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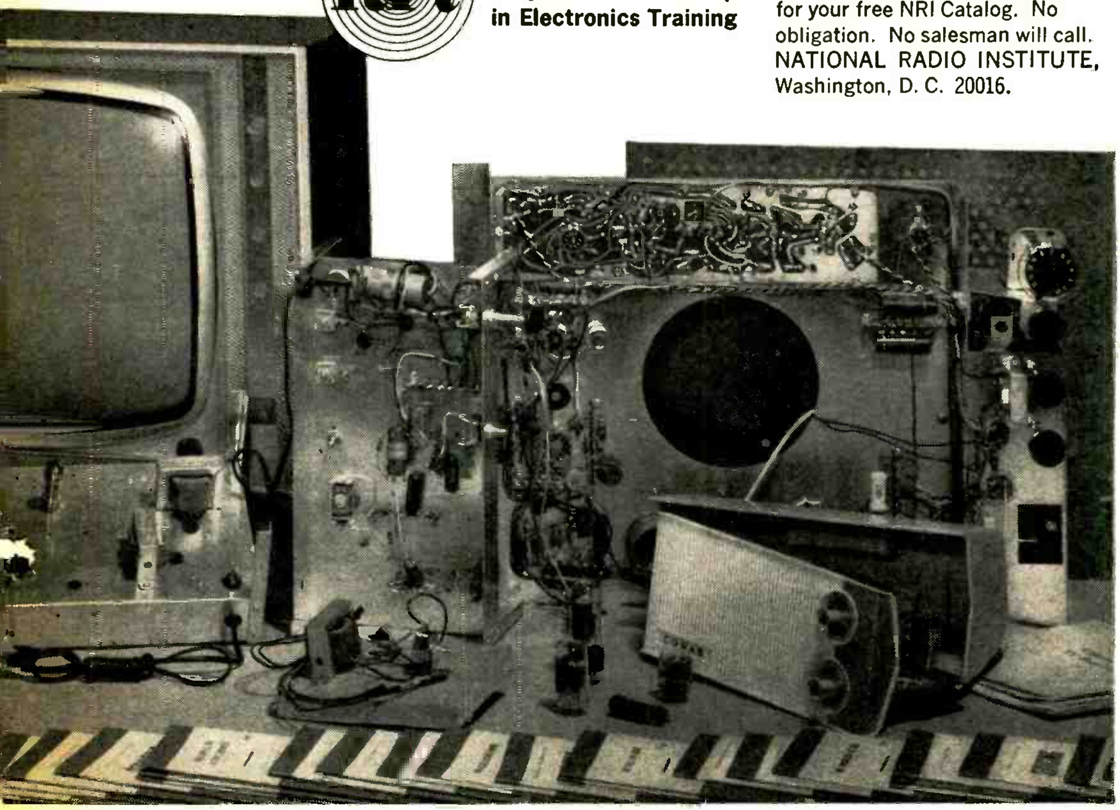

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VOLUME 26 **FEBRUARY, 1967** NUMBER 2

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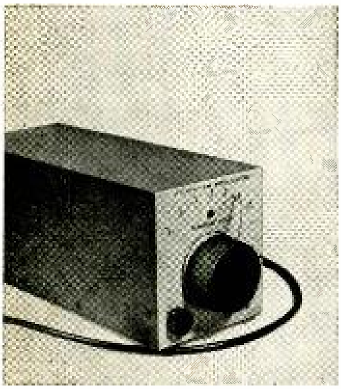
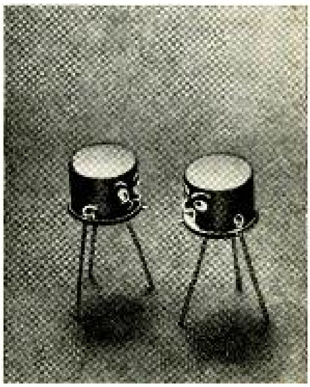
FEATURE ARTICLES

DEPARTMENTS



Six-meter "medicine man" cures TVI's **73**



"But, George, he's not a tube!" **47**

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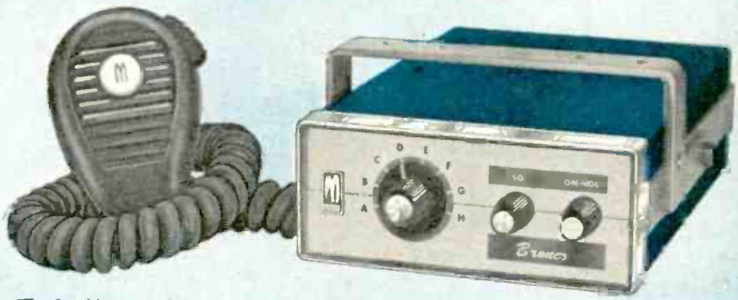

