Wayne (Nice Guy) Green, W2NSD/1, Becomes Our Ham Radio Columnist

BUILD A CHANNELIZED HAM TRANSMITTER

TRANSLATION
Why don't you DX me sometime?... and do it with El's 1-transistor short-wave converter!
See p. 29.

¿POR QUÉ NO ME SINTONIZAS DE VEZ EN CUANDO?*
Varför inte tona in mej någon gång?*
たまには私の声をフマハれてくたらね?
NOW 10 WAYS to Train at Home with the Leader

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

2. COMPLETE COMMUNICATIONS*—Teaches and gives actual practice in operation, service, maintenance of AM, FM, and TV broadcasting stations. Also covers marine, aviation, mobile radio, facsimile, microwave, radar.

3. INDUSTRIAL-MILITARY ELECTRONICS—From basic principles to computers. A comprehensive training plan that starts with fundamentals, then covers servos, telemetry, multiplexing, phase circuitry, other subjects.

4. FCC LICENSE*—Specifically designed to prepare you for First Class FCC Radiotelephone License exams. You begin with Electronic fundamentals, advance to required subjects covering equipment, procedures.

5. MATH FOR ELECTRONICS—A brief course for engineers and technicians who need a quick review of math used in industry, communications, government jobs. Short-cut formulas, digital number systems, much more.

6. BASIC ELECTRONICS—Concise course in modern Electronic terminology and components. Practical, useful information to help you understand the field, give you some technical knowledge of Radio-TV, Electronics.

7. AVIATION COMMUNICATIONS*—Prepares you to install, maintain, service aircraft equipment like direction finders, ranges, markers, Loran, Shoran, Radar, landing systems. Prepares you for FCC License exams.

8. MOBILE COMMUNICATIONS*—Learn to install, maintain mobile equipment and associated base stations. Covers transmitters and receivers used by police, fire departments, taxi companies, etc. Prepares for FCC exams.

9. MARINE COMMUNICATIONS*—Covers transmitters, direction finders, depth indicators, Radar, Sonar, other equipment used on commercial ships and pleasure boats. Prepares you for FCC License exams.

10. ELECTRONICS FOR AUTOMATION—Not for beginners, but for men with some fundamental knowledge of Electronics who want an understanding of Automation. Process control, ultrasonics, telemeasuring and remote control, etc.

COMPARE. You'll find—as have tens of thousands of NRI graduates—that NRI training gives you more value. From the delivery of your first lessons in the remarkable NRI Achievement Kit we send you on enrolling, to “bite size” easily-read texts carefully programmed with custom-designed training kits ... NRI can't be beat. Text for text, kit for kit, dollar for dollar—your best home-study buy is unquestionably NRI. (And NRI training costs you less than one semester's tuition at most colleges.)

New Achievement Kit Starts You Fast

The day we receive your enrollment application we mail you your new NRI Achievement Kit. This attractive starter kit is an outstanding, logical way to help you get an easier, faster start in the training of your choice. It is the first of a number of special training aids developed in the NRI laboratories to make your adventure into Electronics exciting, meaningful. What's in it? Your first group of lesson texts; a rich, vinyl desk folder to hold your material; the industry's most complete Radio-TV Electronics Dictionary; valuable reference texts; lesson answer sheets; envelopes; pencils; pen; engineer's ruler; even postage. No other school has anything like it.

Build, Discover with NRI Equipment

Electronics comes alive with NRI training kits. What better way to learn than by doing? NRI pioneered and perfected the "home lab" technique of training at home in spare time. You get your hands on actual parts to build, experiment, explore, discover. NRI invites comparison with training equipment offered by any other school. Begin now this exciting program of practical learning. Whatever your need ... whatever your education ... there's an NRI instruction plan for you, at low tuition rates. Get all the facts. Fill in and mail the postage-free card today. NATIONAL RADIO INSTITUTE, Electronics Division, Washington, D. C. 20016

*NOTE: You must pass your FCC License exams (any Communications course) or NRI refunds in full the tuition you have paid.
For Tough Recording Jobs
Choose The Only
Microphone With
Backbone!

The backbone of the Electro-Voice Model 676 is no mere decoration. It's visible proof of the most exciting idea in directional microphones - Continuously Variable-D (CV-D)™.

And it takes a directional microphone to solve your tough recording problems: bad acoustics, audience noise, poor balance between performers.

Here's how CV-D works. We attach a very special tapered tube to the back of the microphone element. This tube automatically varies in effective acoustic length with frequency. It's a long tube for lows - a short tube for highs. All this with no moving parts! The tube is always optimum length to most effectively cancel sound arriving from the back of the microphone, regardless of frequency.

This ingenious solution™ is years ahead of the common fixed-path designs found in most cardioid microphones. The 676 offers significantly smoother response at every point - on or off axis - plus more uniform cancellation to the rear. It is also less sensitive to wind and shock. There is almost no "proximity effect"...no boosted bass when performers work extra close.

Long life and smooth response are guaranteed by the exclusive E-V Acoustalloy® Diaphragm. And the 676 has unusually high output for a microphone so small. Of course you get dual output impedances, high efficiency dust and magnetic filters - all of the hallmarks of Electro-Voice design that have made E-V a leader for years.

But that's not all. The 676 has an exclusive bass control switch built in. Choose flat response (from 40 to 15,000 cps) or tilt off the bass 5 or 10 db at 100 cps to control reverberation, reduce low frequency feedback and room rumble.

Write today for complete specifications, or visit your E-V sound specialist's to see this remarkable new microphone. And when difficult recording problems must be faced squarely, stand up and fight back with the microphone with a backbone (and CV-D) - the new Electro-Voice 676 dynamic cardioid!

Model 676 Satin Chrome or TV Grey, $100.00 List; in Gold, $110.00 List. Shown on Model 420 Desk Stand, $20.00 List. (Less normal trade discounts.)

ELECTRO-VOICE, INC., Dept. 7621
622 Cecil St., Buchanan, Mich. 49107

©Pat. No. 3,115,207

ELECTRO-VOICE
SETTING NEW STANDARDS IN SOUND

www.americanradiohistory.com
Special Feature
The Ham Shack .................................................. Wayne Green, W2NSD/1 38

General Features
His Radios Never Die ........................................... J. K. Locke 47
World's Biggest Magnet .......................................... Leo G. Sands 80
Why We're So Weather Wise .................................... Art Margolitis 108
What TV Test Patterns Really Mean .......................... Art Margolitis 108

Construction Projects
Slot-Car Lap Timer ............................................. Al Toler 43
All-Transistor Rock Checker .................................... Herb Friedman, KBI9457 85

Radio: CB • Amateur • SWL
1-Transistor Short-Wave Converter .......................... Charles Green, W3IKH 29
The Listener: Time Signal IDs ................................ C. M. Stanbury II 48
Channelized Ham Transmitter .................................. Russ Alexander, W6IEJ 65
Varactor Super Band Spreader ................................... Kevin Redmond, K2HTZ 73
Notes From El's DX Club .......................................... Russ Alexander, W6IEJ 65
Kit Report: Low-Cost Electronic Keyer ....................... Len Buckwalter, KBA4480 99
CB Corner: Down To The Sea, But Where's CB? ............... Len Buckwalter, KBA4480 99

Audio & Hi-Fi
Hi-Fi Today: Speaker Stuff & Nonsense ..................... John Milder 33
The Day Tape Was Born ......................................... Bob Swathmore 49
A Pro Takes a Look at Consumer Tape Recorders .......... Robert Gaulin 53
Tape Compressor .................................................. Walt Henry 57
Through Europe With a Tape Recorder ....................... Robert Angus 61

Theory & Practice
The ABCs of Radio: Part VI, Signal to Sound ............... John T. Frye, W9EGV 39
Beginner's Corner: Dr. Zener's Diode ....................... H. B. Morris 70
Squeeze Me and I'll Shock You ................................. John Potter Shields 95

Regular Departments
Feedback From Our Readers .................................. 6
Electronics in the News ......................................... 8
Electronic Marketplace .......................................... 14
Electronic Swap Shop ........................................... 19
Subscription Blank .............................................. 24
Broadsides .......................................................... 25
Uncle Tom's Corner .............................................. Tom Kneitel, K2AJS/KBG4303 26
Good Reading ..................................................... Tim Cartwright 92
Over and Out ..................................................... Rodrigues 120

NOW BETTER THAN EVER!
The famous RCA WV-38A Volt-ohm-Milliammeter

NEW FEATURES...
COLOR-CODED FRONT PANEL MARKINGS simplify operation, reduce chance of error.
METER MOVEMENT PROTECTED AGAINST BURNOUT. Special silicon diodes guard meter against overload.
PLUS...
POLARITY REVERSAL SWITCH. Reverses polarity of test leads without need for re-connecting. Handy for checking front-to-back resistance ratio of electrolytic capacitors and many types of semiconductor devices.

39 DIFFERENT MEASUREMENT RANGES.
MEASURES CURRENT from 50 microamps full scale to 10 amps full scale.
SPECIAL 0.25 volt and 1.0 volt (full-scale) DC ranges...useful in checking transistor circuits.
...and many additional features that have made this instrument the best V-O-M buy on the market today. Only $47.95*. Kit version. WV-38A(K), only $29.95*.
See it at your Authorized RCA Electronic Instrument Distributor.

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

The Most Trusted Name in Electronics

www.americanradiohistory.com
INSIST ON CQC

*Controlled Quality Crystals available only from Texas Crystals dealers. Extensive precision testing throughout manufacture enables Texas Crystals to unconditionally guarantee their frequency control crystals. Use of Texas Crystals in space program and by other governmental agencies is evidence of the quality you can count on.

If your dealer can't supply your needs, send his name with your request for catalog to our plant nearest you.

ELECTRONICS ILLUSTRATED

By the Publishers of MECHANIX ILLUSTRATED

editor ROBERT G. BEASON
managing editor Robert D. Freed
feature editor Richard A. Flanagan
art editor Lou Rubsamew
editorial associate Albert P. Lahndt, Jr., K2IAG
production editor Rosanne Walsh
advertising mgr. John F. Webster
eastern adv. mgr. Don Daily, KB10618

CONTRIBUTING EDITORS

amateur radio Robert Hertzberg, W2DJJ
citizens band Len Buckwalter, KBA4480
swl-dx C. M. Stanbury II
special projects Herb Friedman, WZ2LF/KB118457
audio Harry Kolbe
audio John Milder
audio David Muirhead

EXECUTIVE STAFF

president W. H. Fawcett, Jr.
general manager Roger Fawcett
secretary-treasurer Gordon Fawcett
circulation director Roscoe K. Fawcett
vice president Ralph Dalgh
asst. general manager Donald P. Hanson
production director George H. Carl
art director Al Allard
associate art director Ralph Mattison
director of advertising Mortimer Berkowitz, Jr.

ELECTRONICS ILLUSTRATED is published bi-monthly by Fawcett Publications, Inc., Fawcett Bldg., Greenwich, Conn. 06830. Second-class postage paid at Greenwich, Conn., and at additional mailing offices.

EDITORIAL OFFICES: 67 W. 44th St., New York, N.Y. 10036 (phone 212-661-0000). Contributions must be accompanied by sufficient postage and will be handled with care, though the publishers assume no responsibility for return thereof.

ADVERTISING OFFICES: 67 W. 44th St., New York, N.Y. 10036 (phone 212-661-0000); 101 E. Ontario St., Chicago, Ill. 60611 (phone 312-315-7-4666); 1222 Guardian Bldg., Detroit, Mich. 48228 (phone 313-482-7-4860); 2978 Wilshire Blvd., Los Angeles, Calif. 90005 (phone 213-DU 7-8258); 661 Market St., San Francisco, Calif. 94105 (phone 415-SX 7-3441); 1490 W. Peachtree St., N.W., Atlanta, Ga. 30309 (phone 404-TR 5-0372); James B. Boynton, 470 Tequesita Dr., Jupiter, Fla. 33458 (phone 904-TE 8-4871); 123 S. Broad St., Philadelphia, Pa. 19109 (phone 215-PF 5-3658).

SUBSCRIPTIONS: $5 per year (6 issues) in U.S. and possessions and Canada; All other countries $4 for 6 issues. All subscription correspondence, including changes of address (Form 3579), should be addressed to ELECTRONICS ILLUSTRATED, Subscription Dept., Fawcett Bldg., Greenwich, Conn. 06830. Foreign subscriptions and sales should be remitted by International Money Order in U.S. funds payable at Greenwich, Conn.

COPYRIGHT © 1966 by Fawcett Publications, Inc. The title ELECTRONICS ILLUSTRATED is registered in the U.S. Patent Office. Reproduction in whole or in part is forbidden without written permission of the publishers; however, permission is hereby granted to quote from this issue of this magazine in radio or television, provided a total of not more than 1,000 words is quoted and credit is given to the title of this magazine and issue, as well as the statement, copyright 1966, by Fawcett Publications, Inc.

PRINTED IN U.S.A. BY FAWCETT-HAYNES PRINTING CORP., LOUISVILLE, KY. 40201. Microfilm copies of current and back issues are available from University Microfilms, 313 N. First St., Ann Arbor, Mich. 48103.
BUILD 20 RADIO CIRCUITS AT HOME

ONLY $25.95

with the New Improved PROGRESSIVE RADIO "EDU-KIT"®

A Practical Home Radio Course

Now Includes

12 RECEIVERS
3 TRANSmitters
SQ. Wave Generator
Square Wave Tracer
Selenium Amplifier
Signal Injector
Code Oscillator

YOU DON’T HAVE TO SPEND HUNDREDS OF DOLLARS FOR A RADIO COURSE

The "EDU-KIT" offers you an outstanding PRACTICAL HOME RADIO COURSE at a rock-bottom price. Our Kit is designed to train Radio & Electronics Technicians, but is suitable for anyone interested in radio, whether or not you want an interesting hobby, a well paying business or a serious career. You can use the "EDU-KIT" as a well-paid investment. Many thousands of people have used the "EDU-KIT" in more than 70 countries of the world. You can learn the fundamentals, step-by-step, so that you can make your own radio. The "EDU-KIT" allows you to teach yourself at your own rate. No instructor necessary.

PROGRESSIVE TEACHING METHOD

The Progressive Radio "EDU-KIT" is the foremost educational radio kit in the world, and is universally accepted as the standard in the field of electronics training. The "EDU-KIT" uses the modern educational principle of "Learn by Doing." Therefore you construct, learn schematics, study theory, practice trouble-shooting—all in a closely integrated program designed to provide an easily-learned, thorough and interesting background in radio. You begin by examining the various radio parts of the "EDU-KIT" to learn their function, theory and wiring of these parts. Then you build a simple radio. With this first experience you gain confidence and proceed to practice, and trouble-shooting. Then you build a more advanced radio, learn more advanced theory and practice trouble shooting. Then you build high powered radios with tubes. By that time, you are an expert, and with your "EDU-KIT" in your hands you are ready to service radios, do all kinds of work like installing tubes, detectors, rectifiers, test equipment. You will learn the standard type of AC and DC circuits, and MULTI-TUBE circuits. You will learn all the latest development in PRINTED CIRCUITRY, an outstanding method of electronic design and Radio Handbook. You learn symptoms of trouble and what to do about them. You will learn the correct wiring and how to use your Test Equipment. You will become a 100% Radio - TV Technician, and you will be able to take any repair job with confidence.

Printed Circuitry

You will receive all parts and instructions necessary to build twenty different radio and electronics circuits, all guaranteed to operate. Our Kits contain many tube sockets, variable, electrolytic, mica, ceramic and paper dielectric condensers, resistors, the usual tools, solder, soldering iron, and etched Printed Circuit boards. In addition you receive Printed Circuit materials, including Printed Circuit chassis, spares, and all parts, schematics and instructions. You also receive a useful set of tools, a professional electric Soldering iron, and a self-powered Dynamic Radio and Electronics Tester. The "EDU-KIT" also includes Code Instructions and the Progressive Code Oscillator, in addition to FCC Radio Amateur License training. You will also receive lessons for servicing with the Progressive Signal Tracer and the Progressive Signal Injector. A High Fidelity Guide and a Quiz Book. You receive Membership in Radio-TV Club, Free Consultation Services, Certificate of Merit and Service Privileges. You receive all parts, tools, instructions, etc. Everything is yours to keep.

FREE EXTRAS

• SET OF TOOLS
• SOLDERING IRON
• CODE Oscillator
• Pliers-Cutters
• VALUABLE DISCOUNT CARD
• CERTIFICATE OF MERIT
• TESTER INSTRUCTION MANUAL
• TV FIDELITY GUIDE & QUIZZES
• TELEVISION BOOK & RADIO TROUBLE-SHOOTING AIDS
• MEMBERSHIP IN RADIO-TV CLUB: PERSONAL SERVICE & F.C.C. AMATEUR LICENSE TRAINING
• PRINTED CIRCUITY

SERVICING LESSONS

You will learn trouble-shooting and servicing in a progressive manner. You will practice repairs on the sets that you construct. You will learn symptoms and causes of trouble in home, portable and car radios. You will learn how to use the progressive Signal Tracer, the dynamic Signal Injector, and the dynamic Signal Injector and Code Oscillator. While you are learning in this practical way, you will also receive lessons on your job for your friends and neighbors, and charge fees with more than the face price of the "EDU-KIT." Our Consultation Service will help you with any technical problems you may have.

FROM OUR MAIL BAG

J. Staats, of 25 Poplar Pl., Waterbury, Conn. writes: "I have repaired several sets for my friends, and am now doing work like a professional." R. S. L. of 154 Smith St., Waterbury, Conn. writes: "I have really enjoyed this "EDU-KIT," and I was ready to spend more money on something else, but I bought this Kit and sent for your "EDU-KIT." My son, Ralph, and I, both learned a lot of trouble-shooting from the "EDU-KIT."" Harold N. V., of 17 East 6th St., Huntington, N. Y. writes: "I thought I would drop you a few lines to say that I received my "EDU-KIT," and was really amazed that such a bargain can be had at such a low price. I have already started repairing radios and phonographs." My friends were really surprised to see me get into the swing of it, so I sent for the "EDU-KIT." The"EDU-KIT" is really a set that teaches trouble-shooting, and if there is any to be learned, why, work on it.

UNCONDITIONAL MONEY-BACK GUARANTEE

ORDER FROM AD — RECEIVE FREE BONUS RADIUS TV PARTS JACKPOT WORTH $15

☐ Send "EDU-KIT" Postpaid. I enclose full payment of $26.95.

☐ Send "EDU-KIT" C.O.D. I will pay $26.95 plus postage.

☐ Rush me FREE descriptive literature concerning "EDU-KIT."'

Name

Address

PROGRESSIVE "EDU-KIT" INC

1186 Broadway, Dept. 575AE, Hewlett, N. Y. 11557

July, 1966
SLIGHTED

I never knew about boondoggles and then I read what you put in your mag (CB's BIGGEST BOONDOGGLE, May '66 EI). Our Annual Ragchewers Reunion & Reminisce was worse. Not one RRRer except me showed up.

J.B. Brown
Bronx, N.Y.

Left you a lot to chew on, eh?

HO-HO HUES

Interesting, I think, that in the very story where you speak of tape coming up red and eagles coming up blue you should see fit to color your vulture green (THE FANTASTIC FLIGHT OF THE BLUE EAGLE, May '66 EI). One might think you have color TV on the brain.

C.C. Martens
Baltimore, Md.

SOLVED

I want to build your flea-power transmitter (THE FLEXIBLE FLEA, May '66 EI) only I can’t find the tube. Can you tell me where I can get one? (It’s a 6AK6.)

Paul Hahn
Reno. Nev.

The 6AK6 appears under the special-purpose-tubes listings in catalogs by Allied, Lafayette, Newark and other mail-order firms. Net price is about $1.40.

BOUQUETS

Thank you for sending me EI’s DX CLUB’s OFFICIAL COUNTRIES LIST (Jan. ‘66 EI). This list represents considerable work and you are to be congratulated.

H.L. Chadbourne
La Jolla, Calif.

MISSED

I would like to call your attention to an oversight in your report on the Knight-Kit KG-415 stereo tape deck (Mar. ‘66 EI). You state that no instructions are provided for installing the completed unit in the walnut base, though such instructions appear on page 12 of the Operator’s Manual.

David S. Gunzel, Manager
Manual Department
Knight Electronics Corp.
Maywood, Ill.

We goofed. Sorry about that, Dave.

BOOM-BOMBED

Thanks to an article in your magazine, I now have an ultimate weapon against my frugging neighbors. The Dave Clark Five at 2 a.m. is a bit much so I built one of your little big boom boxes (BIG BOOM BOX, May ’66 EI) and blasted them clear out of my hearing range with a lovely little ditty called Atom Bomb Sounds.

Arthur Silverton
New York, N.Y.
Direct line to the world
with the world's first high fidelity multi-band tuner.

No matter where in the world the excitement is, the Fisher R-200-B will bring it right into your living room. Noise-free and with pleasure. Because the R-200-B is the first multi-band tuner built to high fidelity standards.

The R-200-B is an accomplished world traveler. With its three AM bands it can receive long-wave, medium-wave and short-wave broadcasts. Everything from local news and weather to live broadcasts from concert halls throughout the world. Wide-band for full concert fidelity, regular bandwidth for normal broadcasts, narrow-band to eliminate interference.

But the R-200-B is also an elegant stay-at-home. It includes a magnificent FM-stereo tuner with automatic mono-stereo switching and the famous Fisher Stereo Beacon* multiplex decoder.

Behind the remarkable Nuvistor front end, the R-200-B is completely solid state. And completely reliable. Because Fisher is the largest and most experienced manufacturer of high fidelity components.

You would expect a tuner this fine to be very costly. But the price of the Fisher R-200-B is surprisingly modest. Only $349.50. That's really not much to pay for a direct line to the world.

The Fisher R-200-B
SPECK DETECTOR . . . With transistors becoming smaller than a gnat's toenails, the problem of detecting impurities in the materials used in their manufacture is cause for some head-scratching now and again. Faced with this perplexing situation, the people at a British subsidiary of ITT came up with the speck detector in our photo. Showing the nature, extent and position of impurities and magnifying them up to 500,000 times, the detector employs a high voltage to attract atomic particles to a screen (lower left) from heated specks of matter a mere 1/50,000th of an inch small.

...electronics in the news

Lunar Link . . . Designed to give the go/no-go order to an orbiting spacecraft on its way to the moon, the good ship Vanguard recently began her sea trials from the Quincy, Mass., shipyards of General Dynamics. Equipped with eleven major electronic systems, the Vanguard should have no difficulty tuning in on each little wiggle of a spacecraft and each flutter of an astronaut's pulse during the trip to the lunar surface. The would-be lunar link—first of three Apollo instrumentation ships—was formed from the bow and stern of a WW II tanker.

Slenderest Solar Cells . . . Weighing a mere 60 milligrams and measuring just .004 in. in thickness, the world's thinnest silicon solar cells now are producing energy from light. And if the people at Electro-Optical Systems have set a shrinking trend abrewing, hobbyists some day well may be able to paint nearly anything exposed to the sun with a coat of volts and amps. Though efficiency of the slender cells is less than that of their stouter counterparts, engineers have hopes of improving their performance.

Electronics Illustrated
IN ELECTRONICS AND ELECTRICITY
THIS AMAZING NEW SLIDE RULE
SEPARATES THE MEN FROM THE BOYS!

LOOK WHAT YOU GET...

YOU GET... a patented*, high-quality, all-metal 10" electronics slide rule. "Your computer in a case!" Has special scales for solving sticky reactance and resonance problems... an exclusive "fast-finder" decimal point locator... widely-used electronics formulas and conversion factors. PLUS... all the standard scales you need for non-electronic computations such as multiplication, division, square roots, logs, etc.

YOU GET... a complete, "AUTO-PROGRAMMED" self-tutoring instruction course. Four fast-moving lessons with hundreds of easy-to-understand examples and diagrams. You'll learn how to find quick, accurate answers to complex electronics problems... soon be your outfit's slide rule "expert"! Free examination and consultation service if you want it plus a Graduation Certificate! THIS COURSE ALONE IS WORTH FAR MORE THAN THE PRICE OF THE COMPLETE PACKAGE!

YOU GET... a sturdy, handsome carrying case. It's made of genuine top-grain leather, doubly reinforced at the "wear-spots" features heavy duty liner for extra slide rule protection, has a removable belt loop for convenient carrying. "Quick-Flop" cover makes it easy to get your rule in and out of the case. Stamps you as a real "pro" in electronics.

A $50.00 VALUE FOR LESS THAN $20.00!

*Under U. S. Patent #3,120,342

NOW... take full advantage of what you know about electronics and electricity... solve complex problems in seconds while others plod along the old-fashioned "pad and pencil" way!

READ WHY OTHERS CALL THIS REMARKABLE NEW SLIDE RULE PACKAGE TODAY'S BIGGEST BARGAIN IN ELECTRONICS.

The Editor of Popular Electronics, Mr. Oliver P. Ferrell says: "Why didn't someone think of this before. The convenience of having all relevant formulas imprinted right on the slide rule saved me time the very first day!"

A student, Mr. Jack Stegleman says: "Excellent, I couldn't say more for it. I have another higher-priced rule but like the CIE rule much better because it's a lot easier to use."

The Head of the Electrical Technology Dept., New York City Community College, Mr. Joseph J. DeFranco says: "I was very intrigued by the 'quickie' electronics problem solutions. Your slide rule is a natural."

SPECIAL BONUS OFFER:
ANYONE WHO SENDS IN THIS COUPON WILL RECEIVE ABSOLUTELY FREE, A HANDY POCKET ELECTRONICS DATA GUIDE.

It's a useful, pocket-sized electronics "encyclopedia"... jam-full of valuable facts, formulas and other helpful information. Carry it with you... when it comes to electronics, you'll be the "man-with-the-answer"!

Cleveland Institute of Electronics
Dept. EI-111, 1776 E. 17th St., Cleve. Ohio 44114

Please send FREE Illustrated Slide Rule Booklet and FREE Pocket Electronics Data Guide.

NAME: ____________________________
ADDRESS: ____________________________
CITY: ____________________________ STATE: ________ ZIP: ________

A leader in Electronics Training...since 1934

July, 1966
BUILD YOUR OWN
LIGHT-OPERATED SWITCH

In and Around the House
For Dozens of Applications

Light up the night with RCA SCR Experimenter's Kits. These kits, containing a full complement of active components, rectifiers, transistors, a silicon controlled-rectifier, and a photocell, plus other readily available passive components and hardware enable you to build a light-operated switch for garage, yard or path, or even a sign that can be activated by auto lights. RCA Experimenter's Kits offer considerable flexibility in the number and kind of control circuits you as a hobbyist can build. With just three RCA kits, you can build any of 14 different circuits with hundreds of applications. Easy-to-follow directions for all 14 circuits are given in RCA Experimenter’s Manual, KM-70.

Your RCA Semiconductor Distributor has Basic and Add-On Kits as well as the RCA Experimenter's Manual on display. See him about the solid-state circuit you have in mind. Do it today!

AVAILABLE FROM YOUR RCA SEMICONDUCTOR DISTRIBUTOR

RCA Electronic Components and Devices Harrison, N. J.

The Most Trusted Name in Electronics

...electronics in the news

Bottle Knocker . . . Many's the bottle that's given up the ghost with but one well-placed blow. To see why and how bottles break, the Glass Manufacturers Institute of New York rigs bottles with strain gauges and places them in an impact tester. The hammer on the machine in our photo delivers blows to various points on the bottle while gauges record stresses and strains.

Future Phone . . . The dial goes up and down, not round and round. That must have been the theme Dr. Erich Haeussermann had in mind when he designed the telephone in our photo. A West-German inventor, Dr. Haeussermann reasons that his telephone is an improvement over conventional types because of its redesigned dial. Thinking is that current telephones require a difficult-to-control twisting motion of the dial that causes an alarming number of mistakes. New scheme requires only a series of straight-line pulls.

Electronics Illustrated

www.americanradiohistory.com
Be creative—and thrifty too!

Save up to 50% with EICO Kits and Wired.

EICO supports your sense of achievement with no-compromise engineering, finest parts, dramatic esthetics, simple step-by-step instructions and large pictorial diagrams. You need no technical background—just pliers, screwdriver, soldering iron. Three million people, ages 8 to 89, have built EICO kits. If you love to create, EICO is for you. And if you want the best buys in ready-to-use factory-assembled equipment, again EICO is for you. Judge critically for yourself. Send for your free catalog. See EICO at your local dealer.

<table>
<thead>
<tr>
<th>TEST EQUIPMENT</th>
<th>CITIZENS BAND/HAM RADIO</th>
<th>STEREO/HI-FI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 229 Peak-to-Peak VTM. A must for color or B&amp;W TV and Industrial use. 7-non-skip ranges on all 4 functions. With Uni-Prob. $29.95 kit, $49.95 wired.</td>
<td>New Model 778 Sentinel 23 CB Transceiver. 23-channel frequency synthesizer provides crystal-controlled transmit and receive on all 23 channels. No additional crystals to buy ever! Features include dual conversion, incorporates adjustable squelch &amp; noise limiter, TVI filter, 117VAC and 12VDC transistorized dual power supply. Also serves as a 3.5 watt P.A. system. $149.95 wired.</td>
<td>New Model 356B All Solid-State Automatic FM MPX Stereo Tuner/Amplifier. &quot;Very satisfactory product, very attractive price&quot;—Audio Magazine. No tubes, not even transistors. Delivers 117 watts into 4-ohms, 75 watts to 8 ohms. Completely pre-wired and pre-aligned kit. IF and MPX circuitry, plus plug-in Transistor sockets. $319.95 kit (optional walnut cabinet $14.95), $325.00 wired including walnut cabinet. UL approved.</td>
</tr>
<tr>
<td>Model 468 Wideband Direct-Coupled 5&quot; Oscilloscope, DC-4.5Mc for color and B&amp;W TV service and lab use. Push-pull DC vertical amp., bal. or unbal. Input, Automatic sync limiter and amp. $89.95 kit, $129.50 wired.</td>
<td>New Model 712 Sentinel 12 Dual Conversion 5-watt CB Transceiver. Permits 12-channel crystal-controlled transmit and receive, plus 23-channel tunable receive. Incorporates adjustable squelch &amp; noise limiter, &amp; switches for 3.5 watt P.A. use, spotting, &amp; Port 15 operation. Transistorized 12VDC &amp; 117VAC dual power supply. $99.95 wired only.</td>
<td>Model ST70 70-Watt Integrated Stereo Amplifier. Best buy of highest ranked stereo amplifiers according to independent testing. $99.95 kit, $149.95 wired. ST70 40-Watt Integrated Stereo Amplifier, $74.95 kit, $119.95 wired. ST70 Matching FM MPX Stereo Tuner, $89.95 kit; $139.95 wired.</td>
</tr>
</tbody>
</table>
| Model 324 RF Signal Generator, 150kc to 45Mc range. For IF RF alignment and signal tracing of TV, FM, AM, CB and mobile. Built-in and ext. modulation. $32.95 kit, $44.95 wired. | New Model 753 The one and only SSB/AM/CW Tri-Band Transceiver Kit. "The best ham transceiver buy for 1966"—Radio TV Experimenters Magazine. 200 watts PEP on 80, 40 and 20 meters. Receiver offset tuning, built-in VFO, high level dynamic AGC. Unequaled performance, features and appearance. Sensationally priced at $289.95 kit. $299.95 wired. | FREE 1966 CATALOG
EICO Electronic Instrument Co., Inc. 131-05 39th Ave., Flushing, N.Y. 11352
Send me FREE catalog describing the full EICO line of 200 best buys, and name of nearest dealer. I'm interested in:
☐ test equipment  ☐ ham radio  ☐ stereo/hi-fi  ☐ Citizens Band radio
Name ________________________________________
Address _______________________________________
City __________________ State ______ Zip _______

1945-1965: TWENTY YEARS OF LEADERSHIP IN CREATIVE ELECTRONICS

July, 1966
NEW PACE I SOLID STATE CB RADIO only $129.00

3.5 watt output. This new solid state 6-channel mobile CB transceiver delivers the most talk power you can get from a 5-watt transmitter—3.5 watts at 100% modulation.

