning, bandspread, bandswitch, antenna trimmer, volume, sensitivity (bfo), avc, ANL, S-meter. **Circuitry:** Vacuum tube; built-in speaker. **Price:** $44.95.



LAFAYETTE "EXPLOR-AIR"
MARK V 5-BAND RECEIVER

Tuning range: 550 kHz-15.5 MHz. **Selectivity, Sensitivity:** NA. **Antenna input:** Ferrite loop for standard broadcast; connections for short wave. **Controls:** Main tuning, bandswitch, tone, volume. **Circuitry:** Vacuum tube; built-in speaker. **Price:** $49.95.

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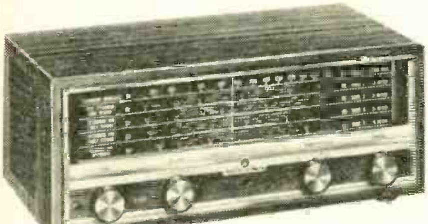
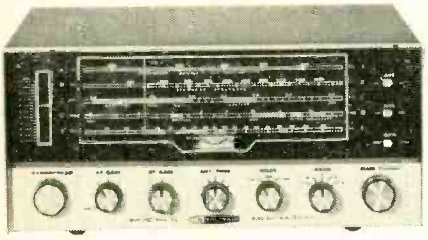


HALLICRAFTERS S-200 "LEGIONNAIRE" 5-BAND RECEIVER

Tuning range: 550 kHz-15.5 MHz. **Selectivity, Sensitivity:** NA. **Antenna input:** Ferrite loop for standard broadcast, connections for short wave. **Controls:** Main tuning, bandswitch, volume, tone. **Circuitry:** Vacuum tube, built-in speaker. **Price:** $59.95.



HEATHKIT GR-54
5-BAND RECEIVER KIT

Tuning range: 180 kHz-30 MHz. **Selectivity:** 3.0 kHz min. at 6dB, 7.5 kHz max. at 20 dB. **Sensitivity:** (for 10 dB S/N). AM, Band A, 1.6 μV; B, 8 μV; C, 1 μV; D, 1.2 μV; E, 6 μV. SSB/CW, Band A, 0.7 μV; C, 0.4 μV; D, 0.5 μV; E, 4 μV. **Antenna input:** Connections for external systems, 30-75 ohms; rod antenna for broadcast band. **Controls:** Main tuning, bandspread, bandswitch, af gain, rf gain, antenna trim, mode with AM, USB and LSB positions, avc, ANL, OPR with REC and STBY positions, meter adjust on rear panel, S-meter. **Circuitry:** Vacuum tube; built-in speaker. **Price:** $87.95.

OLSON RA-48

Tuning range: Band A, 550-1600 kHz; B, 1.5-4.5 MHz; C, 4-12 MHz; D, 11.5-30 MHz. **Sensitivity:** Band A, 2 μV at 50 mW; B, 5 μV at 50 mW; C, 10 μV at 50 mW; D, 20 μV at 50 mW. **Selectivity:** 20 dB, 10 kHz. **Main tuning:** 6:1 spread dial ratio tuning. **Auxiliary circuits:** Bfo pitch control, phone jack. **Circuitry:** Vacuum tube; built-in speaker. **Price:** $39.98.

S-meter reads the highest.

Rf Gain. This control prevents overloading by strong signals.

Bfo Control. This turns on the beat-frequency oscillator, adds a tone to CW signals, and enables the listener to vary code tone to the most pleasing sound.

ANL Switch. This turns on the automatic noise limiter and, in the on position, reduces pulse type noises. Therefore, the signal reaches the loudspeaker practically unaffected by static.

Avc Switch. The automatic volume control helps prevent blasting when a loud signal appears. This switch disables avc for certain types of reception (CW, SSB).

Selectivity Control. This control selects or adjusts a filter for the appropriate bandwidth.

Other features, such as the main tuning control, phone jack, af or volume control, are self-explanatory.

Antennas

Even the best receiver will not perform satisfactorily on short-wave bands unless it is connected to an adequate antenna. A 100′ length of wire strung at a high elevation will pick up signals over the short-wave band. The wire (with insulators at either end) should be positioned away from sources of man-made electrical noise. A shielded lead-in wire will prevent noise signals from being picked up.

Another type of long-wire antenna uses traps on the wire to make sections of the wire sensitive to selected bands. The Mosley SWL-7 kit is a 50′ wire (with lead-in and insulators) that includes traps for the 11-, 13-, 16-, 19-, 25-, 31- and 49-meter bands.

If you don't have space to mount long wires, whip antennas are available that cover the short-wave frequencies. The Hy-Gain SWL-9 is designed for frequencies from 1.8 to 30 MHz, and can be mounted on a window sill.

Accessories

Several devices will enhance your enjoyment of short-wave radio listening. While they aren't essential, they do make SWL a bit easier.

First on the list is a good pair of headphones. These permit you to spend late hours listening without disturbing other members of the household. Chances are you'll be doing much of your listening at odd hours.

And speaking of time zones, another useful item is a time clock. Not the ordinary run-of-the-mill clock, but a 24-hour clock so you can report times correctly on the 24-hour system.

Chart I
CONVERTING TO GMT

24-Hour Time	Eastern Standard Time	Greenwich Mean Time
0100	1:00 AM	0600
0200	2:00 AM	0700
0300	3:00 AM	0800
0400	4:00 AM	0900
0500	5:00 AM	1000
0600	6:00 AM	1100
0700	7:00 AM	1200
0800	8:00 AM	1300
0900	9:00 AM	1400
1000	10:00 AM	1500
1100	11:00 AM	1600
1200	12:00 Noon	1700
1300	1:00 PM	1800
1400	2:00 PM	1900
1500	3:00 PM	2000
1600	4:00 PM	2100
1700	5:00 PM	2200
1800	6:00 PM	2300
1900	7:00 PM	0000
2000	8:00 PM	0100
2100	9:00 PM	0200
2200	10:00 PM	0300
2300	11:00 PM	0400
0000	12:00 Mid.	0500

(Five in the evening is 1700 hours. See Chart I.) If you have an old clock, set it so you can read time in Greenwich Mean Time (GMT).

A crystal calibrator is useful for pinpointing frequencies. Available in kit form, this easily assembled accessory generates a series of accurate signals (usually 100 KHz apart) through the complete range of the receiver that are heard as a tone when the bfo is turned on.

Where and when to listen

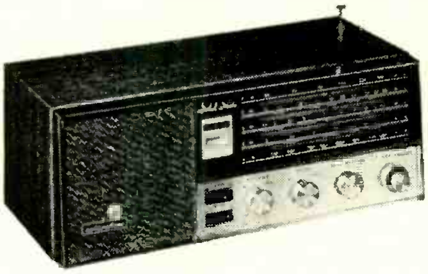
As mentioned earlier, there are 14 international and domestic short-wave bands. Three of these bands (120, 90 and 60 meters) are assigned for domestic broadcasting in tropical areas, and are used mainly by stations in Latin America, Africa, Southeast Asia and Oceania. These Tropical Broadcast Bands are best received when the transmitting station and the listener are in darkness.

The nine remaining short-wave bands are:

MHz band	Meter band
3.9	75
6	49
7	41
9	31
11	25
15	19
17	16
21	13
25	11

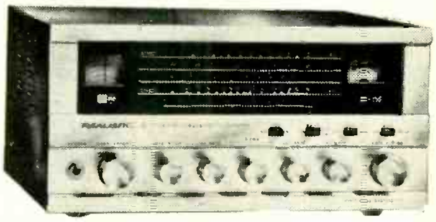
General-Coverage Receivers $100 to $200

HALLICRAFTERS S-240 FM/AM 5-BAND RECEIVER



Tuning range: 550 kHz-108 MHz; 88-108 MHz. **Selectivity AM:** 6-10 kHz at 6 db. **I.F. Bandwidth FM:** 120-185 kHz. **Sensitivity:** NA. **Antenna Input:** Ferrite core for AM; line cord for FM; telescoping whip for short wave; connections for external systems. **Controls:** Main tuning (dual concentric), bandswitch, volume, tone, bfo switch, FM-afc switch. **Circuitry:** Solid-state, built-in speaker. **Price:** $109.95.

RADIO SHACK REALISTIC DX-150 4-BAND RECEIVER

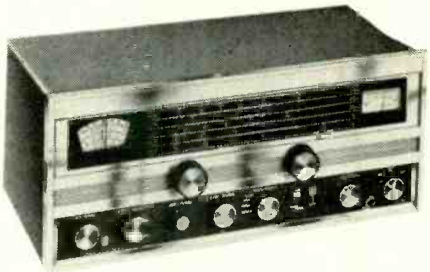


Tuning range: 535 kHz-30 MHz. **Selectivity:** NA. **Sensitivity:** to 5 μV at 30 MHz. **Antenna input:** Connections for external systems. **Controls:** Main tuning, bandspread, bandswitch, ANL switch, bfo, SSB/AM/CW switch, avc switch, receive/standby switch, antenna trimmer, rf gain, volume, S-meter. **Circuitry:** Solid-state; built-in speaker; operates from 117 Vac or 12V dc. **Price:** $119.95.

HALLICRAFTERS S-129 4-BAND RECEIVER

Tuning range: 535 kHz-31.5 MHz. **Selectivity, Sensitivity:** NA. **Antenna input:** Connections for external systems. **Controls:** Main tuning, bandspread, bandswitch, rf gain, antenna trimmer, ANL switch, AM-CW/SSB selector, bfo, volume. **Circuitry:** Vacuum tube. **Price:** $154.95.

HALLICRAFTERS SX-130 4-BAND RECEIVER



Tuning range: 535 kHz-31.5 MHz. **Selectivity:** Crystal filter. **Sensitivity:** NA. **Antenna input:** Connections for external systems. **Controls:** Main tuning, bandspread, bandswitch, rf gain, antenna trimmer, crystal phase, selectivity, ANL switch, AM-CW/SSB selector, bfo, volume, S-meter. **Circuitry:** Vacuum tube. **Price:** $169.95.

General-Coverage Receivers over $200

HAMMARLUND HQ-145A RECEIVER

Tuning range: 540 kHz-30 MHz (11 crystal-controlled frequencies on 145-AX). **Selectivity:** Six positions: 0 for crystal filter disconnected. 1, 2, 3 for AM; 2, 3, 4, 5 for SSB; 4 or 5 for CW. **Sensitivity:** 1.0 μV produces 10:1 S/N ratio. **Stability:** Adjustable high-stability, temperature-compensated bfo for SSB and CW. **Antenna input:** Connections for external systems; nominal impedance 100 ohms. **Controls:** Main tuning, bandspread, bandswitch, rf gain, audio gain, crystal selectivity: OFF-1, 2, 3, 4, 5 positions, crystal phasing capacitor, antenna compensator, function switch (send-receive SSB/CW calibrate), slot frequency adjust, bfo, avc, dial-scale reset (bandspread scale only), S-meter. **Circuitry:** Vacuum-tube, double-conversion superheterodyne. **Price:** $312.95.

General-Coverage Receivers over $200

HEATHKIT SB-310 9-BAND RECEIVER KIT

Tuning range: 3.5 MHz-27.4 MHz. **Selectivity:** AM: 5.0 kHz at 6 dB down, 15 kHz max. at 60 dB down. CW: 400 Hz at 6 dB down, 2.0 kHz max. at 60 dB down (with CW crystal filter, available as accessory). SSB: 2.1 kHz at 6 dB down, 5.0 kHz at 60 dB down (with deluxe SSB crystal filter available as accessory). 2.1 kHz at 6 dB down, 7.0 kHz max. at 60 dB down (with standard SSB crystal filter available as accessory). **Sensitivity:** Less than 0.3 μV for 10 dB S/N for SSB operation. **Stability:** Less than 100 Hz drift/hr after 20-min warm-up. Less than 100-Hz drift for ±10% line-voltage variation. **Antenna input:** Connections for external systems, 50 ohms nominal unbalanced. **Controls:** Main tuning, bandswitch, function switch, mode switch, agc switch, af gain control/ANL switch, preselector, rf gain, meter adjust on rear panel, S-meter. **Circuitry:** Vacuum-tube, double-conversion superheterodyne. **Price:** $249.00.

HALLICRAFTERS SX-122 4-BAND RECEIVER

Tuning range: 538 kHz-34 MHz. **Selectivity:** Three steps: 0.5, 2.5, 5.0 kHz at 6 db down. **Sensitivity:** NA. **Stability:** Temperature compensation of high-frequency oscillator circuits and crystal-controlled second-conversion oscillators. **Antenna input:** Connections for external systems. **Controls:** Main tuning, bandspread, bandswitch, bfo, antenna trimmer, crystal calibrator switch, AM-CW/SSB selector, rf gain, volume, ANL switch, selectivity, S-meter. **Circuitry:** Vacuum-tube, double-conversion superheterodyne. **Price:** $289.95.

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GALAXY R-530 RECEIVER

Tuning range: 5 kHz-30 MHz. **Selectivity:** 2.1-kHz crystal lattice filter, 1.8:1 shape factor, SSB. Optional filters for CW (0.5 kHz) and AM (5 kHz). **Sensitivity:** 0.1 μV for 6 dB signal-plus noise-to-noise ratio, SSB; .05 μV, CW; 0.5 μV, AM. **Stability:** No more than 100 Hz (including 20% line-voltage variation) from turn-on. **Antenna input:** 59 ohms unbalanced. **Controls:** AM, USB, LSB; bfo tuning, preselector tuning, main tuning, frequency synthesizer tuning, meter switch (af/rf), af/rf gain control, band switch, blanker/rf attenuator control, selectivity, agc (fast/slow) switch, headphone jack, function switch (OFF, STBY, OPR, CAL). **Circuitry:** Solid-state dual-conversion superheterodyne. **Price:** $695.

SQUIRES-SANDERS SS-IBS RECEIVER

Tuning range: 3.5-26.1 MHz. **Selectivity:** (A), 8 and 32 kHz at 6 and 60 dB down; (B), 5 and 25 kHz at 6 and 60 dB down; (C), 2.5 and 5 kHz at 6 and 60 dB down. **Sensitivity:** Less than 0.5 μV for 10 dB S+N/N in 2.5-kHz bandwidth (unmodulated carrier in SSB mode); less than 1 μV on 7-7.5-MHz band. **Stability:** Less than 500 Hz drift after turn-on; less than 100 Hz in any 1-hr. period thereafter, including ±10% line-voltage variation. **I.f. and image rejection:** Greater than 60 dB. **Controls:** Bandswitch, rf gain, tuning (manual and motor with digital readout to nearest kHz), selectivity switch, af gain, bfo tuning, AM/LSB/USB/bfo switch, OFF/STANDBY/OPERATE/CAL switch, ANL/noise-silencer controls, agc: SLOW/FAST. **Circuitry:** Vacuum-tube, double conversion. **Price:** $1255.

DRAKE SW-4A 11-BAND RECEIVER

Tuning range: 0.150-26.050 MHz. **Selectivity:** Bandwidth of 5kHz at 6 dB down; 16 kHz at 60 dB down. **Sensitivity:** S/N ratio of 10 dB with input signal of 1 μV when input signal is modulated 30% with 400 Hz. **Stability:** After warmup, will not drift more than 100 Hz. A ±10% change in line voltage will cause frequency shift of not more than 100 Hz. **Antenna input:** Connections provided for external systems; nominal input impedance 52 ohms. **Controls:** Main tuning, bandspread, volume, tone, preselector (changes tuning of antenna and rf circuits), S-meter. **Circuitry:** Vacuum-tube and solid-state dual-conversion superheterodyne. **Price:** $289.00.

Reception of these bands, as well as the tropical bands, is primarily dependent on the electrified region or ionosphere encircling the earth. The density of the ionosphere and its height above the earth's surface vary due to several factors. Since radio waves are reflected from the ionosphere, short-wave reception also varies directly with these factors. Ultraviolet radiation from the sun has the most direct effect on the density of the ionosphere. Consequently, reception varies according to the time of day over the reception path and with the seasons. Broadcasting stations usually compensate for seasonal variations by changing their frequencies in March, May, September and November.

Generally, reception is better on the higher-frequency bands (15, 17, 21 and 25 MHz) during daylight hours (daylight at both transmitter and receiver) and especially during the listener's winter season. During evening and night hours, reception is better on the lower bands (3.9, 6, 7, 9 and 11 MHz). On winter nights 3.9, 6 and 7 MHz are particularly good.

Sunspots are another periodic fluctuation affecting short-wave reception. The number of sunspots varies approximately over a 11-year cycle. As the number of sunspots increases, ultraviolet radiation goes up, increasing the density of the ionosphere and improving reception. At present, we are in a peak of sunspot activity, and consequently there is excellent short-wave propagation, especially in the 15-, 17-, 21- and 25-MHz bands. **R-E**

More Information

Here's a list of short-wave receiver manufacturers.

Allied Radio Corp., 100 N. Western Ave., Chicago, Ill. 60680

Ameco, Div. of Aerotron, Box 6527, Raleigh, N.C. 27608

Eico Electronic Instruments, 283 Malta St., Brooklyn, N.Y. 11207

Hallicrafters, 600 Hicks Rd., Rolling Meadows, Ill. 60008

Hammarlund Mfg. Co., Mars Hill, N.C. 28754

Heath Co., Benton Harbor, Mich. 49022

Lafayette Radio Co., 111 Jericho Turnpike, Syosset, L.J., N.Y. 11791

National Radio Co., Inc., 37 Washington St., Melrose, Mass. 02176

R.L. Drake Co., Miamisburg, Ohio 45342

Radio Shack Corp., 730 Commonwealth Ave., Boston, Mass. 02215

Squire Sanders, Inc., Box B, Liberty Corner, N.J. 07938

Also P. 79

ANTENNAS FOR MOBILE RADIO

Is your sky-piece first class? Match antenna performance with today's high-quality transceivers

By D. BLACKLOCK

ARE YOU HAVING TROUBLE WORKING your mobile units? Do you spend five minutes trying to get a message to a mobile unit and end with the operator calling you by land line? Does he disappear into a dead zone and stay lost for a half hour? If so, the trouble may be in your antenna system.

CB and other two-way transceiver equipment now on the market includes some of the best communication equipment ever designed. Transceivers have to meet FCC technical requirements and stiff competition in the market for the two-way radio dollar. Receiver sensitivity, adjacent-channel rejection, transmitter power output and modulation percentage are all that the law and cost engineering allow.

However, there can easily be a weak link in the communication chain: the antenna system. If the antenna fails to transmit and receive efficiently, you cannot take full advantage of this equipment.

Types of antennas

A study of manufacturers' literature shows a bewildering array of antennas available, from simple and inexpensive quarter-wave verticals to elaborate and expensive multi-element beam antennas. Antenna selection for your base station requires a familiarity with the capabilities of the basic antenna types.

The *quarter-wave end-fed vertical* is the simplest of the vertical antennas. It consists of a simple vertical radiating element cut to one-quarter wavelength. This antenna must work against a ground plane (Fig. 1), cut to one-eighth or one-quarter wavelength.

Advantages of this antenna are its light weight, ease of mounting and low cost. Disadvantages are no relative gain, high radiation angle (Fig. 2-a) and a radiating element that is not at dc ground, allowing static buildup and increasing receiver noise.

Half-wave vertical antennas are identical to the quarter-wave except they are cut for one-half wavelength. They have the same advantages and dis-

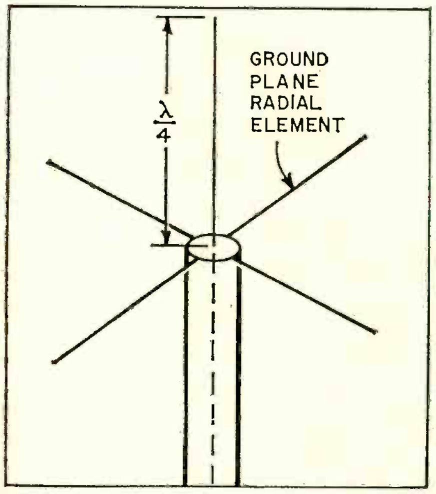


Fig. 1—Radial elements mounted on this quarter-wave end-fed vertical antenna function as an artificial ground plane.