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LETTERS
FROM OUR READERS

Address correspondence for this department to:
Letters Editor, POPULAR ELECTRONICS
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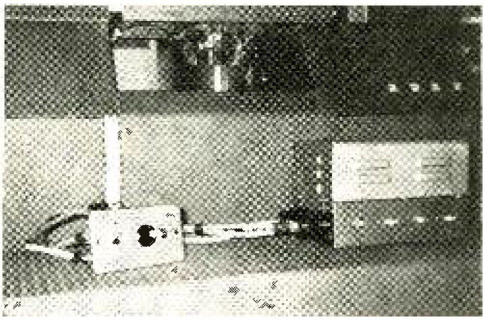
STEREO COLOR ORGAN

Attached is a photo of the "Musette Color Organ" (July, 1966) which I built. My unit has four channels instead of five, and I hooked it up for stereo, making one high and one medium channel in series for each stereo input, and I used one sensitivity control for each pair of channels. For simplicity of operation, the two controls were ganged. As the chassis was going to be out of sight, I placed the on/off switch, pilot light, and sensitivity controls on a remote panel.

The unit works fine and is a real eye-catcher, but I do have a hum problem that seems to be riding the a.c. line. It consists mainly



of small pulses of about 10 volts and some 200 microseconds duration superimposed on each a.c. peak, and is particularly bothersome when tuning in a weak radio station. I would be grateful if you could tell me of an effective way to filter out this interference.

H. P. YRIGOYEN
Mexico, D.F., Mex.

Silicon-controlled rectifiers act like high-speed switches, and as such are capable of setting up r.f. interference. A good r.f. ground connection of the color organ may solve your problem. If interference persists, you may also have to add an L filter between the anode of each SCR and its display lamp. The filter should be placed as close to the SCR as possible and should consist of an r.f. choke in series and about a 0.5-μF capacitor across the display lamp line. The choke must be large enough to handle the current to the display lamp.

COMMUNIST PROPAGANDA

If you think that *Radio Havana* will take your name off its mailing list—forget it (re "Havana Propaganda," page 8, October, 1966). I've been trying (asking nicely) for two

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LETTERS (*Continued from page* 8)

years. However, there are stations in other communist countries that do *not* send propaganda—*Radio Belgrade,* for example, which mails a "Happy New Year" card in several languages. I suggest not letting propoganda scare off prospective QSL's—just get a good book of matches.

R. S. Gilmore, WPE8FJD
Saginaw, Mich.

IF IT'S TRUE, IT'S NOT PROPAGANDA?

I trust it was just a slip of the pen, but if not, I would like to object to the remark made in your November, 1966, issue on page 41 where you couple BBC programmes with Iron Curtain programmes, or propaganda, as you call it. I can assure you that what the BBC puts out is pure unadulterated truth—just like the *New York Times;* London happens to be on the American side of the Iron Curtain, not the Prague side of it. Naturally, I am British.

John Teale
Sea Bright, N.J.

John, we're glad that London is on our side. But, the truth *is often the best kind of "propaganda" we can generate.*

SCIENCE FAIR TROPHIES

I entered your "Flip-Flop Computer" (March and April, 1961) in our school's annual Science Fair, and came up with the first place trophy. Enclosed is a picture of my

project, with the trophy in front of it. I am looking forward to more projects on advanced computers in the near future.

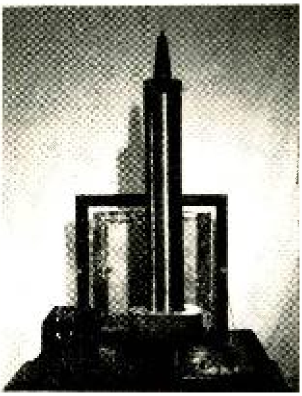
Arthur J. Krumrey
Chicago, Ill.

"Big TC" (July, 1964) won first place for me in our recent Science Fair. It was my first major project and it sure paid off. It

LETTERS

(*Continued from page* 10)

was fun to build and easy on the pocketbook (less than $8) and even more fun to run. One question: Is it supposed to shock you when you hold the light bulb up to it? Mine does, and once it arced over to my hand—it packs quite a jolt.



For those who want to construct this project without much cost, here is the way I did it. I made the large coil from a piece of plastic drainage pipe. The rings for the small coil were cut from two pieces of scrap plastic. The spark gap electrodes were made from a welding rod. I assembled the capacitor from a combination of sheet tin and aluminum foil. The wire for the large coil was salvaged from three TV yokes. I bought the test prod wire from Allied during one of their sales, and the neon sign transformer was given to me. The feed-through insulator is a turned wooden piece with a large thread spool, minus the thread, placed on top of it.

Now, how about an article on a big Van de Graaff generator?

David Byrd
Erwin, Tenn.