Unique double conversion receiver—delivers outstanding mobile performance. Noise-limiting feature provides excellent reception of even weak, distant signals.

All silicon transistor design, plus lifetime guaranteed glass-fiber circuit boards, combine to offer unmatched reliability, minimum current drain, and smallest possible size.

Write for Bulletin Pace I, and the name of your nearest Pace dealer.

From the makers of the famous PACE 5000

PACE COMMUNICATIONS CORP.
24049 Frampton Ave., Harbor City, Calif. 90710
Telephone (213) 325-8444

...electronics in the news

Final Stage . . . Though ITT's orbit-seeking satellite guidance and propulsion package may look like a model of a big-city office building, it's destined to look down on the earth rather than be planted on it. Our photo shows a technician transporting a stand-mounted mock-up of the package whose solar cells look for all the world like the panes of No. 666 White Collar Row. Complete with satellite, the final-stage package will go into orbit after separating from a booster. Nestled under the aluminum-honeycomb skin of the high-flying unit will be two solid-fuel rocket engines capable of supplying enough oomph to orbit a 200-lb. payload.

Wee Washers . . . There's no getting around the fact that the transistor boosted the trend toward gnat-size components. Not to be outdone, many types of transformers took on a new space-saving form called a toroid. Part of the toroid's secret lies in its core, which gives these little doughnut-shaped wonders efficiencies, permeabilities, frequency ranges and Q-figures conventional transformers can't duplicate. The half dollar in our photo reveals how far the people at Pittsburgh, Pa.'s Arnold Engineering have been able to shrink their toroid cores.
The publicity, a gadget called the Robo-Pen was supposed to have the magic power of taking dictation from anyone who simply spoke to it. But EI’s sleuthing soon revealed that the Robo-Pen was less a pen of the present than of the future. Put together by the Parker Pen Co., the dictation-taking pen will be seen in a Stanley Kubrick film called 2001—a Space Odyssey, which will depict life as the film’s script writer imagines it will exist 35 years from now.

ITEMS...Part 15 License-Free Banders—mainly children whose parents have given them walkie-talkies—have increased at such a rapid rate in recent years that they well may qualify for a population explosion all their own. Anyone tuning the 26.97- to 27.27-mc Part 15 band readily understands why these operators remain a problem to the FCC. Interfering not only with each other but with TV reception as well, Part 15ers even have been cautioned officially to stop use of profanity. Should such warnings prove insufficient, the FCC is empowered to put offenders off the air.

Electronics, being the versatile hobby and industry that it is, now is tackling the job of providing the resident doctors at Los Angeles County General Hospital with a dummy patient. Unlike other manikins, the dummy will respond to ten different drugs, have a pulse and, at appropriate times, dilate its pupils, open its mouth, and even change color. The computer-controlled dummy—an anesthesiological training aid—is being developed with the cooperation of Aerojet-General Corp. by the University of Southern California under a grant from the Department of Health, Education and Welfare.

---

**LEARN ELECTRONICS**

**COYNE ELECTRONICS INSTITUTE**

- Electronics Engineering Technology — Degree (2 Yrs.)
- Electrical-Electronics Technician — Diploma (40 Wks.)
- TV-Radio-Electronics Technician — Diploma (40 Wks.)
- Combined Electronics Technician — Diploma (80 Wks.)
- Practical Electrical Maintenance — Diploma (32 Wks.)
- Practical Refrigeration Air Conditioning and Appliance Repair — Diploma (24 Wks.)
- Specialized Industrial Electronics — Diploma (16 Wks.)
- Introduction to Electricity-Electronics — Certificate (8 Wks.)
- FCC First Class Radiotelephone — Certificate (100 Hrs.)

Special finance plans. Part time employment service while in school. Also Free graduate employment service.

Use this coupon to get our FREE BOOK"YOUR OPPORTUNITIES IN ELECTRONICS"

COYNE ELECTRONICS INSTITUTE, Dept. of Electronics BS-A
1501 W. Congress Parkway, Chicago, Illinois 60607

Name ___________________________ Age ______
Address ___________________________ Phone ______
City ___________________________ Zone ______ State ______

1) I only want information on TV Home Study.

---

**EI Classified**

Starts on
Page 118

July, 1966
New, Easy Course—Now a new, easy course trains you at home, shows you professional methods for repair of all types of appliances, including farm and commercial—plus air conditioning and refrigeration—even small gas engines.

Amazing Profits—This amazing field offers amazing profits in spare time or good job opportunities. Enjoy profits soon with learn-as-you earn method.

Low Cost Training—Cost of training is unusually low and includes professional test equipment at no extra charge.

FREE BOOKS—Send for FREE illustrated book and Sample Lesson. No obligation and no salesman will call.

Appliance Division
National Radio Institute, 3939 Wisconsin Avenue
Washington, D.C. 20016
Please RUSH me free books on Professional Appliance Servicing.

NAME
ADDRESS
CITY _ STATE __ ZIP CODE

OLSON ELECTRONICS
INCORPORATED
476 S. Forge Street Akron, Ohio 44308

SNAP-LOADING . . . Shutter bugs lately have become acquainted with the advantages of loading cameras via a cartridge. Among the first portable tape recorders to incorporate this convenience, the Wollensak 4100 makes loading literally a snap. The solid-state 4100—weighing only 3 lb.—manages even to sport capstan drive. $99.95. 3M Co., 2501 Hudson Rd., St. Paul, Minn. 55119.

Newsy . . . Like a news hot line, the FM Alert receiver keeps hobbyists a hop, skip and jump ahead of newspapers and broadcast stations. The receiver's tuning range—30 to 50 or 152 to 174 mc, depending on model—is squarely in the middle of the action on fire, police and Civil Defense bands. $89.95, less speaker. Squires-Sanders, Inc., Martinsville Rd., Liberty Corner, Millington, N.J. 07946.
MARKETPLACE

Hybrid ... The Raven CB transceiver comes in a handsome black-leatherette cabinet that'll match most any automotive interior, and the rig offers something unusual on the technical side as well. Its circuit employs both vacuum tubes and transistors with a two-Nuvistor cascode front end that promises low-noise reception on all 23 channels. The receiver has a sensitivity of 0.2 \(\mu\)V for 10db of quieting; adjacent-channel interference is 80db down. Designed for mobile use, the glove-box-size Raven works off any 12-VDC source. $269. Browning Laboratories, Inc., 1269 Union Ave., Laconia, N.H. 03246.

Versatile ... A portable receiver that doubles as a navigational aid, the Pilot II runs off internal batteries, external dry cells, regular house current and even an optional solar pack while it tunes aircraft, marine, police and weather broadcasts in addition to the standard BCB. A rotating antenna and null meter make it easy to obtain bearings from most any signal source. $129.95. Nova-Tech, Inc., 1721 Sepulveda Blvd., Manhattan Beach, Calif. 90266.

There's GOOD NEWS Today!
PRICES REDUCED on the famous
MARK TEN SCR IGNITION SYSTEM

Factory Assembled

ONLY $44.95 ppd.

OR IN EASY-TO-ASSEMBLE DELTAKIT ONLY $29.95 ppd.

Here's why DELTA offers you these unparalleled savings!

"First SCR Ignition System in mass production." Now Delta — the ORIGINAL manufacturer and the largest — offers this price reduction due to high production levels. Thousands have purchased and installed our remarkable automotive system. We at Delta can now pass along our lowered manufacturing costs to you — with extra savings in addition to the Excise Tax reduction effective January 1st! Save on gas. Increase the life of your points and plugs. Dramatically improve your car's acceleration and general performance. Buy the ORIGINAL, and for less! ORDER TODAY!

DELTA PRODUCTS, INC.  
P.O. Box 1147 PM, Grand Junction, Colo. 81501

Enclosed is $_.  
Ship prepaid. □ Ship C.O.D.
Please send: □ Mark Ten (Assembled) $49.95  
□ Mark Ten (Delta Kit) $29.95
SPECIFY □ Positive □ Negative □ 6 or □ 12 Volt Ground Ground
Car Year. __________________________ Make
Name. ________________________________
Address. ________________________________
City, State ______ Zip ____________

DPT 6-1

July, 1966
A "LONG RANGER"

The SHAKESPEARE fiberglass WONDERSHAFT offers:

- protection from weather a salt water area must
- durable construction takes high winds with ease
- low background noise
- insulated conductor

The BIG STICK 176 is an excellent CB 18'6" — 27.1 mc fiberglass WONDERSHAFT antenna... all direction coverage... minimum of dead spots... no ground radials... independent of mounting location.

See your favorite dealer or write Columbia Sales Office, C/P CORPORATION a subsidiary of the Shakespeare COMPANY RFD 3 • COLUMBIA, S. C. TELEPHONE 787-8710 area code 803

MARKETPLACE

Convertible... Most unique feature of the SX-146 is the way it can be changed from an amateur-band receiver to a general-coverage rig. Addition of auxiliary oscillators converts the normally-ham-band-only SX-146 to a communications receiver tuning all the way from 3.4 to 30 mc, save for a small gap at 9 mc. Other features of the 9-tube, single-conversion SX-146 include a calibrator, switchable automatic noise limiter and a pre-selector. Outputs for headphones and an external 3.2-ohm speaker have been provided, as have crystals for the 80- through 10-meter amateur bands. $269.95. Hallcrafters Co., 5th and Kostner Aves., Chicago, Ill. 60624.

Regulated and S-Metered... An AC power supply for a CB rig seems a strange place to find an S-meter, but the people who make the Master power supply put it there, anyway. Purpose is to enable owners of the company's 23er and SSS CB transceivers to operate these normally S-meter-less mobile rigs at the base. The unit's heavy-duty transformer, solid-state rectifier and regulator components supply 13.8 VDC; voltage variations are held to within ±0.2 V even though input voltage ranges from 105 to 125 VAC. $39.50. Squires-Sanders, Inc., Martinsville Rd., Liberty Corner, Millington, N.J. 07946.

Electronics Illustrated
Choose Your Tailor-Made Course in N.T.S. "PROJECT METHOD" ELECTRONICS!

Now! N.T.S. — one of America's oldest leading home-study and resident technical schools — offers you GREATER CAREER OPPORTUNITIES IN ELECTRONICS. N.T.S. "Project Method" home training lessons are shop-tested in the Resident School in Los Angeles. The Schools' practical methods, plus more than 60 years of experience, have helped thousands of students all over the world to successful careers. Choose your field and prepare now for a secure future with one of 8 N.T.S. Electronics Courses designed to fit your own particular needs.

1. ELECTRONICS-TV-RADIO-SERVICING & COMMUNICATIONS
A basic course thoroughly covering fundamentals of electronics, radio, TV servicing and communications.

2. MASTER COURSE IN ELECTRONICS-TV-RADIO, PLUS ADVANCED TV & INDUSTRIAL ELECTRONICS
This course covers everything included in Course No. 1 plus Automation and every phase of the Electronics industry.

3. FCC LICENSE
Preparation for this government license essential for interesting jobs in radar, radio, television, communications, guided missiles, many others. Upon completion of this course, if you do not pass the FCC exam for a 1st Class Commercial Radiotelephone License your tuition will be refunded.

4. RADIO SERVING (AM-FM-Transistors)
Train for radio sales and service with dealer or distributor.

5. TELEVISION SERVICING (Including Color)
Covers installation, adjustment, repair and servicing of black and white and color television... prepares you for your own sales and service business.

6. STEREO, HI-FI AND SOUND SYSTEMS
A growing field. Prepares you to build, install and service modern sound equipment for home or industry.

7. BASIC ELECTRONICS
Gives you the fundamentals you must know to build on for a future Electronics career. Also offers an excellent background for Salesmen, Purchasing Agents, and others in Electronics.

8. ELECTRONICS MATH
Simple easy-to-follow instructions in the specialized math you need in many electronics jobs.

CUT OUT & MAIL TODAY. NO POSTAGE NECESSARY.

Please Rush FREE Electronics "Opportunity Book" and sample lesson on course checked below:

☐ Electronics-TV-Radio Servicing & Communications
☐ Master Course in Electronics-TV-Radio Advanced TV & Industrial Electronics
☐ FCC License
☐ Radio Servicing (AM-FM-Transistors)

☐ Television Servicing (Including Color)
☐ Stereo, Hi-Fi and Sound Systems
☐ Basic Electronics
☐ Electronics Math

Dept. 213-66

Name __________________________ Age __________
Address _________________________
City ____________________________
State __________ Zip ___________

☐ Check here if interested ONLY in Classroom training at L.A.
☐ Check here if interested in High School Department Catalog only.

Sample Lesson

SEND POSTCARD TODAY FOR FREE BOOK & SAMPLE LESSON.

NATIONAL TECHNICAL SCHOOLS

WORLD WIDE TRAINING SINCE 1905

www.americanradiohistory.com
You can install and maintain electronic circuitry in missiles and rockets, specialize in microwaves, radar, and sonar, or succeed in your own business.

Most courses include Equipment Kits. THERE ARE NO KIT DEPOSITS. Everything included in your low tuition.

CLIP & MAIL POSTAGE FREE CARD TODAY FOR FREE BOOK AND SAMPLE LESSON in Field of Your Choice. You enroll by mail under N.T.S. "No Obligation" Plan. We have No Salesmen; This means lower tuition for you.

BUSINESS REPLY MAIL
No Postage Stamp Necessary If Mailed in the United States

—POSTAGE WILL BE PAID BY—

NATIONAL TECHNICAL SCHOOLS
WORLD-WIDE TRAINING SINCE 1905

4000 South Figueroa Street
Los Angeles, California 90037

TAKE THE QUICK WAY TO HIGHER PAY, LIFELONG BENEFITS, WITH N.T.S. HOME TRAINING!

N.T.S. "Project Method" Courses can help you get a new and better job — or move up to higher pay in your present job. You work on practical job projects, learn to use shop manuals and schematics. Your N.T.S. training is individual. You proceed at your own pace.

BENEFIT NOW AND ALL YOUR LIFE WITH N.T.S. HOME TRAINING

The personal guidance you receive during your training can be very helpful to your progress. Many N.T.S. students are able to earn more money within a few months. You can pick and choose your career. Work in industry or go into business for yourself. Your services will always be in demand wherever you go — and you can pick your spot!

N.T.S. Graduate Advisory Service can help you answer technical questions in establishing your own business and in countless other ways after you've completed your training.
Compact . . . When it comes to CB jamborees and the like, people just don't respond to tonsils alone the way they do when a public-address amplifier helps with the talking. The PA-625, a compact and mobile PA amplifier, lets bystanders know without a doubt that the man with the mike has something to say. This 4-lb., 25-watt solid-stater works on 6 or 12 VDC (positive or negative ground) and drives 4-, 8- or 16-ohm speakers. Price is $59.95. Lafayette Radio Electronics Corp., 111 Jericho Tpke., Syosset, N.Y. 11791.

Toneful . . . Even if an opera star volunteered to help check an audio amplifier by singing a crystal-shattering note into a microphone, the effort would be a waste of breath. A test instrument such as the EICO 378 audio generator sings a mite better tune in this case. The 378—with a wider range than a soprano and a basso profundo combined and an almost limitless capacity for holding unwavering notes—provides 100 frequencies between 1 cps and 100 kc. $49.95, kit; $69.95, factory-wired. EICO, Inc., 131-01 39th Ave., Flushing, N.Y. 11352.

July, 1966

[Continued on page 20]


STereo AMPLIFIER, turntable, other items. Will swap for 50-cc motorcycle and Army mine detector. Frank Kotl, 2235 S. Spaulding Ave., Chicago, Ill. 60623.

ADMIRAL record changer. Will exchange for tuner and/or speaker in enclosure. M. Nytransky, 22-14 23rd St., Astoria, N.Y. 11105.

WEBCOR 56-1 record changer, RCA headphones, other items. Interested in stereo, test and CB equipment. Kim L. Ground, 1620 Jefferson Blvd., Hagerstown, Md. 21741.

HALLICRAFTERS S-44 receiver. Will trade for 12-V CB rig or binoculars. James Shoemaker, 625 E. Vance St., Laurnburg, N.C.

TUBES, vibrators. Want ham gear. J.L. Jacobs, 2068 S. Kennison Dr., Toledo 9, Ohio.

HALLICRAFTERS HT-40 transmitter. Want saxophone or 8-mm movie camera. Bill Beveridge, 930 Evergreen, Amarillo, Tex. 79107.


KNIGHT Space Spanner, CPO Harris key. Will swap for anything of equal value. Ronald Hayes, Rte. 2, Grant, Ala. 35747.


REGENCY UHF converter, AIWA tape recorder. Will trade for FM tuner or SW receiver. J.D. Linton, G-1402 W. Downey Ave., Flint, Mich. 48505.

ATWATER KENT model 40. Need test equipment. Harald Mynster, WN6PDS, 2208 Beachwood Dr., Ceres, Calif. 95307.

KENNETH receivers and back-issue electronics magazines. Will exchange for DX bulletins and electronics magazines. Don Erickson, 24360 Myers St., Sunnymead, Calif. 92388.

WEBCOR wire recorder. Need disc recorder. Martin Balk, WB2SZW, 353 Webster Dr., New Milford, N.J.

TRIPLETT 310 VOM, walkie-talkie, other items. Interested in 2-meter transceiver and ham gear. Steve Morgan, 2415 Suffolk Ct., Dayton, Ohio 45420.


KNIGHT Space Spanner, Royal typewriter. Want ham equipment. Steve Holmberg, 5700 York Ave., Edina, Minn. 55410.

HEWLETT-PACKARD 2020 low-frequency oscillator. Will swap for Knight R100A or HQ-100AC. John Harding, 24 Bertram St., Beverly, Mass. 01915.


HALLICRAFTERS R-47 speaker. Will trade for head geons. George E. Matthews, 1304 Shannon Dr., Wadesboro, N.C. 28170.


GENERAL MC-6 CB transceiver. Will exchange for ham receiver. Robert Manson, 17 Summer St., Dover Foxcroft, Me.
Continued from page 19

DECCA record player, chemistry equipment. Will trade for VHF receiver and ground plane antenna. P. Hicks, 11565 Richmond, Loma Linda, Calif. TSW-32x receiver, Dial-All CB transceiver or ham transmitter. Richard Adams, 2906 Poole Rd., Raleigh, N.C. 27610.

AMIFADOR, TV rabbit ears. Need schematic for 11-tube, 550-kc to 16.5-m E.H. Scott receiver. Marion Faris, Peconic Trailer Park, Box B-3, Riverhead, N.Y. 11901.


JAYFAIR tape recorder, Lionel train set. Will swap for Novice 2-meter equipment. Steve Fetter, WN8-QBW, 378 Moul St., Newark, Ohio, 43055.

KNIGHT X-10 crystal calibrator. Want 2-meter converter. Dick Lochowitz, 2165 Fairhaven Blvd., Elm Grove, Wis. 53122.


GE AC/DC will exchange for Heath CB-1 transceiver. Richard Beatie, 1904 E. 114th Ave., Tampa, Fla., 33612.


PE-73 24-V dynamotor, other items. Interested in SW receiver. Gregory Peacock, WA6UX, 3082 Lake Hollywood Dr., Los Angeles, Calif. 90028.

ELECTRONICS COURSE. Will trade for walkie-talkie. Edward T. Zebrowski, 159 Walnut St., Holyoke, Mass. 01041.


NOVICE transmitter. Will swap for SW receiver. Ralph Trace, 4 Fox Ridge Lane, Avon, Conn. 06001.


RADIO is looking for Heath CB-1 transceiver. Arthur Castrup Jr., Rte. 2, Buxtontown, Ind. 47542.


COMMUNICATIONS will swap for C-555 walkie-talkie. Gary Bennett, 1014 Pemberton Dr., Fort Wayne, Ind. 46805.

HALLICRAFTERS-S-120 receiver, TX-8 transceiver. Want for anything of equal value. Abraham Lung, 823 E. 147 St., Bronx, N.Y. 10455.


KNIGHT Span Master, other items. Will swap for VHF receiver. Gary S. Lescota, 72 7th Ave., Newark, N.J. 07104.


SIEMENS R/C receiver or VHF gear. Will swap for GE or Motorola VHF equipment. Paul Brazil, 77 Fairfield Ave., Norwalk, Conn. 06854.

STAEK'S boat transceiver with accessories. Want test equipment. Clayton L. Philbrook, Malinicus, Me. 04851.

RF AMPLIFIER. AP-12 transceiver/receiver. Will trade for CB, test or ham gear. William B. Dopp, Giasco, Kan.

RF AMPLIFIER components including 100THs, coil caps, capacitors. Will trade for BC-15, Elpelly Line, 2945 Euclid Heights Blvd., Cleveland Heights, Ohio 44118.

HALLICRAFTERS-S-38 receiver, CB gear, other items. Need 2-speed tape recorder, aircraft radios. C. Bechtel, Box 813, Crystal River, Fla.


POLAROID 150 camera, accessories. Want 15-watt amplifier, speaker, stereo/FM tuner, test changer. Harry Gurs, 2923 W. 5th St., Bloomington, Ind. 47404.

WALKIE-TALKIES, transistor tape recorder. Will swap for Novice transmitter. Sam Greb, Box 976, Frederick, Okla. 73542.


TUBES, walkie-talkies, other items. Want CB rig. Bob Francis, Lincoln St., Duxbury, Mass. 02332.

CAR RADIOS, CB receivers, other items. Will exchange for test equipment or SW receiver. Steve Taylor, 4034 Proctor, Flint, Mich. 48504.

CAR RADIOS, Model-T ignition coil. Will exchange for test equipment. Thomas Mayfield, Box 446, Yarnell, Ariz. 85362.

HALLICRAFTERS CB-3A. Will swap for NC-121 receiver. Bill Mahaffey, Rte. 2, Ennis, Tex.

TELESCOPE. Will swap for anything of equal value. David Chamberlin, 1215 Stratford Ave., Nashville, Tenn. 37216.


RCA 17-in. portable TV, Need tape recorder, 8-mm movie projector, FM tuner, other items. Dave DeMaw, 16 Prospect St., Meriden, Conn. 06450.

LAFAYETTE KT-320 receiver, HE-48 speaker. Want Knight T-150A. David Weintrant, WRBSC, 29 Wyman Ave., Huntington Station, N.Y. 11746.


RCA-225 tape recorder. Want 2-meter value. David Cetel, 1208 60th St., Bayside, N.Y. 11361.

GENIAC, Heath 1201 Transceiver. Will trade for anything of equal value. Kenneth Adams, 2935 S. Highland Ave., Dallas, Tex. 75216.


HALLICRAFTERS-S-119. Want Heath GR-64. Steven Thibodeau, 20 Wyndemere Rd., Bloomfield, Conn. 06002.

HALLICRAFTERS HT-17 transmitter. Will exchange for 6-meter transceiver. Gary Albeck, 12 Dey St., Danville, Pa. 17322.


KNIGHT R-100 transmitter, Heath DX-60. Want ARC-5 transmitters, CB walkie-talkies or other gear. Brad West, 1208 S. Garner St., State College, Pa. 16801.

SURPLUS transmitter, Watson 20M or equal value. Robert B. Copeland, 3800 E. 9th St., Dayton, Ohio.


REGENCY MR-33 receiver. Want HALLICRAFTERS-S-118. S-120 or tape receiver. Steve Smay, 2829 W. 60th St., Des Moines, Iowa.

FISHER 80C master audio control and 80AZ amplifier. Will exchange for Heath TW-7. Frank S. Nock, 5430 14th St., Hialeah, Fla. 33012.

PHILCO portable TV. Westinghouse hi-fi record player. Will swap for all-channel CB transceiver.

[Continued on page 23]
Hallicrafters' new CB-19 transceiver is about as sleek and trim and compact as an infantry boot.

That's why there's room for the "S" meter, the receiver tuning VFO, the king-size communications speaker and unsurpassed basic performance— for only $149.95

- 8 crystal-controlled channels. 23-channel receiver tuning with frequency spotting switch.
- Built-in, amateur-type "S" meter. All-electronic push-to-talk circuitry. Dual conversion, superheterodyne receiver. Superior sensitivity—less than 1 microvolt for 10 db S/N.
- Hallicrafters' exclusive "Racket Buster" built-in noise limiter.

Hallicrafters
5th and Kostner Aves.
Chicago, Ill. 60624


"Quality through Craftsmanship"

July, 1966
BREAKTHROUGH...

TALK RIGHT THROUGH SKIP AND NOISE INTERFERENCE WITH THE NEW JOHNSON MESSENGER “350” SINGLE SIDEBAND CB TRANSCEIVER.

The Strategic Air Command, U.S. Signal Corps and overseas telephone companies pioneered single sideband because they required dependable, long range communications, particularly when operating conditions were at their worst. They proved that single sideband penetrated jumbled skip signals, atmospheric noise and other interference with clean, sharp clarity.

Now this “talk power” is yours for CB communication with the new Johnson Messenger “350” single sideband transceiver. The Messenger “350” will give you up to 30% more range than ordinary CB communication. Under severe skip and noise conditions, the “350” can deliver up to 3 times the range previously possible. Maximum legal power input with single sideband provides output equivalent to 3 times ordinary AM talk power.

Johnson engineering superiority gives you these features in the Messenger “350”: Automatic level control that lets you talk as loudly as you like without exceeding legal power limits—and with no speech clipping • Adjacent channel interference virtually eliminated • Crystal stability of .001% • 3-watt audio output on receive or P.A. • Dependable operation from −20° to +140° F.

• Solid state circuitry throughout—no tubes, no mechanical relays • Optional plug-in AC power supply for base operation • Optional Power Pack for high-power, hand carried field operation.

All these and more are yours when you move up to single sideband with the Johnson Messenger “350”. Ask your authorized Johnson Dealer to demonstrate it today!

E. F. JOHNSON COMPANY
® 6521 10TH AVENUE S. W., WASECA, MINNESOTA 56093

Write for your FREE booklet
WHY SINGLE SIDEBAND?
Ron Leibbach, 2506 W. Hamilton Ave., Tampa, Fla. CAI receiver. Will swap for CB rig, 6-meter converter, ham equipment. Finis Gream, WA9PVN, Box 144, Bluford, Ill. 62814.


THREE-ELEMENT BEAM for 10, 15 and 20 meters. Will trade for oscilloscope. Larry Sala, Box 801, Redmond, Ore.

WIRE-RECORDER and record-player combination. Will exchange for SW 30- to 50-mc receiver or type-writer. R. J. Monson, Rte. 1, Box 484, Lancaster, Va.


TRITRONIC RX-127 Rangexpander, Knight 10-2 tester. Will swap for tape recorder or battery eliminator. Larry Rathborn, 22 W. Main St., Alexandria, Ohio. 43001.

HALLICRAFTERS S-38E receiver. Will exchange for 6-meter receiver or power-meter. Chuck Massie, 35 Sherwin Dr., Syracuse, N.Y. 13219.


B&O 53 ribbon mike. Will exchange for Winegard AP-375 FM booster and fittings. Bill McQueen, 1419 S. 14th St., Lafayette, Ind. 47901.

GE analog computer. RCA 45-rpm changer. Will swap for anything of equal value. Lee Pollack, 5054 Culver St., Ill. 60077.


JVC color TV and Ham Transmitter and Knight Ocean Hopper. Will swap for Globe DSB-100. Richard Stark, K7BN, 419 Russell Dr., Billings, Mont. 59102.


EMERSON 560 portable radio, model train transmitter, headphones. Will exchange for CB transceiver or walkie-talkie. Howard Lehrman, 113 Berced St., Brentwood, N.Y.


HALLICRAFTERS S-72 four-band portable receiver. EMC transmitter, DM-288 dynamotor. AM/FM or SW receiver. Thomas A. Berry, Box 338, Lot 38, Niceville, Fla. 32578.


HALLICRAFTERS S-38C receiver, 7 x 50 binoculars. Will trade for 2-meter transceiver. Alan Spitz, 99 Gregory Ave., Passaic, N.J.


TWO-METER, 120-watt transmitter. Will swap for Heath Apache transceiver, 2-meter transceiver or other ham equipment. Robert Bean, Box 541, Wilton, Me. 04294.


ARGUS C-3 camera. Will exchange for communications receiver. John O. Hehn, 378 Main St., Little Falls, N.J.

WALL TELEPHONE. Will swap for SW receiver. Voy A. Murphy, 133 Winston Dr., Williamsburg, Va. 23185.


WRL SB-175 transmitter, HG-10 VFO, power supply. Will trade for anything of equal value. James D. Doyle, 1403 Woodridge Circle, Hurst, Tex. 76053.

REGENCY ATC-1 SW converter. Stan Putra, 1429 Lawndale, Racine, Wis. 53406.

DRAFTING EQUIPMENT and drafting course. Will exchange for oscilloscope or other test equipment. Larry Griffith, 3010 Lillie St. 95508, Lafayette, Calif.


FEDERAL enlarger, other photo equipment. Want oscilloscope, VTVM or other test gear. Bill Lee, 218 Sergeant, Joan, Mo. 64801.

MERIT 1,000-V plate transformer, 811A transmitting tube. Want GE x4 and X1 SCRs, 2N2160 and other semi-conductors. Ron Sparks, 2472 A&M Ave., San Angelo, Tex. 76903.

Q-MULTIPLIER. Will exchange for 100-mw walkie-talkies or preselector. Richard Hardt, 8016 Taft St., Crown Pt., Ind. 46307.

BCB radios and tubes. Want Novice transmitter. Larry Horne, Rte. 1, Box 281, Clegg 99er, Ariz. 85006.


HAMMARLUND HQ-129X receiver, Heath OF-1 Q-multiplexer. Want Heath HW-12 transceiver. Bob Johnson, Box 2133, Southern Station, Hattiesburg, Miss.

ALLEN-DUMONT oscillograph. Will trade for ham gear. Lane Robinson, Box 37, Bastrop, Tex. 78602.

KNIGHT Ocean Hopper. Will swap for 35-mm camera, Craig TR-404 tape recorder or 7 x 35 binoculars. David Barlow, Rte. 8, Box 5, Radio Roke, Va. 22315, Ga.

GE portable TV. Will trade for walkie-talkies. R.L. Wilkes, Rte. 2, Campbell River, B.C.