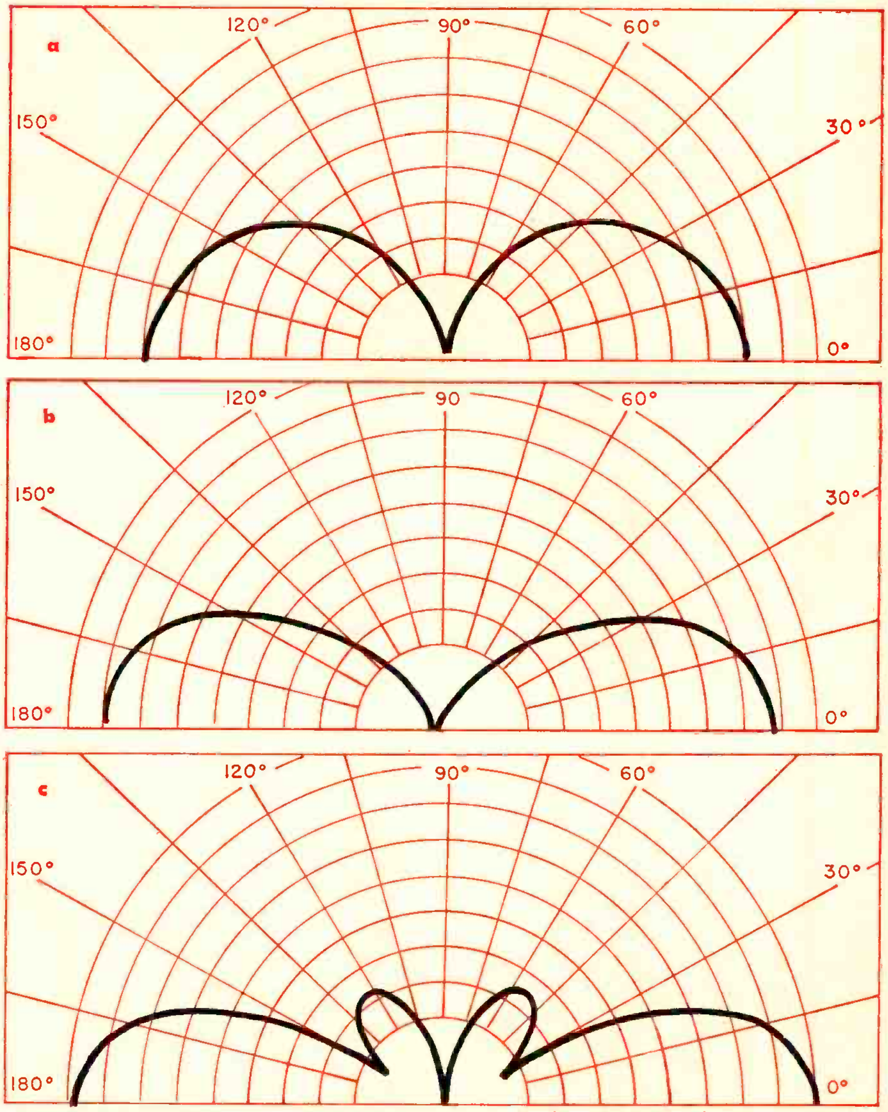


Fig. 2—Side views show radiation change with antenna length. The quarter-wave antenna in a has a high radiation angle. Half-wave at **b** *increases radiation density, and five-eighths wave in* **c** *has very low pattern and high relative gain.*

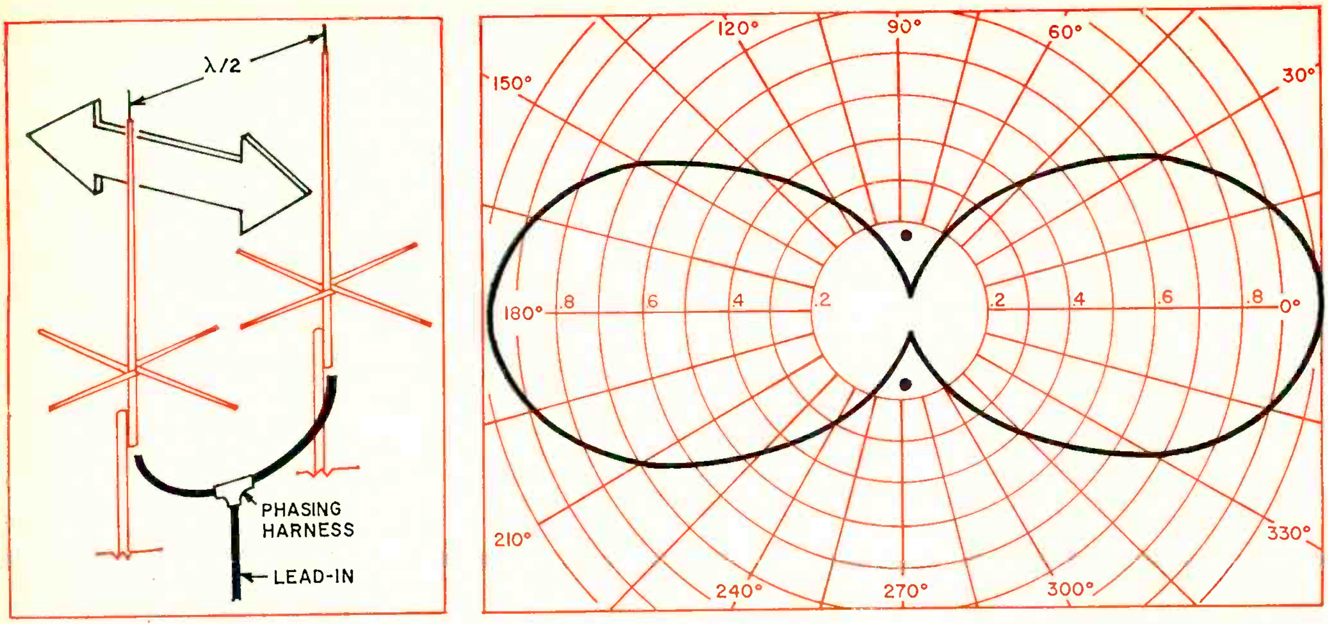


Fig. 3—Bidirectional array used in the broadside mode. Due to spacing of elements, field cancellation takes place and radiation is at right angles to antenna plane. Beam widths are about 60°.

advantages as the quarter-wave, with an improved radiation angle and better gain (Fig. 2-b).

The *five-eighths-wavelength electrically extended vertical* is the most commonly used and one of the most efficient antennas available today. It consists of a vertical element which is electrically extended to represent five-eighths wavelength. This antenna also has a ground plane of three or four radials of one-quarter or usually one-half wavelength. This is the longest vertical (just under 20′) that may be used for CB under current FCC rules.

Development of this type of antenna was a great stride forward in making available more efficient antennas for two-way frequencies. The five-eighths wave has several advantages over quarter- and half-wave verticals. Due to the five-eighths wavelength radiator, the antenna has a very low radiation angle and, as a result, exhibits considerably more gain than the quarter-wave vertical (Fig. 2-c).

This radiation angle may be made even lower by using short radial elements at the top of the vertical element. The use of a loading coil allows this antenna to be shunt-fed, which in turn enables the entire antenna to be operated at dc ground.

With the five-eighths wave it is possible to achieve a gain of 4 to 5 dB over quarter- and half-wave verticals. This is the most powerful nonrotating antenna available. The disadvantages are high cost and the heavier mounting required because of increased weight and wind resistance.

The three antennas discussed so far are of the omnidirectional type. They provide uniform coverage in all directions. Directive antennas have the ability to concentrate the signal into a narrow path, which may then be directed toward a specific point or area.

Multi-element rotatable beam antennas consist of two to five elements

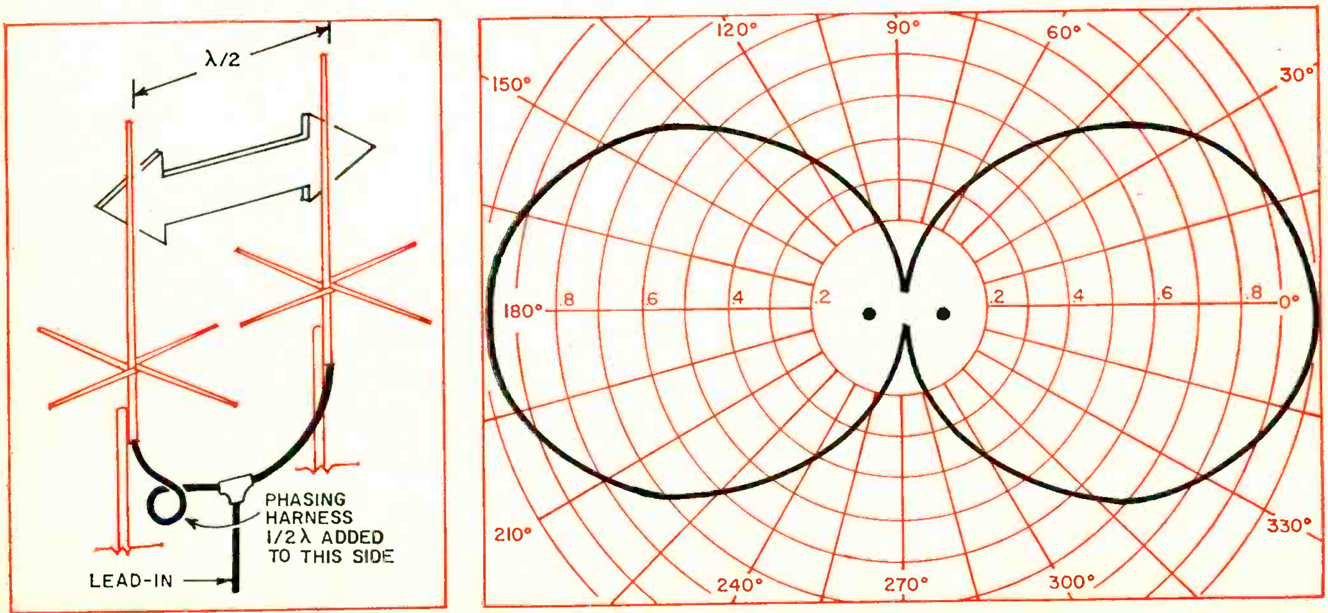


Fig. 4—When feed line to one antenna in a half-wave bidirectional array is half wavelength longer than the other, cancellation spreads radiation pattern along the antenna plane. Beamwidth is about 80°.

mounted on a boom. There is one radiator or driven element, along with one to four reflector and director elements. Since this type of antenna is normally rotated to provide 360° coverage, two identical sets of elements are often mounted on a cross boom, balancing the array and providing a central point of rotation. Two antennas side-by-side will produce a very narrow horizontal beam.

An advantage is effective power gain due to concentration of the radiation. (This may be 6 to 10 dB, depending upon the number of elements.) Also, high rejection (18–26 dB) of noise and unwanted signals not in the beam path is achieved. Disadvantages are high installation costs—array, support tower and rotator—and large physical size requiring a clear area up to 30 feet in diameter for rotation. Strong support is needed because of weight and weather.

Phased or electronically steerable arrays are a relatively new type of antenna having the advantages of the beam antenna while eliminating the disadvantages of size, weight and mechanical rotator. Mechanically more simple, this antenna system is more complex electronically. These arrays are bidirectional and unidirectional.

Bidirectional arrays are the simplest of the phased-array antennas (Fig. 3). Typically, two vertical antennas are spaced one-half wavelength apart. The antennas are fed through an impedance-matching transformer and equal-length feed lines. With these feed lines the signals arrive at the antennas in phase. With the antennas excited in phase and a half-wavelength apart, field cancellation takes place. The signal is therefore radiated along a path at right angles to the plane of the antennas. The pattern extends to the left and right of the antenna plane. This is the *broadside* mode of operation, and for half-wave spacing produces a beam width of about 60°, a gain of 3.8 dB over a single vertical antenna and 30 dB attenuation in the plane.

If the feed line to one antenna is lengthened by a half wavelength (Fig. 4) the antennas are excited 180° out of phase, and the consequent field cancellation results in radiation along the plane of the antennas. This is the *end-fire* mode, producing a beam width of around 80° and a gain of 2.3 dB over a single vertical. Signals broadside to the plane are attenuated by 20 dB.

By addition of a simple switching device, it is possible to shift the array from broadside to end-fire modes. Switching modes allows 360° coverage.

Advantages of this array are a reasonable gain over a single vertical, some rejection of noise and unwanted signals and 360° coverage with mode switching.

Disadvantages are nonuniform 360° coverage in or near maximum range—some dead spots exist due to beam patterns.

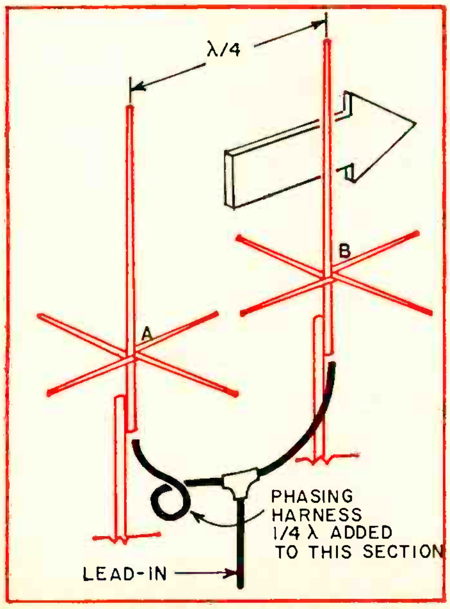
The *cardioid array* is a unidirectional phased array that differs from the bidirectional array in the spacing of the vertical antennas. The verticals are spaced one-quarter wavelength apart. Additionally, the antennas are fed 90° out of phase. The resulting field cancellation produces a cardioid (heart-shaped) radiation pattern (Fig. 5). This pattern is centered about the plane of the antennas and is directed toward the out-of-phase antenna. The beam is approximately 120° wide, with 30 dB rear attenuation and 20 dB side attenuation. With the addition of a simple switching device to switch the 90° phase shift from one antenna to the other, it is possible to shift the direction of radiation 180°.

Advantages of this array are a broad beam covering almost 180°, switching capability to provide 360° coverage, 4.5 dB gain over a single vertical and smaller space requirements than those of the bidirectional array. Disadvantages are that a 360° coverage will have two dead spots.

A *steerable cardioid array* is the basic cardioid array improved to provide an array which can be positioned in six discrete positions of 60° each, thus providing complete 360° coverage. See "Electronic Antenna Rotation," RADIO-ELECTRONICS, Aug. 1967. This requires the use of a third vertical antenna. The three verticals are oriented at the points of an equilateral triangle which is a quarter wavelength on a side. The array is fed through a switching unit that selects the pair of verticals being excited and the antenna which has a 90° phase shift. This antenna and phase-shift selection permits the direction of radiation to be stepped through six positions. The array produces a pattern having a 60° beam width with 20 dB side attenuation and 30 dB rear attenuation.

Advantages are uniform 360° coverage and a gain of 4.5 dB over a single vertical. Disadvantages are the

(continued on page 84)



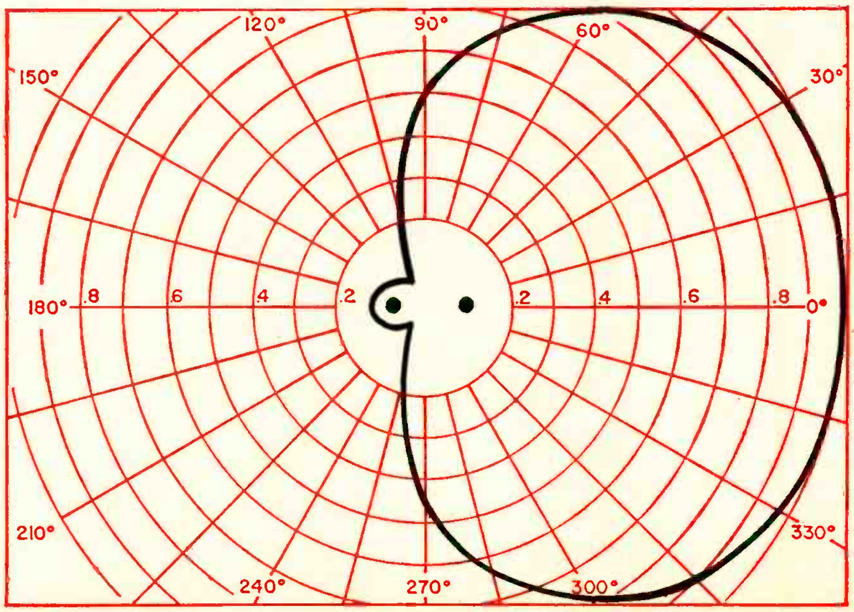


Fig. 5—Spacing of the vertical antennas and 90° out-of-phase feeding in this cardioid array generates heart-shaped pattern. By switching 90° phase shift between elements, radiation pattern is shifted 180°.

Fix Automatic Chroma Circuits

How acc circuits work in modern color receivers

By ROBERT L. GOODMAN

WHY IS IT WHEN I SWITCH MY NEW color TV set to a another station I have to "fiddle" with all the color controls? And don't tell me Lorne Green's face is really green. What makes some color commercials so rich in color while another program is very dull? Yes, Mr. TV technician, what are you going to do about this color viewing problem?

A familiar complaint? It should be. TV technicians and service dealers get an ear full of such grumblings every day. What can you do about it? Frankly, not much. If you've checked the color chassis thoroughly with accurate color instruments and it's okay, then the problem, of course, is the color signal your customer's set is receiving.

Color set manufacturers are busy designing automatic color-equalizing and color-level control circuits. But this isn't the total answer to the problem: Color transmissions travel from network studios, over AT&T microwave video-carrier relay systems, through the local station's transmitter and, increasingly, through CATV systems before reaching receivers.

This "circuit" needs a more accurate, stable color signal. Perhaps the FCC needs to revise its color-signal specifications and call for more stringent standards. Let's hope the whole system of color transmission won't have to be completely revamped.

With the present NTSC (National Television System Committee) system a shift of more than 3° of the 3.58-MHz color subcarrier can cause a noticeable shift in the flesh tints of a color picture.

TV field representatives and engineers of leading manufacturers agree that a much more stable and constant color signal is badly needed. They note that in the past few years TV manufacturers have had to incorporate added circuits in chassis designs to compensate for color-level or phase shifts, and then add blanking circuits to eliminate picture streaks caused by some CATV system transmission deficiencies.

This would not be necessary if the transmitted signal contained all proper blanking pulses and was held at a constant level. Of course, some automatic-control circuits will be needed in color sets since it's unlikely the same signal level can be fed to all receivers. Also, variable signal and noise conditions will exist at each set location.

Station color calibrator

Some help may soon come from the broadcasters. One reason color sets need frequent adjusting by the viewer is that the color balance of the broadcast signal shifts. Switching from one camera to another or changing film, studio or station can upset the balance. Engineers at the Canadian National Research Council have developed an instrument that may help eliminate the color-balance problem.

Main cause of trouble, according to Dr. C. L. Sanders of NRC, is that the monitors TV directors use to adjust color balance aren't set to reproduce a uniform color of white on the screen. When the scene shifts from one monitor to another, incorrect adjustments are made. If monitors have been standardized, the problem of color balance is largely eliminated, according to Dr. Sanders.

NRC's new instrument, a color calibrator, allows the broadcasting station to adjust all its monitors to a standard field of light, internationally recognized as standard television white. The instrument is to be built by Central Dynamic, Ltd., Montreal.