Enclosed is a picture of my latest creation, "Gorgo—The Homemade Robot." He started life as "Emily . . . The Robot With The One-Track Mind" (March, 1962). The photo tells what he can do. I entered "Gorgo" in a local Science Fair and he took second place. "Emily" was originally built for a "Fair" (a

(*Continued on page* 95)

This *Remington* PREMIER PORTABLE TYPEWRITER

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COMPUTERS SELF-TAUGHT THROUGH EXPERIMENTS

by Jack Brayton

It is the author's contention that digital computers are simple rather than complex instruments, and he has written this book to prove it. He points out that computers seem complex because of their size, but that they are actually made up of many simple circuits repeated thousands of times. In these pages discussions of computer theory appear side by side with details that enable the reader to construct working models of the circuits—which seems to us an excellent way to master the subject. All parts values, voltages, and other circuit details are given, and the parts used in the various experiments are both readily available and low in cost.

Published by Howard W. Sams & Co., Inc., 4300 West 62 St., Indianapolis, Ind. 46206. Soft cover. 192 pages. $4.25.

AMPLIFIER HANDBOOK

Richard F. Shea, Editor-in-Chief

Truly a giant of a volume (1516 pages, 410 illustrations), this handbook provides invaluable reference material of both a general and a specialized nature. Prepared by a team of outstanding authorities in the field, the book is divided into three sections: amplifier fundamentals; devices; and circuits. All major forms of amplifying devices (from tubes and transistors to masers and lasers) are described, but the bulk of the book is devoted to specific categories of circuits and includes designs ranging from one end of the frequency and power spectra to the other. Wherever possible, a design is generalized and the necessary information provided to develop desired variations. Emphasis throughout is on practical applications.

Published by McGraw-Hill Book Company, 330 West 42 St., New York, N.Y. 10036. 1516 pages. Hard cover. $37.50.

A TOWER IN BABEL

by Erik Barnouw

If you can forgive the minor technical errors (the author has little knowledge of electronics), you should find this early history of broadcasting fascinating reading. The first of three volumes, it tells how broadcasting started and is spiced with anecdotes about the men and women who foresaw a bright future for radio. Starting with the invention

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LIBRARY *(Continued from page 14)*

of radio communications, the first volume takes the reader up through the winter broadcasting season of 1932-33. This is how it was in the days of the Fresh Air Taxi Company, the A & P Gypsies, the Cliquot Club Eskimos, Norman Brokenshire, etc. Your reviewer cannot help but recommend this book for anyone 45 years old or over.

Published by Oxford University Press, 417 Fifth Ave., New York, N.Y. Hard cover. 344 pages. $8.50.

BUILDING YOUR AMATEUR RADIO NOVICE STATION

by Howard S. Pyle, W7OE

This book is aimed at the prospective amateur with a minimum of electronics background who would like the thrill of making his first Novice contacts over equipment he constructed himself. W7OE gives complete details (including drilling templates) for a 1-tube (6EB8) regenerative receiver covering the 80- through 10-meter amateur bands and a 1-tube (6DQ6B), 25-watt CW transmitter for the 80-, 40-, and 15-meter bands. Both units contain their own power supplies. Unfortunately, if the transmitter's power supply is wired as shown in the schematic on page 63, the transmitter won't work; and the tuning instructions for the transmitter are exactly reversed, which will undoubtedly confuse inexperienced readers. Otherwise, the book is well prepared.

Published by Howard W. Sams & Co., Inc., 4300 West 62 St., Indianapolis, Ind. 46206. Soft cover. 128 8½" x 11" pages. $3.50.

"HOW-TO" ELECTRONICS LIBRARY

Otherwise known as the "103 IRC Series," the *"How-To" Electronics Library* consists of ten books (64 pages each) of useful information for the beginner in electronics. Subjects covered are "Diodes," "The Volt-Ohm-Milliammeter," "Basic Alternating Current," "How to Read Circuit Diagrams," "Basic Electronics Math," "Handbook of Transistor Circuits," "Learn Electronics in 5 Minutes, 37 Seconds," "The Oscilloscope," "The Vacuum-Tube Voltmeter," "Elements of Electronics," "How to Use and Enjoy Your Tape Recorder," and "Practical Radio." Simply written and well illustrated, these books will enable the novice to become familiar with the basic instruments in electronics—how they work and how to use them—and to understand basic theory. Recommended.

Published by M. W. Lads Publishing Co., Philadelphia, Pa. Distributed by International Resistance Company through its electronic parts distributors. Soft covers. 64 pages each. $1.25 each.

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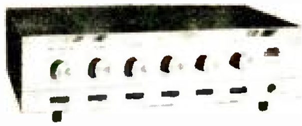


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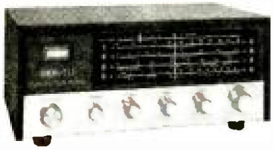

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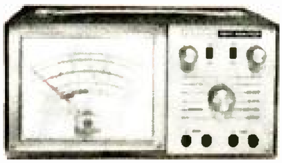

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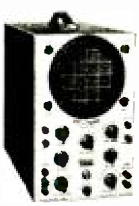

Model 460 Wideband Direct-Coupled 5" Oscilloscope. DC-4.5mc for color and B&W TV service and lab use. Push-pull DC vertical amp., bal. or unbal. input. Automatic sync limiter and amp. $99.95 kit, $139.50 wired.