HALLICRAFTERS SX-99 receiver. Globe Scout 680 transmitter, other items. Will exchange for SW receiver or other SW or VHF equipment. Bruce Hildebrand, 6090 Upland Terr., Seattle, Wash. 98118.


KNIGHT T-60 transmitter, Heath VF-1 VFO. Will trade for Health Twoer with DC-959B or other SW or VHF equipment. Bruce Hildebrand, 6090 Upland Terr., Seattle, Wash. 98118.

KNIGHT Span Master receiver, KN-4515 desk mike Want CB transceiver or test equipment. John Paida.

[Continued on page 24]
ZAP! Sure, I want to take advantage of your special money-saving offer. Enter my subscription bill! wow! right now!

☐ I enclose $3.98  ☐ New order
☐ Bill me later  ☐ Renewal

NAME

ADDRESS

CITY   STATE   ZIP

HOLY HEAT SINK!

You can get 10 issues of EI for only $3.98!

(How about that?)

ELECTRONICS ILLUSTRATED
Circulation Department
Fawcett Building
Greenwich, Connecticut 06830

ZIP! ZAP! ZAP! ZAP! says the Electronics Illustrated Swappin' Shop. The special money-saving offer is still in effect. Enter your subscription bill now and receive 10 issues of EI for only $3.98. Offer valid through next month. Don't miss out on this incredible deal! Enter your subscription information now.

2840 S. Kenneth Ave., Chicago, Ill. 60623


HEATH CB transmitter. Want Heath Tweoer. Roger Atwell, WINCY, Rte. 4, Box 500, Everett, Wash. 


HALLICRAFTERS S-36C. Will swap for ham gear. Roger L. James, Rte. 1, Centertown, Ky. 42328.

JOHNSON Messenger I II. Will exchange for ribbon mike. Thomas Zoss, 1319 E. Washington Ave., South Bend, Ind. 46617.

HAM receivers (40 & 80 meters). Will trade for CB transceiver or a pair of walkie-talkies. Bob Chapelle, 222 Columbia Ave., Meadville, Pa. 16335.

HALLICRAFTERS S-388, Binolux binoculars. Will swap for other communications receiver. Stephen Falk, WB2UFN, 178-01 65th Ave., Flushing, N.Y. 11365. LYSCO VFO, 4-65 transmitting tube. Will exchange for 80- or 40-meter receiver. Roy D. Lincoln, WA4DOUJ4, 602 Southard St., Key West, Fla. 33040.

SURPLUS BC-342 receiver. Want CB or ham transceiver. John L. Chaplin, Jr., K3TWJO, 3161 S. Yale St., Wichita, Kan. 67210.


SURPLUS test and ham equipment. Want Heath CB and ham gear. Stan Kasper, 1742 Petersburg Rd., Burlington, Ky. 41005.

DEUTRONICS transistorized crystal calibrator, assorted tubes. Want transistorized tape recorder. Francis Merat, Frenchainville, Pa. 16836.

LAFAYETTE HE-90 CB transceiver, Drake low-pass filter. Will exchange for Heath DX-60A or other ham transmitter. Mitchell Weinberger, 4 Stuyvesant Oval, New York, N.Y. 10009.

KAY K-102 electric guitar. Want Mosley CM-1 or SW receiver. Sam Champie, Box 73, Slidell, Tex. 76267.


Hi-Fi equipment. Need SW receiver. J.V. Fulda, 5623 Clearspring Rd., Baltimore, Md. 21212.

SAM'S PHOTOFACTS (180 sets). Will swap for anything of equal value. Ben L. Seebinger, 1510 Rose St., Irving, Tex. 75060.

TAPE RECORDER, transistor radio, other items. Want Knight or Lafayette aircraft-band receiver. Ronnie Dixon, Rte. 1, Box 110, Houston, Mo. 65483.

PHILCO SW/BC receiver (1930 model), old tubes. Want Heath novice gear, 2- or 6-meter beam. Bill Sorsby, 1443 Springdale Dr., Jackson, Miss. 32911.


SIVERTONE tape recorder. Will exchange for signal generator, grid dip oscillator or other test equipment. Don Cohen, 2513 Bolch, Shreveport, La. 71104.

NATIONAL NC-77X, Ameco AC-1 transmitter. Will trade for 2- and 6-meter equipment. T. Stone, WB6OJA, 3017 Future St., Los Angeles, Calif. 90045.


Electronics Illustrated
Many hi-fi buffs have need of a piece of furniture to store prized audio gear more attractively, and plans for a professional-looking wall shelf designed specifically for this purpose now can be had. For your copy, write Acoustic Research, Inc., 24 Thorndike St., Cambridge, Mass. 02141.

A 24-page booklet called What You Should Know About Laser Safety qualifies as must reading for any hobbyist interested in laser experimentation. Prepared by a company engaged in laser research, the pamphlet can be obtained by writing Martin Co., Orlando Div., Box 5837, Orlando, Fla. 32805.

The 28-page Encyclopedia of Connectors enables any electronics hobbyist in search of an electrical connector to find most any one he needs from among the hundreds of available styles and types. The catalog explains how connectors can be selected from a stock of six brands through one easy-to-use and fully explained code number. A copy can be yours on request from Spacecraft Components Corp., 14137 Chadron Ave., Hawthorne, Calif. 90250.

Before the tape buff knows it, gadgets like tape editors, splicers and connectors become necessary to get the most from a tape recorder and keep track of who and what are on which reel. Rounding up this gear can be a bit of a chore but catalog 659C makes it easy by presenting only accessories of particular interest to audiophiles. For your free copy, write Robins Industries Corp., Consumer Products Div., Flushing, N.Y. 11356.

Professional Electronic Projects—a catalog of enough plans and kit-style projects to burn up half a dozen soldering irons—should be of value to most hobbyists. Among the 165 projects included in this ninth edition are such novelties as an auto skid warning device and a smoke detector. Copies are available for 25¢ from Henry Francis Parks Laboratory, Box 1665, Seattle, Wash. 98125.

The National Aeronautics and Space Administration now makes available a booklet describing design and construction of a device called an electromagnetic hammer. The report, numbered NASA SP-5034, may be obtained by sending your request and 25¢ to the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. 

July, 1966
I've developed an interesting idea which I think has commercial value. It's similar to a home tape playback machine, except it uses optical sound track recordings on motion-picture film instead of magnetized tape. I find that it offers better fidelity than regular tape, it can't be erased accidentally and the playback machine is no more complicated than a tape deck. How do I go about presenting my idea to a manufacturer?

Terence Donlevy
Boston, Mass.

Sounds like you've got a worthwhile idea there, Terry. Hope you've got it patented because (in case you haven't noticed) we just presented it to the world.

Here's a project for you to work on. I'm trying to find a device that will receive a radio frequency signal and re-emit it in the audible range.

John Russell
San Jose, Calif.

What's wrong with a radio?

I sometimes wonder if you give wise-mouth answers to questions because you don't know the proper answer and are only trying to get yourself off the hook.

Arleigh Weldon

Gives you something to think about, doesn't it?

License Plate Dept. I say shame on the state of New Jersey for being the only state still refusing to issue license plates bearing ham radio calls. Knowing a vehicle is owned by a ham operator has proven of value in many emergencies, and issuance of the plates also has become a way of saying thanks to hams for volunteering their equipment and services in the public interest. Most recent states to give out the plates were long-time hold-outs Massachusetts and New York; anyone know any way to pull the Garden State into line?

I play a guitar in a small band and I'm trying to get a certain sound out of my amplifier. I'm looking for a fuzzy sound from the speaker to make my guitar sound like a saxophone. I heard this sound on Phil Baugh's One Man Band record, so I know it can be done.

Richard Bambenek
Winona, Minn.

Try sax lessons.

Thinking back, it seems to me I've been reading your articles for about ten years now. After spending all this time on your efforts, I don't feel that I know any more about electronics now than I did ten years ago.

Hank Paul
Tulsa, Okla.

That makes two of us.

I am interested in what would be the best device to use in a home to prevent radiotelephone operators from attempting to carry on a conversation with people while they are asleep.

H. K.
Seattle, Wash.

Get an unlisted head.
★ Perhaps you can help me locate a station I have been hearing on the short-wave bands. Judging from its call-sign I've really nailed a rare one. Only problem is that it isn't listed anywhere and the prefix is supposed to belong to the United Nations. My rare station 4UY26 heard on 16200 kc with CW transmissions. They pack a strong signal.

Harlan Singleton
Babylon, N.Y.

I would think that they not only would pack a wild signal but also likely lift the headset off you, seeing that the station is only a few miles away from you in Centeral, N.Y. They operate on 16232 kc with 6,000 watts, beamed to Geneva, Switzerland. Don't let the weirdo call-sign fool you—these UN stations are all over the place.

★ During the recent flying saucer scare, I was listening to a supersonic receiver at 71 kc. I heard some queer noises and something that sounded like people talking, only backwards. Can you explain this?

L. S.
Los Angeles, Calif.

I was waiting for someone to write to me about flying saucers. They are nothing more than humbug and people that see, talk to, hear, smell or sense them are a few steps away from the funny farm. If anybody can prove to me that these things actually exist, I'll send a bottle of Jack Daniel's along with my retraction.

★ My car is a 1960 Ford and I'm being radio-noised to death, both in my transistor broadcast receiver and in my CB rig. As soon as the engine starts up the racket is fierce. Everyone says that Fords are notorious for this. Any suggestions, O great white father?

Sonny Jensen
St. Cloud, Minn.

Start at the voltage regulator. Connect a 10-ohm, 1-watt resistor from the field terminal to ground. This might end your problems. If not, install a 500μF, 12-volt electrolytic capacitor between the generator's output terminal and ground (the negative lead of the capacitor goes to ground). Stay clear of those clip-on spark-plug noise suppressors. I always found that they cut down on engine performance. After listening to some of the trash being palmed off as music and some of the antics on CB, I personally feel the static might be a welcome relief.

July, 1966
Plain Talk from Kodak about tape:

Giving your tape library
a longer prime of life

How long can you keep a recorded tape? As of today, nobody knows for sure. Recording companies have tapes dating back to the late 1940s that are still in fine shape. Actually, the aging problem for tape is somewhat akin to the ones faced by movie-makers. Their problems are tougher, though... movie-makers have to worry about latent chemical reactions, greater mechanical strains, etc. And yet, we can see movies made more than a half century ago if the films have been given proper care and expert duping. Like photographic films, many audio tapes are made on acetate base. Ours is Kodak’s famous DUROL Base, the stronger, tougher triacetate (we also make KODAK Tapes with a tempered polyester base for extra toughness or for long-play applications). Lab tests show that DUROL Base holds up as well as photographic film. So... tape wise, there’s no reason your great grandchildren won’t be able to enjoy your present efforts.

T.L.C. makes the big difference.
Tender loving care is a must when saving anything worthwhile. The same goes for tapes. One obvious safeguard is to keep tapes away from strong magnetic sources like large electric motors or transformers which could demagnetize a recording.

Keep it clean.
Tapes hate dirt just as much as regular records do. Thanks to sturdy, one-piece construction, Kodak’s new “library décor” box helps keep dirt out... won’t fall apart over the years as conventional tape boxes sometimes do. And this new box looks better. Play it clean too, of course. Clean your recorder heads, caps, rollers and guides regularly with a cotton swab moistened with one of the commercial cleaners sold for that purpose. Use a degausser periodically to remove any magnetization of recording heads.

Keep it cool.
Tapes should be kept away from extremes of temperature and humidity. High temperatures may affect the plastic support and increase the possibility of print-through... the transfer of magnetic signals from one layer of tape to the next.

Keep it “backwards”.
For truly valuable recordings, a good trick is to keep your tapes in the “tails out” format rather than rewinding them. The uneven winding induced in the tape by fast rewinding can cause physical warping of the tape over a period of time. Here too, you’re better off with KODAK Tapes because KODAK 5" and 7" Thread Easy Reels are of dynamically balanced, one-piece construction. This gives you freedom from wobbles and pulsations on both “record” and “rewind”... keeps the tape under smoother tension... just what the doctor ordered for long tape life. The need for smooth winding can not be overemphasized.

Last but not least, it’s a good idea to dupe your really old tape recordings onto fresh KODAK Tape in order to standardize on KODAK Tape quality. That’s an interesting subject all by itself, and we’ll try to devote a “Plain Talk” to it soon! KODAK Tapes on DUROL and polyester bases are available at electronic, camera and department stores. To get the most out of your tape system, send for free 24-page “Plain Talk” booklet which covers the major aspects of tape performance. Write Department 940, Eastman Kodak Company, Rochester, N. Y. 14650.

EASTMAN KODAK COMPANY, Rochester, N. Y.
1-Transistor
Short-Wave Converter

Now you can DX the world’s short-wave stations on any broadcast radio!

“COME up and see me sometime,” Mae West once said. Thanks loads, Mae, but that invitation’s so old it has a beard. Besides, our Japanese, Swedish and Spanish girl friends have given us a more modern challenge—to DX them. We’ve taken them up on it and found it much more fun—and stimulating, too.

And our gals have lots of friends in other countries who also keep asking us to DX them. Doubt it? Then build EI’s one-transistor short-wave converter and find out for yourself. You’ll be surprised at the number of female announcers there are on the air. And each one sounds more intriguing than the next.

EI’s converter turns any broadcast radio into a short-wave receiver so you can tune from 5 to 15 mc—the most-popular short-wave frequencies. And you don’t have to make connections or modifications to the radio since the converter radiates its output signal to the BCB radio. The converter includes a band-spread capacitor that opens up those crowded short-wave bands. A 9-V battery supplies power.

By
CHARLES GREEN
W3IKH
1-Transistor Short-Wave Converter

Construction

The converter can be housed in either a wooden cabinet or a commercially-made Bakelite box. The 8½ x 5¾ x 2½-in. cabinet shown on the first page of this article is made of ¼-in.-thick walnut veneer. The tuning (C1A/C1B) and bandspread (C2A/C2B) capacitors, battery and circuit board are mounted on a 7½ x 5½ x ¼-in.-thick piece of plywood which becomes the cabinet's base.

If you want to build your converter in the Bakelite box shown in Fig. 5, mount the aforementioned parts on the bottom of the box. The box's cover then becomes the top on which the radio is placed. The construction notes that follow are for the Bakelite box. Building the converter in a wooden cabinet is practically the same.

Begin by cutting a 6½ x 2¼-in. piece of perforated circuit board. Cut ¾-in. squares out of two corners on one of the long sides, then mount all parts where shown in Fig. 1.

Drill and countersink four holes in the bottom of the box and mount the board with 1-in.-long flat-head machine screws to keep the board ¼ in. above the bottom of the box.

Tuning capacitor C1A/C1B is mounted with a 1¼ x 2¼-in. bracket made from a 2½ x 2½-in. piece of scrap aluminum. After you make the bracket put C1A/C1B on the bottom of the box to determine the location...
of the hole for its shaft in the front of the box. (Note: In the Bakelite box, C1A/C1B's plates will open only to 90 per cent of maximum. Don't worry about this. You still will be able to tune up to 15 mc.)

Then drill holes in the bracket for C1A/C1B's three mounting screws and drill and countersink two holes in the bottom of the box for the bracket's flat-head mounting screws.

Next, make a 2 x 2-in. shield out of a piece of 3 x 2-in. scrap aluminum for C2A/C2B. This shield is required to minimize detuning from hand capacitance when you adjust C2A/C2B. Cut a ¾-in.-dia. hole in the center of the shield for C2A/C2B's shaft bushing. Cut a hole in the front panel for C2A/C2B's shaft and slip the bushing through the shield and the cabinet. Do not use too much force when tightening the mounting nut or the box may crack.

Transformers T1 and T2 have to be modified as shown in Fig. 2. First, remove the 18-in. length of plastic-covered wire supplied on L1 and set it aside. Carefully unwind three turns of the heavy-wire winding on T1, starting at the end of the winding near lug 4. Cut off the unwound wire, discard it and solder a 1-in. length of #22 tinned wire to end of the remaining turns. Then solder a few inches of the plastic-covered wire removed from L1 to the same point. Wind three turns of the plastic-covered wire close together (in the same direction as the remaining turns of wire) around T1 to replace the three removed turns. Solder the wire to pin 4. Repeat the procedure for T2 but tap the coil at the fourth turn.

Make two brackets for mounting T1 and T2 and put solder lugs under each bracket's mounting screw. Put flea clips in the board under lugs 1 and 2 on T1 and T2 for added support. Solder lugs 1 and 2 to the flea clips. Solder nuts on T1's and T2's slug-adjustment screws to make alignment easier. Mount L1 on the board with the bracket supplied with it and put a solder lug under the mounting screw.

July, 1966
**1-Transistor Short-Wave Converter**

Connect C1A/C1B, C2A/C2B, J1 and S1 as shown, keeping all leads short and direct. Bend a piece of aluminum around C1A/C1B's outer, or larger, shaft and make a pointer on the other end.

**Alignment & Calibration**

Turn T1's slug-adjustment screw so it's about ¼ in. out of the form. Turn T2's slug-adjustment screw so it's ¾ in. out of the form. Connect the hot lead of a signal generator through a 300-ohm, ½-watt resistor to J1 and connect the ground lead to J1's shell. Close C1A/C1B's plates and open C2A/C2B's plates.

Place a transistor radio near L1 and turn on the radio and the converter. Tune the radio to a quiet spot on the dial between 540 and 1200 kc. Set up the signal generator for a modulated output at the frequency to which the radio is tuned and adjust L1 for maximum volume from the radio.

Set the signal generator to 5 mc and adjust T1's and T2's slugs for maximum volume. Set the signal generator for 15 mc and open C1A/C1B's plates until the pointer is at approximately the same position as the 15-mc point on the dial shown on the first page of this article. Adjust C1A/C1B's trimmer capacitors for maximum volume. Repeat the 5-mc and 15-mc alignment and then calibrate C1A/C1B's dial with the signal generator.

**Operation**

Write the converter's output frequency on the back of the cabinet so you can set a transistor radio to this frequency quickly.

You may be able to pick up signals without an antenna. However, for best reception, a 25-ft. antenna and a good ground are a must. To listen to short wave, put the radio as close to L1 as possible, tune it to the converter's output frequency and tune with C1A/C1B. To hear a particular station in a crowded band tune with bandspread capacitor C2A/C2B.
EVER so often, I run into someone who advocates—with perfectly straight face and evident conviction—the old saw that it takes a big speaker to produce big sound. And the chap making this solemn pronouncement invariably argues that proof is a matter of simple physics. Compare speakers and symphony orchestras, he suggests, and it's obvious that it takes a big speaker really to emulate a 105-piece ensemble.

About ten years ago, the same kind of theoretician listened to the first acoustic-suspension speakers. And though these jobs pumped out fundamental enough at 30 cps to make his knees buckle, he steadfastly denied with complex equations the simple evidence his ears were offering. His brand of Alice-In-Wonderland thinking couldn't survive too easily, so he eventually shifted to another (and current) proposition. Story goes that while a bookshelf speaker can reproduce actual bass frequencies full-strength, it can't reproduce the sensation of bass instruments, the breadth and sweep of the real thing.

If you've been exposed to this kind of theorizing, let me offer a few easy replies for the time you next run into it. First, all speakers—including the biggest in captivity—are small in comparison with the radiating surfaces of a symphony orchestra (or even three or four bass fiddles, for that matter). Second, the actual span in size between bookshelf speaker mechanisms and so-called big speakers is small; the biggest variable is the box the speaker is in, not the radiating area of the actual speaker diaphragm.

Third, and most important as far as I'm concerned, is that the breadth and sweep of a symphony orchestra isn't a function of bass at all. Instead, it's the highs that provide the air and the hall sound of recordings and these, of course, depend on the smallest of speakers, the tweeter.

In my own listening I alternate between a small acoustic-suspension speaker and one of those huge, full-range electrostats. And if either sounds bigger on all-out orchestral material, it's the acoustic-suspension bookshelf speaker. (It strainlessly will reproduce levels that the electrostatic, due to amplifier limitations, will distort.)

Strong trend in audio these days is for manufacturers to make components other than their original specialties. Among the newest converts is Ampex, which now produces speaker systems and headphones (see cut) in addition to its line of recorders. Also on the diversification kick is Audio Dynamics (ADC), which began with pickups, added speakers and now is producing a transistor receiver and amplifier. These two join a list of make-practically-everything hi-fi manufacturers that includes, among others, Electro-Voice, Fisher, KLH, Scott and Sherwood. I think we have every reason to believe that we can expect more.

One of the things I've noticed about the new generation of transistor tuners is that practically all the better ones have beautifully steep limiting curves. This means that if the new tuners can get a station at all, they get it with an almost completely quiet background. Time was when many tuners with apparently good sensitivity ratings took an exasperating amount of signal to come up with a really listenable brand of reception. Those days, it now would appear, are gone forever.
You can earn more money if you have an FCC License

Employers are paying good money for men holding FCC tickets. Read how to get yours:

When you hold a Commercial License issued by the FCC (Federal Communications Commission) you have written proof that you know and understand basic electronic theory and fundamentals. It’s worth plenty...particularly to companies on the lookout for qualified technicians. Here’s how one of the country’s leading office machine manufacturers rates men with FCC Licenses:

“An FCC License is an asset to any man looking to enhance his career in the field of electronics. At our Company, a licensed man is well-rewarded because an FCC License attests to his knowledge of electronics theory...”

Thousands of employers will tell you the same thing. Licensed men get the good jobs. They make more money...move ahead faster...enjoy exciting, challenging work. What’s more, they’re needed badly in every field of electronics. Industrial electronics. Radio-TV Broadcasting. Aerospace. Electronics Servicing...including mobile and marine radio plus CB.

Yes...your opportunities are unlimited once you’re carrying that FCC Commercial Ticket. AND CLEVELAND INSTITUTE OF ELECTRONICS CAN GET ONE FOR YOU! On the facing page, read how four ambitious men just like you have cashed in on CIE’s surefire FCC Licensing Program. Read about CIE’s exclusive money-back offer. And then enroll in the FCC course of your choice. You will soon be on your way to a Commercial FCC License and the many rewards that go with it!

NEW in 1966

Only CIE offers new, up-to-the-minute lessons in all of these subjects:

- Logical Troubleshooting
- Laser Theory and Application
- Microminiaturization
- Single Sideband Techniques
- Pulse Theory and Application
- Boolean Algebra

Electronics Illustrated
These CIE men have good jobs
(they have Commercial FCC Licenses)

Matt Stuczynski, Senior Transmitter Operator, Radio Station WBOE. "I give Cleveland Institute credit for my First Class Commercial FCC License. Even though I had only 6 weeks of high school algebra, CIE's AUTO-PROGRAMMING teaching method makes electronics theory and fundamentals easy. After completing the CIE course, I took and passed the 1st Class Exam. I now have a good job in studio operation, transmitting, proof of performance, equipment servicing. Believe me, CIE lives up to its promises!"

Ted Barger, Electronic Technician, Smith Electronics Co. "I've been interested in electronics ever since I started operating my own Ham rig (K8ANF). But now I've turned a hobby into a real interesting career. Cleveland Institute of Electronics prepared me for my Commercial FCC License exam...and I passed it on the first try. I'm now designing, building and testing all kinds of electronic equipment...do a lot of traveling, too. It's a great job...and thanks to CIE and my FCC License, I'm on my way up."

Chuck Hawkins, Chief Radio Technician, Division 12, Ohio Dept. of Highways. "Cleveland Institute Training enabled me to pass both the 2nd and 1st Class License Exams on my first attempt...even though I'd had no other electronics training. (Many of the others who took the exam with me were trying to pass for the eighth or ninth time!) I'm now in charge of Division Communications and we service 119 mobile units and six base stations. It's an interesting, challenging and extremely rewarding job. And incidentally, I got it through CIE's Job Placement Service...a free lifetime service for CIE graduates."

Glenn Horning, Local Equipment Supervisor, Western Reserve Telephone Company (subsidiary of Mid-Continent Telephone Company). "There's no doubt about it. I owe my 2nd Class FCC License to Cleveland Institute. Their FCC License Program really teaches you theory and fundamentals and is particularly strong on transistors, mobile radio, troubleshooting and math. Do I use this knowledge? You bet. We're installing more sophisticated electronic gear all the time and what I learned from CIE sure helps. Our Company has 10 other men enrolled with CIE and take my word for it, it's going to help every one of them just like it helped me."

FCC LICENSE WARRANTY

A CIE FCC License Course will quickly prepare you for a Commercial FCC License. If you don't pass the FCC exam...on the first try...after completing your course, CIE will refund all your tuition. You get an FCC License...or your money back!

Cleveland Institute of Electronics

1776 East 17th Street, Dept. EI-64, Cleveland, Ohio 44114

July, 1966
ABOUT THE AUTHOR

In his quarter-century as a ham, there's one thing W2NSD/1 has not done. That is sit quietly and watch the QSOs go by. Wayne Green is a vocal, unquiet doer who, more than nearly any other person, has in recent years wakened the amateur radio ranks and put new interest into a nodding hobby. What Wayne says often leads to controversy but he doesn't write or speak to be popular but for what he believes to be for the good of the hobby. With this issue W2NSD/1 becomes the Ham Shack's new proprietor. We welcome him. Wayne once was editor of CQ magazine and later founded his own magazine, 73, which he now publishes at Peter- borough, N.H. He currently is DXing like gang-busters on 20-meter tone (200 countries in the last year), experimenting with a new antenna on 432 mc, working on 2 meters with a full gallon and 336-element beam, setting up a ham TV station and, when he's not busy, planning a DXpedition to Africa. Every so often he is known to ski, skin-dive, ride horses and drive fast sports cars. As we said, he's nobody's Grandpa Moses. And that's for sure.

MONEY... Is ham radio expensive? It can be. Others watch the dollars and achieve results with shrewdness rather than lavish applications of the checkbook. The object, to me, is to put out a sizable signal. On most bands this means a kilowatt and a beam. I know—who can afford anything like that? Most anyone, that's who. The main thing is the desire to do it. Then you find the way. Working out on CW isn't hard but side-band presents more of a problem. Probably the best bargain is the Heath HW series of transceivers at $120. If you shop the ham ads you can find them assembled for reasonable prices. Those in desperate straits can convert a junked AM rig to double sideband and few will notice.

You need a linear. These are in the ham ads or can be made easily. The beam has to be up there about 70 ft. Towers cost $2 a foot. You can cut this in half with a TV tower but be sure to guy it. Or if you have contacts with phone or power people you may be able to big-deal a pole. If you have lots of lettuce they have delightful crank-up towers for only $1,000. Which would you rather have, leg muscles from climbing or arm muscles from cranking?

Quads can be put together reasonably and they do put out good signals. You probably will get a little more zap from a three-element beam but the $70 price tag means a lot of magazine subscriptions or whatever you do for hobby money. Do not settle for dipoles, verticals or such if you want an outstanding signal.

If you have the long green you don't do badly to buy new. This way you can use it for a couple of years and trade in for new [Continued on page 110]
Now you can worry just like Jim Clark and Dan Gurney about how to get your lap time down to minimum!

You could be running absolutely flat-out on your HO or 1/32nd scale track at home or wheeling with the best on the big banks at a slot parlor but all the soup-ups, tune-ups and skillful driving won’t mean a thing unless you can prove it. And the way to do that is to race against an accurate clock.

You might win heat after heat but no one will know who really is the Jim Clark of the house until you use the same kind of measuring stick that they employ on the oval and road courses—lap times. Clark holds many lap records. So do Graham Hill and Dan Gurney. Who holds the lap record at your house or slot parlor? Now you can build Eli’s Lap Timer and find out!

While you can time slots with a stopwatch, the split-second pauses at the start and finish become a mighty large error when you consider that the average lap time is but a few seconds. But our timer is controlled by...
Be sure rectifier SR1 is installed correctly. Its cathode (+) is connected to the AC line via S2. And also double-check the connections of the leads from SCR1.

**SLOT-CAR LAP TIMER**

the cars themselves—as on regulation tracks. The timer starts when the car breaks the beam of light across the track. When the car comes around and breaks the beam again the timer stops. Since the timer is light-controlled, there are no mechanical connections to slow or throw the cars. In addition, the timer can be set up anywhere—curve or straightaway. Take it to a friend's layout or even take it down to your slot parlor on competition nights.

**Construction**

The timer consists of three units: control box, remote-pickup box and light-source box. All component values are critical. Do not make substitutions.

The control box is built in the main section of a 3 x 5 x 7-in. Minibox. You must mount impulse-relay RY1 on the bottom as shown. If it's installed on the side or the top RY1 may trip slowly—causing timing errors—or may not trip at all.

RY1 is supplied with two sets of DPDT contacts but only one set is used; it doesn't matter which as long as one lead is connected to the wiper (B in pictorial).

The specified clock motor (CM) makes a 360-degree sweep in 60 seconds; it was selected because it costs only $1.19 and because our car takes slightly less than one minute to get around our track. While a 60-second sweep will be adequate for many tracks, you
Interior of control box. Our motor was mounted 3¼ in. from top of 3 x 5 x 7-in. cabinet to allow room for a 4½-in. dial and for relay RY1.

Light source box. Push pilot lamp through grommet so edge of lamp’s base is flush with side of grommet. We added a switch for convenience.

Pickup box. Cover photocell with tape so tape extends ½-in. beyond cell’s face. Fit cell through ¼-in.-dia. hole so tape protrudes ¼ in.

Light source and pickup boxes on track. Light from pilot lamp to photocell must be high enough to be broken by body, not just wheels.

might prefer a slower or faster sweep.

Motors are available which turn as fast as 1 revolution per second or as slow as 1 revolution in several minutes. The choice is yours and depends on track length and speed of your car. Our chart lists some other clock motors and their prices.

Position the motor in the cabinet so the largest possible dial can be used. Since the motors are equipped with only a shaft, drill a tight-fitting hole in a block of plastic or wood and cement it on the motor’s shaft after the motor is installed. Draw a dial on a piece of stiff paper, glue the paper on the cabinet and then cement a pointer to the shaft block with epoxy.

The pickup box is a 3¼ x 2½ x 1½-in. Minibox. Place a car on the track and measure the distance from the table—not the track—to the center of the side of the car. Then drill a hole in main section of the Minibox the same distance from the edge. This is important because if PC1 is mounted too low the car’s wheels will interrupt the beam and produce two pulses—instead of one—each time the car passes.

Drill a ¼-in. hole and then mount a three-lug terminal strip directly behind the hole. Wrap three turns of plastic electrical tape around PC1 forming a tube so that the face of PC1 is recessed ½-in. from the front of the tube. Then wrap two turns of tape around the back of PC1 so it is light shielded.

Position PC1 in the hole so only ¼-in. of tape tube protrudes from the front of the cabinet. Secure PC1 by wrapping several turns of wire around it, then solder the wire to the center lug of the terminal strip. Make

July, 1966
Schematic of light source is in upper left corner. Control-box circuit is at right. When beam of light on PC1 is broken by car, SCR1 fires, causing RY1 to trip and clock motor CM to start. Because RY1 is latching-type relay, its contacts remain closed after light beam comes back on. When car returns and breaks beam a second time, SCR1 fires and energizes RY1, causing its contacts to open and motor to stop.