A basic acc circuit

A means is now provided in most color receivers for controlling the gain of color (chroma) i.f. amplifiers so that overload or wash-out will not occur as program content and signal strengths vary. Fig. 1 shows a basic acc (automatic chroma-control) circuit. A

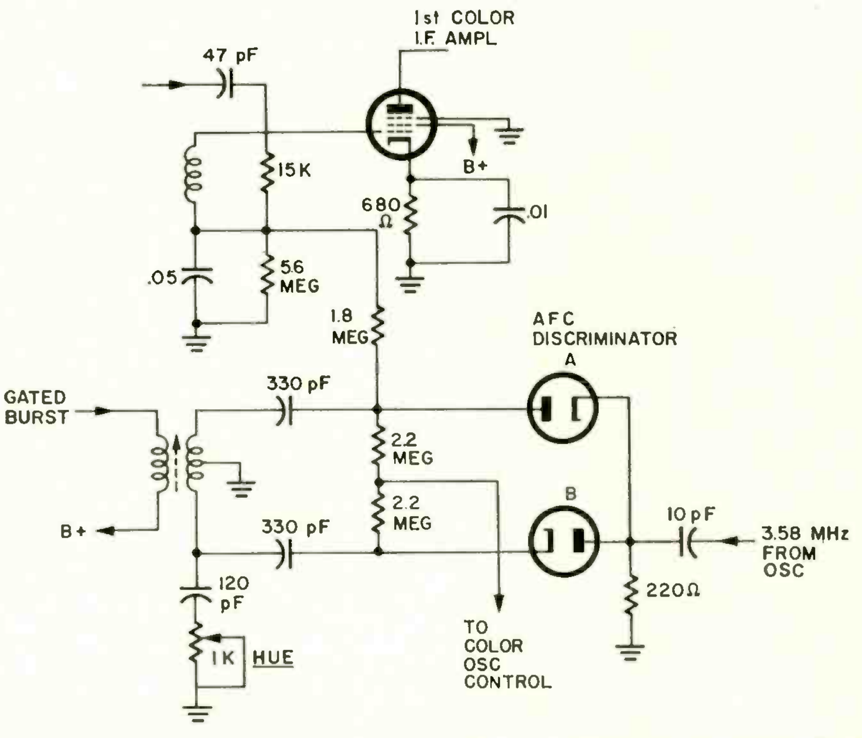


Fig. 1—Amplitude of —dc voltage on plate of diode A (proportional to color burst) controls color strength by varying bias of first color i.f. amplifier.

negative dc voltage that is proportional to the amplitude of the color (burst) appears on the plate of the afc phase detector, diode A. This voltage is coupled through the 1.8-megohm resistor to the first color i.f. input coil, and appears on the grid as bias voltage.

When a strong color signal is received, a large negative voltage develops at the plate of afc diode A. This voltage is applied to the grid of first color i.f., lowering the gain of this stage. This reduces color-signal amplitude to a normal level. On a weak signal, the negative voltage developed will be lower, letting the color i.f. stage increase its gain to normal viewing level.

The color circuit described may vary considerably in different sets, but the principles involved remain essentially the same. By understanding how the basic circuit works, it's easier to understand circuit variations.

Now let's look at how some color-level controls operate in a number of color receivers.

RCA's transistorized acc

Closed-loop acc circuitry in the RCA CTC31 chassis holds the output of the first-chroma amplifier constant during changing signal levels. The closed-loop circuits include those stages shown shaded in Fig. 2. The first-chroma bandpass amplifier is the controlled stage in this circuit.

Composite chroma input is present at the first-bandpass stage. Output of this stage contains the amplified color signal (for application to the second-chroma bandpass amplifier) and amplified color sync (for the burst amplifier). The burst amplifier is followed by the injection-locked 3.58-MHz oscillator. The dc voltage developed in the oscillator grid circuit is a function of incoming burst-signal amplitude. This dc voltage is amplified by the transistor, and coupled to the first-bandpass amplifier to control its gain. The control signal (color burst) passes through the controlled stage (first bandpass), thus the closed-loop circuit is obtained.

Burst-control acc circuits operate on the premise that predetermined information is contained in the reference burst amplitude. This is determined by FCC specifications for color information transmission. Burst should have the needed properties to be used as a reference because its amplitude is independent of chroma scene information, which always varies. Hence, the acc reference for color control can be determined by burst amplitude. As we will soon see, however, this is not always the case.

An odd-ball problem that may crop up now and then is with the TV station or CATV system transmitting color information. The TV set will appear to lack color gain, even with the color control fully advanced. However, when the channel is changed, color will roll in good and strong. Of course, this applies only to sets equipped with automatic color gain or level circuits. If the color burst from the TV station is too high, the acc circuits will be fooled into biasing the color bandpass amplifier stage, which will result in a weak color picture.

Use a scope to double check the color burst level. If the level is too high it must be lowered. Some set manufacturers have come out with modification data that may help eliminate this difficulty. Best bet is to contact the chief engineer of the TV station or CATV system in question and ask him to check the color burst level.

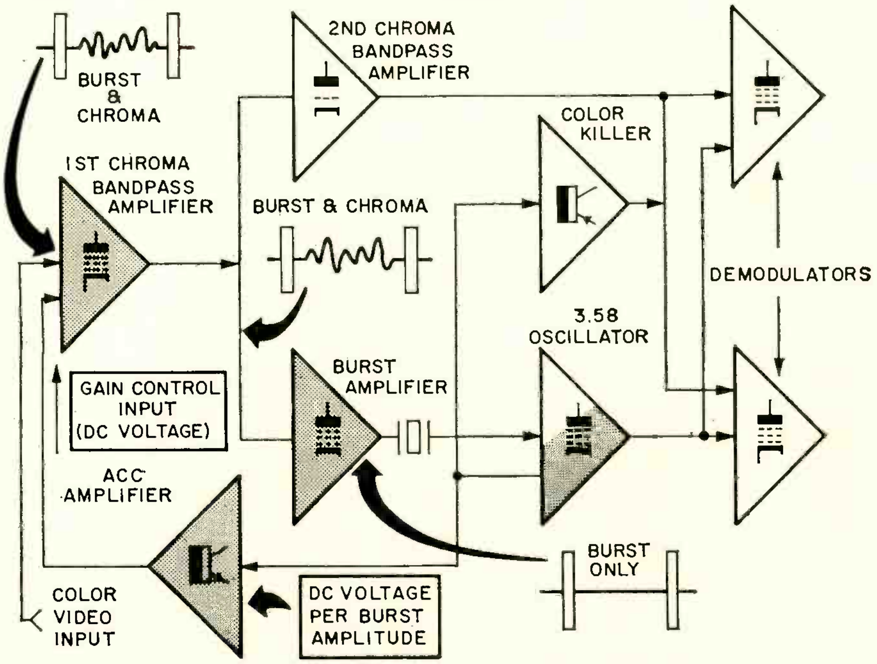


Fig. 2—Shaded stages in RCA closed-loop acc circuit keep first color i.f. stage at constant output. Transistor amplifies dc voltage from 3.58-MHz oscillator, which varies with burst signal amplitude, to bias first color stage.

Motorola's solid-state acc

For a wider range of color fine tuning, and to hold color saturation constant despite changes in amplitude, Motorola's TS-915/919 solid-state chassis (Fig. 3) uses a one-stage dc amplifier (Q4) to vary the gain of the first color i.f. stage.

When color sync is present, the output of 3.58-MHz amplifier Q3 is proportional to the color-signal amplitude. The output voltage is rectified, creating a +dc control voltage which is fed to the base of acc amplifier Q4, increasing its conduction.

The conduction of Q4 is proportional to color sync amplitude. Forward bias for the first color i.f. amplifier (not shown) is obtained from the +35-volt dc supply, with Q4 acting as a variable impedance to ground on the bias supply line. Increased conduction of Q4 because of a strong color signal reduces i.f.'s forward bias, resulting in less color gain. A decrease in color signal increases the color i.f.'s forward bias, producing greater color-signal gain. To assure maximum weak-signal gain, acc voltage is delayed by a reverse-biased diode.

Zenith's acc circuits

On Zenith's 26KC20 color chassis (Fig. 4) the two opposite phases of the burst signal from injection coil L38 are coupled to the plate and cathode of the dual-diode acc phase detector, V24-a. These two signals are compared in amplitude with the signal from the 3.58-MHz oscillator. The reference signal, which is in phase with burst, is fed to the opposite plate and cathode of the diode.

Regardless of the presence or phase of the burst-signal input to the acc dual diode, one diode always conducts more than the other, to develop a negative voltage at the junction of resistors R156-a and R156-b. (With zero burst-signal input, the voltage at this junction is about zero.) The voltage at this junction may vary from as high as

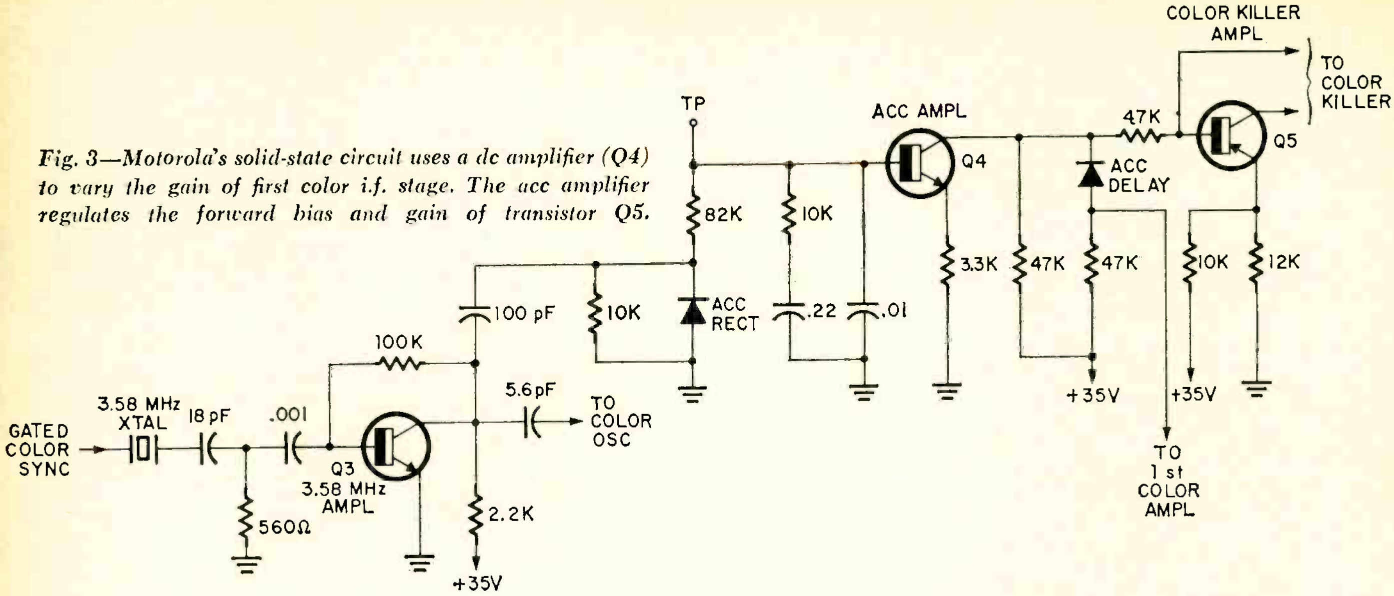


Fig. 3—Motorola's solid-state circuit uses a dc amplifier (Q4) to vary the gain of first color i.f. stage. The acc amplifier regulates the forward bias and gain of transistor Q5.

—12 or —14 volts (on a strong burst signal) to almost zero (with no burst input to the stage.)

The large negative voltage, present only during burst input, is used for two purposes: it serves as an acc voltage for the first color amplifier, and as a cutoff voltage to disable the color-killer stage. The higher the burst signal, the higher the acc voltage and the lower the gain of the first color amplifier. Again, acc voltage adjusts gain of the first color amplifier.

A color-off switch is connected to the acc-voltage lead which, when closed in the grounded position, removes acc and color-killer grid voltage. In the absence of a burst signal, this voltage is not present. Thus the color-killer tube conducts hard (during the on time set by the pulse at the plate during burst time) and develops approximately —50 volts. This is applied to the second color-amplifier control grid to cut off that tube and disable the receiver's color channel.

Checking

Before you start troubleshooting a set with improper color reproduction make sure it's a chassis malfunction. A small portable color set is useful on calls to check the color on the customer's cable or antenna system. A color-bar generator can also be used. This can solve many color complaints. Make sure sets have a strong color level and correct signal information before you dig into a chassis.

How can acc circuits be checked? One way is to use a vtvm and monitor the acc voltage while you switch from one channel to another. If the voltage varies, the acc is working.

A more accurate method is to connect an oscilloscope to the control grid of the R—Y demodulator tube and measure peak-to-peak chroma-signal voltage. This voltage, of course, will

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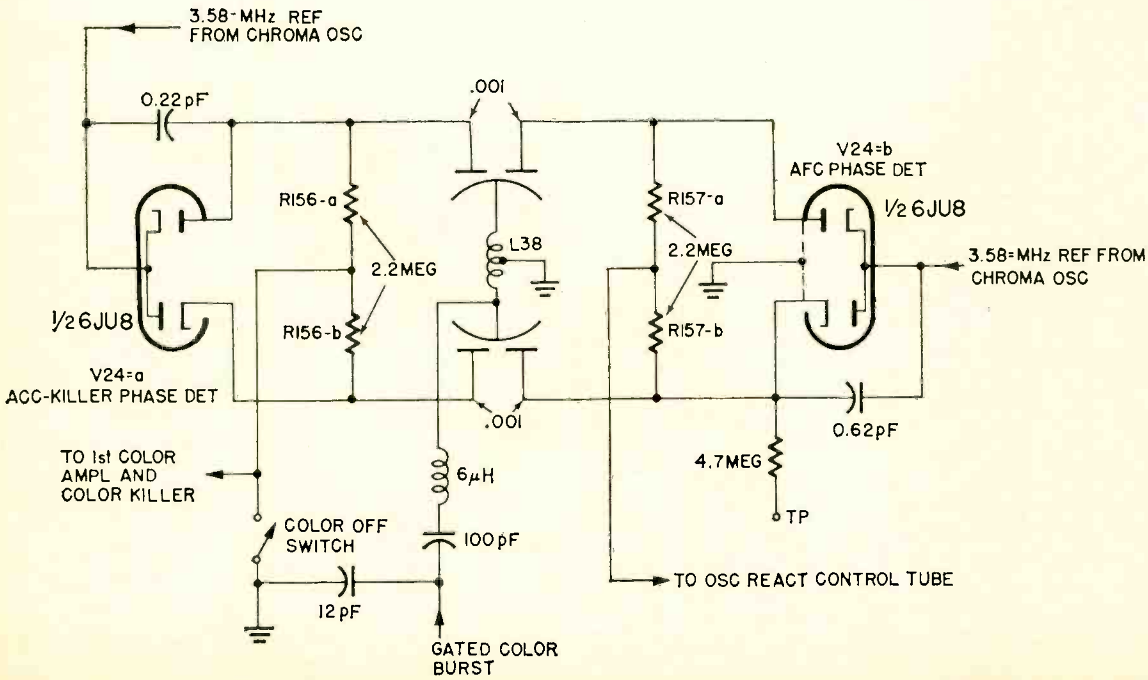


Fig. 4—Zenith chassis uses a dual-diode acc phase detector to compare burst signal and output of 3.58-MHz oscillator. Negative diode output adjusts gain of the first color i.f.

Dipper and Crystal Oscillator

Sensitive device tunes from 4 MHz to 80 MHz

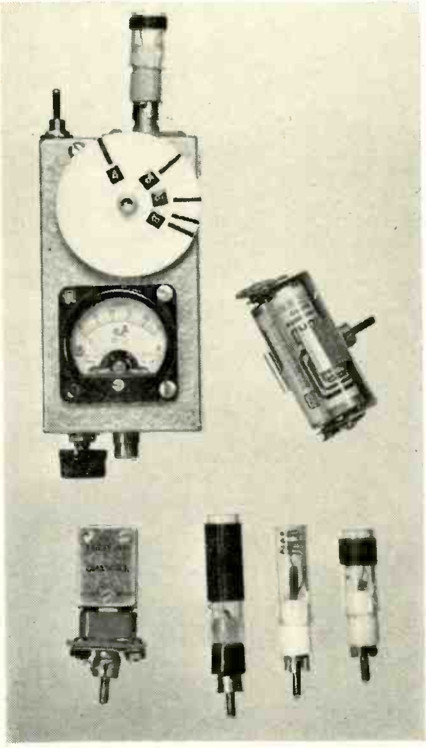
By I. QUEEN
EDITORIAL ASSOCIATE

A GRID-DIP METER OR ITS SOLID-STATE equivalent can quickly measure the resonant frequency of a tank circuit. A "dipper," therefore, is useful when winding coils for a receiver or transmitter, or checking unknown coils or capacitors.

The solid-state dipper described here is easy to build and useful over a wide range of frequencies. Experimenters, hams and short-wave fans will find many uses for it.

Dipper circuits consist essentially of an rf oscillator and a meter to measure its output. Initially, the meter is set near full scale. When the dipper is coupled to a tank circuit, the latter will absorb some of the rf energy and cause the meter to dip. At this point the frequency of the tank equals that of the dipper, so it is simply a matter of reading the dipper calibration.

For serious design work there are excellent, stable, precisely calibrated tube dippers covering a wide frequency range. For most experimental work, however, high precision is neither necessary nor desirable. All that's needed, generally, is an approximate idea of unknown tank frequencies.



The dipmeter with its coils, crystal and battery. Ordinary phono plugs and jacks are used as miniature plug-in connectors.

This dipper uses an inexpensive (90¢) FET for the oscillator. Its circuit is so efficient that it works well on a single-cell power supply. However, 2.5 or 3 volts is recommended for greater output and stability. The circuit also doubles as a crystal oscillator when a crystal is plugged in instead of a coil.

Four coils are used to tune from below 4 MHz to about 85 MHz. This covers the more common short-wave and ham bands. The coils are easy to wind, because they are untapped. Ordinary (RCA-type) plugs and jack connect the plug-in coils.

The schematic is shown in Fig. 1. Note that the FET circuit eliminates need for a diode rectifier, used when the oscillator is a junction transistor. The circuit uses a Colpitts oscillator. At lower frequencies, the feedback capacitance must be increased to maintain oscillations. S1 is used to switch C4 or C5 across C6 as needed.

When S1 is in neutral position, only C6 is in the circuit. This is the correct setting for band D (40–80

(continued on page 82)

TABLE I

Coil	Frequency	Turns (No. 26 enam.)
A	4–8 mHz	61
B	8–16	20
C	16–32	9
D	40–80	4

Notes: Calibration range extends slightly lower and slightly above values given. Coils are wound over ½" polystyrene tubing, except D which is wound inside the tubing.