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Model 232 Peak-to-Peak VTVM. A must for color or B&W TV and Industrial use. 7 non-skip ranges on all 4 functions. With exclusive Uni-Probe.® $29.95 kit, $49.95 wired.

CIRCLE NO. 10 ON READER SERVICE PAGE

You can earn more money if you get an FCC License

...and here's our famous CIE warranty that you will get your license if you study with us at home

NOT SATISFIED with your present income? The most practical thing you can do about it is "bone up" on your electronics, pass the FCC exam, and get your Government license.

The demand for licensed men is enormous. Ten years ago there were about 100,000 licensed communications stations, including those for police and fire departments, airlines, the merchant marine, pipelines, telephone companies, taxicabs, railroads, trucking firms, delivery services, and so on.

Today there are over a million such stations on the air, and the number is growing constantly. And according to Federal law, no one is permitted to operate or service such equipment without a Commercial FCC License or without being under the direct supervision of a licensed operator.

This has resulted in a gold mine of new business for licensed service technicians. A typical mobile radio service contract pays an average of about $100 a month. It's possible for one trained technician to maintain eight to ten such mobile systems. Some men cover as many as fifteen systems, each with perhaps a dozen units.

Coming Impact of UHF

This demand for licensed operators and service technicians will be boosted again in the next 5 years by the mushrooming of UHF television. To the 500 or so VHF television stations now in operation, several times that many UHF stations may be added by the licensing of UHF channels and the sale of 10 million all-channel sets per year.

Opportunities in Plants

And there are other exciting opportunities in aerospace industries, electronics manufacturers, telephone companies, and plants operated by electronic automation. Inside industrial plants like these, it's the licensed technician who is always considered first for promotion and in-plant training programs. The reason is simple. Passing the Federal government's FCC exam and getting your license is widely accepted proof that you know the fundamentals of electronics.

So why doesn't everybody who "tinkers" with electronic components get an FCC License and start cleaning up?

The answer: it's not that simple. The government's licensing exam is tough. In fact, an average of two out of every three men who take the FCC exam fail.

There is one way, however, of being pretty certain that you will pass the FCC exam. And that is to take one of the FCC home study courses offered by the Cleveland Institute of Electronics.

CIE courses are so effective that better than 9 out of every 10 CIE-trained men who take the exam pass it...on their very first try! That's why we can afford to back our courses with the iron-clad Warranty shown on the facing page: you get your FCC License or your money back.

There's a reason for this remarkable record. From the beginning, CIE has specialized in electronics courses designed for home study. We have developed techniques that make learning at home easy, even if you've had trouble studying before.

In a Class by Yourself

Your CIE instructor gives his undivided personal attention to the lessons and questions you send in. It's like being the only student in his "class." He not only grades your work, he analyzes it. And he mails back his corrections and comments the same day he receives your assignment, so you can read his notations while everything is still fresh in your mind.

Mail Card for Two Free Books

Want to know more? The postpaid reply card bound-in here will bring you free copies of our school catalog describing opportunities in electronics, our teaching methods, and our courses, together with our special booklet, "How to Get a Commercial FCC License." If card has been removed, just send your name and address to us.

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 six weeks of high school algebra, CIE's AUTO-PROGRAMMED™ lessons make electronics theory and fundamentals easy. I now have a good job in studio operation, transmitting, proof of performance, equipment servicing. Believe me, CIE lives up to its promises."

Chuck Hawkins, Chief Radio Technican, Division 12, Ohio Dept. of Highways

"My CIE Course enabled me to pass both the 2nd and 1st Class License Exams on my first attempt...I had no prior electronics training either. I'm now in charge of Division Communications. We service 119 mobile units and six base stations. It's an interesting, challenging and rewarding job. And incidentally, I got it through CIE's Job Placement Service."

Glenn Horning, Local Equipment Supervisor, Western Reserve Telephone Company

"There's no doubt about it. I owe my 2nd Class FCC License to Cleveland Institute. Their FCC License Course 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."