CM—1-rpm clock motor (Olson Electronics MO-113). See text
J1—Phone jack
NL1—NE-23 neon lamp (Allied 7 U 950, 16¢ plus postage. Not listed in catalog)
P1—No. 47 pilot lamp
PC1—Photoconductive photocell; Clairex type CL-503A (Allied 7 U 462)

PARTS LIST
PL1—Phone plug
R1—100,000 ohm, 1/2 watt, 10% resistor
RY1—Impulse relay: 115 VAC
S1—Pushbutton switch
S2—SPST toggle switch
SCR1—GE type C6B silicon controlled rectifier. (Allied No. C6B, $2.07 plus postage. Not listed in catalog)
SRI—Silicon rectifier: 750 ma, 400 PIV. (Lafayette 19 R 4202)
T1—Filament transformer; secondary: 6.3 V @ 0.6 A.

SLOT-CAR LAP TIMER

the pickup box’s connecting lead long so it can be located a distance from the control box.

The light-source box is the same size as the pickup box. Drill a 1/2-in. hole in the box the same distance from one edge as you did for PC1 in the pickup box. Then install a 1/2-in. rubber grommet and push P1, a No. 47 pilot lamp, into the grommet from the inside so the base just touches the grommet. Solder T1’s secondary leads directly to P1’s base and the center terminal.

Checkout
Plug the pickup box into SO1. Turn on the light source and put it about 6 in. away from PC1. Then turn on the control box with S2. The clock motor may or may not start—it doesn’t make any difference. Also, RY1 may or may not click when S2 is closed. If RY1 buzzes turn off the power and check to see that PC1’s plug is making good contact in J1. If the connection checks out, look for a wiring error. (Note: RY1 will buzz if the light doesn’t fall directly on PC1.)

Break the light beam with your finger. If RY1 fails to click in, check that SRI is not installed in reverse and is not defective. If SRI is all right and is installed correctly and RY1 still fails to operate, cover PC1 with your finger and see whether NL1 is glowing. If it is not, check the wiring of R1, PC1 and the SCR’s gate (G) lead.

[Continued on page 116]
Proud owner of what just may be the world’s finest private collection of old radios. Milwaukee’s Eugene Kerns lays claim to more than 100 sets from the days when grandpa was young. Every one of the vintage sets has been restored painstakingly to what Mr. Kerns refers to as speaking condition.
TIME-SIGNAL IDs . . . Most SWBC stations can plead guilty to over-modulating on time signals, which fact in itself is no cause for rejoicing. Thing is, this little quirk can prove a boon for hard-working DXers. For though a station doesn't become any louder when it over-modulates, it does spill over into adjacent channels. Such spill-over will be distorted and pretty well useless when the transmission is voice or music. But let a time signal over-modulate and the sound frequently will emerge reasonably clear and intact on nearby frequencies.

As a case in point, take the BBC's new relay at Francistown, Bechuanaland (put on the air especially for Rhodesia). It begins transmitting on 7295 kc at 2300 EST, a time when QRM on this channel in North America is horrendous. Such interference comes both from R. Free Europe and (mostly) from Communist jamming aimed at RFE. So heavy is the barrage that it usually blanks 7295 at 2300.

Fortunately, the BBC relay transmits six beeps every hour on the hour (the sixth occurs exactly on the hour). And these beeps, somewhat lowered in pitch, can be received under just average conditions on both 7290 and 7300 kc (see our illustration). Of course, merely logging that time signal doesn't make for a report; at least two more items would be required. But you'll know your target is there and this should spur you on to greater effort.

Incidentally, certain interval signals (identification chimes, bells and the like) also over-modulate and produce accurate patterns on adjoining frequencies. Further, a long interval-signal transmission, timed exactly, can be used to prove reception.

Another QSL Hurdle . . . Getting QSLs out of Latin American stations often proves a real challenge, though some approaches seem more fruitful than others. Understand, of course, that miracles are out of the question. Fact is, no matter what method(s) the DXer uses, he never will get anywhere near a 100 per cent return for a variety of reasons.

Best time to report is when a station first comes on the air, changes frequency or boosts power. Needless to say, this is when reception reports are appreciated most. Then, too, reports written in Spanish (Portuguese for Brazil) have a better chance than those written in English. Several clubs—the ASWLC, IRCA and NRC are three—will provide sample Spanish-language forms to members. Trouble is, all letters from members of the same club then will read exactly alike.

One way out is to put only program details in Spanish. They can be listed in the following manner:

8.12—propaganda de Coca-Cola.
8.14—propaganda de Exso.

(Naturally, you'll need an English/Spanish dictionary if you're to know that propaganda, for instance, is the word for advertisement.)

You also should add the following sentence in Spanish: Me seria grato recibir de Uds. una tarjeta o carta confirmando mi recepcion de su emisora (meaning, I would be pleased to receive from you a card or letter confirming my reception of your station).

Always send your reports via air mail and always include return postage—either via International Reply Coupons (obtainable at any post office) or uncanceled stamps (from a dealer) of the target nation.

If no reply has been received after three months, send another report. Should you be unable to pick up the station at that time, send a copy of your original report and add the following: Hace algun tiempo le escribi una carta sobre la recepcion de su gran emisora. He esperado la contestacion, pero todavia no ha llegado, tal vez por extraviarse en el correo. (Some time ago I wrote you concerning my reception of your fine station. I have waited for your reply, but it has not yet come. perhaps because it was lost in the mail.)

Time-signal over-modulation permits reception of BBC relay on 7295 kc, though station is on same frequency as R. Free Europe. See text for details.
THE DAY

TAPE

WAS BORN

By BOB SWATHMORE

TUESDAY, October 24, 1944, had been a cold, foggy day in London. And the wee hours of the 25th were, if anything, even colder and damper. But Jack Mullin, serving with the U.S. Signal Corps at a base just outside the city, probably didn't notice. The state of the weather also probably was lost on Ernst Haas, a technician working at Radio Frankfurt's temporary headquarters at Bad Nauheim, Germany. Each found himself far too caught up in more compelling matters to pay much attention to anything outside the window.

That morning, as on many other occasions, Mullin was tuned to Radio Frankfurt, fascinated by a concert of symphonic music which seemingly was being broadcast live. Catch was, who in his right mind would keep a symphony orchestra around at 3 o'clock in the morning simply to provide interludes to news broadcasts and the taunting words of Lord Haw-Haw?

(If then was much easier to tell when a program was canned. Standard procedure in those days was to cut a broadcast on a 33\(\frac{1}{2}\)-rpm, 16-in. acetate disc. Record surfaces 20 years ago weren't what they are today and the sound of a canned program could be identified even by an untrained ear. Sounds were tubby and there was plenty of background hiss.)

These were the exact sounds Mullin missed in the Nazi broadcasts. Too, Allied intelligence had been puzzled for some time by what seemed to be live broadcasts by Hitler from Luxembourg when he was supposed to be at a meeting in Nuremberg or from Munich when he reportedly was reviewing troops in Hamburg. Intelligence officers had used the same evidence Mullin had—the lack of hiss and muffled tones typical of transcriptions—to pinpoint Hitler's presence in the broadcast studio. But even Der Fuehrer couldn't be in two places at once—or could he?

Mullin thought no more about the 3 a.m. concert mystery until the following spring, when he was reassigned to Paris. His new job: to scour the battlefields after the Germans had been routed in search of electronic gear that might be of use to the Allies. Mullin was one of perhaps a score of engineers who were paired off in reconnaissance teams with instructions to send back two of everything of value they found. Such gear would be shipped to research facilities in New Jersey, where it would be checked and evaluated for possible use by the U.S. Government.

Until the teams began to cross into Germany pickings were slim. The Germans destroyed the studios of Radiodiffusion Francaise in Paris before pulling out and damaged as much equipment as they could preceding their withdrawals.
from elsewhere in France, Belgium and The Netherlands.

But Mullin proceeded to follow the advancing Allied armies across France, into Belgium, into Luxembourg and eventually into Germany. Then, one day in July 1945—two months after the end of the war—his path crossed that of Radio Frankfurt technician Ernst Haas. Much had changed since that wartime morn when Mullin unknowingly had listened to Haas' airing of the 3 a.m. symphonic ensemble.

To escape Allied bombings Radio Frankfurt had packed up its microphones, turntables and personnel and beat a retreat 20 mi. north to the resort town of Bad Nauheim. There were no military targets in the vicinity and, so long as the Allies didn't learn of Radio Frankfurt's presence in an appropriated castle, the station was likely to be safe.

But Allied troops poured up the Rhine valley from France and overran the Germans. Before long, Haas' station had been taken over by the Armed Forces Network and the tones of Elmer Davis and Edward R. Murrow replaced Goebbels' diatribes. Where once the Munich Philharmonic played came now the sounds of Glenn Miller and Bix Beiderbecke. AFN announcers took over jobs deserted by their German counterparts and AFN technicians operated the controls.

In one room of the castle was found a big black box and a wall full of gadgets that went with it, though only one person still in Bad Nauheim understood what it was or what it was supposed to do. He was none other than Ernst Haas and he devoted the bulk of his time to maintaining the transmitter, the turntables and consoles and performing odd jobs.

That day in July when he ran into Haas, Mullin recalls today, was a warm one. Those Germans who could afford to and Americans who had the time were sitting outside cafes guzzling beer. Mullin had spent most of the morning touring the facilities at Radio Frankfurt but had seen nothing of particular interest.
"Then," says he, "after a leisurely lunch we went back and they showed me the room with the black monster." Mullin asked what the gadget was for and Haas was brought in to demonstrate it. From one of the boxes along the wall he selected a reel and placed it on one of the arms of the machine.

"He pressed a button and a whole new world opened up for me," Mullin says. "The tape he had selected was one of those symphonic broadcasts I'd been listening to in London. It had life, color... just like a live performance."

In a sense, the finding of the first operating Magnetophon, that day in July 1945, was the beginning of tape recording as we know it. To be sure, magnetic recording dates from 1899, when a Danish inventor and electrical engineer, Valdemar Poulsen, filed a patent claim for a workable device using the then-new principle. Poulsen's invention, however, employed steel wire. To improve sound quality, Poulsen added DC bias in 1907. From that point until Marvin Camras experimented with AC bias on wire recorders during World War II, there were few basic changes in magnetic-recording devices.

The few changes there were came from such German firms as AEG and I.G. Farben, the latter succeeded by Badische Anilin und Soda Fabrik (BASF). In 1931 the Germans developed the Blattnerphone, which the BBC promptly acquired for on-the-air tests. As BBC engineer Linton Fairchild recalls, "The Blattnerphone looked like two ancient Irish spinning wheels joined together—and from one to the other ran the recording tape made of steel and 6mm wide. The machine arrived at the BBC studios in the care of a German engineer, Von Heusing by name. There was only one machine, there was only one engineer and both were extremely temperamental. We knew that what is important in

All modern tape recorders are direct descendants of the amazing Magnetophon (above), perfected in Germany during World War II and first demonstrated to a U.S. audience by Jack Mullin of San Francisco's W.A. Palmer & Co. in 1946. Ampex, a small electric-motor manufacturer founded in 1944, displayed the first U.S.-made tape recorder in the summer of 1947. Photo at left shows a smiling Jack Mullin (left) standing before the original Ampex 200 while Murdo MacKenzie, production manager for the machine's initial customer, singer Bing Crosby, looks on.
recording is that the machine should run at the same speed when it is being played back as it does when it is recording. This the Blattnerphone flatly refused to do."

Editing the steel tape or wire was difficult. Both types of machines used DC bias, which restricted frequency response sharply. And both were subject to restricted frequency response. Both types of recording were flatly refused to do.

But the Magnetophon was another story. When Mullin got back to Paris he found that other teams had turned up Magnetophons and bits of Magnetophons as well. The Signal Corps, following its practice of saving two of everything, proceeded to scrap the extras. Mullin went to work on the scrapped units with the aid of a patched-up instruction book. In a few days, he had reduced two scrapped recorders to a pile of parts which easily could be packaged and mailed home.

By the time Mullin had been mustered out and returned to the States all of his Magnetophon parts and tapes had arrived. He spent his first few weeks of civilian life reassembling the machines and experimenting with them. Then, late in 1946, he was ready to demonstrate his recorders for the Institute of Radio Engineers (now the IEEE) at a San Francisco meeting.

That meeting was to be nearly as important to Mullin as his brief encounter in Germany with Ernst Haas. For in the audience was a product engineer named Harold Lindsay, who was searching for something his company, Ampex, could make now that the war was over. When he heard the sound from the Magnetophon he became as enthusiastic as Mullin himself. And a Bing Crosby staffer saw in the machine the answer to an immediate and pressing problem.

Like Jack Benny, Bob Hope, Fred Allen and other stars of that period, Crosby found himself broadcasting the same script live twice and sometimes three times—a monotonous, time-consuming practice at best. Performers might begin broadcasting live from a Hollywood studio at 6 p.m., then (because of the time differential between East and West Coasts), repeat the program at 9 p.m. for West Coast listeners. Many even were forced to do a third show at 7 or 8 p.m.

Significantly, the fledgling American Broadcasting Company had persuaded Crosby to leave NBC and join it by permitting him to go on the air canned—that is, the show could be recorded at his convenience, then played on the air at the appropriate times. Crosby's engineers used conventional 33 1/3-rpm acetates to record, say, an hour and 30 minutes of program, then cut it down to an hour in the only way they knew—by dubbing from one disc to another. Trouble was that the original lacquer disc had the distinctive canned sound and each subsequent dubbing only increased the canned quality.

Crosby's sponsors, concerned about the inferior sound quality of the show and its possible effect on ratings, specified that if ratings dropped below a certain level Crosby would have to go back on the air live. Mullin's Magnetophon appeared at a point when Crosby's ratings were sagging dangerously near the cutoff point.

[Continued on page 113]
New York's Robert Gaulin has spent almost his entire career with tape and tape-recording equipment (our photo shows him with an Ampex 350 at Magno Sound, Inc., where he is employed). It is this lifelong association with professional recorders that eminently qualifies him to speak his mind on machines in the consumer field.

Every year dozens of magazine articles tell you how to buy or what to look for in a tape recorder. Almost without exception these articles are prepared by professional writers, men who earn their keep by stringing words together, and sometimes by rewriting each other's articles. They almost never seek the advice of a man who makes his living from tape. I can tell you things look mighty different from the pro's side of the table.

When you come right down to it, a tape recorder is something like a car. There was a time when a car was merely a gadget that got you from here to there. Then manufacturers got the idea of adding fins and chrome. The cars didn't get you from here to there any faster with fins and chrome but Detroit sure did sell a heck of a lot of cars.

By the same token, a tape recorder is sup-
posed to be a mechanism that pulls a strip of plastic coated with iron rust past an electromagnet which puts sound on the tape. But somewhere along the line manufacturers discovered a world of wondrous things—sound on sound, automatic reverse, four-track stereo. They didn't get sound on tape any better but they sure sold a lot of machines. Ever since, the tape-recorder industry has been particularly susceptible to gadgetry. Almost any luxury item is subject to gadgetry and a tape recorder (in the home) is largely an oversold luxury. What are some of these gadgets? Which ones do you really need or, to put it another way, which can you do without?

It's true that many people buy tape recorders for specialized purposes and require specialized features. A businessman may need a recorder that is small and light, has remote controls and can be used for dictation. A camera buff may need a machine with facilities for photo synchronization. A language student may need sound-with-sound, to enable him to practice his French. The features needed for these specialized purposes, however, are of no use to the serious home user, the man to whom I address most of my remarks.

The serious home user is a chap who's interested in quality sound reproduction, who uses his recorder to record and listen to music (or other program material) seriously. He'll want to edit and arrange his material in a sequence useful to himself or to others who may use his collection. He's not a semi-pro. A tape professional of any sort is a man whose recorder makes money for him and whose primary reason for owning a recorder is to make money. The demands of our serious user are quite different from those of the professional, making necessary use of a quite different kind of machine.

One of the biggest pieces of chrome of them all is four-track recording. While the pack-rat archivist or background-music aficionado may find it useful, it's nothing but a tape-waster to our serious user. Besides having a poorer signal-to-noise ratio than two-track and vastly exaggerated tape-motion problems, four-track recording permits no editing unless you use only one set of tracks—thereby losing all the so-called advantages. Cutting material out of one recording means you'd be cutting material out of the set of tracks recorded in the opposite direction. This results in incredible tape waste.

Even stereo recording is a piece of chrome in most cases, unless you're going to record stereo music that's broadcast live by an FM station. The reason is that it takes the skill of a professional to record live, at-the-scene stereo properly—to select just the right microphones for the job, place them properly and obtain the right balance. Besides, you've got the manufacturer of your recorder working against you. Usually he supplies you with a little lozenge on a string—only one—that is supposed to serve for live recording. If you want another you have to buy it.

In any case, chances are that these mikes are only half as good as your recorder, no matter how cheap the recorder. In fact, I'd be tempted to say that if the recorder comes with a microphone it's probably not a particularly good recorder and it's definitely a lousy microphone. So if you insist on doing live recording you'd be better off finding a recorder which doesn't come with its own microphone, then going out and buying one or two decent microphones to go with it.

Recording from discs is nonsense, too. Unless the disc is a particularly valued
recording you're likely to get tired of it and want something else. Besides, you won't be able to make as good a copy of it as the original. So if you want quality you're better off sticking to a disc and treating it nicely—as you would any valued friend. It's true that tape is one of the best things ever to happen to background music because of its long, uninterrupted playing time but it's also one of the worst, most stupid ways ever developed of reproducing music in the home. It's much more difficult to find a specific selection on a tape than it is on a disc, and tape is harder for most people to handle than records. Most commercially prerecorded tapes contain more imperfections of one sort or another than a good record. They cost more and the selection of titles is terrible. Tape has the great advantage, however, of enabling the serious user to build an archive of sound to suit his own taste. This may be anything from satellite launchings to Toscanini broadcasts.

**How many motors** should we look for and what kind should they be? For the average user the hysteresis-synchronous motor has been as oversold as automatic headlight dimmers. The fact is that for home applications a properly-designed, six- or even four-pole motor will do just as well. And you don't need three of them, either. Three motors are a disadvantage because they add to the heat, weight and cost of the recorder. A single good motor is quite adequate to pull the tape past the heads at uniform speed with proper tension and motion. Hysteresis-synchronous motors show off to best advantage when you're recording on magnetic coated movie film which has sprocket holes. The sprocket holes and the motor guarantee that the speed and position will be absolutely constant with other such machines or recordings. But home recording doesn't have synchronization problems so the real advantage of the hysteresis motor is lost.

The only advantage of three motors is in providing high-speed rewind for professional equipment. While high-speed rewind is necessary and desirable for the professional, who shuttles a given reel of tape only a few times (and who must be able to do so very rapidly), it's undesirable for the serious home user, who may shuttle his tapes many times. High speeds put unnecessary tensions on tape and fast winding produces rough edges on tape which are particularly harmful to four-track tapes—especially if they're stored as rewound. In fact, any home unit which rewinds 1,200 ft. of tape in less than two minutes is too fast for our serious user.

Three heads are almost as useless as three motors to our home user. They add to the cost and complexity of the machine and may make servicing costs higher. Professional tape recorders utilize three electromagnets—one to erase a recording already on tape, a second to record material and a third to play back what just has been recorded.

Because the three heads are arranged in this order from left to right, the third head can be used for instant monitoring. It can also be used for trick effects such as echo. In professional machines it's absolutely necessary because it shortens the calibration time for different batches of tape and overall maintenance time, factors not really significant at home. Most home machines, however, combine the functions of record and playback into a single head, largely to save money. Two-head machines usually cost less than three-head machines of comparable quality and produce just as good sound.

Let's assume you buy a machine with a third head. Chances are you don't want to add echo to a broadcast of the Boston Symphony so you'll use it to monitor the recording as you make it. All of a sudden, something goes wrong during the third movement of Leinsdorf's reading of the Brahms First Symphony—a sputtering, then silence. It's all over, fellow. The third head has done you no good and you now are paying for a feature you can't take advantage of.

True, you know there's something wrong. But Leinsdorf won't back up and do it over again for you so your recording is ruined. If something goes wrong...
while you're taping from discs you can back up and do it over again. But you don't need the third head to tell you. The VU meter provides all the information you need about signal, record level and your recorder's performance. Playback checks the rest.

The VU meter is a vital piece of equipment, in my opinion. Cat's eyes and neon bulbs can't provide the same degree of accuracy as a needle swinging against a numbered scale. The numbers on the scale give you a point of reference so you can match volume levels. It's awfully difficult to estimate just how brightly a neon bulb glowed a few minutes ago when making new volume adjustments.

What about pressure pads? In my experience, properly designed machines don't use them but pads in themselves are not a damning feature. If they exert just the right amount of pressure against the head and aren't used to overcome some defect in design pressure pads can provide better head wrap and can make better recordings than machines where tape tension is used to provide head contact. Head wrap and pressure are the criteria here. You want the maximum of the first and minimum of the second. All things being equal, however, pressure pads do tend to get in the way when you're editing and they provide one more mechanical linkage which must be serviced. The best pressure pads I ever saw were on an early Grundig machine. They consisted of polyurethane wheels which rotated against the head as the tape passed.

Selective erase, better known as sound-on-sound or sound-with-sound, is a classic example of fins on a tape recorder. Generally, when one or both of these features are built into a tape recorder they're built in badly and add to the price and the servicing problems. They are of no value whatever to our serious user, though they may have value for a student of French or the piano. And there are other fins, all of which add to the cost of the recorder but nothing to the fidelity or convenience of operating it:

- **Automatic shutoff.** This isn't necessary because our serious user always will be in the same room with the machine. However, it's easy to build in and adds little to the overall cost of a machine.
- **Automatic reverse.** This adds tremendously to cost, servicing and complexity of a recorder. It's a big and silly fin.
- **Automatic head demagnetizer.** Solid chrome! Seldom in my career have I run across a magnetized head that wasn't accompanied by magnetized tape guides or a magnetized erase head. Treating one head does nothing and to take care of all these problems is both expensive and impractical. It's like putting one blowout-proof tire on a car. In all of my 18-year professional career I haven't run across enough magnetized heads to make me take off my shoes to count them.
- **Automatic threading.** Depends on how it's done. If it doesn't damage the tape it can be handy for four-track use.
- **Voice control.** This is at the bottom of my list of things necessary in a good tape recorder.
- **Tape duplicating facilities.** Bah! Humbug!
- **Footage counter.** These are of no earthly use because they are too inaccurate and when you change even one short selection on a reel all the other positions

[Continued on page 112]
By WALT HENRY  TAPING the monthly meeting of the debating club isn't just a matter of setting the recorder's level control when the first member starts speaking. Reason is, the discussion may get quite heated before you realize it. Then others, trying to emphasize their point, begin to move closer to the table and mike. Several people start talking at once, then suddenly everyone's shouting. By this time the record-level indicator's needle is pinned.

Or, after setting the recorder's level control for one person you discover some other members speak softly. When you play the tape back you find it's difficult to hear them. One solution is to get the moderator to adjust the record-level control constantly. But this would distract him and is not a particularly fast or reliable way to maintain a constant-level signal.

El's tape compressor is like having an extra hand there to ride gain all the time. You connect the mike to the compressor and feed its output to the recorder's mike input. Next, you make a test tape of the quietest speaker sitting a normal distance from the mike. While you do this you set the recorder's level control for optimum record level.

Then you start talking loudly and simultaneously increase the compression to pull the record-level indicator's needle back into the safe area. You're all set for the great debate. And no matter who speaks, you can rest assured that the meek will be heard and the loudmouths will be gagged. The compressor also can be used with a PA system. This will permit the speaker to move away from the mike or shout until the rafters ring. The sound level in the room always will be the same.

Or suppose you want to record a fading short-wave program. The compressor will put a constant-level signal on the tape. The same is true if you want to tape the Citizens Band or Aircraft Band. A strong signal that comes blasting through will come out of the compressor no louder than weak or moderate-level signals. Your gain-riding days are over.

There are several other applications for the compressor. For example, it can be used between your mike and a CB or ham transmitter to produce a modulating signal whose amplitude remains constant regardless of changes in the level of your voice. This means more talk power, which makes your signal sound as though your RF is much greater than it actually is.

J  u  l  y,  1 9 6 6

57

www.americanradiohistory.com
Our compressor has all the features of commercial models. The compression is variable from zero to a maximum of about 26db. The noise level is -60db. A preamp stage and a gain control enable the compressor to be used with almost any program source. There's plenty of gain (25db) which means a dynamic mike can be used with it. The compressor will handle inputs up to 5 V peak-to-peak (1.77 V rms).

The circuit has a fast attack time (time required for the compressor to reduce the level of a strong signal). The hold (decay) time required for the gain to return to maximum after the input signal is removed is

---

**Fig. 1—Inside the compressor.** First thing to do is mount all parts on a 3 x 5½-in. piece of perforated board, as shown, using flea clips for tie points. Then install other parts on 5 x 7-in. chassis cover plate. Use two small angle brackets to attach circuit board to panel about 3¼ in. from the edge near J2 and J4. Mount jacks J5 and J6 underneath the circuit board. Note that several ground leads are tied together and connected to the ground lug on J4.

---

**PARTS LIST**

B1—9 V battery (Burgess 2MN6 or equiv.)
C1, C12—-47 µf, 200 V tubular capacitor
C2, C8, C10—30 µf, 15 V electrolytic capacitor
C3, C4—5 µf, 15 V electrolytic capacitor
C5, C6, C9, C11—50 µf, 15 V electrolytic capacitor
C7—100 µf, 10 V electrolytic capacitor
C13—02 µf, 500 V ceramic disc capacitor
C14—150 µf, 15 V electrolytic capacitor
C15, C16—015 µf, 500 V ceramic disc capacitor
D1, D2—1N914 diode D3, D4—1N270 diode
J1, J3—Phono jack J2, J4—Phone jack
J5, J6—Insulated tip jack (H.H. Smith type 241 or equiv.)
C1, C2, C8, C10—.47 At 200 V tubular capacitor
C3, C4—5 µf, 15 V electrolytic capacitor
C5, C6, C9, C11—30 µf, 15 V electrolytic capacitor
C7—100 µf, 10 V electrolytic capacitor
C13—02 µf, 500 V ceramic disc capacitor
D1, D2—1N914 diode D3, D4—1N270 diode
J1, J3—Phono jack J2, J4—Phone jack
J5, J6—Insulated tip jack (H.H. Smith type 241 or equiv.)
Q1, Q2—2N3393 transistor (GE)
Q3, Q4—2N414 transistor (GE, RCA)
Resistors: 1/2 watt, 10% unless otherwise indicated
R1—22,000 ohms R2, R3, R15—56,000 ohms
R4, R9—2,200 ohms
R5—10,000 ohm, linear taper potentiometer
R6, R20—120,000 ohms R7—15,000 ohms
R8—120 ohms R10, R22—3,300 ohms
R11—8,200 ohms
R12, R18—50,000 ohm, linear taper potentiometer (SPST switch on R18)
R13, R17, R21—1,000 ohms
R14—22,000 ohms
R16—660 ohms R19—33,000 ohms
R23, R24—10,000 ohms
S1—SPST switch on R18
Misc.—Perforated board, flea clips, 5 x 7 x 3-in. aluminum chassis (Premier ACH-428GH), 5 x 7-in. aluminum chassis bottom plate (Premier ABP-423GH).
about one second. The compressor does not clip or limit the audio signal—it reproduces it without distortion.

An output stage (Q4) and an output level control (R18) permit you to adjust the level of the output signal to match it to the input of any tape recorder, amplifier or transmitter. Since the current drain is only about 10 mA, the battery will last a long time. As a bonus we've included a four-component circuit (Fig. 4) that will turn the compressor into a 1,000-eps oscillator for checking audio equipment.

**Construction**

Circuit layout is fairly critical; therefore, try to duplicate ours. All components except for the input, output and battery-test jacks, the controls, R11 and R13 are mounted on a 3 x 53/4-in. piece of perforated circuit board on which flea clips are used as tie points. Note in Fig. 1 that several ground wires must be attached to the ground lug on J4. This is important to keep hum and noise low.

Our compressor was built in a 5 x 7 x 3-in. aluminum chassis. The battery, circuit board, controls and jacks are mounted on the chassis' cover plate. The cabinet could be plastic or wood; however, we recommend that it be metal to shield the circuit to prevent pickup of hum and noise.

Note that we put jacks (J5 and J6, not shown in Fig. 1) on the front panel so that the battery voltage can be checked without disassembling the unit. If you want to use a separate supply, any well filtered source of 6- to 9-V DC will do.

**Checkout**

After construction is finished, double check your wiring. Then, turn the preamp-gain (R5) and compression (R12) controls full counterclockwise and turn on power. Measure the DC voltage from the emitter of Q1 to ground. It should be between 3 and 6 V with a new battery. Next, measure the voltage on Q2's collector. It should be between 4 and 7 V. Measure the collector voltage on Q3 and Q4. It should be between 3 and 6 V. If any of these voltages do not fall within these ranges, they can be corrected by changing the values of R3, R6, R15 and R20, respectively.

**Using the Compressor**

As we said, the compressor will handle up to 5-V (peak-to-peak) input signals. However, with a signal this large R5 must be carefully set to prevent the input stage from being overloaded and to prevent distortion. (R5 has little effect on compression characteristics.) The preamp stage is simply a variable-gain amplifier which was included to boost low-level input signals to get full compression.

Here's the way to adjust the controls by making a test tape or with a pair of high-impedance phones plugged in J4. Turn R12 full counterclockwise. When the input signal...

*July, 1966*
is at its highest permissible level, increase R5 until the signal becomes slightly distorted. Then back off on R5 until the distortion disappears.

Once R5 is adjusted with a high-level input signal, it need not be changed again. Now, set R12 for the desired compression. (It may be necessary to readjust R18 when compression is changed.) When recording speech, R12 should normally be set full clockwise. Generally speaking, the compressor should not be used when recording music since loud and soft passages are an important part of musical expression.

To use the compressor as an oscillator set R12 full clockwise. Set R18 for the desired output level, and turn R5 clockwise until the circuit just begins to oscillate.

How It Works

Input stage Q1 is a bootstrapped emitter-follower which gives the compressor an input impedance in excess of 250,000 ohms. Preamp stage Q2 provides a voltage gain of about 20db so that low-level signals can be compressed. Gain control R5 compensates for different input-signal levels.

The circuit that automatically controls compression is a push-pull diode attenuator which consists of D1-D4, C5 and C6. Since the resistance of diodes D1 and D2 depends on the DC current through them, they function as variable attenuators. Here's what happens: An input signal fed to Q2 appears at the junction of R10, D1 and D2 and the base of Q3.

Q3 amplifies a portion of the signal and feeds it to D3 and D4 where it is rectified and then filtered by C5 and C6. The DC is then fed to gain-control diodes D1 and D2. When the input-signal level increases the output of Q3 increases causing more DC to flow through diodes D1 and D2. D1 and D2 reduce the overall circuit gain (compress) by lowering the level of the signal to Q3 and to (via R11, R18 and C10) output transistor Q4. Compression control R12 permits you to vary compression up to about 26db.