Parts list

R1—27,000-ohm, ½ watt resistor
R2—50,000-ohm miniature potentiometer
C1—70-pF miniature variable capacitor (Hammarlund MAPC-75 or similar)
C2, C5—100-pF disc ceramic capacitor
C3—4.7-pF disc ceramic capacitor
C4—47-pF disc ceramic capacitor
C6—18-pF disc ceramic capacitor
RFC1—2.5-mH rf choke
M1—50-µA 1½" square dc meter
Q1—MPF-102 FET, Motorola
J1—phono jack for coils
P1—Phono plug, one for each coil, see text.
L1—See coil table
MISC—FET socket, ½" o.d. polystyrene tubing and No. 26 enameled wire for coils; 4" x 2" x 1-⅝" 2-piece aluminum case.
S1—Spdt, center-off miniature toggle switch
S2—Spst miniature switch, see text

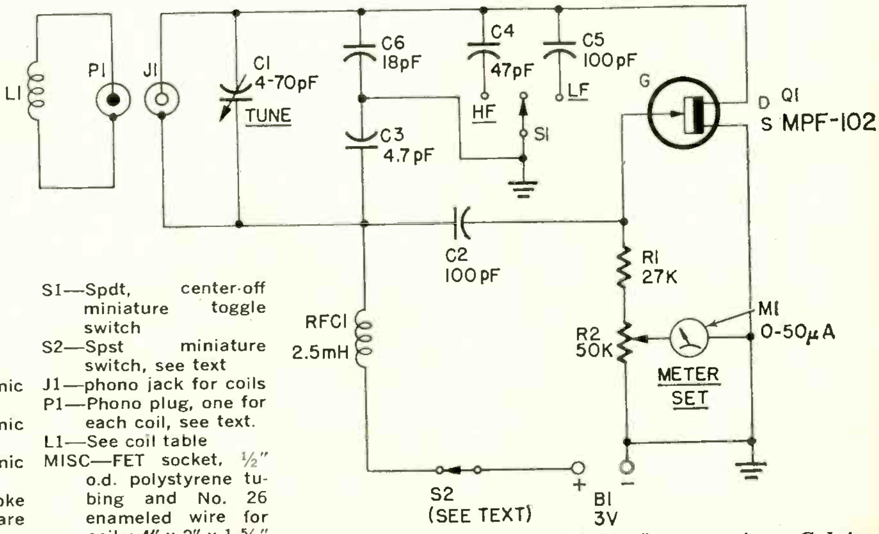
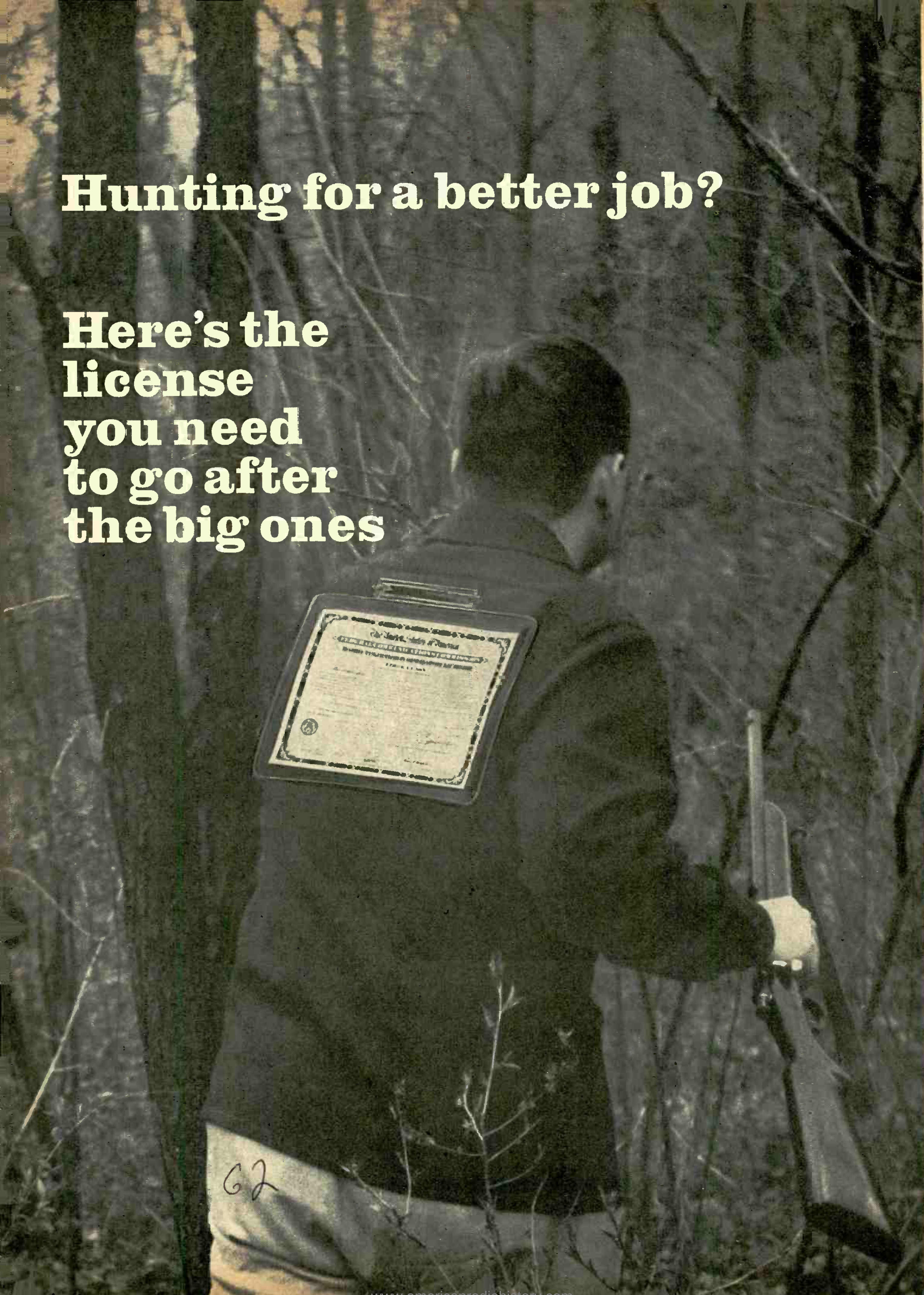


Fig. 1—Dipmeter uses a field-effect transistor Colpitts oscillator for high sensitivity and easy coil winding.


Hunting for a better job?
Here's the license you need to go after the big ones

EQUIPMENT REPORT

Sencore TR-139 Transistor Tester

Circle 26 on reader's service card

I HAVE ALWAYS FIRMLY BELIEVED THAT ACTUAL OPERATION is the best way to evaluate test equipment. So, when the Sencore TR-139 transistor tester came in, I did the obvious; I tested transistors with it. And I'll say this: it lives up to its name.

How does the TR-139 work? A simplified schematic

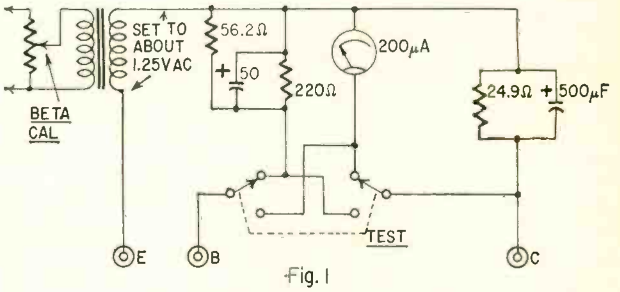


Fig. 1

of the beta test is shown in Fig. 1. A small signal—about 1.25 volts of ac—is applied to the transistor. Zener-diode regulators in the transformer primary hold this constant during the test. A calibrate control (variable resistor in the primary) is adjusted for a full-scale meter reading. This voltage is actually the dc drop across a 24.9-ohm resistor in the collector circuit.

Full scale means 2.0 mA in the collector circuit, well below the limits of even the smallest transistors. When the TEST button is pushed, the meter is switched across a 200-ohm resistor in the base circuit. Since the reading is the result of an ac *signal*, this gives an actual test of signal amplification. This is about as near as you can get to actual circuit operation.

The leakage test is shown in Fig. 2, again in simplified form. The meter, an 0–200-μA type, is shunted to read 0–5-mA full scale. A diode–resistor network shapes its response

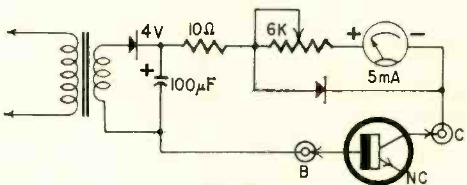


Fig. 2

so that the center-scale reading is still only 100 μA, for greater accuracy in spotting minute leakages. The smallest scale division is 2 μA. It is used for out-of-circuit diode testing, reverse-leakage checks and comparison.

A good tube tester checks for shorts, then tests the *quality* of the tube—in other words, "Will it amplify a signal?" The TR-139—an easy-to-operate instrument—will do the same thing for transistors. All we need to know is "Is it shorted or open?" and "Will it amplify?" The TR-139 will check any kind of bipolar transistor, pnp or npn, in-circuit, disregarding any shunt impedance or resistance down to a very low value, which seems to be somewhere around 20–30 ohms!

The reading you get is the *beta* of the transistor, roughly the same as mutual conductance of a tube; in other words, signal-amplifying ability. Test voltages applied are so small that you won't damage a transistor even if it's hooked up backward. If the meter backs off scale, just turn the PNP–NPN switch to the other position.

I used the TR-139 on everything I could find: transistor radios, TV sets, stereo amplifiers, antenna boosters, and even a CATV line amplifier. It worked fine.

Actual operation is simple. Three color-coded test leads are provided, and the jacks are marked E, B and C. You hook these up to the transistor and then set the BETA CAL knob for a full-scale reading. Then you push the red TEST button, and read beta directly on one of the two scales, "high" (0–500) or "low" (0–100).

If the meter jumps to the right when you push the TEST button on the low scale, go to the high scale. If it jumps to the right on *both* scales, the transistor is bad or one of the clips has slipped off! (If you get nothing at all; no CAL or beta reading, check back to be sure that all three clips are still hooked up—and to the right places!) A bad reading means that the meter won't CAL, or that you get nothing when you push the TEST button.

Exercising my right to be prejudiced, I tried the TR-139 on a couple of little transistor radios that had been on the bench far too long. One showed no bad transistors (so I happily put that one aside again for another day). The other showed a bad i.f. transistor. Replaced; the radio worked. Hmm. Prejudice began to fade a little. Finally I gave the tester what I thought would be the acid test: a CATV line amplifier known to be defective. In less than 5 minutes, I found a bad transistor. That did it—the thing really worked!! Prejudice laid down and expired; this doodad had some very small coils and things!

If you have an FM mpx demodulator that won't balance, you can check the transistors for balanced beta, in or out of circuit. You can also check diodes, video detectors, afc, afpc and so on, for balance if necessary, or for reverse-leakage ratios or shorts, both in or out of the circuit. You can even read leakage; this is one of the hardest things to do on a transistor.

One thing the TR-139 won't check is Zener diodes below 5 volts. These will read the same in each direction. Around 6 volts, you'll get some reverse leakage, about 3/4 scale. Anything above 8 volts will check out like any other diode.—*William Darragh* **R-E**

Size: 9½" x 7½" x 6" Weight: 7 lb Price: $89.50

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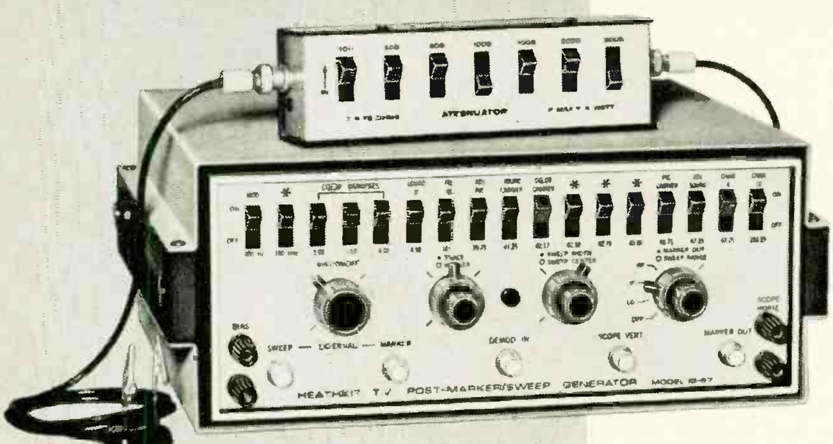
You Can Always Depend On Heath . . .



NEW kit IG-57

$135.00

New Solid-State Color TV Marker/Sweep Generator . . . 15 Crystal Markers 3 Sweep Ranges

The IG-57 combines the features of both a post marker and a sweep generator for less than you'd expect to pay for just one of these functions. This compact easy-to-use instrument has all the facilities you need for critical Color TV and FM alignment . . . just attach any 'scope and you're ready. 15 crystal-controlled marker frequencies, 3 sweep ranges . . . all crystals included. External attenuator provides 1, 3, 6, 10 and 20 dB steps to 70 dB maximum; also can be used with external sweep or marker. Picture and sound carrier frequencies for channels 4 and 10; FM tuner, FM IF and discriminator alignment; TV sound IF adjustment. Completely isolated 0-15 v. variable voltage supply. Built-in 400 Hz modulation; Phase Control and Trace Reverse Switch. Blanking Switch eliminates return sweep and provides base line. Solid-state circuit uses 27 transistors, 7 diodes . . . 3 circuit boards. Handsome new Heathkit instrument styling. Order your IG-57 now, it's the best investment in Color TV and FM alignment facilities you can make. 14 lbs.

NEW kit IT-18

$24.95

NEW HEATHKIT In-Circuit Transistor Tester

At last, a realistic price for in-circuit testing of transistors! The new Heathkit IT-18 Tester has the facilities you need and it costs a lot less. It measures DC Beta in-or-out-of-circuit in 2 ranges from 2 to 1000 (the spec. commonly used by mftrs. and schematics to determine transistor gain). It tests diodes in-or-out-of-circuit for forward and reverse current to indicate opens or shorts. Measures transistors out-of-circuit for ICEO and ICBO leakage on leakage current scale of 0 to 5,000 uA. Identifies NPN or PNP devices, anode and cathode of unmarked diodes; matches transistors of the same type or opposite types. Cannot damage device or circuit even if connected incorrectly. Big 4½″ 200 uA meter. 10-turn calibrate control. Completely portable, powered by "D" cell (long battery life). Front panel socket for lower power devices. Attached 3′ test leads. Rugged polypropylene case with attached cover. Build in 2 hours. 4 lbs.

NOW, THE TUNER AND AMPLIFIER OF THE FAMOUS HEATH AR-15 RECEIVER ARE AVAILABLE AS SEPARATE COMPONENTS

NEW kit AJ-15

$189.95*

NEW HEATHKIT AJ-15 Deluxe Stereo Tuner

For the man who already owns a fine stereo amplifier, and in response to many requests, Heath now offers the superb FM stereo tuner section of the renowned AR-15 receiver as a separate unit. The new AJ-15 FM Stereo Tuner has the exclusive design FET FM tuner for remarkable sensitivity, the exclusive Crystal Filters in the IF strip for perfect response curve and no alignment; Integrated Circuits in the IF for high gain, best limiting; elaborate Noise-Operated Squelch; Stereo-Threshold Switch; Stereo-Only Switch; Adjustable Multiplex Phase, two Tuning Meters; two variable output Stereo Phone jacks; one pair variable outputs plus two fixed outputs for amps., recorders, etc.; front panel mounted controls; "Black Magic" panel lighting; 120/240 VAC operation. 18 lbs. *Walnut cabinet AE-18, $19.95.

NEW kit AA-15

$169.95*

NEW HEATHKIT AA-15 Deluxe Stereo Amplifier

For the man who already owns a fine stereo tuner, Heath now offers the famous amplifier section of the AR-15 receiver as a separate unit. The new AA-15 Stereo Amplifier has the same superb features: 150 watts Music Power; Ultra-Low Harmonic & IM Distortion (less than 0.5% at full output); Ultra-Wide Frequency Response (±1 dB, 8 to 40,000 Hz at 1 watt); Ultra-Wide Dynamic Range Preamp (98 dB); Tone-Flat Switch; Front Panel Input Level Controls; Transformerless Amplifier; Capacitor Coupled Outputs; Massive Power Supply; All-Silicon Transistor Circuit; Positive Circuit Protection; "Black Magic" Panel Lighting; new second system Remote Speaker Switch; 120/240 VAC. 26 lbs. *Walnut cabinet AE-18, $19.95.

NOW—Color-Coded Schematics for 1500 TV Sets . . . at an Unbelievable 1.3¢ Per Set!

Yes, now you can speed-repair 1500 popular TV receivers for just about 1¢ each . . . with the serviceman-proved COLOR-CODED TV COLORGRAMS.

If you've heard about TV Colorgrams, then you know they were a real bargain at their original total price of $102.50. Now, at this special price of only $19.95, they're almost a steal.

What are TV COLORGRAMS?

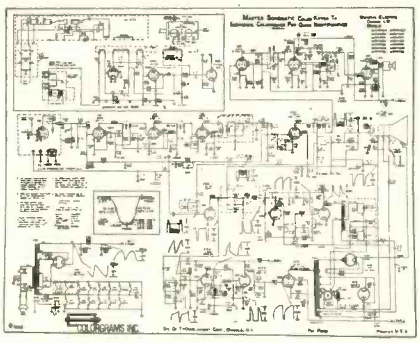
They're amazing new color-coded charts that help you isolate TV receiver difficulties and with less effort than you ever dreamed possible. Each COLORGRAM chart is clearly color-coded to show signal-flow, continuity, test points, and voltages. The entire ground conductor is shown in its own distinctive color. Every component in the circuit is clearly identified, and its relationship to other components made readily recognizable. COLORGRAM charts let you concentrate on that small portion of the set most likely to be the cause of the trouble. There's no time wasted working back and forth between schematic and set looking for test points . . . wading through superfluous information . . . identifying components incorrectly. With COLORGRAMS, everything is there, before your eyes, and very often looking just as it does in the set.

What does a TV COLORGRAM Service-Pak include?

Everything you need to service a whole series of TV sets!

Typical COLORGRAMS SERVICE-PAK sold for $1.95. You get 50 such PAKS . . . plus 148-page Index . . . for only $19.95!

First of all, the Pak includes COLORGRAM charts for IF, Video, Audio, Vertical and Horizontal (showing sync and sweep circuits), B+ distribution and AGC circuits. You use the Video chart if you have a Video problem, the Audio chart if you have an Audio problem, etc.



Easy to read complete master schematic is color-keyed to the colors used in the Colorgram Charts.

Second, the Pak includes color-keyed master schematic providing an overall view of the receiver circuit. It shows the Tuner, IF, Video, Audio, Vertical and Horizontal sections, color-keyed to the colors used in individual COLORGRAM charts. It also shows test points, waveforms, voltage, resistance, capacitance, practical alignment data, etc.

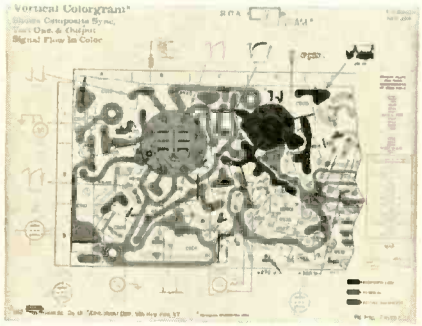
CONTENTS

ADMIRAL	(25 CHASSIS,	179 MODELS)
EMERSON	(24 CHASSIS,	100 MODELS)
G. E.	(9 CHASSIS,	332 MODELS)
MAGNAVOX	(1 CHASSIS,	27 MODELS)
MOTOROLA	(8 CHASSIS,	63 MODELS)
PHILCO	(24 CHASSIS,	122 MODELS)
R. C. A.	(125 CHASSIS,	539 MODELS)
WSTGHSE.	(27 CHASSIS,	183 MODELS)

Third, the Pak includes a Rapid Repair Manual that is an effective guide to the use of the COLORGRAM System. It contains original manufacturer's service notes, special instructions, circuit modifications, parts list, and parts numbers. Other practical service data in the Guide are a Pictorial Tube and Component Location Chart, and a Tube Failure Guide.

What do I get for my money?

50 complete Service-Paks . . . each Pak containing data on approximately 30 TV sets. PLUS, as an added bonus, we'll include the 148-page MASTER-INDEX and Cross Reference Replacement Parts Guide which lists all 1500 TV sets you can quickly repair with TV COLORGRAMS. It describes the black-and-white receivers of Admiral, Emerson, General Electric, Magnavox, Motorola, Philco, RCA, and Westinghouse. These receivers are cross-referenced (by IBM data-processing) to nine replacement parts manufacturers . . . Aerovox, Centralab, Clarostat, G. C., Merit, Stancor, Thordarsan, Triad, and TVD, covering over 25,000 parts listings. This INDEX gives you the newest, fastest, clearest,



Each Colorgram chart is color-coded to show signal flow and continuity—just like a road map!

most practical approach to obtaining the correct replacement part in a hurry.

MONEY-BACK GUARANTEE

So sure are we that the data in these invaluable Service-Paks will save you time and money we're offering them on a guaranteed money-back basis. Order at our risk for 10-day examination. Put the data in these schematic-packed guides to work for you for 10 days. If they don't prove to be worth several times their cost, return them and we'll refund the full purchase price. Simply fill in and mail the NO-RISK coupon below, with your check or money order, to obtain these time-saving, money-making manuals.