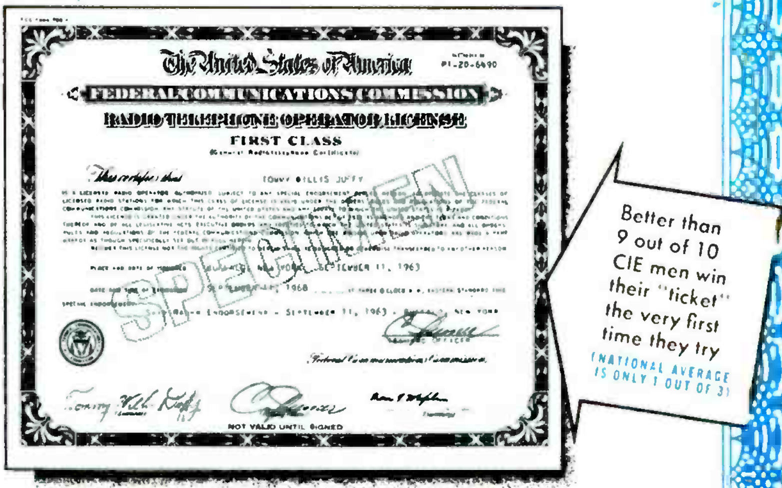
ENROLL UNDER G.I. BILL

All CIE courses are available under the new G.I. Bill. If you served on active duty since January 31, 1955, or are in service now, check box on reply card for G.I. Bill information.

CIE Cleveland Institute of Electronics

1776 E. 17th St., Dept. PE-51, Cleveland, Ohio 44114

Accredited by the Accrediting Commission of the National Home Study Council, and the only home study school to provide complete coverage of electronics fundamentals plus such up-to-date applications as: Microminiaturization • Laser Theory and Application • Suppressed Carrier Modulation • Single Sideband Techniques • Logical Troubleshooting • Boolean Algebra • Pulse Theory • Timebase Generators...and many more.



Cleveland Institute of Electronics

WARRANTY

of success in obtaining a Government FCC License

The Cleveland Institute of Electronics hereby warrants that upon completion of the Electronics Technology, Broadcast Engineering, or First-Class FCC License course, you will be able to pass the FCC examination for a First Class Commercial Radio Telephone License (with Radar Endorsement);

OR upon completion of the Electronic Communications course you will be able to pass the FCC examination for a Second Class Commercial Radio Telephone License;

AND in the event that you are unable to pass the FCC test for the course you select, on the very first try, you will receive a FULL REFUND of all tuition payments.

This warranty is valid for the entire period of the completion time allowed for the course selected.

G. O. Allen

G. O. Allen
President

NEW PRODUCTS

Additional information on products covered in this section is available from the manufacturers. Each new product is identified by a code number. To obtain further details on any of them, simply fill in and mail the coupon on page 15.

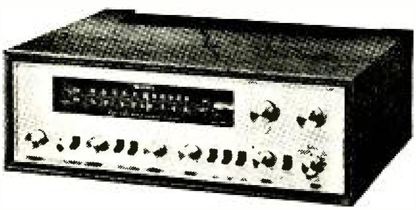
AUTO/HOME SPEAKERS

There's no need to cut holes in your car doors to accommodate the "Stereo Modulators" now being marketed by *Capitol Records*—they can be mounted in the car's rear deck, between the seat and the back window. Designed to replace conventional-type speakers for use with tape cartridge systems, or other electronic components, the Stereo Modulators represent a new concept in auto/home speakers: each one consists of 13 frequency tuned pipes. Each of the pipes, which vary in length, enhances a different segment of the audio spectrum—from 40 to 13,000 hertz. The Modulators come with mounting plate and other materials needed for installation.

Circle No. 75 on Reader Service Page 15

90-WATT SOLID-STATE AM-FM RECEIVER

You get a handsomely styled walnut cabinet at no extra charge with the SX-1000TA AM-FM solid-state receiver announced by *Pioneer Electronics U.S.A. Corporation.* The SX-1000TA itself contains a time switching circuit equipped with automatic mono-stereo switching and provides 38 dB channel separation. Each channel has separate bass and treble controls. Power output is distortion-free (less than 1%). The front end of the FM tuner has a sensitivity of 2.2 μv, with absolute selectivity assured by four tuned i.f. amplifier stages followed by a wide-band ratio detector. A unique transistor protection circuit is claimed to guarantee reliability until now only available in tube-type units.



Circle No. 76 on Reader Service Page 15

IMPROVED SSB TRANSCEIVER KITS

Providing low-cost, high-performance SSB communications on 80, 40, or 20 meters, the new *Heathkit* "Single-Banders" now boast front panel selection of upper or lower sideband operation, improved audio and a.v.c. response, microphone and gain control, plus bias adjustment on the front panel for convenience in changing from fixed to mobile operation. Other new features include: more convenient front panel control locations, a mode switch position for control of the optional HRA-10-1 plug-in crystal calibrator, a.l.c. input for operation with linear amplifiers, power connectors which are compatible with the Heath SB-Series power supplies, and updated styling to match the SB-Series equipment.