The external plug-in oscillator circuit (Fig. 4) is simply a Wien-bridge network. When it is connected from the input to the output, the compressor becomes an audio oscillator. The part values shown produce approximately a 1,000-cps frequency. You can experiment with other values for different frequencies. If desired, the oscillator circuit can be built in. Simply connect R24 directly to J3. Use a SPST switch to connect the junction of R23, C15 and C16 to J1 and J2. Be sure to disconnect any other inputs when using the unit as an oscillator.
MY wife had a word for it. "You're crazy," she said, "and that thing will only get in the way. We'll lug it all over the place and when we get back we won't have a thing to show for it." This outburst came shortly after I announced that we were going to Europe for our vacation (unbounded joy) and that our battery-operated tape recorder was going with us (opposite reaction).

Fact is that the three of us spent a month touring southern Europe and northern Africa (accompanying a good 35mm camera). We came back with plenty of slides our friends would be bored with were it not for the fact that these slides are different. For this time we have the sounds that go with them. Sounds like the gurgling of a fountain in Granada, a royal fanfare for the King of Morocco, a taxi driver cursing pedestrians in Lisbon, the staccato of dancing gypsy feet in southern Spain, the calm British accents of a policeman directing traffic in Gibraltar. And more.

But I'm getting ahead of my story. Perhaps I should explain that, as a

THROUGH EUROPE WITH A TAPE RECORDER

By ROBERT ANGUS

July, 1966
THROUGH EUROPE WITH A TAPE RECORDER

free-lance writer, I've been to Europe before—occasionally with assignments from broadcasters for taped interviews or from record companies for unusual sounds or music. This trip, on the off-chance I might stumble onto something that would require high-fidelity equipment, I determined to take along a recorder of broadcast quality—the Uher 4000L, which offers a choice of four speeds. You can record at 7½ ips with a frequency response comparable to that of a good home recorder or you can cram six hours of uninterrupted sound onto a 5-in. reel of triple-play tape at 15/16 ips.

The Uher weighs about 8 lbs. (including its power source), roughly half what earlier professional-quality battery portables used to weigh. It occupies about the same space as an extra-thick telephone directory and can be carried reasonably conveniently. Power can be supplied by five 1½-volt flashlight batteries, by a rechargeable alkaline battery or directly from an AC outlet through a converter/charger which can be adjusted to accommodate various European and North American voltages. I elected to use flashlight batteries. One set proved quite adequate for all my recording needs.

As for how much and what kind of tape to take along, previous experience had shown that it pays to take tape from the U.S. because, generally speaking, European tapes are more expensive. To conserve space, I settled on half a dozen reels of Kodak's tensilized, triple-play tape, offering a total recording time in excess of 9½ hrs. (at 7½ ips). Since Kodak tape is back-printed, it's easy to tell whether you're recording on the first or second track (and this is something easy to forget when you're traveling).

I had determined not to do any editing until our return home. Tourists simply can't be bothered while on the road and the gear occupies space in the suitcase. Material intended for professional use, therefore, was recorded on one track only so that the tape could be edited at a later date. In the case of lower-fi material, recordings were made in both directions (usually at 3¾ ips), with a view to transferring the material to another tape which could be edited.

The microphone I packed was dictated by the nature of one of my assignments. I knew I would be recording some school children in a particularly noisy neighborhood in London so my microphone would have to have a sharply defined pickup pattern if it were to capture only those sounds I wanted. The answer seemed to be an Electro-Voice Sound Spot (model 644) which promises a cardioid pattern. This model may not be practical for the casual recordist—it looks like a small rifle and occupies much more space than most microphones. But it proved adequate for all my recording needs with the exception of one interview in a stiff London breeze (the voice in this instance being lost in a roar which sounds like an express train).

Two final pieces of equipment included a Channel Master AM/FM transistor radio and a patch cord to facilitate taping off the air.

Best place to start a sound documentary of any vacation is at the beginning. For us, this was New York's Kennedy Airport, where we were scheduled to leave aboard Pan American's flight 154 to Lisbon, Barcelona and Rome. We taped the public-address announcement of the flight, then picked up the recorder and our hand luggage and strolled...
aboard. Naturally, we taped our stewardess' friendly welcome-aboard as well as the roar of the jet engines on take-off. Early next morning found us winging over the Iberian peninsula—setting down in Barcelona under a warm Spanish sun. What to record? We found out almost immediately.

Dinner in Barcelona isn't served until well after 9 p.m. so we fortified ourselves with fried shrimp bought at a lunch counter in a small carnival near the waterfront. The recorder picked up sounds which are almost international—balls thudding against a canvas backdrop in vain attempts to knock over a row of milk bottles, the crack of an air rifle, the calls of candy butchers and pitchmen, the sizzling of sausages, the sounds of people having fun.

The dinner hour came and we made our way down a narrow, twisting side-street to an outdoor restaurant with a reputation for some of the best seafood in Europe. No sooner had I tucked the recorder under the table than a strolling musical trio made their way along the streets to serenade diners. Dressed in the flowing velvet robes a Don Juan might have worn, they played Catalan folk melodies on the unlikely instrumental combination of flute, guitar and mandolin.

After disposing of a Spanish brunch the next morning (which was Sunday), we heard sounds coming from the steps of the city's massive Gothic cathedral—sounds, however, unlike any we ever had heard. We hurried over to find the municipal band in the midst of a program of Catalan music. What made for the unusual sounds was the instruments the band was using—reed-like affairs that looked like clarinets and oboes but with brass rather than wooden bells. A spectator explained that these were coblas, trombos and tipples. The sounds they produced were louder and slightly less reedy than those from oboes or bassoons. (Yes, we put them on tape.)

Though Madrid had more to offer our camera than our recorder, the colorful street market, just off the Plaza Mayor in the center of the city, proved rich in both sights and sounds. Here butchers proclaim the quality of their lamb or rabbits; fishmongers announce the availability of squid or snails or mussels; greengrocers display a colorful array of bananas, onions, apples, grapes, oranges, lemons and lettuce; farm girls sell garlic, and somewhat more sedate shopkeepers offer ample stocks of Manchego cheese or olive oil.

In Granada we were met by a friend who offered to show us and our tape recorder around town. Fortunately our host, Don Horacio del Arbol Navarro, has the soul of a romantic and the ear of a musician. "The sound of Granada," he said, "is the sound of water—laughing, playing, rushing, quiet, even sad."

To prove his point, he took us first to the Alhambra, the delicately beautiful mountain-top palace built by the Moorish caliphs and seized by Ferdinand and Isabella in 1492. Between them, the Moors and the Spanish rulers created nearly 1,000 pools, waterfalls and fountains within the palace grounds, all fed by melted snow pumped from the nearby Sierra Nevada mountains.

Though Sr. Arbol never had used a tape recorder, he managed to solve a problem that had plagued us in Madrid. It had been our practice to carry recorder in one hand, microphone in the other, aiming the mike at subjects as we found them. Result was to attract a crowd and thereby cut off whatever it was we wished to record. Sr. Arbol, showing us through the street market in Granada, simply grabbed the recorder, cable and microphone all in the same hand and ambled nonchalantly through the market. Here and there he'd stop.

July, 1966
THROUGH EUROPE WITH A TAPE RECORDER

next to a gypsy girl singing the praises of her home-grown garlic or a butcher haggling with a customer. Results, somewhat to our surprise, were excellent. Moral: it pays to experiment.

Every visitor to Granada, the guidebooks assert, must visit the Sacro Monte, or gypsy quarter, to see the gypsy caves and authentic flamenco dancing. The guidebooks also warn tourists to be careful of their money and jewelry and imply that gypsies are somewhat less than clean and trustworthy. Not so, Sr. Arbol protests. "Gypsies are honest, industrious people and everybody in Granada loves them."

In any event, he led us to a cave, which proved to be both clean and comfortable, and asked the lady of the house whether we could record a performance. Permission granted, we settled back in chairs lining one wall of a long room while friends and relatives began streaming in with their guitars and castanets. Before long, we were engulfed by the sounds of flamenco dancing and singing—including the traditional songs of a gypsy wedding ceremony.

It had grown dark during our sojourn with the gypsies but our day of Andalusian music-making and recording was not yet over. Since the dinner hour—10 p.m.—fast was approaching, Sr. Arbol escorted us back downtown to a charming little restaurant behind the cathedral, where an instrumental trio was providing music consisting of Spanish popular songs, a few light classics and folk tunes. With permission of the management, we parked our recorder beside the mandolinist-conductor and settled down to a meal of Andalusian specialties.

Granada is built in a valley and on the sides of several hills. Public transportation is provided on the level by buses and along some of the narrower, more winding streets by tramcars reminiscent of the Toonerville Trolley. Sr. Arbol explained the following morning that the trams must be short, light and narrow to negotiate some of the sharper curves—yet they must be powerful, because their routes stretch as far as 20 miles out into the countryside. The groan of one of these midgets starting its journey downtown and the screech as it rounded a curve going up a steep incline were added to our tape collection before we left town.

Next port of call was Algeciras, a town strategically located between Gibraltar and Tangier. Gibraltar proved to be only 7½ mi. from downtown Algeciras, while Tangier is 25 mi. and 2½ hrs. by ferry.

We headed first for Gibraltar, whose main street is a fascinating collection of shops selling everything from Arab rugs and novelties to German lenses and tape recorders. Merchants there hail from India and Pakistan, London's East End, North Africa, even Singapore and Hong Kong. Here stood a policeman in the full uniform of the London Bobby—and we couldn't resist recording his British tones as he directed traffic.

Forsaking the shops temporarily, we found a congenial taxi driver whose desire to explain the sights and specialties of Gibraltar outstripped his command of English. His "Looka da ri" and "Looka da lef" may not mean much to our friends but for us it's an invaluable souvenir of our day on The Rock.

Not so many years ago, Tangier had the reputation of being an international center of intrigue and vice. Today, the intrigue is gone [Continued on page 114]
Channelized Ham Transmitter

Now! The convenience of instant positive tuning to preselected frequencies!

By RUSS ALEXANDER, W6IEL

MANY'S the ham who can recall when he was clobbered by what sounded like a kilowatt transmitter on his roof. Like as not, the interruption occurred in the middle of a DX QSO or during a local rag chew. Most of the time the only solution is either to close up the shack or to hunt around for another crystal that likely has fallen behind something or other.

By the time the vital rock is located and inserted and the rig retuned, the QSO is long gone. Our 40-watt Channelized Ham Transmitter will solve this problem. Designed for instant frequency changes that can be made with the ease and convenience of channel-switching on the (pardon the expression) Citizens Band, it lets both Novices and Generals enjoy the delights of 40-meter DX with the stability only crystals can offer. With ten rocks inside and another on the front panel, this neat brief-case-size rig sports an 11-position rotary switch that permits you to pick a new operating frequency as quickly as you could with a VFO. A spot switch enables you in a second to find your operating frequency with your receiver and also aids in finding the right crystal for answering a CQ.

The rig's high-voltage supply is worthy of note, too. A solid-state voltage doubler is the key to this two-tuber's light weight and trim size. There's no plate transformer. Shock hazard—a sometimes unpleasant aspect of voltage-doubler circuits—has been eliminated by including a keying relay which isolates the key from the chassis.

Construction. The secret to the rig's trim appearance lies in the way it's built in a standard 12 x 8 x 3-in. aluminum chassis. The first step is to remove an 8 x 11-in. piece of aluminum from what normally would be the top of the chassis with a nibbling tool or by drilling holes and hacksawing.

Next, form part of the removed metal into an L-shape subchassis as shown in Fig. 3. The main part of the subchassis on which the tubes are mounted is 2½ x 7½ in. The side of the subchassis is 2½ x 2½ in. A 5/16-in. lip should be formed along the edges and
**Channelized Ham Transmitter**

½-in. lips should be left on the ends of the subchassis to fasten it inside the main chassis. Looking at the underside of the subchassis in Fig. 4, drill a 5/8-in.-dia. hole 1 ½ in. from the left side for tuning-capacitor C17’s shaft. Also drill a 5/8-in.-dia. hole 1 ¼ in. from the right side of the chassis for loading-capacitor C18’s shaft. After the holes have been drilled the subchassis should be held in its mounted position and a pencil passed through each of the shaft holes to the back of the center of the panel. The pencil marks will locate the holes for the capacitor shafts in the front panel. Drill holes in the front panel and insert the shaft bearings in them. Mount the capacitors on the subchassis and locate the tube sockets between them. Mount the tube sockets, terminal posts TP1-TP3 and L3. Wire the subchassis following the schematic (Fig. 5) and pictorial (Fig. 4).

The crystal-selector switch bracket shown in Figs. 1 (bottom panel) and 2 should be made next. It is made by bending a U-shape bracket from metal left over from the piece cut out of main chassis or from other scrap aluminum. The side of the bracket on which the crystal sockets are mounted is 2 5/8 x 3 3/4 in. The part of the bracket that separates the front and back of the bracket is 2 in. long. The shape of the bracket through which S1 is mounted is triangular (see Fig. 1). Mount the switch and ten crystal sockets on the

---

**Fig. 1**—Head-on views of rear (top) and front (bottom) panels show component locations. Install all parts before mounting subchassis. C17’s and C18’s extension shafts pass through panel bearings (Al- lied 44 U 098). Portion of home-brew bracket for crystal sockets and S1 is shown at right of front panel.

**Fig. 2**—Part of bracket on which crystal sockets are mounted is 2 5/8 x 3 3/4-in. Front of bracket (not shown) fits between S1’s bushing, front panel. 
bracket and connect the sockets to the switch. With this completed mount the assembly in the left front corner of the chassis as shown in Figs. 1, 3 and 6.

Next, install all parts on the front and back panels. After the power supply and the front panel have been wired, install the subchassis and wire it into the circuit. The shaft extensions for C18 and C17 should be installed next and the knobs tightened.

The L4/R3 combination should be prepared by winding 9 turns of No. 22 enameled wire around R3. Solder the ends of the wire to R3’s leads. This component (a parasitic choke) should be installed by soldering one of R3’s leads to the top of L5. Solder a piece of hookup wire to the other resistor lead and solder V2’s plate cap on the other end of the hookup wire. The wire should be made long enough so the plate cap can be removed. Install the crystals and tubes.

**Checkout.** Before the final can be checked.

---

**Fig. 3—View into top of transmitter shows location of major components.** Leads from underside of subchassis to back panel and to S1 pass through grommeted holes. Note especially position of L5, L4/R3 combination, NL1 and L6. Lead from L4/R3 should be long enough to permit installation of clip on V2’s cap.

---

**Fig. 4—Underside of 27/8 x 7½-in. subchassis.** Mount parts where shown and keep all leads short and direct. Wire from meter (not shown) passes through grommeted hole under C12’s ground lug and connects to L5’s bottom lug (not shown, but visible in Fig. 3). Lead from R7 also goes through hole in lower right corner.
it is necessary to tune the grid circuit. This is done best with a grid-dip oscillator (GDO) tuned to the center of the 40-meter Novice band (7175 kc) and held near L3. While watching the GDO, adjust L3's slug for a dip.

If you don't have a GDO, plug a crystal, whose frequency is near the center of the band, into the front-panel socket and fire up the transmitter (but do not press the key). Tune your receiver to the crystal's frequency. The receiver's BFO should be turned on, the AF gain should be turned up and the RF gain should be just cracked. Press spot switch S3. You should be able to hear a tone from the receiver. (If it isn't clean, reverse the AC plug.) Adjust L3's slug for maximum volume.

Tune Up. The transmitter's final now is ready to be tested. Connect a 40-watt light bulb to SO3. The receiver setup used in the preceding step again should be used. Be certain not to touch anything inside the transmitter since high voltage is present. Plug a key into J1 and close it. You should see an indication of plate current on the front-panel meter (M1) and hear a loud tone from the receiver. While holding the key, quickly adjust tuned capacitor C17 for maximum brilliance of neon lamp NL1 and the lowest indication on M1. Then adjust load capacitor C18 for the brightest glow of the neon and 40-watt lamp. Repeat this procedure of dipping with C17 and increasing lamp brilliance with C18 until the meter indicates about 140 ma.

On the Air. Ground BP1 (or else the center pin of SO2) and connect your antenna to SO3 with 52-ohm coax. Tune and load the transmitter the same way as you did with the light bulb. Neon lamp NL1 (near L6 and C17) should serve as a guide in tuning the antenna. After tuning the rig you're ready for your first CQ. You'll soon appreciate the performance of this transmitter. It's quiet when the key is up and scoots around the band at the quick twist of a switch. Good DXing!
Fig. 6—View into bottom of transmitter is mirror image of top view in Fig. 3. One part that can be seen better in this view is capacitor C15 at base of L5 and V1. Author used surplus mica but you can use a mylar. Note No. 16 enameled wire connecting C18 (extreme left) to L6. Capactor C16, barely visible, is at the base of L5 (between the tubes). Mount rubber feet on corners of bottom cover. Install top and bottom covers before putting transmitter on air.

<table>
<thead>
<tr>
<th>Capacitors:</th>
<th>PARTS LIST</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1—20 μf, 1,000 V ceramic disc</td>
<td>R1—47,000 ohm, ½ watt, 10% resistor</td>
</tr>
<tr>
<td>C2—220 μf, 1,000 V ceramic disc</td>
<td>R2—27,000 ohm, ½ watt, 10% resistor</td>
</tr>
<tr>
<td>C3—.005 μf, 1,000 V ceramic disc</td>
<td>R3—22,000 ohm, 1 watt, 10% resistor</td>
</tr>
<tr>
<td>C4, C6—.01 μf, 1,000 V ceramic disc</td>
<td>R4—8,200 ohm, 1 watt, 10% resistor</td>
</tr>
<tr>
<td>C5—100 μf, 25 V electrolytic</td>
<td>R5—10 ohm, 5 watt, wirewound resistor</td>
</tr>
<tr>
<td>C7, C10, C16—.001 μf, 1,000 V ceramic disc</td>
<td>R6, R7—25,000 ohm, 10 watt, wirewound resistor</td>
</tr>
<tr>
<td>C8, C9—100 μf, 350 V electrolytic</td>
<td>RY1—SPDT relay, 6-V, 85-ohm coil. (Phillips Advance No. 15-6 1C. Newark Electronics Stock No. 60F1274; $1.50 plus postage.)</td>
</tr>
<tr>
<td>C11—40 μf, 1,000 V ceramic disc</td>
<td>S1—1-pole, 11-position, non-shorting rotary switch. (CentraLab No. 1403. Newark Electronics 22F439. $2.52 plus postage.)</td>
</tr>
<tr>
<td>C12—390 μf, 500 V, 5% silvered mica</td>
<td>S2—SPST toggle switch</td>
</tr>
<tr>
<td>C13—.05 μf, 600 V mylar</td>
<td>S3—SPDT pushbutton switch</td>
</tr>
<tr>
<td>C14—.0047 μf, 1,000 V ceramic disc</td>
<td>SO1—Crystal socket (11 reqd. National Type CS-6, Lafayette 40 R 3713 or equiv.)</td>
</tr>
<tr>
<td>C15—.005 μf, 1,600 V mylar</td>
<td>SO2—3-contact cable-clip socket (Cinch-Jones S-303-CCT)</td>
</tr>
<tr>
<td>C17—10-365 μf variable (Lafayette 32 R 1103 or equiv.)</td>
<td>SO3—SO-239 coax connector</td>
</tr>
<tr>
<td>C18A, B, C—12-367 μf, 3-gang variable (Allied 13 U 522 or equiv.)</td>
<td>SR1—Silicon rectifier, minimum ratings: 100 ma, 100 PIV</td>
</tr>
<tr>
<td>J1—Phone jack</td>
<td>SR2, SR3—Silicon rectifier, minimum ratings: 750 ma, 750 PIV</td>
</tr>
<tr>
<td>L1, L2—2.4 mh, iron-core RF choke (J.W. Miller 4666. (Newark Electronics Corp., 223 W. Madison St., Chicago, Ill. 60606. Stock No. 59F304; 75¢ plus postage.)</td>
<td>T1—Filament transformer, secondary: 6.3 V @ 6 A (Allied 62 U 325 or equiv.)</td>
</tr>
<tr>
<td>L3—Adjustable RF coil, nominal inductance: 15 μh (J.W. Miller 21A155RB1. Lafayette 34 R 8906)</td>
<td>TPI—TP7—Solder terminals (Cambion No. 1947-2, Newark Electronics 40F1842 or equiv.)</td>
</tr>
<tr>
<td>L4—Choke, 9 turns No. 22 enameled wire wound on R3</td>
<td>V1—6CL6 tube V2—6DQ5 tube</td>
</tr>
<tr>
<td>L5—2.5 mh RF choke (National R-300S. Allied 61 Z 515. $1.12 plus postage. Not listed in catalog)</td>
<td>XTAL 1 to XTAL 11—40-meter crystals. (Available for $1.50 ea. from Jet Crystal Lab, 2424 S. Crenshaw Blvd., Torrance, Calif., and others.)</td>
</tr>
<tr>
<td>L6—15-turn air-wound inductor. Made from 1-in. dia. 16-turns-per-in., No. 20 wire, Barker &amp; Williamson No. 3015 Miniductor (Lafayette 40 R 1624 or equiv.)</td>
<td>Misc.—12 x 3-in. aluminum chassis, 9-pin and 8-pin (octal) tube sockets, ¼-in. extension shafts and couplings, terminal strips (TS1, TS2), Binding post (BP1), rubber feet (4 reqd.), 12 x 8-in. perforated aluminum (2), sheet-metal screws.</td>
</tr>
</tbody>
</table>
ASK most people what the function of a diode is and they'll say rectification—in either a detector or a power-supply circuit. Right they are so far. But there's one diode, called a zener diode, which does more than just rectify. Its primary purpose is to regulate a voltage. The device takes its name from Dr. Carl Zener (pronounced zee-ner), who discovered what now is known as zener action or zener effect.

Voltage regulation once was the job of gas-filled tubes, neon lamps and vibrating mechanical contacts. But today the zener diode, a rugged solid-state device which does not require a complicated circuit, does the job. Let's see how it works and how you'd design a circuit for other applications.

Up to a point, the operation of a zener diode is practically identical to that of a conventional solid-state diode. Fig. 1A shows what goes on in a conventional forward-biased diode and even a zener diode if it were connected the same way. The positive battery terminal connected to the P-type semiconductor material repels positively charged holes and pushes them toward the junction. The negative battery terminal similarly pushes free electrons in N-type material toward the junction where the holes and electrons combine quickly. The combining of holes and electrons constitutes a current flow through the diode and external circuit.

In a reverse-biased diode (Fig. 1B) the positively charged holes and negatively charged electrons are attracted to the negative and positive terminals, respectively. Thus, there are no electrons and holes at the junction to combine and, hence, there is no current flow.

Fig. 1C shows what happens with a zener diode. The diode is connected the same way as a reverse-biased diode. Let's see what happens now if we keep increasing the reverse-bias voltage. At first the zener behaves just like a conventional reverse-biased diode.

![Diagram of diode action](image-url)
That is, it appears as a high resistance in a circuit. Reason for this is there are no free holes and electrons combining.

But when the voltage finally reaches the zener voltage, something new and different happens. In the P-type material a few injected electrons pick up energy from the high negative voltage. Under the influence of this high negative voltage these electrons, which are called minority carriers, become active and cross the junction.

Let’s sidetrack for a second to see what minority carriers are. First, let’s review some semiconductor theory. In N-type semiconductor material the majority carriers are electrons. In P-type semiconductor material the majority carriers are holes.

However, in N-type semiconductor material there also happen to be a few holes. And in P-type semiconductor material there are a few electrons.

These electrons and holes, which are not where you’d expect them to be, are called minority carriers. Their flow in a reverse-biased diode constitutes something called reverse-saturation current. The current is of the order of microamperes and usually is disregarded. (Refer to Fig. 1B and you’ll see that majority carriers are now out of the picture since they’re away from the junction.)

The minority carriers (electrons in the P-type semiconductor material) get pushed across the junction and collide with atoms in the N-type material. A chain reaction takes place in which the collisions knock loose some fixed electrons, which in turn knock loose more fixed electrons. This causes a substantial current flow through the diode. The process is known as electron multiplication.

That resistor R,—let’s see what its purpose is since it is found in all zener-diode shunt regulator circuits. If the battery voltage is increased, more current will flow through the diode and R. However, the voltage drop across the resistor will increase but it will not increase across the diode. In other words, R absorbs all voltage that is greater than the diode’s zener breakdown voltage. This is the important characteristic of the zener diode: an increase in voltage above the zener voltage causes a proportionate increase in voltage across R, but not across the diode. Therefore, you simply connect the load across the zener diode where the voltage is constant.

But voltages and currents must remain within limits. Zener diodes are rated in catalogs according to zener voltage (Vz), the voltage at which reverse breakdown starts.

The wattage rating of the zener diode is the maximum power the diode will handle safely at its zener voltage. Zener diodes are available in 150, 250, 400, 750 mw and 1, 10 and 50-watt sizes. Zener voltage tolerances are 5, 10 or 20 per cent.

Let’s look at our practical circuit to see how you go about selecting the zener diode and how to determine the value of R. Fig. 3 is the schematic of a shunt-type regulator which reduces 12 V to 9 V. Not only does the circuit reduce voltage, it stabilizes it as well to prevent annoying volume changes as the car voltage shifts from 12 to 15 V.

First, we must solve this formula for R.

\[ R_s = \frac{E_{in} - E_s}{I_s + I_l} \]

E_in in input voltage to the regulator—the voltage supplied by the car. Since a car’s voltage can rise to as high as 15 V, we will use 15 V for E_in in the formula.

E_s is the diode’s zener voltage. You know

![Zener-Diode Characteristic Curve](color)

Fig. 2—Zener-diode characteristic curve. When forward biased (top right quadrant) the zener diode behaves like a conventional diode. When reverse-biased (lower left quadrant) no current flows until zener voltage is reached. Then the current increases rapidly. The result of this is that the voltage drop across the zener diode will remain constant even if the current through the diode is increased. A conventional diode behaves similarly except its reverse-bias curve (black, lower left quadrant) slopes and is rounded. The sharply-defined breakdown point in the zener diode is produced during manufacture, at which time carefully controlled impurity concentrations are added to the semiconductor material.
Dr. Zener’s Diode

Fig. 3—Zener-diode shunt-regulator circuit, top. Be sure that the diode’s cathode is connected to positive bus. Voltage in excess of zener voltage is dropped across Rs. Pictorial of an adapter that will drop 12 V from car’s electrical system to 9 V for transistor radio is shown at right.

what it is—it’s the voltage required by the load. Since our transistor radio is powered by a 9-V battery, the zener diode should have a 9-V rating. The diode we used had a 9.1-V rating. (International Rectifier type No. 1ZFR9.1T10, Allied Radio, $1.12 plus postage. Not listed in catalog.) A zener with a power rating of 1 watt will easily handle the low power consumption of the radio.

I, is the zener’s maximum current-handling capability in amperes. If you don’t find this rating listed in a catalog, compute it by dividing the zener’s wattage rating by its voltage rating. In the case of our diode, the maximum current would be equal to 1 watt/9.1 V which is about 100 ma. But this is a maximum current rating and is not used. To be on the safe side, the zener is normally operated at about 20 per cent of its maximum current. Thus, in the formula we will use 20 ma (or .02 A) for I,.

I, is current consumed by the load (in this case, the radio) in amperes. You’ll have to measure this with a VOM. Easiest way to is to connect a milliammeter in series with one of the battery’s leads. The average current of two of our radios was 10 ma. Therefore, I, is 10 ma, or .01 A.

When we put these values in the formula and solve it we get

$$R = \frac{15 - 9.1}{5.9} = 196 \text{ ohms}$$

Thus, resistor R, should be 196 ohms. A close standard value of either 180 or 220 ohms can be used. The power rating of R, is determined by multiplying the voltage drop across it by current through it. These values can be taken from the formula above: E = 5.9 V and I = .03 A. The answer is .177 watts; therefore, a half-watt resistor will do the job.

Construction details are shown in Fig. 3. Polarities are important. If your zener diode is not marked with the symbol shown, connect the lead which is insulated from the case to negative side of the circuit. You can connect the 9-V output to the transistor radio with a battery clip from a discarded 9-V battery. Connect the regulator to the car’s electrical system with a cigarette lighter plug. The .02 µf capacitor kills noise from the ignition system.

---

Electronics Illustrated
By KEVIN REDMOND, K2HTZ

Varactor Super Band Spreader

$4 in parts makes any spot on your dial as broad as the side of a barn.

MOST short-wave receivers nowadays include bandspread. Good thing, too, for if they didn’t it would be practically impossible to tune in stations that are packed together on the dial.

But frequently a receiver’s conventional bandspread doesn’t sort out the pile-ups as much as you’d like. Think back to the number of times you wanted to be able to bandspread the bands—especially when you are trying to tune SSB!

And if you happen to own a short-wave receiver that has no bandspread (like the Lafayette HA-226 below) then reach for your soldering iron fast.

Adding bandspread to either type receiver doesn’t require a system of pulleys and belts. There’s a better and easier way to do it electronically—with varactors.

What are varactors? Simple—solid-state diodes that work like and are used as variable capacitors. By applying a reverse bias voltage to a varactor (positive voltage on cathode, negative voltage on anode) you change the capacitance between its leads.

For example, when the reverse-bias voltage across a 1N3182 silicon voltage-variable capacitor (varactor) diode is −4 V, the diode resembles a 33-µµf capacitor. Change the DC voltage and the capacitance changes. In our application, we connect several diodes in parallel with the oscillator section of the receiver’s tuning capacitor. When we vary the reverse DC bias on the diodes, the diodes’ capacitance changes. Consequently, the receiver’s oscillator frequency changes. Varying the receiver’s oscillator frequency then shifts the receiver’s tuning. You can make the frequency shift any amount you want—it depends on the size of capacitor C1 and the number of diodes.

To see how much standard and super bandspread can be obtained with varactors, look at the table on the next page which shows what happened to a Lafayette HE-30 (superseded by the HA-230) communica-

Fig. 1—Lafayette HA-226 short-wave receiver does not have bandspread and can use it. Control we added is at left between phone jack and switch.

July, 1966

www.americanradiohistory.com
Band Spreader

A band spreader is added to the Lafayette HA-226 receiver to produce the frequency shifts shown below when the potentiometer is turned 300 degrees. All frequencies are in kilocycles.

<table>
<thead>
<tr>
<th>FREQ. TO WHICH RCVR. WAS TUNED (KC)</th>
<th>WIDTH OF BANDSPREAD WITH Conventional Bandspread</th>
<th>WIDTH OF BANDSPREAD WITH Varactor Bandspread</th>
<th>WIDTH OF BANDSPREAD WITH Super Varactor Bandspread</th>
</tr>
</thead>
<tbody>
<tr>
<td>1600</td>
<td>10</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>4800</td>
<td>32</td>
<td>31</td>
<td>3</td>
</tr>
<tr>
<td>14500</td>
<td>100</td>
<td>98</td>
<td>10</td>
</tr>
<tr>
<td>30000</td>
<td>200</td>
<td>196</td>
<td>20</td>
</tr>
</tbody>
</table>

Construction. Our bandspread circuit was built on a 3 x 1¼-in. piece of perforated board. Before you start to build the circuit shown in Fig. 2, two or three points must be considered. The number of diodes and the capacitance of C1 determine the amount of bandspread. In a tube receiver, a 10 μf capacitor for C1 and three diodes produce about the same amount of bandspread as could be obtained with the existing bandspread control in, say, the Lafayette HE-30 or a Hallicrafters S-38B receiver. The circuit we show, therefore, would be the one you would want to add to a receiver that has no bandspread, such as the Lafayette HA-226.