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I enclose $19.95 for which please send me your complete 50-Package Colorgrams Schematic offer postage prepaid. I understand I must be completely satisfied or you will refund my money if the package is returned in 10 days.

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Company ....

Address ....

City .... State .... Zip ....

RE-88

Circle 32 on reader's service card

RADIO-ELECTRONICS READER'S SERVICE

Here's how you can get manufacturers' literature fast.

1. Tear out the post card on the facing page. Clearly print or type your name and address.

   Include zip code! Manufacturers will not guarantee to fill your requests unless your zip code is on the reader service card.

2. Circle the number on the card that corresponds to the number appearing at the bottom of the **New Products, New Literature** or **Equipment Report** in which you are interested.
   For literature on products **advertised** in this issue, circle the number on the card that corresponds to the number appearing at the bottom of the advertisement in which you are interested. Use the convenience index below to locate quickly a particular advertisement.

3. Mail the card to us (no postage required in U.S.A.)

Advertisements in this issue offering free literature (see the advertisement for products being advertised):

NEW PRODUCTS

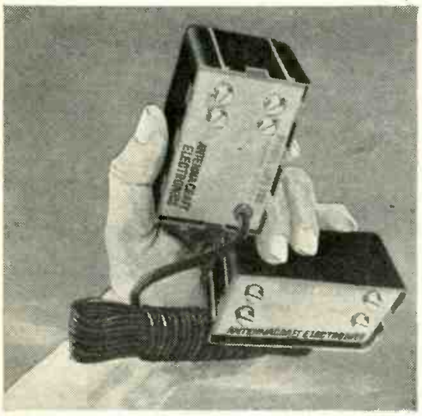
More information on new products is available free from the manufacturers of items identified by a Reader's Service number. Turn to the Reader's Service Card facing page 72 and circle the numbers of the new products on which you would like further information. Detach and mail the postage-paid card.

CARTRIDGE RECORDERS, *Models KX-899, KX-900.* Both models feature ability to stop when in contact with metallic foil sensing tape featured on all 8-track tapes, and which can be added to

4-track. This eliminates need of a stop watch to prevent overrecording. Both operate at 110V–120V ac but can be converted for use with 12V dc. *Model KX-899* incorporates record electronics only and sells for $160. *Model KX-900* combines both record and playback electronics; sells for $170.—**Kinematix, Inc.**

Circle 46 on reader's service card

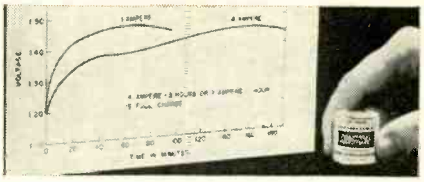
BOOSTER PREAMPLIFIERS. *Antennacraft's* new line of high-gain TV booster preamps are mast-mounted. Uhf, vhf and uhf-vhf combinations are offered. All models feature stable, high-gain performance, with a wide dynamic range in the



uhf section. Vhf, uhf and vhf-uhf combos available in 75 and/or 300 ohm. vhf only: 16.5 average dB gain across band. Uhf only: 11 dB gain and v-u combo: 11.5 dB on vhf and 8 dB gain across the uhf band. Prices range from $29.95 to $44.95— —**Antennacraft Company**

Circle 47 on reader's service card

FAST-CHARGE BATTERY. Sealed, rechargeable nickel-cadmium battery cell is capable of taking a quick charge. Can be fully charged in one hour or charged to a sufficient capacity in a matter of minutes to operate a cordless device. Fully charged in 60 minutes at 20 ampere rate or in 3 hours at 400-mA rate. Battery is self-sustaining: quick charge is built into



the battery cell. It is also capable of accepting overcharge; at the one-hour rate, the cell can be overcharged for days . . . at the slower three-hour rate, the cell can be left on overcharge for long periods of time.—**Sonotone Corp.**

Circle 48 on reader's service card

(*continued on page 76*)

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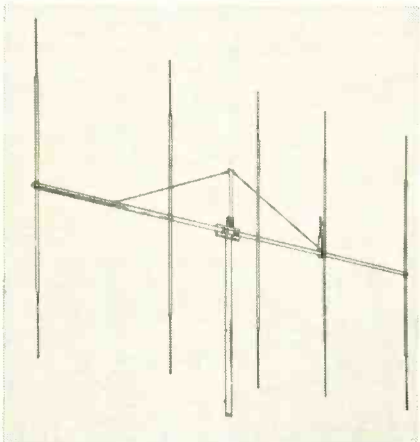
Circle 107 on reader's service card

NEW PRODUCTS
(continued from page 75)

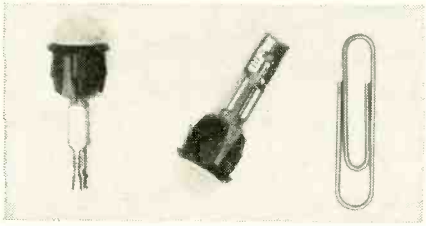
CB BASE-STATION ANTENNA, *Delta-5, Model SA-511-S.* Features an SWR of 1.5/1 or better, feed-point impedance of 52 ohms. Has a 20 db front-to-back ratio and a forward gain of 9.5 db over refer-



ence dipole or 11.6 over isotropic source. Antenna has a maximum element length of 18′ 8¾″, boom length of 24′ and 12′ turning radius horizontally mounted or 15.3′ vertically.—**Mosley Electronics, Inc.**

Circle 49 on reader's service card

INDICATOR LAMP, *Minilamp.* Installed from the front of the instrument panel to eliminate going into the interior of the equipment. Lamps are available in



red, yellow, green, blue and white, and special colors to order. Will not discolor. Five can be mounted in a 1½″ square. Current rating: 6–8 volts—0.05 amp; 12–14 volts—0.04 amp; 24–28 volts—0.04 amp.—**International Products, Inc.**

Circle 50 on reader's service card

MAGNETIC DETECTOR SWITCHES. *Ferotec* switches are precision sensing devices operated by the proximity of magnetic metals; physical contact is not necessary. Operating medium is the smallest

possible to give maximum air gap, and switching repeatability is generally ±0.002. Switches are completely proofed against water, oil, spray, dust and dirt. They are small in size and easily installed. Can be used for counting, sensing, and do not need an additional amplifier or power pack. 18″ leads of core-insulated flexible cable are provided; longer leads available. —**Electro-Tec Corp.**

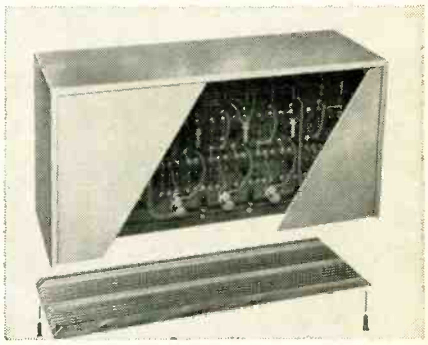
Circle 51 on reader's service card

INTRUDER ALARM SYSTEM. The slightest sound of forced entry can alert police or set off alarms when business or residential buildings are guarded by ultrasensitive *Detectalarm* intruder detection system. Designed for total premise protection, these electronic units

utilize special microphones or existing intercoms to give early warning of forced entry through doors, walls, roofs and windows. Vandals or intruders who stay behind after buildings are closed can also be detected. Vibration, smoke, fire, flooding and freezer monitoring sensors can be added to the device.—**Alarmtronics Engineering, Inc.**

Circle 52 on reader's service card

EXTRUDED ALUMINUM CASES. Available in 1.6″, 2.0″, 3″ and 4.5″ widths in "U" shape. Separate bottom plate. Case joints overlap to provide excellent rf shielding. Interior surfaces have parallel 0.070″ grooves that hold

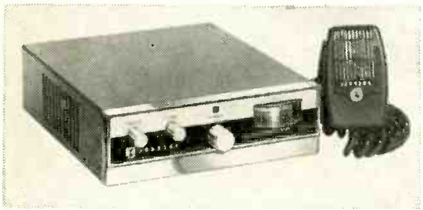


circuit boards running the long dimension of the case. 14 models are available in sizes from 1.6″ to 4.5″ wide, 3.10″ to 8″ high and 3.10″ to 14″ long. Prices range from $3 to $10.34.—**Vector Electronic Co.** **R-E**

Circle 53 on reader's service card

New Communications Equipment

23-CHANNEL TRANSCEIVER, *Messenger 320.* Uses a double-conversion receiver with 0.5-mV sensitivity for a 10-dB signal-to-noise ratio. Transmitter features a 5-watt dc input. Furnished with universal mobile mounting bracket. Operates on



12-volt dc on all 23 channels and can be removed in seconds for base or portable use. Plug-in power supplies for ac operation require no wiring. Unit features built-in S-meter and rf power output meter; 3-watt PA system requiring only an external speaker for operation, and a ceramic microphone.—**E. F. Johnson Co.**

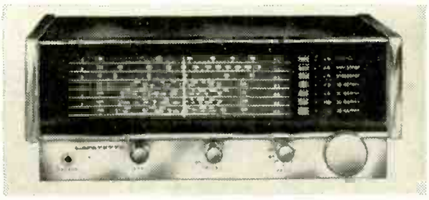
Circle 54 on reader's service card

VHF BAND CONVERTER, *Model RA-26.* Tunable from 108 to 136 MHz, unit picks up airplane communications over any portable radio. Operates on 9-volt battery and requires no wiring connections

to radio battery. Large, clearly marked megacycle indicator is easy to read. Picks up signals and converts them without any complicated adjustments. Antenna is retractable.—**Olson Electronics, Inc.**

Circle 55 on reader's service card

7-BAND RECEIVER, EXPLOR-AIR *No. 99-2601WX.* New 7-band FM, AM, shortwave and weather/marine receiver also receives 150–400 kHz, plus 4 short-wave bands from 5.9 to 15.55 MHz. FM sensitivity: 2 μV or less; crossmodulation: 70 dB; de-emphasis; 75 μsec; distortion: 1%



or better @ 20 μV; image ratio: 45 dB; antenna impedance: 300 ohms. AM: 3-gang tuning capacitor. Short wave: as low as 2 μV sensitivity. Features individually tuned circuits for each band, 455 kHz mechanical filter, tuned rf stage and shock-free high-voltage transformer-operated power supply. $99.95—**Lafayette Radio Electronics**

Circle 56 on reader's service card

CB TRANSCEIVER, *Courier 23-Plus.* Features cascode front end and nuvistor mixer, 23 crystal-controlled channels, modulation sampler and dual conversion. The unit has an illuminated S-RF meter and channel selector and a built-in PA

system. Also features auxiliary speaker jack, single-knob tuning and a modulation indicator. Comes complete with crystals for all 23 channels, mounting brackets, power cords and microphone. $199.—**Courier Communications, Inc.**

Circle 57 on reader's service card

MOBILE RADIO AC ADAPTER, *Power Pedestal Model 790* provides dc power for almost all transistorized in-car shortwave radio transceivers. Unit is suited for

(continued on page 78)

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NEW COMMUNICATIONS EQUIPMENT

(continued from page 77)

use with many 5-watt CB and low-power amateur and business radio service vehicular communications equipment. Output voltage is 13.5 Vdc nominal with 5% output regulation with only 0.05% ripple. Low current ripple is 0.4 mv at 100 ma. High current ripple is 4 mv at 1 amp. Unit measures 6 x 8 x 3 inches, weighs 4 lb, costs $29.95. Two magnetically impregnated rubber mounting strips hold the transceiver firmly in place. The strips are electrically isolated from the supply circuit and permit use of any mobile transceiver that has a flat metal base.—**Amphenol Distributor Div.**

Circle 58 on reader's service card

Circle 109 on reader's service card

Circle 110 on reader's service card

BUSINESS BAND 2-WAY RADIO, *Courier Tradesman* operates on the 25–40 MHz band. Provides 5-watt power input and can be coupled with 100-watt *Model ML-100 Linear Amplifier.* Unit provides

100% modulation. Has illuminated channel selector, transmit indicator, auxiliary speaker jack. Safety circuit protects transceiver against mismatched antenna, incorrect polarity and overload. Price $129.—**Courier Communications, Inc.**

Circle 59 on reader's service card

PORTABLE SECURITY COMMUNICATIONS KIT. 3-watt, 2-channel, dual-conversion units provide reliable two-way communications for police or surveillance work. Kit comes complete with 2 transceivers, lapel-attached speaker/microphones, crystals for both channels,

4 batteries, 2 belts and 2 flexible antennas. An additional antenna for attachment to an auto, and a battery charger are also included. The kit is easily carried in its attaché case. An economy kit containing 2 transceivers, 4 batteries, battery charger and carrying case is also available.—**Polytronics Communications**

Circle 60 on reader's service card

HF RECEIVER, *Galaxy R-530.* Features continuous frequency coverage of 0.5 to 30 MHz, solid-state construction, phase-locked fundamental oscillator, and adjustable noise blanker. Frequency stability: less than 100 Hz drift after turn-on; accuracy: 1 KHz. Receives selectible

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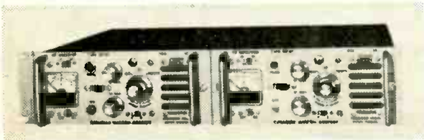
upper and lower sidebands, AM, CW and RTTY signals. Rear-panel outputs of the P.T.O. (permeability-tuned oscillator), high-frequency i.f., avc, rf gain control and balanced 600-ohm audio permit dual and space diversity utilization with minimum accessories. Operates on 115/230 Vac, 50/60 Hz or 12 Vdc at 1 amp for applications where normal power loss may occur. $700—**Galaxy Electronics**

Circle 61 on reader's service card

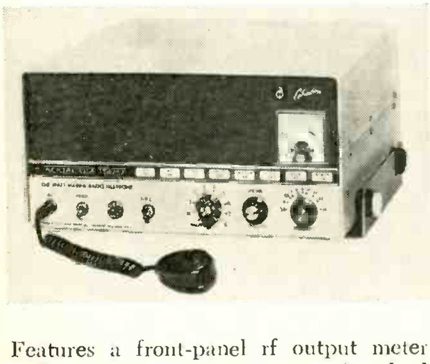
RADIO COMMUNICATIONS RECEIVER, *The Kaar XH-14.* Receives SBS and AM on one or two frequencies within the 1.6–24-MHz range, using solid-state circuitry and a built-in loudspeaker. Sensitivity: 0.5 μV for 12 dB S+N/N (SSB reception) and 1.0 μV for 6 dB



S+N/N (AM reception) SSB bandwidth is 2 kHz and AM is 6 kHz at —6 dB points; 60 dB attenuation is provided at 6 kHz in the SSB mode, and 30 kHz in the AM mode. Spurious rejection at 455 kHz is more than 90 dB down. Unit operates on 115 or 230 Vac or a battery or other external 12-volt dc source.—**Kaar Electronics Corp.**

Circle 62 on reader's service card

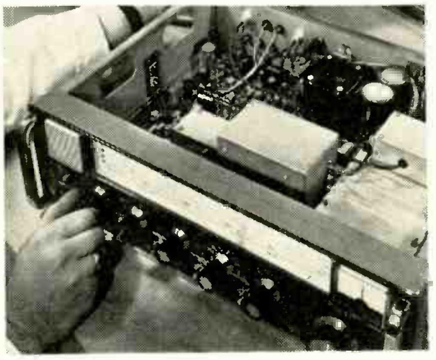
MARINE RADIO TELEPHONE, *Aquacom 150-D.* 150-watt unit is designed for extended-range cruising. Input current for receiving is 1.1 amps, 2.2 amps at standby and 30 amps for transmitting.



Features a front-panel rf output meter and a 2–4.5-megacycle range. Standard equipment includes crystals for 2 channels, push-to-talk plug-in microphones, power plug and leads, tunable standard broadcast band for weather. Input is 12 volts dc. Input power: 140 watts; out-put power: 76 watts; sensitivity: 2μV, 10 dB S/N; selectivity: ±2.5 kc, 6 dB down, ±14 kc, 60 dB down; audio output: 4 watts to internal 8-ohm speaker. $439—**Columbian Hydrosonics**

Circle 63 on reader's service card

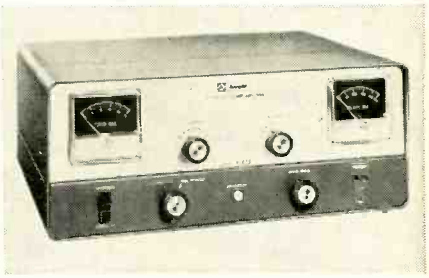
VHF RECEIVER, *990R.* Using 39 transistors and 14 diodes; the solid-state unit features a carrier-level meter, a muting circuit, high- and low-level audio channels. Operates from any standard ac supply or 12 Vdc; can be battery-operated. Frequency range: 27–240 MHz in



4 ranges; intermediate frequency: 10.7 MHz; Noise factor: 10 dB; sensitivity 5 μV for 10 dB S/N ratio with 50 mW output in AM mode (30-kHz filter); spurious response: 50 dB down. Calibration accuracy: within 1%; i.f. bandwidth: 30 kHz and 200 kHz; audio output: maximum 500 mW at 10% distortion; audio response: within 6 dB from 200 Hz to 10 khz.—**Eddystone Radio Limited**

Circle 64 on reader's service card

LINEAR AMPLIFIER, *Knight-Kit T-175.* Delivers plate power input of up to 300 watts pep on SSB, 120 watts AM and 150 watts CW. Features 2 illuminated meters for plate current and combination grid current relative power, internal automatic antenna changeover for SSB, AM and low-speed CW (no internal connec-



tions required), air-cooling fan and thermal radiators on plate caps. Frequency coverage: 26.960–29.700 MHz and 50–54 MHz. Output impedance: pi-matching network for 50–70-ohm loads with a vswr of 3:1 or less. Price, including wire, solder and detailed instructions, is $99.95—**Allied Radio Corp.** **R-E**

Circle 65 on reader's service card

NEW LITERATURE

All booklets, catalogs, charts, data sheets and other literature listed here with a Reader's Service number are free for the asking. Turn to the Reader's Service Card facing page 72 and circle the numbers of the items you want. Then detach and mail the card. No postage required!