Circle No. 77 on Reader Service Page 15

THEATRE ORGAN KIT

No special skills are required to assemble the new *Schober* Theatre Organ kit, and a savings of over 50% over the price of a comparable completed organ purchased through organ dealers is promised, with no sacrifice in quality. Printed circuits are used throughout to keep the amount of assembly time down; the keyboards, wood console, and bench are supplied fully assembled. The Theatre model features a traditional horseshoe-shaped console, 25-note pedalboard, and two full 61-note keyboards. There are 48 stop tablets and the pitch registrations available range from 1 to 16 feet.

Circle No. 78 on Reader Service Page 15

GOOSENECK FLASHLIGHT

When you need a light beam for working in "inaccessible" places, and a regular flashlight won't do the job, the flexible flashlight put out by *Bryce-Branton* could be the answer. This inexpensive flashlight has a completely flexible 4" head that can be twisted, bent around corners, or snaked into narrow

CIRCLE NO. 20 ON READER SERVICE PAGE→

LAFAYETTE HB-525 Solid State Mobile 2-Way Radio

All Crystals Supplied!

• Size: 2⅜" by 6¼" 99-3076WX*

All 23 CB Channels Crystal Controlled

149.95 NO MONEY DOWN

Plus 2 Reserve Channels

- 19 Transistors, 7 Diodes, Thermistor
- Dual Conversion Receiver for Extra Selectivity and Sensitivity
- Full 5-Watt Input
- Range Boost™ Circuitry for Added Power
- 3-Position Delta Tune—Provides Accurate Fine Tuning
- Mechanical 455KC Filter for Superior Selectivity
- Push-to-Talk Dynamic Microphone
- Variable Squelch plus Series Gate Automatic Noise Limiting
- Public Address System (with external speaker)
- 12-Volt DC Operation (pos. or neg. ground) 6-Volt DC (with optional DC Power Supply)
- Pi-Network for Optimum RF Output
- 117 Volt AC Operation with Optional Power Supply

*Imported

FREE

Over 500 Pages

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Featuring Everything in Electronics for

• HOME • INDUSTRY • LABORATORY

from the "World's Hi-Fi & Electronics Center"

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☐ Send me the **FREE** 1967 **LAFAYETTE** Catalog 670 IB-7

Name ______________________________

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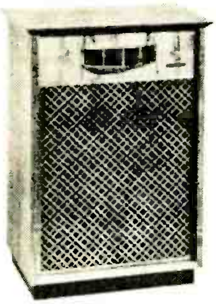
PRODUCTS (*Continued from page* 22)

openings. About 5" long, plus 4" head, it comes in a black leatherette cover, with a handy clip for fastening it to a shirt pocket or belt.

Circle No. 79 on Reader Service Page 15

THREE-WAY SPEAKER SYSTEM

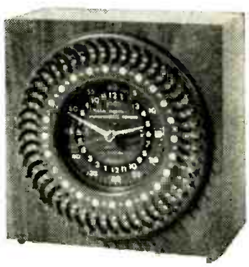
Another new "Ultima" three-way speaker system from *Olson Electronics*, the Model S-778, features a full 16" woofer with die-cast frame that handles low frequencies down to 35 Hz. A multi-cellular mid-range horn is coupled to the woofer through an LC-type crossover network, and a 2½" "super-tweeter" extends the response to 20,000 Hz. There are level controls for the mid-range horn and the tweeter. Impedance is 8 ohms; power capacity, up to 50 watts. The Model S-778 measures 29½" high x 20⅜" wide x 13¾" deep.



Circle No. 80 on Reader Service Page 15

AUTOMATIC TIMER

Any electrical product can be switched on and off automatically many times with the "Functional Timer" offered by *Yale Audio of Florida* — as many as 48 combinations of time intervals can be preset. It will turn on your tape recorder and FM radio in your absence, record a particular program, then shut them off again. Other applications include time-lapse photography, sleep learning, phone answering service, water and lighting systems, and what have you. Models are available for either 12-hour or 24-hour operation, and with or without a tone-adjustable buzzer.



Circle No. 81 on Reader Service Page 15

GENERAL-COVERAGE COMMUNICATIONS RECEIVER

Beginning SWL's and Novice hams will be interested in the imported, low-cost, 7-tube receiver announced by *Lafayette Radio Electronics*. The HA-63A provides full fingertip coverage of AM broadcast, marine and aeronautical bands, civil defense, WWV, amateur and foreign broadcasting frequencies. An easy-to-read illuminated slide rule dial with built-in "S" meter insures accurate tuning. The superheterodyne circuit has a 3-gang tuning capacitor with separate tuning coils for each of four bands to provide excellent selectivity and a sensitivity of 1.5 μV. Frequency range of the HA-63A is 550 kHz to 31 MHz. Other features include: switchable a.v.c./m.v.c., a.n.l., BFO, and antenna trimmer control. Output impedance is 4-8 ohms; audio output, 1.5 watts.