If your receiver already has bandspread...
you naturally would want to add super-bandspread to be able to produce with a 300-degree turn of R3 about 10 times the bandspread you presently get. To do this, use a 2 µµf capacitor for C1 and three diodes. An alternative is to eliminate two diodes and use a 10 µµf capacitor for C1.

Next thing to do is measure the RF voltage across the oscillator section of the tuning capacitor. You'll need an RF probe for your VTVM or scope to do this. If the voltage is greater than 15 V you'll have to use a smaller-value capacitor for C1. This is because C1 is part of a capacitive voltage-divider network (which includes the capacitance of the varactors) that reduces the oscillator voltage across the varactors.

If the RF oscillator voltage is too high the varactor will be driven into forward conduc-
tion and will load down the oscillator. When driven into reverse breakdown the diodes will be damaged. But on most receivers this won't be a problem. The oscillator voltages (rms) in our S-38B and HA-226 were 15 V and 9 V, respectively.

Below is a table that relates receiver B+ voltage, oscillator voltage, the number of diodes to use and the value of other parts. C1 is 10 µµf and R3 is 10,000 ohms.

<table>
<thead>
<tr>
<th>RCVR. B+ VOLTAGE</th>
<th>RCVR. OSC. VOLTAGE</th>
<th>NO. OF DIODES</th>
<th>R2 (OHMS)</th>
<th>R4 (OHMS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>180</td>
<td>15</td>
<td>3</td>
<td>680</td>
<td>47,000</td>
</tr>
<tr>
<td>120</td>
<td>15</td>
<td>3</td>
<td>560</td>
<td>47,000</td>
</tr>
<tr>
<td>12*</td>
<td>15</td>
<td>3</td>
<td>4.8</td>
<td>—</td>
</tr>
</tbody>
</table>

* Transistor receiver: C1 = 47 µµf.

Wiring is critical at the point where C1

[Continued on page 110]
"Get more education or get out of electronics...that's my advice."
Ask any man who really knows the electronics industry. Opportunities are few for men without advanced technical education. If you stay on that level, you'll never make much money. And you'll be among the first to go in a layoff.

But, if you supplement your experience with more education in electronics, you can become a specialist. You'll enjoy good income and excellent security. You won't have to worry about automation or advances in technology putting you out of a job.

How can you get the additional education you must have to protect your future—and the future of those who depend on you? Going back to school isn't easy for a man with a job and family obligations.

CREI Home Study Programs offer you a practical way to get more education without going back to school. You study at home, at your own pace, on your own schedule. And you study with the assurance that what you learn can be applied on the job immediately to make you worth more money to your employer.

You're eligible for a CREI Program if you work in electronics and have a high school education. Our FREE book gives complete information. For your copy, airmail postpaid card or write: CREI, Dept. 1707-D, 3224 Sixteenth Street, N.W., Washington, D.C. 20010

NOW! TWO NEW PROGRAMS!
- Industrial Electronics for Automation
- Computer Systems Technology
By J. K. LOCKE  Slowly the pulsing, whirling cloud of dust, gas and space debris coalesced into a planet. As it formed, the heat of radioactivity grew. Gravity pulled the molten heavy elements—iron, nickel, chromium—toward the center of the sphere.

Then somewhere in the seething, liquid heart of the planet a small electric current sprang up. Chemical variations may have created a crude battery. A weak current may have been induced in a blob of flowing metal as it moved within a stray magnetic field. Or a thermoelectric junction where molten core met outer mantle perhaps sparked a current flow. Whatever the cause, the current began. And, as all currents do, it created a magnetic field around itself. The field was cut by still other masses of molten metal and still more currents—and more magnetic fields—were generated.

Gradually the currents built. The molten core of the planet and its 1,800-mi.-thick plastic outer mantle did not rotate at exactly the same speed. The magnetized rocks of the crust began to act like the field coils of a dynamo; the moving masses of metal within were armatures. As in a dynamo, the magnetic fields and electric currents were self-perpetuating, so long as the huge machine continued to move and radio-active heat within made the metal churn.

The planet, of course, is the earth. Its circulating currents create the world’s biggest magnet—the world itself.

This gigantic self-excited electromagnet went into operation during the earth’s formation but for more than 4 billion years this fact went unnoticed. Finally man evolved and discovered lodestones—naturally magnetized rocks. According to legend, a Grecian shepherd named Magnes was tending his sheep on Mount Ida one day. He touched his iron-tip staff to a stone and, much to his surprise, couldn’t pull it away. Thus in one stroke he discovered the lodestone and gave his name to its most important quality: magnetism.

The stone with the magic power both delighted and frightened the ancients. Many thought charms made of lodestone would attract a lover, cure an illness or perform other miraculous deeds. The ancient Chinese noticed that the rock, hung from a thread, always would turn itself in the same direction. And it soon was found that a delicate needle, magnetized by rubbing it on a lodestone, did the same job even better. That was the birth of the compass.

The small lodestones, or needles, the ancients felt, were pointing toward a mountain-size mother lodestone somewhere on the earth. This explains why ancient mariners were wary. Though they used the compass to navigate, they feared the great mountain of lodestone that their needles pointed toward would attract any ship that sailed too close, pull all the nails from the hull and dump everybody into the sea. History doesn’t reveal how apprehension about encountering the mother lode may have affected explorers searching for a Northwest Passage, but Sinbad the Sailor was shipwrecked by Lodestone Mountain in The Arabian Nights.

To this day the lodestone-mountain legend is so strong (and, perhaps, teaching of the sciences so poor) that a surprisingly large proportion of
our average citizens, when asked what makes the compass needle point the way it does, answer, "The lodestone." (To set the record straight: the needle only by coincidence is pointing at anything; it turns the way it does to align itself with the earth's lines of magnetic force, and this brings the N end around to point toward the imaginary Magnetic North Pole.)

In 1600, Sir William Gilbert, physician to Queen Elizabeth I, made a small lodestone globe. Noting that a compass passed over its surface behaved exactly as one moved similarly over the surface of the earth, Sir William correctly concluded that the earth was a giant magnet. He erroneously repeated the errors of the ancients, however, when he assumed that global magnetism came from a giant mass of magnetic material somewhere in the earth. Truth to tell, only within the last few decades have men begun to understand what does cause the mysterious, invisible field of force that cloaks the earth. And the discoveries have brought surprises.

For centuries scientists imagined that the earth's magnetic field was similar to that surrounding an ordinary bar magnet. Lines of force, according to this classical picture, circle symmetrically from pole to pole, enclosing the earth in a neat cocoon of magnetism. The strength of the field gradually diminishes as distance from earth increases. Theoretically, the field extends to infinity.

It's a tidy, orderly picture. But it's all wrong. Satellite-borne magnetometers—instruments that measure magnetic fields—recently have given scientists cause to discard ages-old concepts. Such devices show the earth's magnetosphere (its sheath of magnetic energy) is a turbulent area, battered by solar winds and storms. And this magnetic field, this blob of celestial Jello, shaking and quivering under the sun's repeated assaults, doesn't extend to infinity. It stops sharply at a point some 40,000 mi. from the earth on the side nearest the sun.

And it's not symmetrical. Instead, it is a vastly elongated teardrop with its blunt end toward the sun. Its tail flutters in the solar breeze on the earth's leeward side. (Our illustration on the opening pages of this article shows an artist's concept of what now is known about the earth's magnetic field. The quarter-moon-like areas on either side represent the Van Allen belts, held in place by the earth's magnetism.)

Above all, the earth's magnetic field is not static as has been pictured. Geophysicists now think that the movement of molten metal in the earth's core—the movement that gives rise to the magnetic field—is not smooth and steady. Instead, it's a series of turbulent eddies and churning currents. The magnetic fields generated by these eddies all add up to produce the planet's overall magnetic pattern. But each of the eddies has its own individual magnetic field, too. And these individual currents play strange tricks.

As every sailor knows, the magnetic compass points directly toward the magnetic North Pole at only a few spots on earth—places of so-called zero declination. In most areas, the needle points 5, 10 or even more degrees to the left or right. Anyone using a compass must compensate for this declination to get a true reading. What's more, the declination at any given point changes slowly over the years. The longest magnetic records extant have been kept at Greenwich, England. When the record-keeping was begun just before 1600, the compass needle at Greenwich pointed 11 degrees east of true north. In the next 200 years, the needle drifted west some 35 degrees and by 1810 was at 24 degrees west (current declination: about 15 degrees west).

The shifting currents deep within the earth cause the magnetic field on the surface to vary in strength as well as direction. In 100 years the magnetic intensity in South Africa has doubled. In other places it has weakened. While eddies in the earth's interior cause local declination and variations in intensity,
the drifting of the molten core causes the entire magnetic pattern of the globe slowly to drift westward some 17 miles a year. This slippage between crust and core may account for another strange feature of the earth's magnetic field: the wandering of the poles.

The magnetic poles themselves, of course, are nothing but imaginary points on the surface of the globe where the magnetic lines of force surrounding the earth converge. One pole is arbitrarily called North, the other South. We think of the compass as pointing north but that's arbitrary, too. The Chinese who, after all, did invent the instrument, always have considered the compass needle as indicating south.

Interesting, too, is the fact that the magnetic poles do not coincide with the true poles. The position of the true poles is fixed by the earth's axis—the imaginary line around which the planet rotates. But since the location of the magnetic poles is determined by the shifting currents in the molten interior, they can be almost anywhere. Truth is, scientists now believe the magnetic poles have been on the move for hundreds of millions of years. The Magnetic North Pole, according to recent evidence, was somewhere near what is now the state of Washington 600 million years ago. It later took a looping tour of the Pacific, then cut up through Japan, China and Russia in making its way to its present position. And it's still moving. In 1831 the Magnetic North Pole was on Boothia Peninsula on the North American coast. During the next 116 years it drifted north 200 miles and was on Prince of Wales Island in 1947. Then it put on a spurt of speed and had moved another 200 miles by 1959. When last seen it was racing across Melville Island at better than 240 feet a day.

Paleomagnetism—the study of magnetic particles frozen in sedimentary rock laid down by ancient seas—shows that the poles even have flipped from time to time. Once every million years seems to be the flip frequency and some observers believe the poles may be readying for another flip right now. The
total magnetic strength of the earth has dropped by about 10 per cent in the last century. Should this trend continue, some scientists think the field could pass through zero, then reverse its direction.

If this happens it will be quite a jolt to humanity. Compasses will cease to work. The aurorae borealis and australis (northern and southern lights) will disappear. Long-range radio channels will go out of business. The Van Allen belts, held in place by the earth’s magnetism, will vanish. It even could mean the end of human life as we know it. A Canadian geophysicist, Professor Robert J. Uffen of the University of Western Ontario, believes previous magnetic field reversals may have altered life on earth drastically. Explanation is that the disintegration of the protective Van Allen belts allowed unusually high levels of cosmic rays and other radiation from space to hit the earth. This radiation according to Professor Uffen, could have set off waves of violent mutation among living things and thus might account for the relative rapidity of evolution. Should such radiation be allowed to reach earth again, life could be altered markedly.

As the possibility of extinction by magnetism faces life on earth, other less lethal magnetic phenomena are in progress. The entire atmosphere of the earth is subjected to twice-a-day tides, just as are the oceans. People living at the bottom of this restless sea of air don’t feel fluctuations any more than fish at the bottom of the deep notice ocean tides. But a hundred miles above the earth they’d witness a continuous mile-high tidal wave of air.

Since the gasses of the thin atmosphere at this level largely are ionized by the sun’s ultraviolet rays, they are excellent conductors of electricity. And when any conductor is moved across magnetic lines of force—in this case, the earth’s magnetic field—an electric current is generated. Averaging more than 1,000,000 amperes, the current generated in the ionosphere creates its own magnetic field. Since the air is free to move rapidly, the field varies rapidly, too. Measuring instruments on the ground easily can detect the ebb and flow of the magnetic tide.

Fluctuations of the plasma-borne current circling the globe reach a dramatic climax during the most spectacular of the earth’s magnetic shows—a magnetic storm. One of the most violent ever recorded began at 4:08 p.m. EST on Sunday, Feb. 9, 1958. A huge solar flare—a leaping, twisting tongue of flame—shot hundred of thousands of miles across space, spewing a dense cloud of plasma toward the earth. By 6:02, the flare had disappeared but the cloud now was speeding across space at better than 3,000,000 mph.

All day Monday magnetographs on earth continued to trace normal, relatively straight lines across their charts. Then at 8:26 that evening, the thin front edge of the cloud struck the earth’s magnetosphere. Huge electric currents shot through the ionosphere, creating massive, pulsing magnetic fields. The tracing on the magnetograph at Fredericksburg, Va., suddenly drew a series of jagged lines. Badly disrupted, the ionosphere quit reflecting long-distance radio signals and began absorbing them. At 8:30, an operator at the American Telephone & Telegraph Co. in New York reported that radio circuits to Europe were acting up.

Simultaneously, a spectacular fiery aurora lit the Canadian sky from Atlantic to Pacific and started moving south. Minutes later, intense red and green arcs, rays and patches made a brilliant display over the northern United States. At 8:55, the full force of the cloud struck, and magnetic hell broke loose from pole to pole. At Fredericksburg the magnetograph tracing skittered crazily to the edge of the recording paper. In Fairbanks the tracing shot clear off the page. All radio contact between the Old and New Worlds stopped as though someone had thrown a switch.

The earth’s magnetic field, collapsing before the onslaught from space, induced tre-

[Continued on page 119]
A BAD crystal often is the last thing a CBer thinks of when his rig’s performance isn’t up to snuff. But rocks do poop out. And the reason they do is because transceivers often pull the last drop out of the rock, leaving no reserve activity. And when a crystal’s output falls the rig’s output goes right down to the basement.

Or, due to a failing crystal, the receiver’s sensitivity could get so bad you hardly could hear a shout from a station a block away.

And a reduction in RF drive to the final—caused by a weak crystal—can affect modulation adversely.

On the flip side of the coin there are those CBer who suspect the crystal at the first sign of poor performance. This means many good crystals are consigned to the junk box that shouldn’t be. But with EI’s 1-transistor rock checker handy you’ll know for sure whether your crystals are good or bad.

The checker will determine the condition of 99 per cent of all (6 mc and up) overtone and fundamental crystals used in CB gear. The meter indicates directly whether a crystal is bad, fair or good. You also can use the checker to keep track of a crystal’s continuing performance. You simply jot down the meter indication when you check a new crystal, then compare it periodically with the indication after the crystal has been put in service.

**Construction.** Parts layout and component values are extremely critical; therefore, follow the pictorial closely and use only the components specified. Make no substitutions.

Start off with L1, which is wound on a J. W. Miller No. 4400 coil form. Unlike the case with other coil forms, you must install the ring-terminal lugs and slug spring on this one. Take the slug spring—the triangular wire object—and slip it in the notch at the top of the mounting bushing. Slip one ring terminal on the form and slide it on until it is 5/32 in. from the end with the metal collar.

Next, tensilize a 4-ft. length of #22 enamelled wire by clamping one end in a vise and pulling until the wire goes dead slack. (If the wire isn’t tensilized the coil will unwind.) Attach one end of the wire to the mounted’ ring terminal and wind on 15 tight, close-wound turns. Then slide the other ring terminal up against the winding and solder and the wire to it. If the coil looks sloppy take it apart and wind it again. Set L1 aside.

Install all parts on a 2 7/16 x 3 3/8-in. piece of perforated board and mount the board on the back of the cabinet cover, using ¼-in. spacers between the board and the cover at each mounting screw. Flea clips should be used for tie points.

Note S2’s wiring carefully. Capacitor C5 is switched into the circuit when L1/C4 are switched in. If C5 and C6 are reversed the meter will indicate, but incorrectly.

*July, 1966*
Schematic of checker. Circuit is simply an oscillator in which meter measures detected RF output voltage at collector of Q1. Since capacitors C5 and C6 form an RF voltage divider network for the meter's calibration, they must be 5 per cent silvered micas because their values are critical.

Only an HC-6/U crystal socket is indicated because it is almost impossible to obtain sockets for wire-lead and close-pin crystals. If your rig uses miniature crystals solder two small alligator clips to short lengths of wire. Then, to test miniature crystals simply plug the clip leads into SO1 and connect the clips to the crystal.

Test and Alignment. Connect a milliammeter, set to measure at least 25 ma, in series with one of B1's leads and turn S1 on. Do not place a crystal in SO1. Current should be from 6 to 9 ma. If the meter indicates higher than 12 ma, turn off the power quickly and check for a wiring error.

Set S2 to the overtone position (L1/C4 in the circuit, R4 out of the circuit), plug a mid-band transmit overtone crystal in SO1 and adjust L1's slug for maximum dip on the test meter. While watching M1, adjust L1 for maximum indication. The adjustment may be broad. If it is, turn the slug to the midway point. If adjusting L1 causes M1 to go off-scale, you may have interchanged C5 and C6.

No adjustment to L1's slug is needed for fundamental crystals. Just plug the crystal into SO1, set S2 to fundamental and check to see that M1 indicates. If you don't get an indication check for a wiring error.

Using the Checker. For both overtone and fundamental crystals this is M1's calibration: bad: 0 to 0.25; fair or questionable: 0.25 to 0.5; good: 0.5 to 1.0. Naturally, the more active the crystal the higher the meter indication.

As a general rule, overtone crystals tend to...

**PARTS LIST**

B1—9V battery (Burgess 2U6 or equiv.)
Capacitors: All 75 V or higher
C1—33 μf
C2, C3, C7—0.1 μf
C4—100 μf, 5% silvered mica
C5—10 μf, 5% silvered mica
C6—22 μf, 5% silvered mica
D1—1N34A diode
L1—Coil, wound on J.W. Miller No. 4400 form (Lafayette 34 R 8951)
M1—0.1 ma DC milliammeter (Lafayette 99 R 5052 or equiv.)
Q1—2N697 transistor
Resistors: 1/2 watt, 10%
R1—27,000 ohms
R2—10,000 ohms
R3—100 ohms
R4—470 ohms
R5—1,000 ohms
S1—SPST toggle or slide switch
S2—DPDT miniature toggle switch
SO1—Socket for HC-6/U crystal (National Type CS-7. Lafayette 40 R 3715 or equiv.)
Misc.—6 1/4 x 3 1/2 x 2 in. Bakelite box (Lafayette 19 R 2001), cover for box (Lafayette 19 R 3701), perforated board, flea clips, alligator clips.

Electronics Illustrated
Be sure D1 is under L1's slug against the board, not up in the air. If L1 is wound correctly its terminals should line up with two flea clips spaced two holes apart. Solder L1 directly to clips.

Circuit board just fits on cabinet cover. Layout is critical; therefore, mount D1 and associated parts at bottom of board. Install Q1 and its circuit at top of board. L1 goes between the two circuits to cause a meter indication of 0.7 or higher when they are new. Fundamental crystals will cause indications from about 0.4 to 0.7. To keep track of a crystal's performance, cement a chart on the front panel, showing the indication you get with a new crystal. Then you can check suspect crystals against reference values.

Overtone crystals also will produce an indication on M1 when S2 is set to fundamental while fundamental crystals might indicate when S2 is set to overtone. Readings taken with S2 in the wrong position naturally are meaningless. Always set S2 to the correct position before inserting a crystal.

**Note:** Some overtone crystals used in older CB rigs will not cause the checker's circuit to oscillate. It is easy to tell whether your crystal fits this group since it will perform in the transceiver but will not cause M1 to indicate higher than 0.1—if at all. If your crystal fails to start the oscillator, substitute a 130 µµf capacitor for C4. This will permit you to test your hard-start crystals.
St. Pierre and Miquelon Islands always have been classed as a comparatively rare game though there are at least two FP8s active on 20 meters. Saul Kaplan, WB2HIZ, reports working FP8DR, and Jerry Sokolowski, K8BZK, has worked FP8CK.

SWLs hoping to log E. Pakistan (which EI’s DX Club counts separately from W. Pakistan) should watch for the transmitter at Dacca on 17890 kc. Station has news in English at 0835 EST.

That station at Elizabethville, Rep. of Congo, again is being logged in North America on 11866 kc. It now identifies as R. Interprovincial du Katanga and peaks around 1530 EST. Latest person to report it is Gerry Dexter of Wisconsin.

R. Republik Indonesia has shown up on a brand-new channel—9770 kc—for its 0545 PST English news. Station easily is the best bet for anyone on the West Coast desirous of logging Indonesia.

The international service of R. Kabul, Afghanistan, currently is installing a new 100-kw transmitter but should be back on the air by the time you read this. Watch for it on approximately 15225 kc around 1330 EST.

R. Nacional, Colombia, again is on 4955 kc, though its frequency varies slightly from night to night. Station puts out one of the strongest signals on 60 meters.

The Republic of Honduras is a surprisingly difficult logging for many, though HRST, R. Primero de Mayo, at Tela often squeaks through. Station can be heard on 4790 kc until sign-off at 2200 EST.

Two New Guinea territory stations—R. Wewak on 3335 and R. Rabaul on 3385 kc—currently are being picked up on the West Coast around midnight PST. Both are weak and under heavy QRM, so be prepared for a battle.

At last report, both R. Mogadiscio, Somalia, and ETLF (R.V. Gospel), Addis Ababa, Ethiopia, were on 7120 kc at 2230 EST. Result is lots of QRM plus a chance to log both stations at once. Could this doubling on 7120 be an accident or are sinister forces afoot?

R. Tahiti has moved both its transmitters and now is operating on 6135 and 11820 kc. The latter sometimes can be heard early as 2200 EST, though the 6135-kc outlet ordinarily is blanketed by R. Habana Cuba until RHC’s 0100 (2200 PST) sign-off.

Don’t get excited if you hear Arabic on 4810 kc. Explanation is that R. Popular, Venezuela (of all places), has a program in this language just before 1900 EST.

According to European sources, R. Thailand is on 11945 kc with English at 0530 EST and perhaps 1200 as well. Anyone hear them on this new frequency?

Propagation: Short-wave radio conditions during daylight hours will be good to excellent in the 16- and 19-meter bands and good to fair in the 13-meter band. At night, the 25- and 31-meter bands will be best, though some DX will be possible on all bands between 49 and 19 meters.

TV and FM DX will remain fair to good in July, then taper off during August due to seasonal decreases in short-skip, sporadic-E openings.

Short-skip openings to distances up to 1,000 mi. will occur in the 10-meter amateur band as well as in the 11-meter Citizens Band during daylight hours—especially from 10 a.m. to 2 p.m., local time.

Broadcast-band DX will continue poor because of high nighttime noise levels.

Electronics Illustrated
JOHN Burroughs, an American scientist who died decades before our jet-age was dreamed of (in 1921, to be exact), once remarked that he was born with a chronic anxiety about the weather. Mr. Burroughs assuredly wasn't alone then—and he would be even less so now. We're still anxious. But for a different reason, Mr. Burroughs worried about the next day. Now we can be reasonably sure of what's coming tomorrow, the next day—or even the next. It's the day after that that worries us, especially if it's a week end.

There's no getting around the fact that nowadays we are pretty weather-wise as compared to the good old days and the reason for this lies in a single four-syllable word: electronics. Far-seeing radar, earth-girdling satellites, nearly goof-proof computers and a host of electronic devices are making the weatherman's job easier and his forecasts more reliable. Stated simply, weather forecasting is being automated. And, chances are, reliable, computer-graphed weather forecasts soon will be available for viewing on television screens and in newspapers all over the world.

Should such a prediction ring true, automatic satellite-borne cloud-mappers whirling about the earth will observe cloud formations, computers will interpret and analyze their findings and the data will be transmitted round the world in a matter of minutes. The satellites will spot potentially dangerous storms and hurricanes and watch them for signs of movement, intensification or dissipation.

Simultaneously, additional weather information will be gathered by radar and other instruments, on land as well as on buoys in oceans round the earth. Once assembled, weather and oceanographic data will be transmitted to a central computer via earth satellites.

Already we've relegated to the past such weather signs as the color of the sunset and the direction of smoke flow. For centuries, a red sunset indicated that the morrow would be fair. Smoke spreading out horizontally rather than rising spelled rain. A halo around the moon augured snow. Fact or fiction, we can discard the whole lot—if we haven't done so right now.

To be sure, residents of California and Arizona will continue to believe with assurance that there will be no rain during summer
months. There won't be—not until man manages to manipulate as well as outguess the weather. High- and low-temperature predictions will remain the only forecasts of interest to people in these regions during the summertime. Similarly, in areas where it rains every month—Seattle and environs, say—the natives rightly will continue to believe that it's about to rain when they can see the top of Mt. Rainier and raining when they can't.

Though a battery of space-age devices now is in on the weather, the barometer remains one of the meteorologist's basic tools. Thing is, the ordinary aneroid barometer must be read by a human. But a new electronic barometer developed by Lear-Siegler converts barometric pressure into digital signals which can be fed to a computer or a teletypewriter circuit for direct print-out.

And space-age forecasters aren't necessarily expensive, either. Temperature can be sensed by thermistors and the presence of sunshine or degree of overcast can be detected by solar cells and light-sensitive transducers whose output signals can be encoded.

Fog, in fact, already is being sensed by the backscatter of light from a xenon discharge tube which radiates a 1° beam in 1 millisecond flashes equivalent in brightness to 100 million candles. The density of the fog is determined by how much light the moisture particles reflect.

Also figuring in man's growing weather adeptness is the fact that conventional weather instruments such as the anemometer and weather vane have been combined with other devices in complete weather stations small enough to be portable. One, developed by Berkeley Instruments (see our photo on the first page of this article), already is in use by the Weather Bureau and other government agencies. Modern as a supersonic jet, it readily reports wind speed and direction, air temperature, barometric pressure, relative humidity, rainfall, nuclear radiation, solar energy and dewpoint in the form of encoded signals.

For a look at just how far electronic forecasting has come, take a gander at the nation's largest metropolis, New York City. There, Weather Bureau radar high atop the RCA Building scans a 45,000-sq.-mi. area
Aircraft, too, are getting in on the latest in weather-wiseness. For though radar long has been used aboard aircraft for looking at the weather ahead, some air lines recently have installed new, more-sensitive radars that figuratively can see weather beyond the weather. According to RCA, the manufacturer, these new radars provide twice the usual airborne radar range. In addition, new weather-radar techniques developed by RCA permit us to see such meteorological phenomena as wind shear in clear air.

Wind shear results when two adjacent masses of air moving in different directions slide past one another, producing downdrafts, turbulence and other rough atmospheric conditions. According to RCA, the new radar techniques will enable weathermen on the ground to give pilots almost instantaneous information on wind-shear areas. Simultaneously, they will provide data on direction, velocity and vertical extent of wind field aloft and the location and severity of the turbulence.

Another part of the RCA scheme of things is plans for positioning a meteorological station as high as the plane which carries it can fly. Information will be transmitted continuously and with greater accuracy than afforded by the current radiosondes. Reason is that balloons presently sent aloft to gather information about wind fields, turbulence and other weather conditions must radio the information back to ground, where it then is interpreted. Hope is that the proposed airborne station would eliminate many of the pitfalls inherent in the balloon-to-ground-to-computer setup.

Also worth noting is our increasing reliance on weather satellites. Already in orbit for more than five years, these dutiful space-travelers have provided man with a window on the weather. As of this writing, more than 2,100 storm bulletins based on satellite observations have been issued to some 50 countries by the Weather Bureau. The TIROS satellites alone have observed about 165 hurricanes, typhoons and tropical storms. Matter of fact, during the past three years not one day has passed during which the satellites did not send out cloud-cover pictures for use by meteorologists.

As for the future, first of the new TOS satellites, which was launched this year, will provide global meteorological data to

[Continued on page 119]
GOOD READING

INVENTORS IDEA BOOK. By L. George Lawrence. Howard Sams & Bobbs-Merrill, New York & Indianapolis. 128 pages. $1.95

According to some old advice echoed at the beginning of this book, successful invention sometimes depends less on your skill at solving a problem than on your ability to find the right problem to solve in the first place. And that's what this little book is all about. It suggests some known needs of sorts and implies that a resourceful person might devise gadgets to meet many of them.

Thing is, we're not entirely certain all these needs can or should be satisfied. A flying-saucer detector (p. 59) might appeal to the nutty fringe, though they seem to be detecting a more-than-ample quantity without electronic help. Fusing the filament of an electronic vacuum tube (p. 53), another of the book's 185-odd suggestions for electronic and mechanical inventions the author feels are needed, likely would interest only those sweet souls who have been plugging for fuses in flashlights all these years. And a self-contained oscillator (p. 103) is something we always thought already was on the books, though the author seems to have a rather special oscillator in mind. Says he:

"A method for producing continuous, self-contained oscillation of LC-type oscillators that does not use vacuum tubes or transistors should be worked out. The substance of this problem is illustrated in Fig. 184.1 (see our illustration). Once triggered, the circuit will continue to oscillate if it is maintained at cryogenic temperatures. This is a cumbersome process due to the machinery involved. The new invention should therefore strive to approach this problem by special feeding methods (connected at a and b) based on solid-state inductance coupling."

Lamentable, we think, that this book wasn't around in Edison's time. He no doubt would have found a place for it on his library shelf beside Peck's Bad Boy.


The product of a group of students at the Harvard Business School, this is the kind of report you seldom see on a new area of technology. Rather than a technical treatise, it's an interesting look at the VTR from a socio-economic standpoint and an estimate of how much and how fast it's going to influence the way we live.

Considering the book's origin as a student research report, it's questionable whether the price of $12 (yaiks!) really is justified. Even so, the book does contain a lot of information for anyone whose interest in this branch of electronics goes beyond schematics.

DICTIONARY OF ELECTRICAL ENGINEERING. Compiled by K. G. Jackson. Philosophical Library, New York. 373 pages. $10

British spoken here! But once you get accustomed to translating valve into tube and earth into ground you have a useful and comprehensive dictionary that's just the right

[Continued on page 117]
Brass pounders become artists with the key after using an electronic keyer. Quite unlike the ham's old standbys, the J-38 straight key and the semi-automatic bug, an electronic keyer enables you to send perfect code every time. Hold its paddle to one side and it produces dahs continuously. Hold the paddle the other way and dits pour out without end. And you never have to worry about character duration and spacing—they're always perfect.

Up to now electronic keyers have been expensive accessories and regarded as luxuries around the ham shack. But the $39.95 Heathkit HD-10 has brought the electronic keyer into the ballpark of practically any operator whose dream has been to send clean-as-a-whistle code effortlessly.

Eleven transistors, in a computer-like circuit full of flip-flops, put the HD-10 among the most advanced-design keyers. Regardless of where the speed knob is set the spacing between and the length of the characters remain constant. The dits and dahs are self-completing. That is, even if you just tap the paddle to one side of the other, the dit or dah lasts for its full duration.