TWO-WAY RADIO BULLETIN. 2-page bulletin gives specs, features, options and general information on *Model 592* 148–172-MHz two-way radio. Lists dimensions and primary power and individual specs for transmitter and receiver.—**COMCO Communications Co., Inc.**

Circle 66 on reader's service card

COMPONENTS BOOKLET. 10-page booklet explains the ABC's of soldering and gives reader other helpful hints. Also lists specs of microphone-, power-and rf connectors. Includes chart of symbols used in schematic diagrams.—**Amphenol Corp.**

Circle 67 on reader's service card

ANTENNA BROCHURE. "How long have you been playing 'Hide and Seek'?" is the caption on this booklet about CDE's AR33 antenna rotor. Includes photos, specs and applications and suggests an answer to antenna rotor guess work. —**Cornell-Dubilier Electronics**

Circle 68 on reader's service card

CB BASE-STATION ANTENNAS *Hustler Series.* Describes New-Tronics' line of base-station and mobile antennas. Includes matchers, special cables, leads, body mounts and springs and special mounts for varied applications. Catalog helps you decide what to buy for your needs.—**New-Tronics Corp.**

Circle 69 on reader's service card

CONSTRUCTION MANUALS. *CF802, "Enclosure Construction Manual"* discusses the basics of loudspeaker enclosure design, ported enclosure, grille assemblies and more. *CF706, "Enclosure Construction for JBL 'F' Series Musical Instrument Speakers"* gives dimensions and port sizes for typical guitar and organ speaker enclosures.—**James B. Lansing Sound Co.**

Circle 70 on reader's service card

BUSINESS SUPPLIES. Booklet describes a variety of time-saving business aids. Includes purchase orders, invoices, voucher checks, business stationery, matching billheads, collection envelopes, announcement cards and many more useful items. Anything ordered is on a trial basis. If you don't like it, you don't pay.—**The Drawing Board, Inc.**

Circle 71 on reader's service card

ANTENNAS FOR 2-WAY RADIO. 9-page booklet covers mobile (low band, high band and uhf), base station and accessories. Includes pictures, graphs and specs. Descriptions include applications for each individual unit.—**Hy-Gain Electronics Corp.**

Circle 72 on reader's service card

TUBE AND SEMICONDUCTOR GUIDE. Guide is 20 pages long and lists over 7,000 tubes, semiconductors and integrated circuits by type, including prices. Listing covers radio, TV, ignition, photo, nuvistor, planar and cathode-ray tubes as well as transistors, diodes, rectifiers and many more.—**Thor Electronics Corp.**

Circle 73 on reader's service card

TOWER CATALOG, *No. 4-C.* 24-page catalog lists towers manufactured by the company, accessories, guying charts and other general information. Includes a readers-aid index which describes each tower briefly. Prices and uses listed.—**Tristao Tower Co.**

Circle 74 on reader's service card

VOLTAGE-VARIABLE CAPACITORS. 4-page technical *Bulletin No. 371* lists over 400 of the most frequently used types. Includes description of the requirements in terms of function generators and gives equation which describes performance. Also has a discussion of capacitance vs voltage, and four performance charts.—**Computer Diode Corp.**

Circle 75 on reader's service card

HOME-STUDY COURSES. Try an NRI course for 60 days in your spare time. NRI offers courses in subjects such as electronics, TV, Radio and Communications. Regardless of which course you choose, training begins with the Achievement Kit, an illustrated book averaging 40 pages and a training kit to give on-the-job experience. You learn by doing—exploring the same transistor, solid-state and tube circuits you will be working with in your new career. No further cost or obligation if you decide to quit the course.—**National Radio Institute**

Circle 76 on reader's service card

PANEL METERS. *Catalog No. D-68,* 20 pages. Features detailed mechanical and electrical specs of new panel instruments designed for communications, military ground support, data processing, industrial process control and general instrumentation electronics equipment. Includes drawings, charts and measurements.—**Triplett Electrical Instrument Co.**

Circle 77 on reader's service card

IC Cross-Reference Guide was developed for the hobbyist-experimenter. 8 new projects have been produced by the HEP program. Guide lists 16 HEP IC's which replace over 100 integrated circuits produced by various manufacturers. Projects include audio signal generator, precision tachometer and sine–square-wave converter.—**Motorola Semiconductor Products, Inc.**

Circle 78 on reader's service card

FIVE NEW DATA SHEETS describe a line of 10 DTL integrated circuits recently introduced. *DTL SW770-SW771* describes a 10-input complementary gate; *DTL SW772-SW773* a triple R-S flip-flop; *DTL SW774-SW775,* a triple 3-input AND gate; *DTL SW776-SW777,* a dual AND/OR gate; *DTL SW778-SW779,* a dual 4-input complementary gate.—**Stewart-Warner Microcircuits, Inc.**

Circle 79 on reader's service card

TWO BRIGHTENER SELECTOR CHARTS. Color brightener Selector Chart (CS6-68) identifies the 13 color-tube numbers of the small-shell neodiheptal tubes and 37 color tubes of small-button dineptar. Indicates proper brightener for each type of tube. Tu-Brite Selector Chart (LPB68) has been augmented to show 125 additional tubes, bringing the total to 845.—**Perma-Power Co.**

Circle 80 on reader's service card

Write direct to the manufacturers for information on items listed below:

USA GRAPHIC SYMBOLS, *Standard Y32.2-1967.* Features new symbols, new quick reference to symbols, a 30 x 40" wall chart of all basic symbols, rearrangement of the symbols into 18 associated sections, adjustments and modifications. The standard represents a national consensus of domestic manufacturers and users of electrical and electronics equipment. $6.00—**USA Standards Institute, 10 E. 40 St., New York, N.Y. 10016.** **R-E**

P. 80

Service Clinic

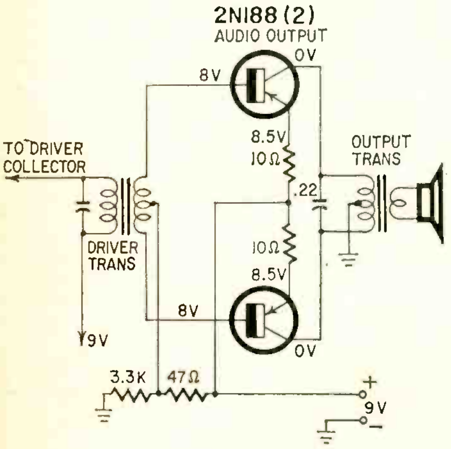
By JACK DARR

Transistor currents

I've got to overhaul a little Arvin 9574P transistor radio that I picked up at a sale. Very low volume and the output transistors get so hot you can't hold them. On a 0–1-amp range, the meter slams! The bias voltage seems to be okay. What's the matter?—W. G., Toledo, Ohio

I'm going to argue with you on *one* point: If you're pegging a 1-amp meter, that bias *can't* be right! The normal current reading on this set is 8–10 *mA!* No wonder those poor little output fellers are hot!

The base bias for the output transistors is taken from a voltage divider—



47 ohms and 3,300 ohms—from the 9-volt tap to ground. The actual bias, measured from emitter to base, is −0.5 volt. (8.5 V−8.0 V) Collector voltage is zero, when read to ground, because the center tap of the output transformer primary is grounded. *Maximum* current for the 2N188's should be not more than 200 mA apiece, and that doesn't add up to 1 amp or more! In this kind of circuit, it takes only about a tenth of a volt to control a pretty good-sized current in the 2N188 collector (output) circuit, so check this *very* closely.

Changing CB antennas

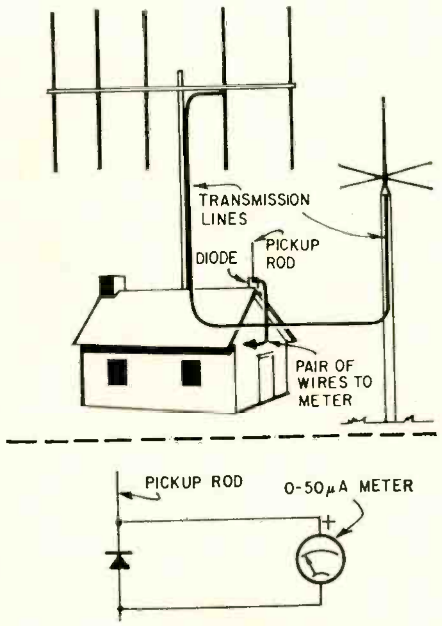
I've got two antennas on my CB base station—one is a nondirectional ground-plane whip, the other is a 5-element beam that's as big as the house! What I need to do is find a way to adjust the transmitter correctly when I change antennas. Can you give me any ideas?—B.F., Key Biscayne, Fla.

I'm full of ideas. Here's one. What you want from each antenna is *maximum output.* Each one matches 50

> This column is for your service problems—TV, radio, audio or general and industrial electronics. We answer all questions individually by mail, free of charge, and the more interesting ones will be printed here.
>
> If you're really stuck, write us. We'll do our best to help you. Don't forget to enclose a stamped, self-addressed envelope. Write: Service Editor, Radio-Electronics, 200 Park Ave. S., New York 10003.

ohms—*theoretically!* Because of differences in lead-in, etc., *every* antenna has to be tuned to the transmitter before it will give maximum output. Your CB transmitter has adjustments for the output, so that it can deliver maximum efficiency with any type of antenna.

What you need is a maximum-output indicator. Put a piece of wire on a diode, and set it up somewhere in the field of the antenna. As long as you



DIODE AND METER CIRCUIT

don't get closer than half a wavelength, it won't affect the antenna pattern at all (see diagram). The diode rectifies the rf and makes dc out of it. Run a pair of wires (like ordinary bell wire) from the diode to the control point, at the transmitter. Hook an 0–50-μA meter across it, and you'll get a reading when the transmitter is keyed. How much you get depends on the sensitivity of the meter and the length of wire used for a pickup rod.

If you don't have a meter this sensitive, put a tuned circuit with the diode, and peak it for your channel. This will bring the reading up. Alternative: make up a small dc amplifier with a single transistor, and put this at the pickup point. You can put a milliammeter in series with the wires, put the supply battery inside the house, and read the current drawn as peak signal.

All you need for this is a *peak* indication; you don't have to calibrate the meter at all. If you can get say ¼ scale, that's fine!

Find your rf tuning devices—the variable capacitor or coil, or both. Put extension shafts on them, so that you can retune the antenna circuit without tools. When you change antennas, simply key the transmitter, and tune it up for a peak. (Don't forget to give your call sign, and the fact this is a test transmission.) If you want to gussie it up a little, you can even make up dials and use pointer knobs on the tuning gadgets! Then, you can preset each one to about the right position, and touch it up when the transmitter is keyed.

"Piecrust" in Sonora portable TV

This Sonora portable, S60-P173, worked fine in the shop, after I replaced the horizontal hold and C-51. When I took the set to the home, it looked like it had waves all over the picture! In the shop again, worked fine. Took my TV Analyst to the home, and it still waved. It's "piecrusting": all circles are gear-toothed. Customer now tells me that it's always done this at times. I want to fix it!—R. P., Portsmouth, Va.

First, check the line-voltage difference between your shop and the home; I can remember an old Zenith that did the same thing. Finally discovered that it piecrusted if the line voltage was raised only 5 volts above the shop line voltage! (Voltage at home was high, of course.)

The real cure for this was adding more filtering. We checked out the afc, just as you did, without result. The villian seemed to be one of the electrolytics in the B + line that fed the horizontal oscillator/afc stages. There was quite a bit of horizontal-frequency hash.

As the line voltage increased, so did the dc voltage, and this made the feedback worse. Check all electrolytics, and add more capacitance until you get that B + line clean. **R-E**

Dipper and Crystal Oscillator

(continued from page 61)

MHz). For B and C (8–16 and 16–32 MHz, respectively), the HF position is best. Band A may be used with either HF or LF. On band A (4–8 MHz), use the position which results in most uniform output (meter reading) throughout the band. The LF setting is required for crystal oscillation.

When using the dipper as a crystal oscillator, remove the coil and replace it with the desired crystal. Rather than drill more holes in the box, I used a special plug-in jig. Constructed on a 1" x 1" plastic base, it holds a crystal socket and phono plug (see photo). Crystals between 1.6 MHz and 8.3 MHz have been found to oscillate in this dipper. No doubt, lower and higher frequencies may be used as well. Maximum output (as indicated by the meter) will occur when C1 is at minimum, just above 8 on the dial.

To eliminate switch S2 and solve space problems, and for general convenience, I did not mount the battery inside the dipper box. Instead, I use a plug-in battery holder and a phono jack built into the rear of the box. You may prefer to mount the battery inside and rearrange parts to make space. Two tiny penlight cells or button types may be used.

The dipper is sensitive. It will indicate resonance of high-Q circuits as far as 4" away. The meter is set at full scale or slightly below by R2. Output from band D will be less than full scale, but is ample for measurements. For use as a signal generator (crystal or noncrystal) just place the dipper near a receiver tuned to the desired frequency.

Construction

A two-piece 4" x 2" x 1⅝" aluminum box houses the instrument. This size is convenient for one-hand operation and makes it easy to probe around inside a receiver or transmitter to measure resonant circuits. The dial extends a little beyond the side of the box so that your thumb can do the tuning This leaves one hand entirely free while you use the dipper.

The FET socket is mounted on a small piece (1" x ½") of insulating material, held by a metal standoff.

A phono jack is the coil socket. It is mounted on a 1" x ¾" piece of perforated board. Drill a hole in the box larger than the jack itself, so that neither jack terminal can touch the box. Use metal screws to hold the jack assembly in place.

Phono plugs are of the type that comes with a ⅜" diameter plastic finger grip. Incidentally, the plastic shells are color-coded so you can use a different color for each band. File down the plastic slightly until it fits snugly inside ½" *outside* diameter polystyrene tubing.

Coils are wound around the poly form as shown in Coil Table I. Small holes drilled through the tubing can hold the coil leads in place. Solder the leads to the plug, connecting the *near* end of the coil to the shell or to the *ground* lug.

My dial is a white plastic disc 2" in diameter and ⅛" thick. This is forced onto the capacitor shaft. Heavy cardboard or other material may be used. I calibrated my scale at 4, 5, 6, 7 and 8 MHz. These points were found by listening for the dipper signal on a nearby short-wave receiver. This calibration applies for coil A only.

Coil B is a "multiply by 2" coil. For example, if a dip is observed at 5 with coil B, the frequency is 10 MHz. The turns of coil B may be spread apart or pushed together for best calibration. Coil C is a "multiply by 4" coil. For D, multiply by 10. This method greatly simplifies calibration, and is sufficient for a home-made dipper. Note that the range is slightly *greater* than a 2:1 ratio. **R-E**

NEW BOOKS

ACOUSTICS FOR THE SOUND CONTRACTOR, by Victor Brociner. *Published by Sound Publishing Co., 150 E. 37th St., New York, N.Y. 10016. 4½" x 7½", 85 pages, hard cover, $5.00*

Mr. Brociner is a well-known authority who has devoted a lifetime to sound reinforcement and distribution systems and methods. In this easy-to-read, well-illustrated book, he sets forth basic rules for installing sound systems. Sound reproducing equipment and the properties of rooms and outdoor areas are covered and should contribute to the reader's knowledge of propagation, reflection and absorption of sound waves; precedence effect; power ratings; speaker characteristics; hearing characteristics; etc. The contents page and index are noticeable by their absence, but it is relatively easy to find the desired material.

ELECTRONIC MUSICAL INSTRUMENTS, third edition, by Richard H. Dorf. *Published by Radiofile, 43 West 61st Street, New York, N.Y. 10023. 9¼" x 6¼", 303 pages, hard cover, $10.00*

An all new edition of what has been since 1954 the definitive technical book on electronic organs brings the literature up to date on the most recent technology in the field of electronic organs. Eleven of the 19 chapters are devoted to specific organs of various makes, including Baldwin, Schober, Thomas, Lowrey, Gulbransen, Wurlitzer, Seeburg, Hammond, Rogers, Allen and Conn. Mr. Dorf, no newcomer to RADIO-ELECTRONICS' readers brings to engineers, technicians and hobbyists the full electronic organ story, with clear, readable expositions. Electronics-minded hobbyists and professionals interested in electronic organs, as well as prospective organ purchasers will find this book most helpful.

SYLVANIA TECHNICAL MANUAL (13th Ed.). *Published by Sylvania Electric Products, Inc., Electronic Components Group, Seneca Falls, New York. 8½" x 5½", 623 pages, soft cover, $1.50*

More than 3,300 types of electron tubes and semiconductor devices are listed in this comprehensive reference for the service industry. Contains mechanical and electrical ratings, characteristics, basing diagrams and other essential information for all makes and types of receiving tubes and TV picture tubes in general use. Available from Sylvania distributors or from Sylvania's Central Advertising Distribution Dept., 1100 Main St., Buffalo, N.Y., 14209.

LINEAR INTEGRATED CIRCUITS MANUAL (Series IC-41). *Published by RCA Electronic Components and Devices, Harrison, N.J. 8⅜" x 5⅜", 352 pages, $2*

This manual, 50% larger than the previous edition, consists of five main chapters: General Considerations; Basic Differential-Amplifier Configuration for Linear Integrated Circuits; Integrated-Circuit Operational-Amplifier Configurations; Description and Applications of RCA Linear Integrated Circuits, and Technical Data. Copies of the manual are available from RCA distributors or by sending remittance to Commercial Engineering, RCA Electronic Components & Devices, Harrison, N.J., 07029.

PIN-POINT TV TROUBLES IN 10 MINUTES, by Harold P. Manly. *Tab Books, Blue Ridge Summit, Pa. 17214. 5½ x 8' in 342 pp. Paper, $4.95*

Book uses 63 photos of picture troubles keyed to trouble-finding charts which identify over 600 probable defects. Nearly 50 detailed trouble-finding charts pinpoint causes for defects in every circuit or major component. Also included are explanations of circuits used in the majority of receivers produced since 1953. Well illustrated and easy to use.

EASY WAY TO SERVICE RADIO RECEIVERS, by Leo G. Sands. *Tab Books, Blue Ridge Summit, Pa. 17214. 5½ x 8½ in., 173 pp. Cloth $6.95*

Tells how to diagnose and correct troubles in any AM receiver. Chapters cover alignment, special quick-check techniques, adding modifications, such as extension speakers, headphones, tuning indicators, etc. Last chapter is devoted to equipment needed and how to use it. **R-E**

SCHOOL DIRECTORY

83

(*continued from page 57*)

cost of the three verticals and a more complex switching unit.

With phased arrays it is possible to achieve the same gain and side-back rejection as with a stacked-beam array less mechanical disadvantages.

Antenna selection

Choice of an antenna must be governed by requirements of your communication system. Factors to be weighed are area to be covered (both range and terrain), weather conditions, rf interference (nature and man-made) and cost. Generally, limit use of simple quarter- and half-wave antennas to applications where the area to be covered is small and relatively free of rf interference. For areas of larger coverage, a five-eighths wave extended antenna is advisable. Highly directive antenna systems should be reserved for coverage over large areas, or areas where shadows and masks occur because of tall buildings, hills and valleys.

Remember that a directional antenna can cover only one small segment of a large area. A directional system is definitely appropriate when the communication traffic is in one direction from the base station. Why scatter the signal to the "four winds" if it can be aimed where it does the most good?

When an evaluation of requirements indicates a directional system can be used to advantage, consideration should be given to the phased array. This type of antenna array can give the same performance as the stacked beam without the mechanical and space problems. In areas of the country with high winds or severe icing conditions, the stacked beam can be easily damaged.

Furthermore, the phased array is unobtrusive when installed. Large stacked beams always give the appearance of a ton of pipe hung in the air. A neighbor is less likely to object to two or three vertical antennas than to what appears to be a "30-foot psychedelic mobile!"

Ideally, antennas should be installed on the highest object in the area. Unfortunately, this is usually impossible. The location should be as free as possible of obstructions. If the installation is a phased array or rotary beam, there of course must be sufficient room to allow for correct spacing or movement. The location should also be as free as possible of manmade noise. Consideration must be given to the distance from the transceiver, as long feed line(s) will introduce loss and attenuate the signal. Large leafy trees in the signal path should be avoided as they cause great rf attenuation.

It is almost impossible to formulate general rules or requirements on choosing an antenna location, as each installation will have its own problems. If general rules can be stated they are these: Keep the antenna as high as possible. Keep it as clear as possible. Keep it as quiet as possible.

A word of caution. Pick a location clear of power lines for two good reasons. First, power lines can generate noise. Second, if your antenna is blown down during a storm, the resulting display of fireworks may be exciting for a moment, but after the sparks stop flying it will surely be unpleasant. Power companies become very unhappy about other people's things in their power lines. Buying candles for the neighborhood can be expensive!

Mounting the antenna

When it comes to mounting the antenna, too much is better than not enough. Remember the antenna and supports will be exposed to the elements and will deteriorate. Use good mechanical construction practices. All hardware should be galvanized if made of steel, and anodized if made of aluminum. Use the mounting hardware supplied with the antenna and follow the manufacturer's instructions.

A mast or short tower can be used. One thing to remember, do not use a chimney. Stack gas is highly corrosive, and will reduce the most expensive antenna to junk in a short time.

Vertical antennas are designed for mast mounting. This may be either pipe or tubing, as long as it is capable to taking the load. The mast sections and hardware used for TV antennas are suitable if they are heavy-duty.

Rotary beam antennas are best supported with a tower, because of beam and rotator weight. The support for a beam antenna is subjected to, not only the loading of antenna weight and ice, but also a torsional or twisting load caused by the rotator moving the beam and wind stress on the beam. This requires a strong support structure. It's possible to use TV components, but they must be suitable for very heavy-duty use.