Circle No. 82 on Reader Service Page 15

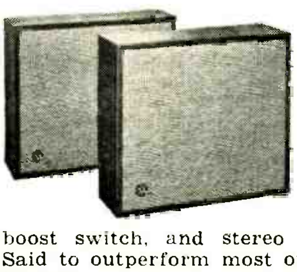
ALL-PURPOSE TWO-WATT TRANSCEIVER

Claricon's new 2-watt, 2-way CB transceiver is suitable for portable, mobile, marine, or base station use. It features two crystal-controlled channels with 2-watt output from 13 transistors, and simple push-button operation. In addition to the on/off switch, preset volume control, squelch control, and channel selectors, there is a battery level indicator which assures full power operation. The unit is furnished with four crystals (2 transmit, 2 receive), and a combination dynamic push-to-talk microphone and speaker.

Circle No. 83 on Reader Service Page 15

SELF-ENERGIZED SPEAKER SYSTEM

The Model 4400 stereo speaker system introduced by *Viking of Minneapolis* consists of two walnut speaker enclosures of bookshelf size, each of which contains an 8" woofer and 3½" tweeter with crossover network. A 60-watt solid-state power amplifier, built into one of the enclosures, feeds both speakers—it has an on-off volume control, bass boost switch, and stereo headphone jack. Said to outperform most other speaker systems of comparable size, the 4400 will work equally well with any tape deck, preamplified tuner, or phonograph.



Circle No. 84 on Reader Service Page 15

NEW FROM ALLIED

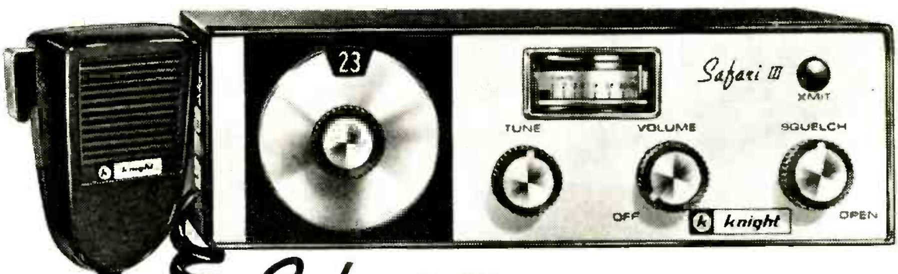
knight-kit® Safari® II & III Citizens Band Transceivers

Safari II 5-Watt 5-Channel Transceiver Kit

With Mike/Speaker, Channel 9 Crystals

$59.95

Versatile, easy and fun to build, features compact solid-state design with factory assembled and aligned transmitter section, yet is priced remarkably low. Full 5 watts input power, 5 crystal-controlled channels. Just 2 1/8 x 6 7/8 x 8 1/2" overall. Connects to 12-volt battery in car, truck or boat in minutes . . . use as portable with optional battery pack, or as base station with optional AC supply. Simple 3-control operation—illuminated channel selector, squelch control, on/off volume control. Series gate noise limiter circuit overcomes interference. Unique push-to-talk microphone/speaker.



Safari III 5-Watt 23-Channel Transceiver Kit

With Mike/Speaker, Channel 9 Crystals

$84.50

Designed for those who want the best in CB at a low price. All the deluxe features of the Safari II above . . . PLUS provision for 23 crystal-controlled channels; easy-to-read front-panel "S" meter and fine tuning control to tune in stations that are off frequency; and transmit indicator light.

HANDCRAFTED FOR QUALITY BY YOU

— YOUR SATISFACTION GUARANTEED BY ALLIED

Read the unique money-back guarantee below . . . exclusive in the industry . . . then rush the coupon at right for full details and Special Introductory Offer.

KNIGHT-KIT GUARANTEE

Build a Knight-Kit in accordance with our easy-to-follow instructions. When you have completely assembled the kit, you must be satisfied or we will return your money, less transportation charges, under the Allied guarantee of satisfaction.

ALLIED RADIO

ALLIED RADIO, Knight-Kit Div., Dept. 3-BB
P. O. Box 8528 Chicago, Illinois 60680

Please rush—FREE and without obligation—full details and Special Introductory Offer on **Knight-Kit Safari II & III.**

Name ______________________
PLEASE PRINT

Address ______________________

City__________ State__________ Zip______

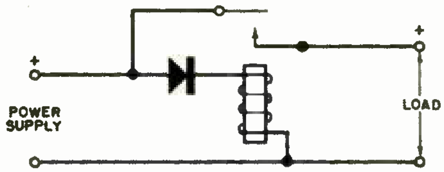
CIRCLE NO. 18 ON READER SERVICE PAGE

TIPS & TECHNIQUES

PARTS · METHODS · IDEAS · GADGETS · DEVICES

PROTECTION AGAINST WRONG POLARITY APPLICATIONS

If a diode is connected between your power supply and the load, the wrong voltage polarity can be prevented from getting to your equipment and damaging components. However, the diode would have to handle the full current drawn by the load. You can get better results if the contacts of a relay carry the load current, leaving only the small amount of current needed to energize the relay to be passed by the diode. Connect a diode and relay as shown. When the voltage is of proper



polarity, the diode conducts and causes the relay to energize, applying the full power supply voltage to the load. If the polarity is reversed, the diode doesn't conduct and the relay stays open. Use a sensitive (5-mA to 10mA), normally open s.p.s.t. relay whose contacts can handle the current drawn by the load. —*Mahaveerchand Bhandari*