Building It

Construction includes two types of wiring: printed-circuit and point-to-point. The circuit board virtually eliminates all chances of error and saves much construction time. However, there's enough routing and soldering of cable-harness wires to give that real build-it-yourself feeling. It's about a ten-hour job to assemble the kit, plus a little time for putting with mechanical adjustments.

On The Air

It was with trepidation that we put this keyer on the air for the first time. Reason was that its design looked similar to a circuit we'd seen published somewhere before. We constructed that circuit, which worked beautifully until the transmitter was flipped on. Then RF fields occasionally caused false triggering and garble.

The problem did not exist with the HD-10. Itkeyed a 100-watt transmitter when it was about 15 ft. from the antenna (thus in strong

The keyer contains a lot of components but construction is not that difficult since most parts are mounted on an uncrowded printed-circuit board.
Controls in cover are connected to circuit board with cable harness. The dual pot is the speed control. Other pot is for the keying-monitor volume.

**LOW-COST ELECTRONIC KEYER**

RF fields) without one misfire. A big feature of the HD-10 is that it has electronic (transistor) switching instead of a rat-a-tat-tat keying relay found in some other keyers.

If the keyer can be faulted at all it's for lack of flexibility in allowing selection of the basic speed range. Early in construction you must decide whether you want to send 10 to 20 wpm or 15 to 60 wpm. You then solder either a 10,000-ohm or a 68,000-ohm resistor on the board, depending on desired speed range. Neither range met all the requirements for our CW operator, an 18-to-25-wpm man.

The high-range resistor did not permit the keyer to be slowed sufficiently for two important functions: working DX through heavy QRN/QRM conditions or working slower operators who could well provide a rare QSL, say, to get a worked-all-states certificate. Installing a low-range resistor, on the other hand, can cramp your style if you want to get over 20 wpm.

The back panel of the keyer permits hookup of a manual key for slow-speed work, but in a sophisticated instrument such as the HD-10 the addition of a speed-range switch would be a welcome feature.

The keyer works with most transmitters but cannot be plugged indiscriminately into every jack. Keyed current shouldn't exceed 35 ma and voltage across the key contacts must be under 105 V.

The manual gives a good checkout procedure plus a method for adjusting the dit-dah space ratio with a VTVM. Shown, too, are several possible hookups for listening to your fist through the keyer's built-in speaker or via your receiver.

Old-time hams like to caution beginners against any kind of speed key. You'll send faster than you can receive, goes the argument. We disagree. The statement is almost true since anyone who sends faster than he can copy has neither much fun nor success on CW. And he soon finds it out. An electronic key, on the other hand, provides a near-effortless method for sending remarkably clean code that others find a pleasure to copy. Getting the hang of the key takes no great skill—just some practice.

The rear terminal board takes connections to transmitter for keying, to receiver for optional monitoring and has a jack for a conventional key.

*Electronics Illustrated*
STEREO sets, communications receivers and ultrasonic cleaners aren't the kind of gear their users normally would consider shocking, though all can be capable of a nasty jolt at times. Thing is, each of these items often as not incorporates a rock that packs a real punch. For squeeze that rock—called a piezoelectric crystal — and the result is bound to be shocking.

A thin slice of brittle material about the size of a fingernail, a piezoelectric crystal has the unique property of converting mechanical vibrations into corresponding electrical signals and vice-versa. As such, these little slivers represent one of our most intriguing and useful transducers—substances or devices capable of changing energy from one form to another. And though most familiar as phonograph and microphone elements, piezoelectric crystals are finding their way into all sorts of gear, ranging from the most sophisticated submarine detection systems to artificial heart mechanisms.

How it Started. Interestingly enough, piezoelectric crystals aren't new, being, we suppose, old as the rocks they're made of. But it remained for the Curies (of radium fame) to stumble across the fact that certain rocks, notably quartz, possess the peculiar quality of generating an electric voltage when squeezed. Incidentally, the word piezoelectricity is descriptive of what's going on, *piezēin* in Greek meaning to press; hence, pressure electricity.

Though piezoelectricity was discovered before the turn of the century, there was little that could be done with it at that time. The vacuum tube still awaited DeForest so there was no way to amplify the rather minute electrical currents that piezoelectric materials generate.

Came DeForest with his triode, however, and things began to look up for piezoelectricity. First major applications were phonograph pickups, microphones and headphones. World War II saw development of an underwater detection system called sonar which relied on piezoelectric properties. And in the years after the war, piezoelectricity really came into its own, being incorporated into a wealth of devices from ultrasonic cleaners to bandpass filters. And as things now stack up, piezoelectricity is destined for applications limited only by the imagination of our engineers.

What It Is. All piezoelectric materials have two basic properties. They can convert a mechanical squeeze (pressure) into an electric charge (voltage). Or they can do just the reverse, i.e., convert an electric charge into mechanical movement. The phonograph pickup is a good example of the first property, while crystal headphones are representative of the second.

In the case of the phonograph pickup, the mechanical vibrations from the needle riding the record grooves apply pressure to the piezoelectric material, causing it to generate a corresponding electrical voltage. But with crystal headphones the piezoelectric elements

**SQUEEZE ME AND I'LL SHOCK YOU**

*By JOHN POTTER SHIELDS*
operate the other way round. An applied electrical signal causes the elements to vibrate and these vibrations are coupled to the headphone diaphragms. The result is reproduced sound.

Exactly why piezoelectric materials act as they do is not precisely understood. Even so, scientists have a fair idea of what goes on inside a piece of piezoelectric material. Our explanation won't be a deeply scientific one but it should suffice to shed some light on the inner workings of these mysterious shockers.

To begin, let's assume we are looking at a piece of piezoelectric material through a high-power microscope. Magnification permitting, we can see that the material contains minute electric-charge-bearing particles called domains. Part of the domains carry a positive charge, the others a negative charge. Of those domains appearing on the faces of the crystal some likewise are positive, some negative.

When pressure is applied to the crystal the domains realign themselves so that one face of the crystal becomes positively charged and the other negatively charged. Pressure removed, the domains snap back to their original configuration, and the charges on the faces of the crystal disappear.

However, let a voltage be applied across the faces of the same crystal and the domains again realign themselves. This realignment also causes a change in the physical dimension of the material as depicted in Fig. 1.

The amount of voltage which a piezoelectric material will generate depends on the amount of pressure applied to it—the greater the pressure, the greater the voltage. Explanation is that increased pressure causes more and more domains to realign themselves and, therefore, to increase the voltage present. And in much the same fashion, the larger the voltage applied to a piece of piezoelectric material, the greater its physical change. Reason is that the greater the applied voltage, the greater the number of domains realigned; and the more domains realigned, the greater the physical deformation.

**Natural and Man-Made.** Quartz is the earliest known piezoelectric material and large quantities still are consumed in the manufacture of piezoelectric devices. Natural quartz is mined in the form of large crystals which must be sliced into wafers before they become usable as piezoelectric materials.

The widespread use of quartz as a piezoelectric element partially is due to its stable piezoelectric characteristics. The amount of voltage it will generate for a certain applied pressure or the amount of physical change for a given applied electrical voltage show little variation over long periods. Still another of quartz's advantages stems from the fact that it can be operated at relatively high temperatures without losing its piezoelectric properties.

Rochelle salt is another type of piezoelectric material in wide use. Unlike quartz, it isn't mined but rather is grown in large tanks. This growing is done by seeding a saturated Rochelle salt with a tiny crystal, the seed ultimately growing into a crystal several feet long. In essence, the procedure is the same as making rock candy from a saturated sugar solution.

As in the case of quartz, the large Rochelle salt crystals must be sliced into thin wafers in order to produce usable piezoelectric material. However, compared to quartz, Rochelle salt will generate a larger voltage for the same applied pressure. Similarly, it will provide a larger physical change for an applied voltage.

On the minus side of the ledger, Rochelle salt can't withstand the high temperatures of quartz's operating conditions.
quartz can tolerate. Also, Rochelle salt readily absorbs moisture so it preferably must be waterproofed with a suitable coating if it is to retain its piezoelectric properties for any length of time. Nevertheless, due to its high piezoelectric activity, Rochelle salt is used extensively in such devices as phonograph pickups, microphones and headphones.

Both quartz and Rochelle salt are so-called natural piezoelectric materials. And, though other natural piezoelectric materials exist, quartz and Rochelle salt account for the bulk of natural piezoelectric elements in use.

During and after World War II, a number of man-made piezoelectric materials were developed. These new materials, which basically are special forms of ceramic, possess properties not obtainable in the natural variety of piezoelectric crystals. For example, ceramics can withstand much higher operating temperatures than any of the natural piezoelectric materials. What's more, they are not affected by humidity or moisture.

Another advantage of ceramics is that they can be molded into various shapes. Quartz or Rochelle salt crystals, in contrast, only can be sliced into wafers.

All is not entirely rosy with ceramics, however. Their piezoelectric abilities are not in the same league as those of Rochelle salt and they also are a bit more expensive to produce. And, unlike the natural piezoelectric materials, ceramics must be poled to impart piezoelectric properties to them.

This poling operation (see Fig. 2) consists of applying a high DC voltage (several thousand volts) across each ceramic element. Application of this poling voltage aligns the domains in the same direction (see Fig. 3). Poling is done with the ceramic heated to several hundred degrees. When the ceramic is cooled and the poling voltage removed, the domains stay aligned.

Much like permanent magnets which lose their magnetic properties when heated above a certain temperature, ceramics are stripped of their piezoelectric properties when subjected to heat. The reason for this is that above a certain temperature (known as the Curie Temperature or Curie Point) their domains drop out of alignment and assume the random pattern they exhibited before the elements were poled.

**Putting It To Work.** Most common application of piezoelectricity is the phonograph cartridge. Since it is comparatively easy to obtain a voltage from a slice of Rochelle salt by applying pressure to it, all that need be done to produce a cartridge is couple the vibrations from the needle to the Rochelle salt element. This will result in an electrical output from the Rochelle salt element which is a facsimile of the mechanical vibration impressed in the grooves of the record.

In practice, the needle is coupled to the Rochelle salt element in such a manner that it imparts a twisting motion. This provides a greater electrical output from the element for a given needle vibration. Frequently, two Rochelle salt elements are sandwiched together in such a way as substantially to increase the electrical output for a given twist.

Crystal microphones operate in much the same manner as the piezoelectric phonograph cartridges. Only change is that a diaphragm has been substituted for the needle assembly. The mike's diaphragm is coupled to the element (Rochelle salt or ceramic) via a yoke arrangement which imparts a twisting action to the element in accordance with sound waves striking the mike's diaphragm.

Crystal headphones are much like crystal mikes in their construction, though their function is just the reverse. Electrical impulses fed to the headphone's piezoelectric element cause it to twist in step with the applied signal. This twisting action is transmitted to the diaphragm, which radiates sound. [Continued on next page]
Another big application of piezoelectricity is in the field of ultrasonic cleaning. Here, one or more piezoelectric ceramic elements are mounted on the bottom of a water- or solvent-filled tank, as shown in Fig. 4. When a high-frequency AC signal is applied the elements vibrate in step with the applied frequency. Vibrations are transmitted mechanically through the bottom of the tank and into the liquid, causing it to be agitated violently (people in the ultrasonic-cleaning industry refer to the action as cold boiling). Used in conjunction with the proper solvent, such intense vibrations cleanse small, delicate parts, such as watches and jewelry.

Boating fans often find themselves with a piece of piezoelectric material on the hull of their boats in the form of a gadget called a depth sounder. In this case, a hull-mounted ceramic element sends out a series of pulses. When these pulses strike the water bottom, a log or other object, they bounce back to the same element which now is connected to act as a mike. The length of time it takes the reflected signal to reach the element after it was transmitted directly is related to the distance the signal has traveled.

Even teeth aren’t immune to the workings of piezoelectricity. Not long ago a dental drill was developed in which the actual cutting was performed by a piezoelectric element vibrating at a high frequency. In this application, the drill operates at high efficiency and generates little heat, assuring minimum pain for the patient.

Perhaps the most dramatic use of piezoelectricity is a high-voltage generator. The device calls for piezoelectric ceramic rings to be stacked one on another, then squeezed by hydraulic pressure. As the pressure is increased, the voltage developed by the rings increases until a point is reached where the rings figuratively explode with a volley of voltage.

Piezo Probing. Those with a bent toward experimenting may wish to perform an experiment or two in order better to become acquainted with piezoelectricity and its properties. Only special piece of equipment required is a Rochelle salt element equipped with leads. An old crystal phonograph cartridge will suffice, though larger elements yielding up to several hundred volts are available from science-equipment sources. Elaboration on one or more of the following experiments might make an excellent Science Fair project.

For a basic demonstration of piezoelectricity, connect the leads from a large Rochelle salt element to an NE-2 neon lamp as shown in Fig. 5. Gripping the two opposite corners, flex the element gently back and forth, taking care not to fracture it. The lamp should flash each time the element is flexed and again each time the element is released.

The reason is that flexing the element beyond a certain point develops a voltage sufficient to ionize the neon lamp. This discharge effectively shorts out the charge developed across the element. When the element is released, a charge again builds up, though this second charge will be of opposite polarity.

Lacking a large piezoelectric element, a VTVM can be connected across a small crystal to give some indication of its behavior under stress.

The conversion of applied electrical energy [Continued on page 116]
INDICATIONS are that most manufacturers of CB transceivers would rather walk the plank than actively bring CB to boating enthusiasts. Good example was CB’s absence at the boat show in New York, held months in advance of the current boating season. The affair lured 300,000 people and was replete with electronic gadgetry—from a gleeie that tells when the rudder’s centered to one that shrieks when the bilge can blow. But for all CB was in evidence it would have gone down with the Spanish Armada.

Electronic exhibitors busily pushed their high-ticket marine radios. And at prices four times those of CB transceivers, who could blame them? When one was asked if he had CB equipment on display, he replied, “No,” we make marine radio.” (His company, in fact, does make CB gear.) Clearly, this head-in-the-sand attitude simply doesn’t measure up to reality. Here’s why.

If you think CB is crowded, tune in the standard marine bands (2000 to 3000 kc) during the boating season. What you’ll hear sounds like Errol Flynn and his mates grappling on the poop deck. And if CB has been guilty of salty language, give a listen on the marine channels (ho-ho-ho). In any case, congestion has been so bad that a new VHF marine band recently was opened on 150 mc to sop up the overflow.

But how about boating’s estimated 8 million enthusiasts? Not only is the cost of regular marine equipment prohibitive and spectrum space scarce, but high-powered marine rigs (which generally start at about 30 watts) don’t sit well in the ubiquitous 16-ft. runabout. And as local waters boil with water skiers and Sunday pilots, the open sea looks ever so inviting. That’s where two-way radio becomes a lifesaver.

We say CB has the answer. Even a 1- or 2-watt walkie-talkie, which needs no installation, power source or permanent antenna, goes bounding over the main with remarkable range. Regular 5-watters hop to the horizon and more, with ease. Sure, there’s congestion on CB, but try waving for help from a small boat. (One boatman in distress did just that; passing boats simply waved back.)

Can you get help via seagoing CB? One Coast Guard auxiliary officer says there’s no official monitoring but in many areas a call on channel 13 alerts other CB-equipped craft as well as shore-side monitors. CB, at least to this officer, is mighty effective and cheap.

Size-wise . . . Imagine a lusty, brawny 8-year-old who talks twice as much as anyone else in his family. That’s CB. Though most anyone might guess that CB’s grown like a leaking can of Crazy Foam, official figures for 1965 reveal precisely how the various radio services are divided numerically (see our chart).

As quickly is evident, youthful CB is about three times larger than ham radio, an aging uncle now passing the 50 mark. And adding all those license figures brings a grand total of more than 1½ million, of which CB alone claims over half.


“Holy barracuda!” echoes the Boy Wonder.

That’s what the Dynamic Duo surely would say if they got wind of a fresh battering for CB radio.

A press-service story picked up by newspapers and radio told how Citizens Radio is [Continued on page 113]
By DON CARTER

The 25-meter band rightfully can be said to reflect more of the fascinating chaos of today's world than any other SW spot. For international power politics, clashes between ideologies, brush-fire wars between small nations and that fight between international and regional broadcasters just for radio space itself all are moving to make 25 the trouble spot of the spectrum. Fact is, an SWL well could camp continuously on 25 and come up with a whole bagful of sizzling DX and equally red-hot listening.

Two factors, in no way related one to the other, lie behind this unusual state of affairs. One is a resurgence of nationalistic spirit that makes all previous upheavals of the type pale by comparison. The other is the return, in increasing numbers, of spots to the surface of the sun (see SUNSPOTS ARE COMING!, Sept. '64 EJ).

For with the sunspot count rising the lower bands are ceasing to be the best source of DX as they have been for the past few years. Twenty-five meters will take their place. But, interestingly enough, it is both high enough to permit use by international broadcasters and low enough to afford regional (DX) stations ample reason to scramble aboard. And with broadcaster after broadcaster zeroing in for the kill it's easy to predict red-hot propaganda wars on 25, especially from the Near East, Far East and Africa.

Generally speaking, the Far East and South Pacific are received best before noon and again starting around 1800 local time. Such information is of prime interest to SWLs in Eastern North America, where these areas sometimes are difficult to hear. Europe, Africa and the Near East (including Iran, Armenia and Uzbek S.S.R. but not Pakistan) are good from 1200 to 1800 EST. Latin America is strong from late afternoon into evening, though reception from this region generally isn't spectacular.

In official terminology, 25 meters runs from 11700 to 11975 kc but some of the most interesting action takes place just beyond those legal boundaries. Prime example is Peyk-e-Iran on 11697 kc, a Communist clandestine broadcasting primarily in Persian from 0800 until approximately 1330 EST. During these hours it also airs (though not as Peyk-e-Iran) programs in Arabic and Kurdish for Iraq. In the latter instances, the Reds would seem to be playing two feuding factions one against the other.

Some experts believe Peyk-e-Iran has its headquarters in East Germany. Whether this is the case or not, the 11697-kc transmitter itself definitely is not in East Germany but probably is located either at Tashkent (Uzbek S.S.R.) or in Bulgaria. If located in Uzbek, it would provide reception in Southern Iran and Iraq with other bands used to cover nearer target areas. Such a setup can be described as a regional operation, i.e., transmitter and target both are located in the same general area, in this case the Near East. While Bulgaria of course is a European location,
approximately the same distance factors apply.

What might be dubbed a counter-regional station also transmits on 11697 kc. It continuously plays one record, Honey Honey, and is an attempt to jam Peyk-e-Iran. As for location, Northeast Iran is a likely spot, though Iraq cannot be ruled out entirely as a possibility. Other regional stations occupying 25-meter territory include Elizabethville (formerly R. Katanga) and Leopoldville in strife-torn Congo, R. Diamang at Dundo, Angola, and R. Clube de Mozambique. (See our chart at the end of this article for frequencies and times.)

Incidentally, that station at Elizabethville now is calling itself The Voice of African Fraternity and has been granted partial status as an international broadcaster by the Leopoldville government. It has English news at 1400 EST and, inasmuch as anything seems possible in the Congo (including another declaration of independence by Katanga province), this one definitely should bear watching.

Though regional transmitters may offer the best DX prospects, most 25-meter stations are of the international variety and these provide some really important programming. For example, R. Lebanon’s English transmission at 1330-1400 EST on approximately 11775 kc well warrants tuning in. Lebanon is one of the few pro-Western republics in the Near East, which fact makes its views worth watching. Iran itself, another nation of the we-like-the-West camp, has English at 1500 EST via potent R. Tehran. Unfortunately, this station has been wandering all over the band but at last report it was on 11730 kc.

In Asia, the biggest battle on 25 meters takes the form of a three-corner free-for-all between Malaysia, Singapore and Indonesia, with Communist China waiting in the wings (though waiting perhaps implies more innocence on the part of the Chinese Reds than is their due).

R. Singapore (which nation recently broke away from the Malaysian federation) maintains an English-language overseas service on 11940 kc which is heard widely in North America around 0900 local time. R. Malaysia
BIG TROUBLES ON 25

Itself has English newscasts on 11900 at 0615 and 1745 EST. Sukarno’s R. Republik Indonesia (which desperately wants to break up this Malaysian federation) airs our language on 11715 kc at 0600, 0900 and 1400 EST. Incidentally, multi-channel R. Peking may use 11940, too, or any other 25-meter frequency, for that matter.

Still another Asian station of major interest is R. Pakistan. That dispute over Kashmir could move from smouldering into flickering (or raging) flame again at any time and also could be a cause of the Karachi government’s allying itself with Peking. R. Karachi’s English news at 0835 EST often is heard throughout North America.

To return to Africa, R. Nigeria and R. South Africa potentially are the hottest international prospects. Matter of fact, with the possible exception of Franco’s Spain, the Republic of South Africa is the only neo-fascist power left. During midday EST, R. South Africa has broadcasts to the rest of Africa on 11900. And at time of writing, word is that R. South Africa shortly will open transmissions to Europe with new, 250-kw transmitters. Even more significant is the fact that one of these powerhouses reportedly will be turned on North America.

As for still another hot topic of the day—subversion in Africa—sharp-eared SWLs often are informed of startling changes almost as they happen. During the space of two months there were four ultra-right coups in Africa—five if you count Rhodesia. First sweep took place in the Central African Republic, followed by governmental flips in Dahomey and Upper Volta. Later came the biggest eruption of all: Nigeria. But ultra-right is a pretty broad term and the incidents pose some challenging questions. Is there any connection between these four events? Is there some outside group (such as the people who formerly propped the Katanga affair) behind it? And exactly how far right are these new regimes?

For clues, SWLs might tune to the potent Voice of Nigeria on 11915 kc. English is scheduled at 1000, 1200, 1600 and 1700 EST; reception should be comparatively easy.

Finally, some nations use 25 meters for both international and regional purposes. R. Cairo relays two of its home services (Voice of Arabs plus a so-called main program) via potent transmitters on 11745 and 11940 kc while simultaneously using 11915 kc for transmissions to Europe at 1630 EST.

Also in this category is the Syrian Broadcasting and Television Service (once controlled by Egypt’s Nasser) with a low-power regional outlet on 11750 kc. Station operates throughout daylight hours (EST) and also claims a North American service on 11915 kc starting at 1800. Mysteriously, reception of neither has been reported during the past few years though the NA beam (apparently) was noted one day only on 11670 kc.

---

### E1’S HANDY GUIDE TO 25-METER DX

<table>
<thead>
<tr>
<th>FREQ. (KC)</th>
<th>STATION</th>
<th>LOCATION</th>
<th>TIME (EST)</th>
<th>QSL INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>11674</td>
<td>R. Pakistan</td>
<td>Karachi</td>
<td>Mid-morning</td>
<td>Slow in answering</td>
</tr>
<tr>
<td>11685</td>
<td>R. Diamang</td>
<td>Dundu, Angola</td>
<td>1300-1430</td>
<td>Answers by QSL card</td>
</tr>
<tr>
<td>11697</td>
<td>Peyk-e-Iran</td>
<td>(see text)</td>
<td>0900-1130</td>
<td>Not available</td>
</tr>
<tr>
<td>11697</td>
<td>Honey Honey</td>
<td>(see text)</td>
<td>0800-1300</td>
<td>Not available</td>
</tr>
<tr>
<td>11745</td>
<td>R. Cairo</td>
<td>(Home Service)</td>
<td>Daylight</td>
<td>Answers erratically by QSL card</td>
</tr>
<tr>
<td>11745</td>
<td>(Commercial Service)</td>
<td></td>
<td>1300-1700</td>
<td></td>
</tr>
<tr>
<td>11775</td>
<td>R. Lebanon</td>
<td>Beirut</td>
<td>Before 1100</td>
<td>Answers by letter</td>
</tr>
<tr>
<td>11795</td>
<td>R. Leopoldville</td>
<td>Congo</td>
<td>1300-1400</td>
<td>Answers by QSL card</td>
</tr>
<tr>
<td>11800</td>
<td>R. Ceylon</td>
<td>Colombo</td>
<td>Daylight &amp; Evening</td>
<td>Answers by letter</td>
</tr>
<tr>
<td>11810</td>
<td>R. Lebanon</td>
<td>Beirut</td>
<td>1300-1600</td>
<td>Answers by QSL card</td>
</tr>
<tr>
<td>11820</td>
<td>XEBR</td>
<td>Hermosillo, Mex.</td>
<td>Mid-morning &amp; 1900</td>
<td>Answers by letter</td>
</tr>
<tr>
<td>11872</td>
<td>R. Elizabethville</td>
<td>Congo</td>
<td>1100-1300</td>
<td>Answers by card</td>
</tr>
<tr>
<td>11900</td>
<td>R. Malaysia</td>
<td></td>
<td>1300-1600</td>
<td></td>
</tr>
<tr>
<td>11915</td>
<td>R. Damascus</td>
<td>Syria</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11940</td>
<td>R. Singapore</td>
<td>Singapore</td>
<td>Mid-morning</td>
<td></td>
</tr>
<tr>
<td>11945</td>
<td>R. Thailand</td>
<td>Bangkok</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11962</td>
<td>R. Clube de Mozambique</td>
<td>Lourenco, Marques</td>
<td>1200-1400</td>
<td>Answers by QSL card</td>
</tr>
</tbody>
</table>

---

Electronics Illustrated
SEND CARD FOR RCA'S NEW 1966 HOME STUDY CAREER BOOK TODAY

CUT THE TIME BETWEEN NOW AND SUCCESS

- Find out about RCA Institutes Career Programs.
- Learn about the amazing "Autotext" programmed instruction method—the easier way to learn.
- Get the facts about the prime quality kits you get at no extra cost.
- Read about RCA Institutes' Liberal Tuition Plan—the most economical way for you to learn electronics now.
- Discover how RCA Institutes Home Training has helped its students enter profitable electronic careers.

Lots more helpful and interesting facts too! Send postage-paid card for your FREE copy now. No obligation. No salesman will call.

RCA INSTITUTES, Inc. Dept. El-76
350 West 4th Street, New York, N. Y. 10014

The Most Trusted Name in Electronics

RCA Institutes also offers Classroom Training. Catalog free on request. (Courses also available in Spanish)

July, 1966
6 HEATHKIT® Values...See

NOW AVAILABLE FOR IMMEDIATE DELIVERY...
HEATHKIT 21" COLOR TV!

THE ONLY 21" COLOR TV
YOU CAN INSTALL 3 WAYS!
1. In a wall
2. In your own cabinet
3. In either Heath optional factory-assembled cabinets

COMPARE THESE FEATURES!
• "Rare-earth" 21" color tube for brighter colors
• 24,000 volt regulated picture power
• Tunes channels 2-83
• Automatic color control & gated automatic gain control for steady, "jitter-free" pictures
• Deluxe "turret-type" tuners with "push-to-fine-tune" that " remembers" so you don't have to readjust each time you return to a channel
• All critical assemblies prebuilt, aligned & tested...just 3 simple circuit boards to wire...requires no special skills or knowledge
• 1-year warranty on picture tube, 90 days on all other parts

No Need To Wait...Enjoy "True-To-Life" Color TV Now! Until recently, this unique color TV kit has been on a reservation basis due to the nationwide shortage of color tubes. Now we have them in stock and can fill your order immediately.

The Only 21" Color TV You Can Align & Maintain...eliminates costly TV service calls for simple color picture adjustments and minor repairs. Exclusive built-in self-servicing facilities coupled with simple-to-follow instructions and detailed color photos show you exactly what to do and how to do it. You become the expert! Results? Clean, true-to-life color pictures day in and day out.

From Parts To Pictures In Just 25 Hours! As easy to build as an audio amplifier. And you enjoy the savings (quality compares to sets costing up to $200 more). You even set-up and converge the picture...another cost-saver! Easy credit terms available, too. Use the coupon to order now!

KIT GR-53A, 125 lbs., all parts except cabinet, for wall or custom cab. mounting...$375.00
GWA-53-7, 82 lbs., deluxe walnut cab. (illust.)...$108.00
GWA-53-6, 51 lbs., economy walnut-finished cabinet...$46.50

23-CHANNEL 5-WATT SOLID-STATE CB TRANSCEIVER
23 crystal-controlled transmit & receive channels for the utmost reliability. Low battery drain...0.75 A transmit, 0.12 A receive. Only 2 3/4" H. x 7" W x 10 1/4" D...ideal for car, boat, any 12 V. neg. gnd. use. "S" meter, adjustable squelch, ANL, built-in speaker, PTT mike, aluminum cabinet. 8 lbs.

Kit GWA-14-1, 5 lbs., optional AC power supply for base-station operation...$14.95
GWA-14-2, 1 lb., 23-Channel Crystal Pack (46 crystals)...reg. $137.50 value...only $79.95
Kit GWA-14-4, 3 lbs...6 to 12 V. DC converter for GW-14...$14.95
CB crystals only $1.99 with any Heathkit CB Transceiver order.

Electronics Illustrated
The Other 244 In FREE Catalog!

Deluxe All-Transistor, 10-Band Shortwave Portable!

10 bands tune longwave, standard AM, FM and 2-22.5 mc shortwave. 16 transistors, 6 diodes, and 44 factory-built & aligned RF circuits. Separate FM tuner & IF strip same as used in deluxe Heathkit FM tuners. Two built-in antennas, 4" x 6" speaker, battery-saver switch. Operates anywhere on 7 flashlight batteries, or on 117 v. AC with optional charger/converter GRA-43-1 @ $6.95. Assembles in 10 hours. 17 lbs.

Kit GR-43
$159.95

New Deluxe Shortwave Radio!

Compare it to sets costing $150 and more! 5 bands cover 200-400 kc, AM, and 2-30 mc. Tuned RF stage, crystal filter for greater selectivity, 2 detectors for AM and SSB, tuning meter, bandspread tuning, code practice monitor, automatic noise limiter, automatic volume control, antenna trimmer, built-in 4" x 6" speaker, headphone jack, gray metal cab., free SWL antenna. 25 lbs.

Kit GR-54
$84.95

Low Cost Shortwave Radio!

Covers 550 kc to 30 mc—includes AM plus 3 shortwave bands. 5" speaker; bandspread tuning; signal strength indicator; 7" slide-rule dial; BFO; 4-tube circuit plus 2 rectifiers; noise limiter; external antenna connectors; Q-multiplier input; gray aluminum cabinet; AM antenna. 15 lbs.

Kit GR-64
$37.50

New "Q" Multiplier!

Use with matching GR-64 (opposite) or similar SWL receivers with IF circuits from 450-460 kc. Creates extra-sharp selectivity through an efficient "Q" of 4000 and provides a notch for adjacent signal attenuation. Includes built-in power supply. Charcoal cabinet, gray front panel. 3 lbs.

Kit GD-125
$14.95

FREE 1966 Catalog!

Describes these and over 250 easy-to-build Heathkits... save up to 50%. Mail coupon or write Heath Company, Benton Harbor, Michigan 49022 for your FREE copy.
WHAT TV TEST PATTERNS

THOUGH there are dozens of TV test patterns (each station transmits its own version), all are designed to let you know more than what station you’re tuned to. Nearly any test pattern will enable you accurately to read off the quality of a) aspect ratio, b) vertical and horizontal linearity, c) line count and interlace, d) video frequency response and line resolution, e) contrast and f) low-frequency phase shift.