Roof structure must be taken into consideration when choosing mounting hardware. Flat roofs are much easier to attach the mast or tower to than steeply pitched roofs. With masts, an adjustable mounting foot can be used that will follow the roof pitch, while allowing the mast to be vertical. Towers present a more difficult problem on pitched roofs. The legs of the tower must be cut to fit or a tower with adjustable legs must be used. Often the best solution is to build a wooden platform to match the pitch of the roof.

The roof must be capable of supporting the antenna load. This is important in the case of the beam type of antenna as total weight of antenna tower and rotator can be 100 pounds or more. With some types of construction it may be necessary to add bracing in the attic under the mounting base. In any case, the mast or tower base must be securely attached to the roof. Wind pressure and vibration can cause the base to "walk" and one day your antenna might be flat on your roof.

Guy wires may or may not be required with the mast support. This will depend upon the type of mast. The short tripod base does not require support, unless the mast extends several feet above the top of the tripod, or wind conditions are high.

The tower requires guy wires in almost all cases. If guy wires are used, three are the minimum. Spacing should be symmetrical and must not interfere with the rotation of the beam. Tension on the wires must be uniform. The manufacturer of the tower can supply instructions on "guying" and these should be followed.

Waterproof all points of attachment to the roof to prevent leakage. This can save the expense of ruined insulation or ceilings.

In mounting an antenna, keep in mind that inclement weather will try to take it down, so put it up to stay.

Before you charge out and buy enough mast or tower to rival the local broadcasting station, remember the FCC has some definite ideas about the maximum height of an antenna. So, before you start cutting pipe, read and heed *FCC Rules and Regulations*, Vol. VI, Part 95, Section 95.37. A small advantage gained from an unlawful installation will not make up for a citation and possible fine.

A few words about something of extreme importance, and one of the most neglected items of antenna installation. This is *grounding* the antenna and mast or tower. This is important for two reasons. First, with the five-eighths wavelength extended vertical, the ground plane and the base of the vertical must be at dc ground to take full advantage of this design. The second reason is safety. You've just stuck about 20′ of metal into the air, and if you're lucky it's the highest object in the surrounding area, or at least the highest on the roof of your buildings.

A grounded mast or tower will not prevent a lightning stroke, but it will

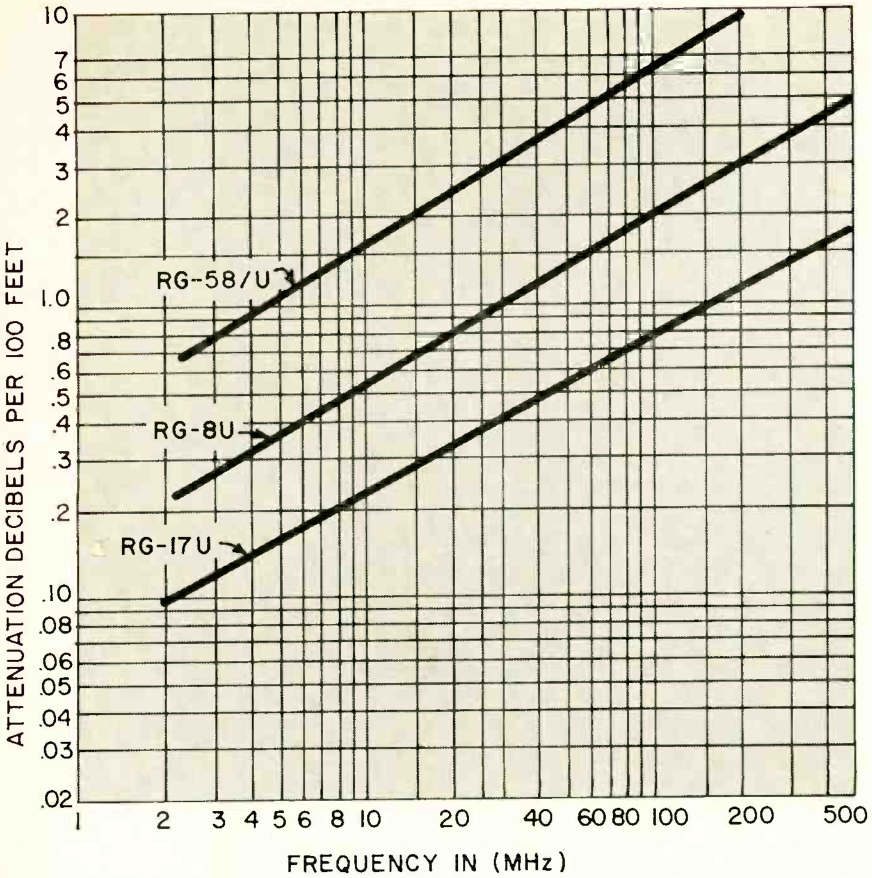


Fig. 6—Chart shows attenuation in three common types of 52-ohm coaxial cable.

act as a lightning rod and provide a path for the bolt. The ground wire must be of heavy-gauge cable, No. 4 or heavier. The ground must be a good earth ground: a metal stake at least 6′ long driven 5′ deep. In rocky ground it should be driven even deeper. In all cases, it must go deeper than the frost line. Use this ground for the entire system. A ground placed on the transceiver may cause a ground loop and resultant trouble. The feed line shield will ground the transceiver.

Antenna connections

Connecting the antenna to the transceiver is another area where many two-way radio systems fall flat. This connection must be of the highest quality. By now you have a large investment in your transceiver and the installation of a good antenna. If you skimp here, your money will be wasted.

Feed lines, or to be more accurate, rf transmission lines, are a very special type of cable. It is not lamp cord and cannot be handled like an extension cord. There are many types of coaxial cable, but the antennas discussed all require 52-ohm coax.

The most common 52-ohm coaxial cables are RG-8/U and RG-58/U. Either may be used. Choice is determined by the length of the feed line required. RG-8/U has the lowest loss, 1 dB/100′, at 30 MHz while RG-58/U has a loss of 3 dB/100′ (Fig. 5). RG-8 is approximately ½″ in diameter. RG-58 is ¼″ in diameter.

For feed lines up to 30′ (at 30 MHz), RG-58 is satisfactory but this should be considered its maximum length. The loss for 30′ is almost 1 dB, and remember a 3 dB loss is equal to one-half the power. For top performance, RG-8 should be used for all feed lines because of the lower loss. For CB cable runs over 100′ and all vhf applications, RG-17/U should be used.

Bargain surplus coaxial cable should be avoided unless it carries a guaranty. First, it may not be 52-ohm impedance. Second, coaxial cable must be stored and handled carefully to avoid damage. Surplus cable may be damaged internally yet show no external damage. Also, it is of utmost importance that coaxial cable be kept dry. Even a small amount of moisture leaking into the cable can seriously increase losses, and once moisture has seeped into the cable it is very difficult to dry it out. If the cable has been rolled into a small tight coil, the dielectric insulation may have cracked, again increasing loss. It may be hard to find surplus coaxial cable in the length needed and splicing, which should be avoided, may be necessary.

So, spend a little bit more and go first class. Buy new. top-quality coaxial cable in sufficient length to make the feed line(s) in a continuous run without splices or connectors.

Most antennas available today are fitted with coaxial connector type SO-239, the mating plug being a PL-259. This or an equivalent connector should be used. Unfortunately, this connector is not waterproof, and all exposed connectors must be waterproofed.

Routing of the feed line(s) should follow the most direct path to keep the line as short as possible. The coaxial cable should be secured to keep it out of the way and from moving around. Use clamps that will not damage the outer covering or crush the cable. Do not make sharp bends in the cable; bends should have a minimum radius of 6″. Leave a strain relief at the point where the cable connects to the antenna. If you are using a phased array, remember all feed lines must be the correct length.

Antenna checkout

After installation of the antenna, the final step is to make an electrical check of the system. This will require the use of a standing-wave ratio (SWR) bridge, an instrument capable of measuring the ratio of incident or forward power to reflected or reverse power. This ratio is an index to the performance of an antenna system. Ideally, you would have 100% incident power with 0% reflected power, but like all ideal conditions this is not possible. The maximum ratio allowable should be 1 to 1.5.

If measurement shows the SWR to be greater than 1 to 1.5, something has gone wrong. The first step is to isolate the trouble to the feed line or antenna. This is done by disconnecting the feed line at the antenna and terminating the line with a 52-ohm *non-inductive* resistor. Remeasure the SWR. If it is still high, the trouble is in the feed line, the most likely place. Check all soldered joints at the connectors. Check the line for obvious physical damage. If this doesn't correct the problem, chances are the line has moisture in it and must be replaced. With phased arrays check each antenna in this manner.

If the line checks out, the problem is with the antenna. Check the connector for dirt or metal chips. Check to see that the vertical element was assembled properly. Follow the manufacturer's instructions.

The antenna and feed line are exposed to the elements and are subject to deterioration over a period of time. The amount of deterioration will, of course, depend upon the weather conditions in your area. High winds, ice coatings, salt, and industrial fumes all have damaging effects. The antenna and feed line should be inspected at least every 6 months.

If your area has high winds, inspection should be made after each wind storm, especially of large beam antennas.

Check the VSWR once every 6 months. If the VSWR is increasing, it's your first sign of electrical trouble.

Don't put up your antenna system and just forget it, for when something goes wrong it will do so at the most inopportune time. It's nicer to be up on the roof on a sunny day than in the middle of the night during a storm.

All this may seem like a lot of trouble just to put up an antenna, but a two-way radio system that does not work reliably both ways is next to useless. It will do nothing but cost you money in lost time. A two-way radio system should save both. **R-E**

You Know I Can't Hear You When The Window's Closed

Or, an introduction to antenna acrobatics

By DAVID LACHENBRUCH

"THERE'S REALLY NOTHING TO IT, Harry. If you'll just help me, we can get this thing up in a jiffy."

"Sure, George. What do you want me to do?"

"You just stay down here and watch the set. I'll take the antenna up on the roof and move it around. You tell me when I've got the best picture. Okay?"

"Okay, George. I got 'er on channel 6."

. . .

"Harry, I'm on the roof. How's the picture?"

"I can't hear you. What'd you say? Yell louder."

"I said how's the picture?"

"Mixture of what?"

"Is it coming in clear?"

"Sure, I'll have a beer. But don't you think *you* ought to wait 'til you're off the roof?"

"I'm talking about the picture. How's it coming in?"

"Oh, the picture! Lot of snow, George."

"I said how's the picture?"

"I can't hear you, George. Wait 'til I open the window."

"How is it now?"

"Seems to be a Western. No, it's Joyce Brothers. Both of them. Hey, I think you've got a ghost."

"Okay, I moved it. Is it better, Harry?"

"Nothing on the screen but stomach acid. Let me change the channel."

"Harry!"

"Can't hear you, George. The sound's too loud."

"Well, turn the sound off."

"What?"

"Turn it off!"

"Okay, it's off."

"That's better. How is it now?"

"No picture at all, George."

"What channel is it tuned to?"

"None. I thought you told me to turn it off."

"For Pete's sake, turn it on. I don't want to stay up here all day."

"I'm sorry, George. Here comes the picture. It's a movie. Humphrey Bogart. Hey, hold that antenna still. You're lousing up the picture."

"Harry, just tell me about the picture."

"Well, Humphrey plays this gangster, see . . . No, I think he's a detective. And then there's this dame—I think it's Mary Astor——"

"Will you stop that? Just tell me if it's coming in clear."

"I think it's almost over. Wait just a minute."

"Harry!"

"Yes, George."

"Switch it back to channel 6, will you?"

"George!"

"What?"

"Any beer in your icebox?"

"For Pete's sake, *will* you get channel 6?"

"Nothing on channel 6 but cartoons."

"How's the picture?"

"It's Bugs Bunny. Can't be all bad. Oh, I've seen this one."

"Is it snowy?"

"Can't tell. Picture isn't clear enough. There, it's getting better. What's you do? Hold 'er, that's good!"

"Fine. Now turn it back to channel 2."

"What?"

"Switch it to channel 2, Harry."

"There's nothing on channel 2."

"Can't see anything at all?"

"Just a commercial."

"Is it fuzzy?"

"No, not exactly. Well, I guess you could call it foamy."

"Foamy?"

"It's a beer commercial, Harry."

"Watch it carefully. I'm going to turn the antenna a little. How is it now?"

"It's gone."

"The picture's gone?"

"No, the beer's gone. Ball game's on now. Got any beer in the refrigerator?"

"I thought you were going to help me, Harry."

"Okay, George. Sure, George. What'ya want me to do?"

"Just watch the picture. Tell me if it gets better or worse."

"It doesn't look so good——"

"What happened?"

"——for the Yankees. Two outs, two strikes and——"

"Harry!"

"Yes, George."

"How's the PICTURE?"

"If you really want to know, it's fuzzy . . . Now it's wavy . . . Now it's a little better."

"Harry!"

"What?"

"I think I got it. Watch closely. I'm going to walk very slowly with this antenna. Keep telling me whether it's better or worse."

"Gotcha, George . . . It's better . . . no, a little worse . . . now it's getting better . . . much better . . . keep going . . . now there's a little ghost . . . not so good . . . getting worse . . ."

"Harry!"

"What is it?"

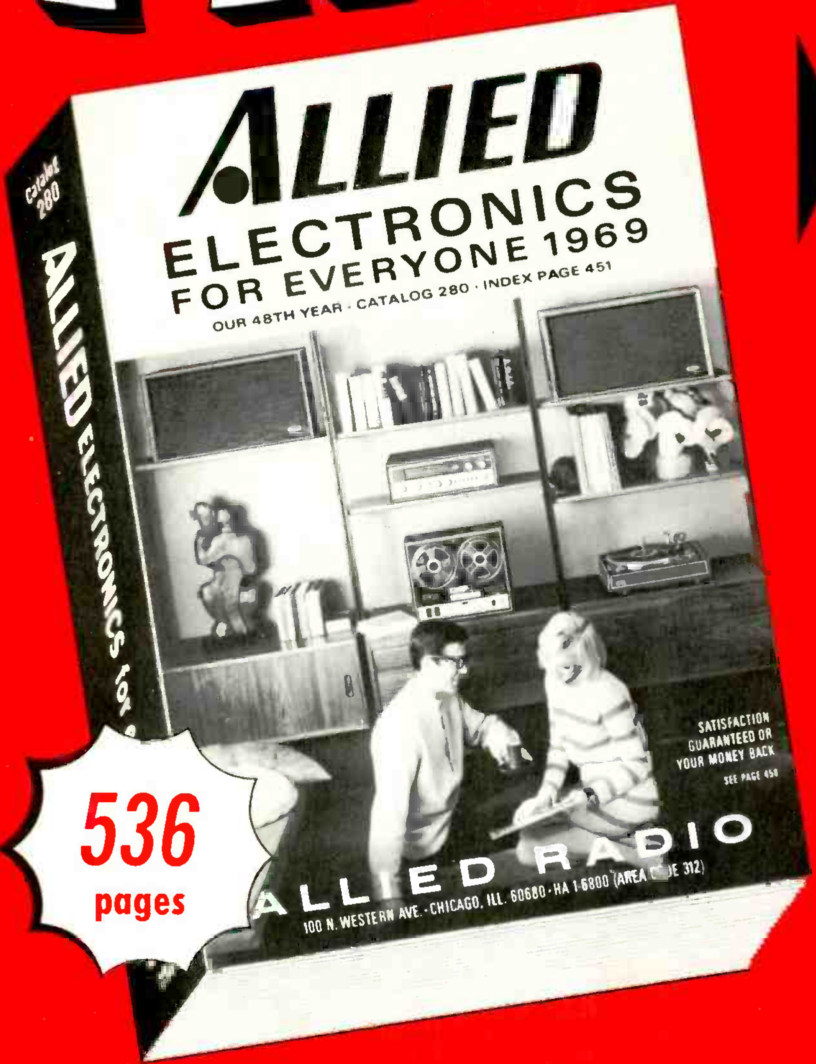
"How's it now?"

"I told you. It was good and got worse. Go in the other direction. Go back!"

"Okay. I'm going to walk backward very slowly. Tell me whether it gets better or worse."

"A little better . . . more . . . more . . that's better . . . keep going . . . it's getting sharper . . . better . . . a little more . . . HOLD IT, THAT'S PERFECT! . . . Hey, what did you do? It's gone completely! Hey, George, the picture's gone! George! . . . GEORGE? . . . *GEORGE!!!*" **R-E**

FREE



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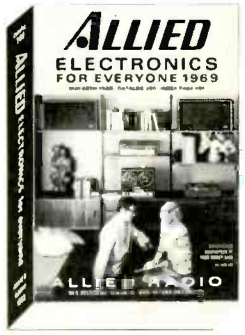

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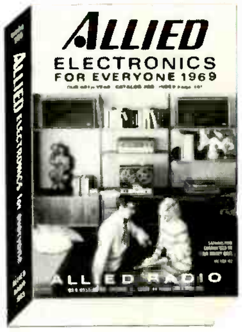

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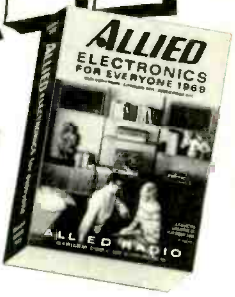

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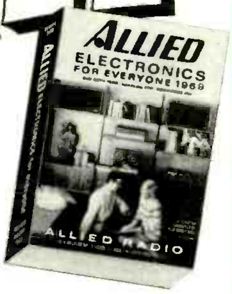

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48

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TECHNOTES

ADMIRAL G11, G13, H12 AND K15

Loss of red or blue in these color chassis may be caused by failure of phase coils L506 and L507 induced by failure of the spark gaps on the picture-tube leads.

Early production sets use a twin-lead gap. Some of these have been found with the insulation extending beyond the ends of the wires—the ends of the wires must be exposed for the gap to operate. Trim the twin-lead insulation so the wires extend slightly beyond it. *The exposed ends must not be moved from their original spacing.* Replacement of either L506 or L507 without checking the spark gaps may result in repeated failures.—*Admiral Service News Letter*

COLOR IMPURITY
G-E CB AND KC CHASSIS

Complaint: Severe color impurity. The condition can be corrected by manual degaussing, but it returns when set is turned on after having been turned off and allowed to cool. The impurity gets worse as set is cycled on and off.

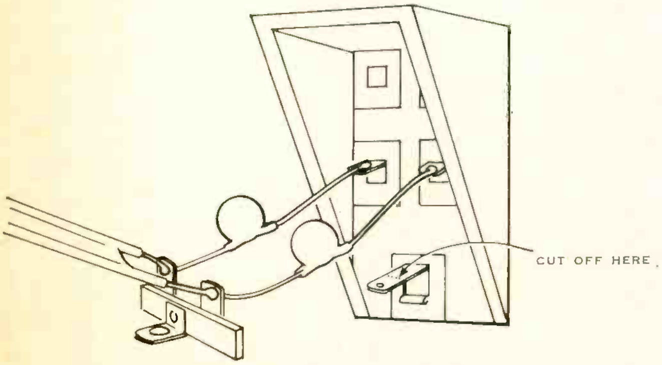
Remedy: The problem has been traced to an open diode or a cold-soldered joint in the full-wave bridge rectifier circuit. This unbalances the bridge and sends spurious pulses through the degaussing coil.

This condition cannot be detected by voltage measurements because the resulting drop in B+ voltage is only 25–30. Check rectifier diodes with an ohmmeter and inspect their terminals for cold-soldered joints.—*G-E Service Talk*

RCA KCS 158 TV CHASSIS

On this chassis, a metal screw—used to help secure the rear cover—goes into a Tinnerman nut on the antenna terminal board. This Tinnerman nut has a spade-type extension used in some chassis (*not the KCS 158*) for antenna connections.

Since this spade extension is not used, RCA recommends that it be cut off (see drawing) whenever this chassis is being



serviced. This will eliminate the possibility of a technician redressing the antenna Capacitor lead so it touches the spade and causes the rear mounting screw to become "hot", creating a possible shock hazard.—*RCA Television Service Tips* **R-E**

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Tire Thermistors

New test techniques for driving safety

Heat has always been an enemy of tires. With today's high-speed driving and heavier tire loading, tire rubber and fabric must withstand tremendous stress. Because of the recent industry–government push for better tire safety standards, new techniques are being devised to measure tire heating under laboratory and driving conditions.

In the past, one method for measuring tire temperature was to stop the car (or test machine) and insert a thermocouple into the tire. This method is inaccurate because temperature changes occur before the measurement can be made. Also, errors arise due to heat conductivity of the probe itself and imprecision in positioning the probe in the tire.

Another technique permits temperature measurements during tire use by bringing sensor leads out through the valve and transferring the signal from the turning wheel with slip rings and brushes.

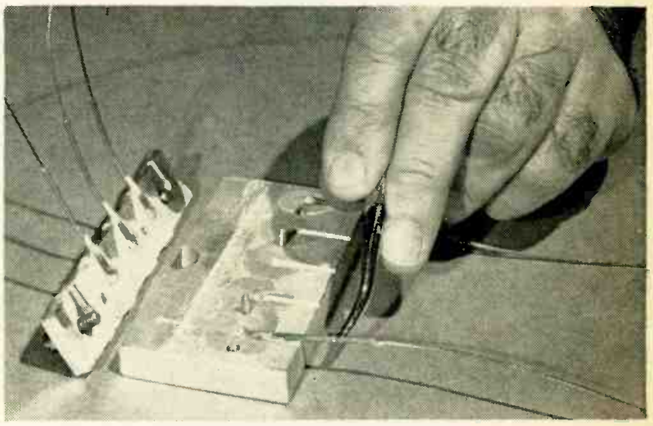


Fig. 1—Thermistors for measuring temperatures in running tires at NBS are protected by encapsulating them in epoxy.

More recently, solid-state telemetering transmitters mounted on the wheels under test have replaced mechanical commutators. The National Bureau of Standard's (NBS) instrumentation, for example, utilizes thermistor probes to modulate the signal emitted from the wheel-mounted transmitter. Thermistors have the advantage of a large output change per degree of temperature shift.

But shortness of sensor life has limited the usefulness of telemetry systems. Typically, after 150 miles of testing (not enough to complete measurements), the leads are torn off the thermistors. To prevent this, NBS now protects these fragile sensors by sliding a glass fiber sleeve over their leads, daubing the thermistor with epoxy and allowing it to cure in a split mold. Closing the mold forces the epoxy into any spaces around the thermistors and about ½" up the leads and sleeves (Fig. 1).

Temperature measurements made with the sensors are meaningful only if sensors are positioned in exactly the same location on all tires. This is done by insetting them in holes drilled under the edge of the tread at the tire shoulder, where the tire is thickest and generates the most heat (Fig. 2). Holes are uniformly drilled with a positioning jig placed on the tread.

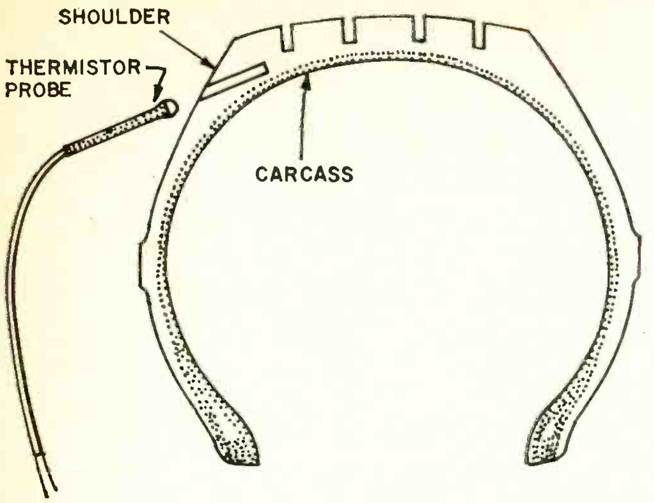


Fig. 2—Thermistor probes are put in tire shoulders. Tire temperature varies thermistor output, modulating transmitter.

Encapsulated thermistors are installed by coating them with a silicon rubber paste that cures at room temperature. They are then inserted into holes partially filled with the rubber compound. This forces some of the compound out in a mound, which offers flexible support for the leads. Using this method, tires have been run up to 4000 miles on a test wheel without interruption for sensor replacement.

The wheel-mounted telemetering package is a miniaturized modulator and transmitter mounted with its batteries on a plate that replaces the wheel hubcap. Thermistor resistance controls the frequency of a relaxation oscillator, which modulates the 104-MHz transmitter frequency. The entire unit occupies about the same volume as a deck of cards.

Signals from a tire under laboratory test are picked up by a nearby antenna, while those from a tire road-tested on a car are picked up by a loop antenna mounted in the fender-wheel cutout (Fig. 3). Signals are fed to an FM tuner in the laboratory or car, and are demodulated to produce a signal of frequency identical to that of the relaxation oscillator in the transmitter.

Other circuitry converts this signal to a direct voltage, which is recorded on a temperature strip chart. Telemetry equipment is mounted on a small rack which can be carried in the car. **R-E**

Fig. 3—For road testing, a loop antenna is installed near the wheel-mounted transmitter. Strip chart records signals.

NEW TUBES AND SEMICONDUCTORS

10-AMPERE RECTIFIER BRIDGE

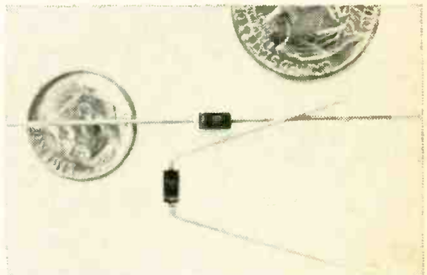
The new Bendix 10-amp integrated full-wave bridge rectifier series is a thick-film silicon type using hybrid construction and a plastic encapsulant

in a case similar to the TO-3. These rectifiers—the BHC-0001 through BHC-0005—are for working (rms) voltages of 70 to 420 and have PRV ratings per leg of 100, 200, 300, 400 and 600 volts, respectively.

Maximum dc reverse current at the PRV is 10 mA and maximum forward voltage drop at 10 amps and 25°C is 1.2 Peak surge current (at 60 Hz and 25°C) is 100 amps.

1-WATT SUBMINIATURE ZENERS

The 1N4728, -A to 1N4764-A makes up a series of 1-watt Zener diode voltage regulators covering from 3.3 to 100 volts. The 1N4728 series, housed in a 0.2″ by 0.1″ diameter molded plastic case similar to the DO-7, is many

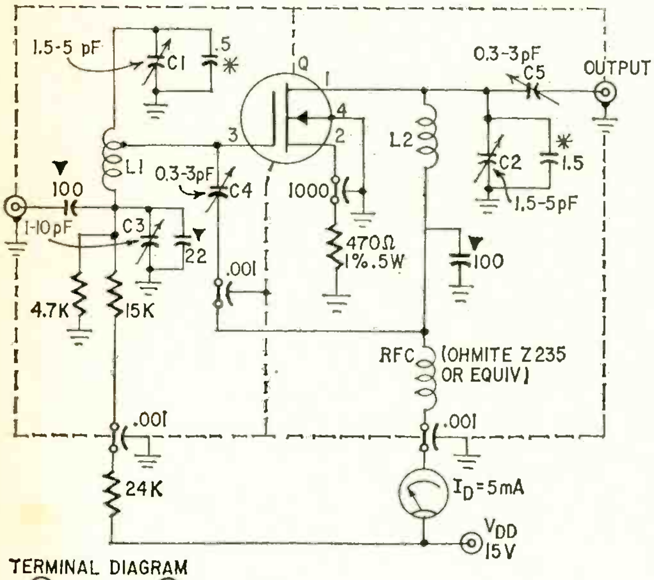


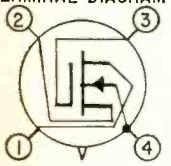
times smaller than most popular 1-watt Zeners.

Full technical information on the series is available in Bulletin C-107 from International Rectifier, Dept. 781, 233 Kansas St., El Segundo, Calif. 90245.

LOW-NOISE IGFET

The RCA 3N152 is an N-channel depletion-type silicon FET designed for low-noise rf applications up to 250 MHz. Superior transfer characteristic and wide dynamic range provide better cross-modulation performance than conventional bipolar transistors. The insulated gate (leakage current 0.1 pA, typical) eliminates the problem of diode-current loading of the input circuit with strong signals.





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The low feedback capacitance (0.12 pF) makes possible the design of high-gain vhf amplifiers without using neutralization. The 3N152 is in a TO-72 metal package. The diagram shows the unit used as a 200-MHz amplifier. Minimum power gain is 16 dB and the noise figure is 3.5 dB. Capacitors C3, C4 and C5 are piston-type variables. C1 and C2 are miniature air-type variable tuning capacitors. L1 is five turns of 0.02″ thick x 0.07″ wide silver-plated copper ribbon. Winding is 0.25″ I.D. and 0.65″ long, tapped at 1½ turns from the C1 end of the coil. L2 is the same as L1, except winding length is 0.7″; no tap. **R-E**

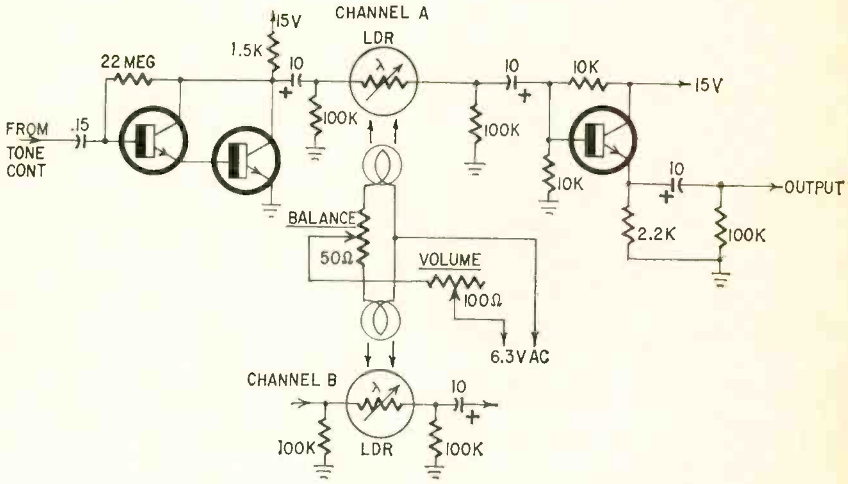
NOTEWORTHY CIRCUITS

REMOTE STEREO VOLUME AND BALANCE CONTROLS

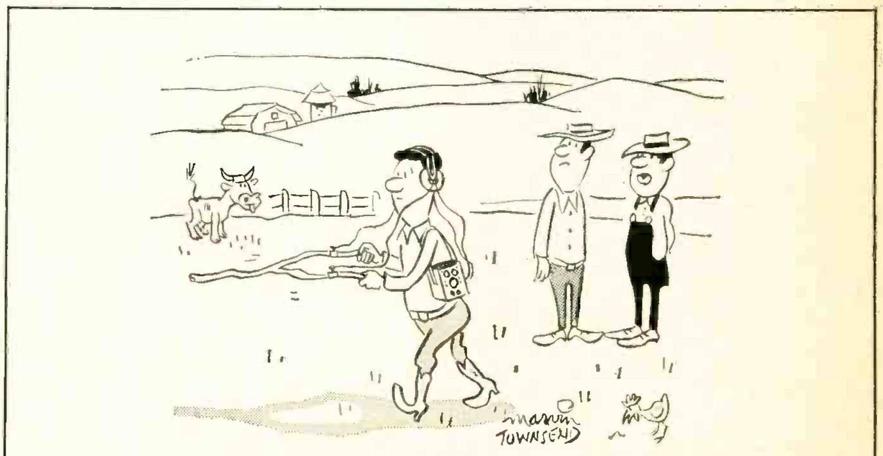
Remote stereo balance and volume controls would add greatly to the enjoyment and convenience of operating hi-fi equipment by permitting us to adjust volume and balance from a favorite chair or even another room. In most cases, these controls are connected at high-impedance points in the circuit and long leads cannot be used.

The diagram shows how a pair of LDR's (*l*ight *d*ependent *r*esistors such as cadmium selenide photocells) and small pilot lamps are used as volume and balance controls in a stereo amplifier described in *Radio Bulletin* (Bussum, Netherland). The LDR's are connected as variable legs of a voltage divider in the audio signal path of each channel. Their resistance varies from around 10 megohms in darkness to about 300 ohms when illuminated by the lamp. The lamps are 6-volt, 100-mA units.

The brightness of both lamps is controlled by the 100-ohm volume control. Channel balance is controlled by varying the relative brightness of the two lamps with the 50-ohm control.



Each LDR and its associated lamp are placed close together in a light-proof box or wrapped with black plastic tape. You can replace each lamp and LDR with a photocell/lamp module such as the Raytheon Raysistor or Clairex Photomod. In the original unit the lamps were fed with ac from a 6-volt winding on the power transformer. This may introduce hum into the system. If it does, change to a simple dc supply for the lamps. **R-E**

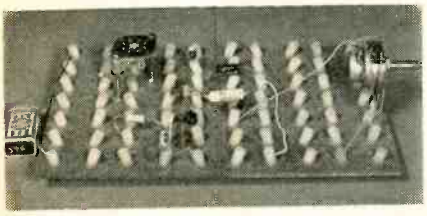


"Personally, I don't go for all this electronic jazz."

TRY THIS ONE

BUILD A SOLDERLESS BREADBOARD

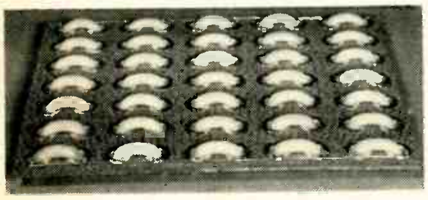
A solderless breadboard can be inexpensively constructed using $\frac{1}{8}$" pegboard with brass grommet termi-



nals and rubber tubing to hold component leads together.

First enlarge the pegboard holes to $\frac{5}{16}$", countersinking the bottom sides to provide clearance for the base flare of the grommets. Insert No. 1 brass grommets from the bottom and place the board on a solid base. Flare the grommets with a punch made from $\frac{3}{8}$" rod stock ground to a partial point at a 45° angle. Then hammer the flares flat.

Gum-rubber tubing with $\frac{5}{16}$" OD (usually listed as $\frac{3}{16}$" ID) may be obtained from surgical supply stores. Cut the tubing into 2" lengths and insert it in pairs of holes. The tub-



ing fits the grommets snugly, but when the ends are pushed aside space is provided to insert component leads. To provide a common ground or B+, connect the grommets in the edge rows with wire.

Regular pressed board is suitable for use under most conditions. If the breadboard is to be used in damp areas or in high humidity, it is advisable to use tempered board or to apply two coats of shellac before inserting the grommets.—*Lawrence G. Betz* **R-E**

Automatic Chroma Control

(continued from page 60)

vary for different color sets and from one TV station to another. After you have checked out several makes of color sets and made p-p voltage notations for the number of TV channels received, you will know about what voltage to expect.

First measure p-p chroma voltage at the demodulator grid for three TV stations and then from a color-bar generator. This can be used as your standard color-signal test.

The peak-to-peak voltages you obtain may be similar to these examples (Set the color gain control at midrange):

TV channel A: 3.5V
TV channel B: 3.4V
TV channel C: 3.6V
Color-bar generator: 3.8V

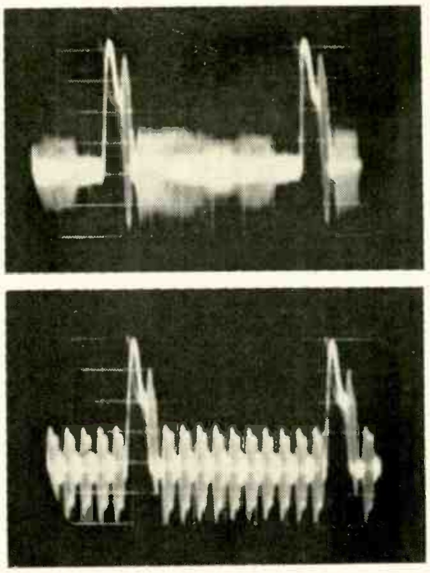


Fig. 5—Correct chroma signals generated by a station and color-bar generator are shown at a *(top) and* b*, respectively. Waveforms were measured on the R—Y demodulator control grid.*

Next, disable the acc circuit voltage, either by grounding or disconnecting the circuit. Take your p-p readings again.

This is what you might obtain:

TV channel A: 6V
TV channel B: 2.5V
TV channel C: 4V
Color-bar generator: 8V

These measurements tell you that the acc circuit is operating. If both sets of p-p scope readings have similar values, this indicates a lack of acc action. Figs 5-a and -b show proper chroma signals at this test point on a Zenith 20X1C38 chassis with station and color-bar signals, respectively. Keep the acc circuit disabled and using a color-bar generator with a variable rf-output gain control, adjust rf input to the color set while monitoring chroma signal for acc action. Now reconnect the acc circuit and make the same test for a comparison signal check. This is a good test for acc action of fluctuating signal operating conditions.

These tests should be one of your routine procedures for a complete color chassis checkup, even with sets in the shop for other repairs. You and your customers will be glad you made them. **R-E**

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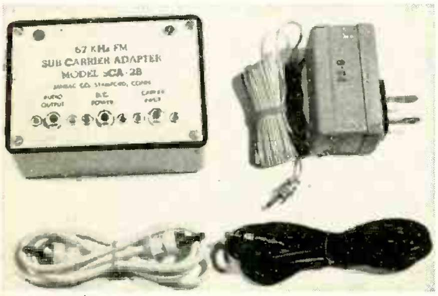

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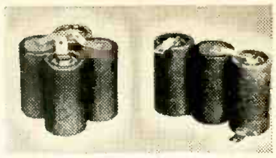

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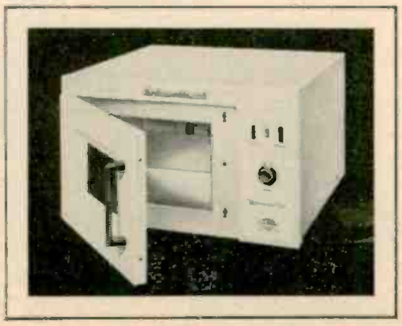

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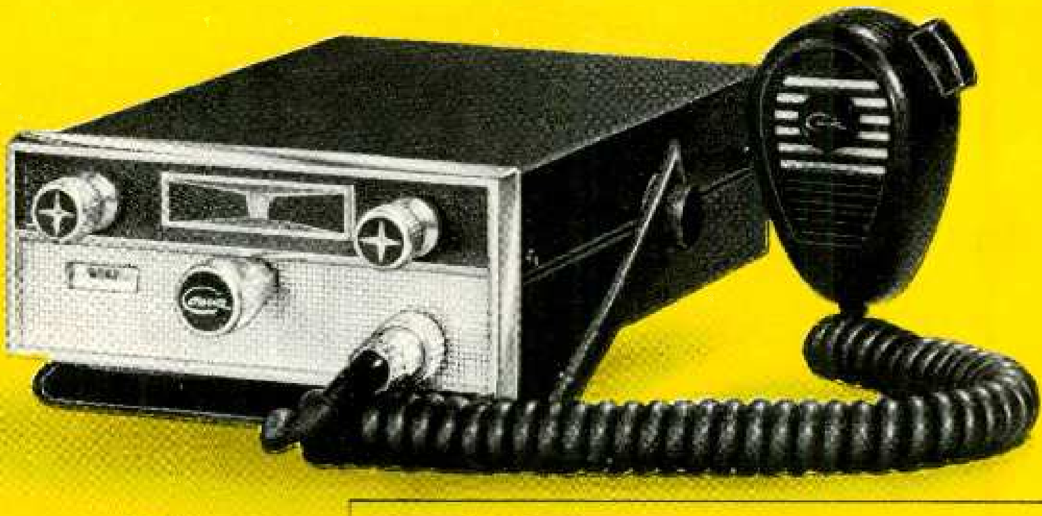

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