A test pattern is composed of a frame, a large dark circle, horizontal and vertical wedges, concentric circles and black-and-white bars. (Our photo shows the test pattern transmitted by New York’s WPIX; others are similar.) Let’s see what each measures and what can be done to improve picture quality.

Aspect Ratio, Linearity. The frame is transmitted with a height-to-width ratio (technically called an aspect ratio) of 3 to 4. Tied in as a supplementary measurement with the frame is the familiar large dark circle. It is transmitted perfectly round, perfectly centered, with the top and bottom touching the top and bottom center of the frame.

Try to position the picture so the center of the large circle is at screen center, then adjust vertical linearity to vary the top of the circle and vertical height to change the bottom of the circle (these adjustments interact somewhat, so it’s best to rock both together for final adjustments). Adjusting horizontal drive, horizontal width and horizontal linearity will vary left and right sides of frame and circle. Properly adjusted, height and width of the frame will have a 3:4 ratio, all circles will be perfectly round and all wedges of equal length. If they are not, test the low- and high-voltage rectifiers, damper, horizontal and vertical output tubes.

Line Count, Interlace. A TV station transmits a picture contained in approximately 490 usable horizontal lines formed by a spot of light less than 1/64th-in. in diameter. The spot starts in the upper left corner of the screen and is drawn across to the right, then retraced over and over.

Unfortunately, a TV set can’t make such a tiny spot, which means that the number of lines on the screen ordinarily is less than 490. And the fewer the lines the more picture details will blur.

You can determine the approximate number of lines on your TV by observing the horizontal, pie-slice wedges and noting the point where the individual black and white lines blend. The white dots in the center line indicate the approximate line count (see our drawing—we show only one wedge because both are identical). If interlacing is poor, lines will be blurred and jagged.

To some degree, you can improve line count by decreasing spot size (poor interlace best is left to a serviceman). Test the low- and high-voltage rectifiers, damper, horizontal output and picture tubes. Also, try adjusting the focus, horizontal drive, brightness and contrast controls while viewing the horizontal wedges. Each has some effect on spot size.

Video Frequency Response, Line Resolution. TV pictures are transmitted with a bandwidth of 4.5 mc, though many TVs are incapable of producing the entire range of frequencies. Some cut off as low as 2.5 mc, resulting in a picture with little detail. You can determine response by judging the blend point in the upper vertical wedges of the test pattern. (The lower vertical wedge checks line resolution and can be used as a supplemental guide when checking line count. Ringing at any frequency will be indicated by additional lines in the vertical wedges at that point.)

To increase frequency response, test the RF amplifier, mixer-oscillator, IF, video detector, video amplifier and output tubes. Also, adjust the fine-tuning
and video-peaking controls (if possible) and finish with a full-dress alignment of the tuner and IF strip.

Contrast. Test patterns contain five shades—white, light gray, medium gray, dark gray and black—in concentric circles or blocks. All five shades should be available at some setting of the contrast control.

If they are not, first check the setting of the AGC control (contrast will be limited if it's set too high). Second, test the AGC tube, the video amplifier or output tubes, the video detector and the picture tube itself (a gassy tube will overload the picture to a degree, causing lack of contrast range).

Low-Frequency Phase Shift. Streaking or smearing of the black and white horizontal bars indicates excessive low-frequency phase shift. This often can be reduced by adjusting the video amplifier and output, video detector, IF stages, mixer-oscillator and RF amplifier.
Adjustable RF Coils

On Resinite Forms

Moderately priced resinite coils are used frequently for construction projects in amateur and experimenter publications. These coils give dependable performance and are stocked nationwide.

Series 20A  .079 uh to 1.25 mh
Series 21A  .68 uh to 12.5 mh
Series 22A  5.7 uh to 125 mh

Write for full line catalog

J. W. MILLER CO.
5917 So. Main St. • Los Angeles, Calif. 90003
AVAILABLE NATIONALLY FROM DISTRIBUTORS AND MAIL ORDER HOUSES.

Bandspreader

Continued from page 75

is connected to the oscillator section of the tuning capacitor. The connection should go directly to the tuning capacitor or to the lug on the oscillator wafer of the bandswitch that is connected to the tuning capacitor. The ground connection should go directly to the oscillator coils’ ground point.

Checkout. The first check to make after the circuit is installed is of the DC operating point. Remove the oscillator (or mixer) tube or short the diodes by placing a $2 \mu f$ 50 V electrolytic capacitor across them. Measure the DC voltage across the diodes. It should vary from about 1 to 25 V (proportionately less in transistor sets) when R3 is turned from one extreme to the other. Replace the oscillator tube or remove the $2 \mu f$ capacitor.

Observe the signal across the diodes with your scope (using an RF probe) as R3 is turned. The addition of the RF voltage from the oscillator and the DC voltage should not cause breakdown or forward conduction. Both these conditions will appear as a flattening of the top and bottom of the sine wave. If there is flattening decrease the value of C1 or increase the value of R4.

Finally, disconnect C1 from the tuning capacitor and tune in a station at a high frequency. Set R3 at its midpoint, then reconnect C1. Adjust the oscillator trimmer capacitor (usually located on the oscillator section of the tuning capacitor or next to the oscillator coil) until the station again comes in at maximum volume. Repeat this procedure on all bands as each has a separate trimmer.

The Ham Shack

Continued from page 38

again and get most of your original money back. You can cut the mustard for about $1,500 complete. This means $150 a year if you figure it is worth zero in ten years. A $1,500 package which I bought a few months back (see photo) included transceiver, linear, tower beam, rotator, coax and accessories.

With this setup I worked 100 countries on 20 one in two weeks and eventually hit 200 countries, even though I have only a few hours a week to operate.
LAFAYETTE SOLID-STATE 5-WATT C.B. TRANSCEIVER
Model HB-500 Small, Quiet, Powerful . . . only 3" High
109.50  • Mechanical Filter for Razor Sharp Selectivity
  • 12 Crystal Transmit and Receive Positions
  • 23 Channel Tunable Receiver with Spotting Switch
  • Multi-Stage Automatic Noise Limiting Circuit
  • With Channel 12 Transmit and Receive Crystals, Push-to-Talk Dynamic Mike, Crystal for Dual Conversion, Mobile Mounting Bracket.

LAFAYETTE 12-TRANSISTOR C.B. WALKIE-TALKIE Model HE-100A
with Noise Squelch ANL
39.95  • Separate Microphone and Speaker for Better Modulation, Increased Range
  • 12 Transistors, 1 Diode and 1 Thermistor
  • Superhet Circuit
  • 2-for-78.88 is Crystal Controlled on Transmit and Receive
  • Variable Squelch Reduces Background Noise
  • Optional Plug-in 117V AC Power Pack
  • Easy to Use and Lightweight
  • With Leather Case, Earphone, Telescoping Antenna, Batteries, Crystals for Channel 10.

THE WIDELY ACCLAIMED LAFAYETTE TAPE RECORDER Model RK-137A
89.50  • Takes Full 7" Reel of Tape  • 2 Speeds—33⅓ and 7½ ips  • Electronic Track Selector Switch  • Features 4-Track Monaural Record/Playback
  • Adaptable to 4-Track Stereo Playback
  • With Lightweight Carrying Case, Dynamic Mike, Shielded Patch Cords. 7" Take-up Reel.

LAFAYETTE 70-WATT COMPLETE AM-FM STEREO RECEIVER Model LR-800
179.50  • Just Add Speakers and Enjoy FM, FM Stereo and High-Quality AM Reception  • FM "Stereo Search" Circuit  • Nuistor "Front End"  • Powerful 70-Watt Amplifier plus Complete Preamp plus AM Tuner plus FM Tuner plus FM Stereo Tuner on One Chassis.

FREE!
LAFAYETTE Radio ELECTRONICS
1966 Catalog 660
Now BETTER THAN EVER
"World’s Hi-Fi & Electronics Center"

512 Pages

Send me the Free 1966 Catalog

[ ] Name
[ ] Address
[ ] City
[ ] State
[ ] Zip (Please Give Your Zip Code No.)

LAFAYETTE Radio ELECTRONICS
Dept. EIG-6, P.O. Box 10
Syosset, L.I., N.Y. 11791

July, 1966
Continued from page 56

have to be renumbered. Actually, these counters tell you reel-turns, not feet.

- **Tone controls.** Desirable only for playback—and I don't like them there, either.
- **Solenoid construction.** Machines designed for home use which feature solenoid construction are over-designed (and, as a result, over-priced). They also create service problems.
- **Multiple speeds.** These days, 15 ips is impractical on home recorders because it doesn't yield sufficient quality improvement over 7½ ips to justify such rapid tape consumption. While 1⅝ ips is desirable for dictation, it's outside the normal area of the serious user (as is 15/16 ips). That leaves two speeds, 7½ and 3¾ ips, on our ideal machine.
- **Built-in mixer.** You need one only if you're going to be doing live recording.

This, then, gives us a full-track mono or two-track stereo recorder, sold without a microphone, operating at two speeds (7½ and 3¾ ips), with two heads, probably no pressure pads and certainly no automatic shutoff or reverse, no selective erase, no tape duplicating or mixer. The drive mechanism is a single good motor with a properly designed drive system—belt drive being a leader.

There are some positive things I believe a machine should have. One is a handle mounted in a convenient position for moving the bloody thing about or taking it with you when you want. For some reason, most manufacturers don't make their machines easy to get hold of. One of the best I ever saw was a British unit which had two little hand-holds right under the deck so that the whole thing could be lifted out easily. These days, I'm for solid-state construction, since I'd be hard-pressed to name any advantages for tubes. Horizontal operation generally is to be preferred to vertical because you don't need to hold the reels down. Personally, I approve of a variable bias control but I believe the user must be able to set his bias adjustment correctly and be told clearly in the instruction manual how to do so.

When it comes to controls and inputs, I think manufacturers could give more thought to the subject. I think the two should be as far apart as possible. I prefer a joystick con-
trol for record/play, forward/reverse because it's the easiest and most logical to use. My next choice would be piano keys, though these usually mean more complicated linkages which can break down and require servicing. I don't like knobs because you can't tell at a glance what's happening with them. For the few knobs which may prove necessary, I believe manufacturers should mount them against a numbered scale so you can set each knob at exactly the same place every time you play back a given tape. The recorder should have a fuse and a space for storing cords. The AC cord should be detachable.

There should be a high-impedance input for each channel and, if you plan to do live recording, a separate microphone input and volume control. Inputs should be mounted out of the way, preferably on the rear of the recorder.

Finally, a word or two about tape. A good recorder should be able to take a wide latitude of tapes, although it usually will perform best with one of them. The best way to select a recorder is to select it on the basis of what you want it to do, then select the brand of tape that will do that on your recorder. We don't use high-output tapes professionally because we have to recalibrate everything before using, then set everything back to normal after we've finished. No home machine is designed specifically to accept high-output tapes. Low-print tapes, too, usually aren't necessary for home recording unless long-term storage is involved—in which case you may need it, particularly if you're recording on thin-base tapes. Low-noise tapes, on the other hand, are beautiful. To get the most out of them, however, it's desirable to own a recorder that can be adjusted for proper biasing of these tapes. Your machine also should be capable of extremely high signal-to-noise ratio.

One thing you'll keep encountering in your search for the right tape recorder is manufacturers' specifications. I won't say that these are works of fiction but I will say that, with few exceptions, you can't have much faith in them. There are so many methods of measurement and so many weighting curves and/or reference points that the whole thing is senseless. A weighting curve is our method of getting rid of the things we don't like in our test readings and virtually everybody puts his best numbers forward.

Caveat emptor.

*Electronics Illustrated*
The Day Tape Was Born

Continued from page 52

"It became apparent immediately," a Crosby associate of the period remembers, "that tape was the answer. Mullin's machine had a live quality about it and the tapes could be edited and re-edited directly, with no need for shuttling back and forth between disc cutters." So Jack Mullin installed his two Magnetophons in an unused studio in NBC's Hollywood Radio City (though ABC now was an independent company, it still had no studios or facilities of its own).

"For weeks," Mullin says "I lived in that studio with those recorders. I even slept there and had meals sent in."

Mullin proceeded to record every Crosby show for the 1947-48 season. And in doing so, he and his Magnetophons proved to American broadcasters what German technicians already had proved to Hitler—that tape could be used to provide a lifelike quality to recorded radio programs, that programs could be edited quickly and conveniently, that one tape could replace an indefinite number of live broadcasts, that tape was capable of everything discs were—and much, much more.

Shortly thereafter, Ampex marketed its first broadcast recorders, engineered by Lindsay and sold by Bing Crosby Enterprises. Mullin concentrated on tape manufacture and today is an executive with Minnesota Mining & Manufacturing Co. And what happened to Ernst Haas? Nobody seems to know. He walked out of the story of tape recording the day after its birth 20 years ago, never to return.

CB Corner

Continued from page 99

causing big headaches at the FCC due to TV1 and other assorted shenanigans. The culprits, went the report, were kids playing with transceivers given to them as gifts by unwitting parents. Thing is, only at story's end could one discern that CB wasn't its subject. The journalists really were talking about the little walkie-talkie sets, which operate under Part 15 of FCC regulations and have no more to do with CB than baby carriages with Boy Wonders.
Europe With A Tape Recorder

Continued from page 64

and the vice consists primarily of small boys demanding payment for unsolicited services, such as guiding you or washing your car. By the time our boat had docked and we had checked into our ocean-front hotel, it was time for dinner (which occurs in Morocco at a much more American hour than in Spain).

Nestled deep in the Medina, or old city, is Hamadi’s, a restaurant reputed to serve the best bstila (a spicy meat pie) in town to the accompaniment of an Arab orchestra and dancers. While we were enjoying our dinner the recorder—with the ensemble’s permission—was capturing the four instrumentalists and barefoot dancing girls for posterity. Permission to record was granted with the tacit understanding that when the musicians passed the hat—as they do at regular intervals—we would be generous.

Our first experience with one of Morocco’s more quaint customs involved a water-seller in Tangier. We asked his permission, took his picture, then offered a 20-cent tip. The coin was returned with loud protests; he demanded (and eventually got) 50 cents—a day’s wages—for his picture. Fortunately for amateur tape recordists, the recorder is new to the Arab. It can be used without attracting attention and you can record just about anything in the street without fear of harassment.

The next morning, we set out for Rabat, some 170 mi. and 2½ hrs. to the south. Rabat is the capital of Morocco and at our hotel we found preparations in order for a state banquet that night at which King Hassan would play host to Habib Bourguiba of Tunisia. “It’s the first time our hotel has been so honored,” the excited desk clerk told us.

Late in the afternoon as we walked along a main shopping thoroughfare in the old city a voice suddenly burst out of the heavens, seemingly from all directions. Activity in the streets stopped and we discovered the sound was coming from the minaret of a nearby mosque. We switched on the recorder in time to get some of the afternoon prayers on tape. Once upon a time these prayers were chanted in person from the top of the towers. Nowadays precisely at 4 p.m. the cleric in charge uses a microphone and series of public-address loudspeakers to reach a larger audience (and, presumably, to save himself a long, tiring climb up a flight of stairs).

After a shopping tour and dinner we returned to the hotel to find the King’s bodyguard and household band on duty across the street from the hotel. We stepped up to the curb, virtually on the doorstep of the hotel, and aimed the microphone at the band as it struck up the royal fanfare. The King and his guest finally arrived, waved to the crowd and passed into the hotel for their dinner.

A few minutes later, we followed them, only to find an orchestra playing Arabic dinner music in the lobby. The recorder, of course, was able to capture it. Shortly after our entry, the string orchestra was relieved by a military band. Realizing we weren’t likely to get much sleep in the middle of a band concert, we placed our recorder beside a potted palm and left it on till bedtime.

Soon we were on our way to Lisbon via Meknes, Fez, Tangier, Algeciras, Cadiz, Seville and Evora. Lisbon, a bustling seaport, presents at least as many opportunities for the recorder as does Morocco. Along the wharves there are the sounds of ships docking and unloading, the pitchmen outside the sailor’s bars on the Rua Carvalho, the cries of seagulls and the clanging bells of buoys. In the city itself there are the small yellow trolleys, manufactured in Britain at the turn of the century and still in use because nothing better has been found to negotiate Lisbon’s hills, narrow streets and sharp curves; the cries of newsdealers which start as early as 5 a.m. and last until nearly that hour the following morning; the whine of the passenger elevator just off the central square, built by Alexandre Eiffel (of Eiffel Tower fame); the bells of cathedrals, and the clicking of the roulette wheel at the casino in Estoril.

Next day found us winging our way to London, where a hectic 48 hrs. of sight-seeing and recording awaited us. We arrived at our hotel, the Carlton Tower, just in time for bed. Early next morning we persuaded one of the porters, Jimmy Power, to take us up to the Tower Suite, which commands a splendid view of metropolitan London. When the hotel was built in 1961 many Londoners protested the idea of a skyscraper overlooking Buckingham Palace. Now it’s part of the landscape, along with Hyde Park, Battersea Power Station, Piccadilly, the U.S. Embassy,
the Houses of Parliament and Big Ben. All of this Power dutifully explained to us and our recorder as we took photographs.

After getting the overall picture we set out for several locations to record specific sounds—first to Speaker’s Corner in Hyde Park, where we recorded snatches of speeches urging unification of Northern Ireland with Ireland, calling for war on Rhodesia (by a vociferous African with an Oxford accent), attacking the use of chemicals in Britain’s food and water and suggesting communism for Britain’s farms. Then into the underground to capture the approach of a train, the guard’s “Mind the doors!” and whistle before it pulls out. We got off near the Houses of Parliament and strolled out onto Westminster Bridge to try to record the sounds of commerce on the Thames while waiting for Big Ben to chime the hour. Then to St. Paul’s Cathedral to tape church bells and the magnificent organ. The afternoon saw us pursuing London’s street musicians, shopping and recording Londoners.

A similar round of sight-seeing, taping and shopping filled our last full day in Europe. Finally, reluctantly, we checked out of the Carlton Tower and told the cab driver we wanted the Pan Am departure building. We reached it with moments to spare, recording Pan American’s last call for New York passengers. It provides a somewhat wistful ending to our tape-and-slide showings. I always feel...
Slot-Car Lap Timer

Continued from page 46

If everything checks out—indicating the control-box circuit is put together properly—trip RY1 once by passing your finger in front of PC1 to stop the timer. Bring the timer back to zero by pressing and holding S2. Finally, make a tube about 1 in. long from stiff paper and fit it over P1.

Using The Timer

Place the pickup box on one side of the track and the light-source box on the other side of the track so P1 is shining directly at PC1. Then turn on power with S2. If the motor is running place your finger in front of PC1 to stop it. Then reset the timer to zero with PB1. Place the car(s) directly behind PC1 and let it go. The instant the car cuts the light beam, the timer should start. When the car comes around and cuts through the beam a second time the clock motor will stop and indicate the lap time. Reset on the second lap and then time the third. The timer will time every other lap.

Squeeze Me And I'll Shock You

Continued from page 98

to mechanical energy in a piezoelectric element easily can be demonstrated by connecting a Rochelle salt element to the output of an audio amplifier. Since the element presents a high-impedance load to the amplifier, it should be connected directly into the amplifier's plate circuit as shown in Fig. 6. Blocking capacitor C1 is required to isolate the DC plate voltage from the element.

If this approach is not convenient, an alternative method is to connect an output transformer in place of the speaker with its windings reversed (i.e., with secondary serving as primary and vice-versa).

Feeding a signal from an audio oscillator, microphone, phono cartridge, etc., into the amplifier will cause the Rochelle salt element to reproduce the applied input signal with surprising volume. The element in this hook-up makes an excellent point source and thus affords an opportunity for demonstrating one of the more interesting aspects of high-frequency sound.

Electronics Illustrated
Diesel Locomotive Horn
...makes your car roar like a powerful diesel locomotive!

Powerful new dual blast horn that attaches easily, compactly under hood to all cars, all models, makes your car sound remarkably like diesel locomotive! Deep, pulsating tone emitting from jumbo trumpet—followed immediately by high-pitched wail of smaller horn ...gives you the sound of the "Super Chief".
Unique piggy-back assembly takes just 6" x 6½" x 10¾" of space and a few minutes of time to in-

Good Reading

Continued from page 92

size (roughly 5 by 8 in.) for handy reference. The entries are fairly terse, which is just the way they should be; there's no attempt to get encyclopedic about things. Also outstanding is the quantity and quality of the illustrations, almost all of them line drawings with a kind of crispness and detail you just don't see much anymore.

HOW TO BUILD PROXIMITY DETECTORS AND METAL LOCATORS. By John Potter Shields. Howard W. Sams & Bobbs-Merrill, New York & Indianapolis. 128 pages. $2.50

Whether you're interested in making a home-brew burglar alarm (exotic variety) or in having a way to find all those things—lunch boxes and bait buckets—that your kid throws out of your boat every summer, this volume contains all you need to build the right gadget for the purpose. The circuits for proximity detectors and metal locators range from ultra-simple to ultra-advanced and parts lists and instructions for every variety are quite complete. For lagniappe, there's a final chapter on our old friend, the theremin.

USE THIS HANDY COUPON NOW!

Hamilton House, Dept. 49L-7, Cos Cob, Conn. 06807 Gentlemen:
Kindly rush "Diesel Locomotive" air electric horns. □ 6-volt □ 12-volt at $15.98 plus 75¢ shipping & handling each. I enclose my check or money order for total amount of $________

NAME

ADDRESS

CITY STATE ZIP

SEMICONDUCTOR CIRCUITS HANDBOOK. Techpress, Inc., Brownsburg, Ind. 191 pages. $2.95

Here are more than 70 semiconductor circuits for the hobbyist on DC amplifiers, low- and high-frequency amplifiers, AF and RF oscillators, multivibrators and flip-flops. All originally were designed for use in commercial and industrial equipment but all are open to cut-and-try modifications for your own purposes.

And make note of . . .

50 EASY-TO-BUILD SOLID STATE PROJECTS. Radio Shack, Boston, Mass. 96 pages. $2

Simple, straightforward projects using Radio Shack parts.


Must-have information for every serious SWL.
SAVE MONEY • ORDER BY MAIL

Before you buy receiving tubes, transistors, diodes, electronic components & accessories... send for your Giant Zalyntron Current Catalog, featuring Standard Brand Tubes: RCA, GE, etc.—all New Brand New Premium Quality individually boxed. One Year Guarantee—all at Biggest Discount in America! We serve professional servicemen, hobbyists, experimenter, engineers, technicians. Why Pay More? Zalyntron Electronics, 461-F Jericho Turnpike, Mineola, N. Y.

**DISTANCE ONE-TO-ONE PLANS—25c.** One-tube Handbook—50c. Includes Transistor experiments, catalog. Laboratories, 993-K, Redwood City, Calif. 94063

FREE CATALOG. Electronic parts, tubes, Wholesale. Thousands of items. Unbeatable prices. Arcturus Electronics El., 504-23 St., Union City, N. J.

TV TUNERS rebuilt and aligned per manufacturer specification. Only $9.50. Any make UHF or VHF. We ship COD. Ninety day written guarantee. Ship complete with tubes or write for free mailing kit and dealer brochure. JW Electronics, Box 129K, Bloomington, Ind. 47401

FREE GIANT bargain catalog on transistors, diodes, rectifiers, SCR's, xerons, parts. Poly Paks, P. O. Box 942El, Lynnfield, Mass., 01940


WIRELESS MICROPHONE F.M. pocket size "Bug." No License, complete. Send 523 P. O. Box 993, Electrosites, 2801 W. Becker, Milw., Wis. 53215

Build it—do it yourself


Make $100.00 FORMICA Counter Tops with few material dollars. Complete Instructions $1.00. Build cabinets like Professionals, with new manual, "Cabinetmaking Made Easy." $2.00. Japs, 126-C Seventh North, Hopkins, Minn. 55343

**TAPE RECORDERS**

Learn while Sleep with your recorder, photographe, or "Electronic Educator" endless tape recorder. Details free. Sleep-Learning Research Association, Box 24-El, Olympia, Washington

Rent Stereo Tapes—over 2500 different—all major labels—free brochure. Stereo-Part, 1616-A Year Way, Santa Rosa, California.

Your advertisement can reach this mail-buying audience for only 50¢ per word... payable in advance (Check or M.O. please)... minimum 10 words. Closing dates are the 20th of 4th preceding month i.e. copy for the November issue must be in our office by July 20th. Mail to ELEONICS ILLUSTRATED 115 West 44th St., New York, N. Y. Word count: please) Name of state (New Jersey), name of city (New York); sets of characters as in key (14-D); also abbreviations as 35MM. 8x10, D.C., A.C.
mendous multi-million ampere surges of current in the globe. Voltages in buried power cables soared wildly and circuit breakers, suddenly overloaded, popped all over the Northeast. Toronto and other cities were thrown into darkness.

Six minutes later, massive currents in the ocean floor began to wreck undersea cable communications. Western Union reported trouble at 9:01. AT&T, whose cable was farther north, recorded surges of 2,650 volts in its undersea cable—just short of enough to destroy it. Associated Press teletype machines around the country fell victim to the surging currents and began spewing gibberish. At 9:45 AT&T lost radio circuits to South America. Now the entire North American continent, except for occasional spurring, unreliable contact by cable, was cut off from the rest of the world just as it had been in the days of the clipper ships.

Between 1 and 2 o'clock the next morning the traces at Fredericksburg began to calm down somewhat. But by now, the aurora was at its peak. Brilliant displays were seen over the entire United States. A ship's officer off Acapulco, Mexico, saw the bright rays in the sky from the southernmost position ever recorded. By dawn transatlantic radio was beginning to work again and by 10 o'clock Tuesday morning was nearly back to normal. Tuesday night there again were brilliant auroral displays and occasional radio blackouts.

By Thursday the magnetographs had quit jigging, the northern and southern lights had faded and the plasma cloud from the sun was speeding into space beyond the earth's orbit.

It was a spectacular show. And from it astronomers and geophysicists were able to learn more about the complex, turbulent magnetic field that envelops the earth. For though man now understands the main features of the earth's magnetism, many details are missing. And many of the current theories—such as the one at the beginning of this article about the original formation of the earth's magnetic field—still are unproved.

But research goes on. And from it comes an ever-clearer understanding of the mysterious universe that surrounds us.

Why We're So Weather-Wise

Continued from page 91

the Weather Bureau on a regular basis without interruption.

Satellite cloud photographs can be converted into digital form for a computer, then reproduced as Mercator projections. Other photo map projections can be obtained and distortions in the image that can be expressed mathematically can be corrected automatically during processing. The pictures are scanned by a light beam and changed into an electrical signal which is digitized and recorded on magnetic tape. An IBM 704 computer then transforms the picture elements in the Mercator view, which can be photographed on film.

Sign of the times is the fact that the U.S. Weather Bureau has installed VHF FM weather broadcasting stations in five major metropolitan areas. Intended for motorists, mariners, aviators, farmers and others who require up-to-the-minute weather information, these broadcasts emanate from stations in New York, Chicago, St. Louis, Kansas City and Los Angeles. Anyone in these areas wishing to tune in on the weather has only to possess an FM receiver capable of picking up the required frequency—162.55 mc.
"You asked about our rig, Helene. Well, for a receiver we're using a black radio with ten or 12 knobs and our transmitter is grey, about a foot and a half high and it has maybe six knobs."

"He says he's an amateur, but I think he's just being modest."

"Hey! Here's another kilowatt you could modulate for a while."

"Calling CQ DX, CQ DX, CQ DX . . . except Cuba, Russia, Hungary, Romania, Poland, Bulgaria, China, Albania, East Germany, Yugoslavia . . ."
Men 17-55... Prepare

NO ADVANCED EDUCATION REQUIRED!

To help you EARN GOOD MONEY later in industry, DeVry's modern training provides a thorough grounding in basics... then develops your skill. Thus, there is no need for advanced education or previous technical experience at the start. Whether you prepare in your spare time at home or in our well-equipped Laboratories, DeVry helps you become a well-trained technician, ready for a real career in Electronics.

BUILD AND KEEP VALUABLE EQUIPMENT!

You build the 5-inch streamlined commercial type oscilloscope and the transistorized, portable meter above. This test equipment is similar in every way to the latest design used on today's jobs -- with function grouped controls and meter scales color-keyed to the panel markings. And you keep this valuable equipment, you'll use it both in your training and on the job.

2 FREE BOOKLETS GIVE YOU FACTS ON HOW YOU MAY GET STARTED!

MAIL POSTAGE-FREE CARD NOW!

DeVRY TECHNICAL INSTITUTE
4141 Belmont Ave., Chicago, Illinois 60641, Dept. EI-7-W

Please give me your two free booklets, "Pocket Guide to Real Earnings" and "Electronics in Space Travel"; also include details on how to prepare for a career in Electronics. I am interested in the following opportunity fields (check one or more):

- Missile Electronics
- Communications
- Television and Radio
- Computers
- Microelectronics
- Broadcasting
- Radar
- Industrial Electronics
- Automation
- Electronic Control

Name ________________________ Age ______
Address ________________________ Apt. ______
City _____________________________ Zone ______ State ______

□ Check here if under 16 years of age. 

Please print legibly. 

HERE'S MORE FACTS...
WHETHER IT'S RADIO-TV OR MISSILE ELECTRONICS...

Get Your Training From DeVry!

PREPARE FOR A VARIETY OF GOOD JOBS

Hundreds and hundreds of companies in the vast Electronics industry are on the lookout for trained technicians. They seek men to help build, test, install and service a wide variety of Electronic devices. To men with skill in Electronics, these firms offer GOOD-PAYING JOB OPPORTUNITIES, such as those shown below, and others.

What's more, the trained man can start his OWN BUSINESS in Electronics, when he has all the advantages of preparing the DeVry way.

WHY not see for yourself how YOU may get ready with DeVry's help to enter and prosper in Electronics... one of history's fastest-moving fields! Mail the coupon now.

WHAT SOME DeVRY TECH GRADUATES ARE DOING

Edward Hahn, Illinois, was a laborer. Now he is an Electronic Senior Engineer with the Martin Company, a large producer of missiles.

Dale L. Gawthorpe, Illinois, left a clerk's job to take the DeVry program. He is now enjoying his work with automatic pilot equipment at Sperry Phoenix Company.

Charles Morishita, Oregon, worked as a farmer before taking DeVry's training. Now he builds and tests equipment at Lockheed's Space and Missile Division.

Gerald R. Borner, Washington, has found his DeVry training a valuable aid on his job as Radar Technician in Boeing Airplane Company's Aero Space Division.

A FEW OF THE MANY JOB OPPORTUNITIES!

COMMUNICATIONS

COMPUTER SPECIALIST

TELEVISION

MISSILE CHECKOUT

QUALITY CONTROL

RADAR

AUTOMATION

MAKING ELECTRONIC DEVICES

DeVry Tech
4141 Belmont Avenue
Chicago, Illinois 60641

DeVry's president, Mr. T. J. Lafeber, accorded a special invitation to inspect a famous missile facility, was deeply impressed with the role of Electronics in the national defense.

ELECTRONICS - THE HEART OF THE MISSILE! Unwinding wiring in missile devices soon comes clear to a DeVry Tech man because he learns basic circuits by use of the "Electro-Lab", a training method that helps speed up learning.

DON'T DELAY MAIL TODAY!