KEEP YOUR CW KEY CLEAN WITH A "DUST COVER"

Here's a handy way to prevent dust from "bugging" your key and to reduce the danger of shocks where high voltage is present. Take a common plastic food container that measures about 2½" deep by 3" in diameter, and cut openings in it to clear the key, the shorting lever—if any—and connecting cable. Then place the container over the key. The resulting "dust cover" can also house a click filter, if you use one. Plastic food containers are available from most dime stores for about 29 cents. —*Stephen Stone WN1FSU*

(*Continued on page* 30)

Regardless Of What You Pay For A Color TV...

It Can't Perform As Well As This New Heathkit® "180" For Only $379⁹⁵*

Here's Why!

Exclusive Features That Can't Be Bought In Ready-Made Sets At Any Price! *All* color TV sets require periodic convergence and color purity adjustments. This new Heathkit GR-180 has *exclusive* built-in servicing aids so *you* can perform these adjustments anytime . . . *without* any special skills or knowledge. Simple-to-follow instructions and detailed color photos in the GR-180 manual show you exactly what to look for, what to do and how to do it. Results? Beautifully clean and sharp color pictures day in and day out . . . and up to $200 savings in service calls during the life of your set!

Exclusive Heath Magna-Shield . . . surrounds the entire tube to keep out stray magnetic fields and improve color purity. In addition, *Automatic Degaussing* demagnetizes and "cleans" the picture everytime you turn the set on from a "cold" start.

Choice Of Installation . . . Another Exclusive! The GR-180 is designed for mounting in a wall or your own custom cabinet. Or you can install it in either optional Heath factory-built Contemporary or Early American styled cabinets.

From Parts To Programs In Just 25 Hours. All critical circuits are preassembled, aligned and tested at the factory. The GR-180 manual guides you the rest of the way with simple, non-technical instructions and giant pictorials. You can't miss!

Plus A Host Of Advanced Features . . . like the hi-fi 180 sq. inch rectangular tube with "rare earth phosphors", smaller dot size and 24,000 volt picture power for brighter, livelier colors and sharper definition . . . *Automatic Color Control* and gated *Automatic Gain Control* to reduce color fading and insure jitter-free pictures at all times . . . deluxe *VHF Turret Tuner* with "memory" fine tuning . . . *2-Speed Transistor UHF Tuner* . . . *Two Hi-Fi Sound Outputs* for play through your hi-fi system or connection to the GR-180's 4" x 6" speaker . . . *Two VHF Antenna Inputs* — a 300 ohm balanced and a 75 ohm coax . . . *1-Year Warranty* on the picture tube, 90 days on other parts. For full details mail coupon on the following page.

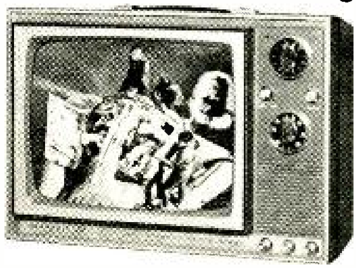
***Kit GR-180,** everything except cabinet, 102 lbs. **$379.95**

GRA-180-1, walnut cabinet (shown above), 30 lbs. . . 18¼" D x 28¼" W x 29" H. **$49.95**

GRA-180-2, Early American cabinet, 37 lbs. . . 18¼" D x 28¼" W x 31¾" H . . . Available February **$75.00**

NEW 12" Transistor Portable TV — First Kit With Integrated Circuit

Unusually sensitive performance. Plays anywhere . . . runs on household 117 v. AC, any 12 v. battery, or optional rechargeable battery pack ($39.95); receives all channels; new integrated sound circuit replaces 39 components; preassembled, prealigned tuners; high gain IF strip; Gated AGC for steady, jitter-free pictures; front-panel mounted speaker; assembles in only 10 hours. Rugged high impact plastic cabinet measures a compact 11½" H x 15¾" W x 9⅜" D. 27 lbs.



Kit GR-104

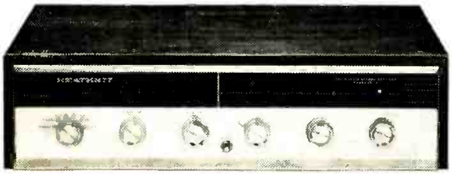
$119⁹⁵

Turn Page For More New Kits From HEATH

CIRCLE NO. 16 ON READER SERVICE PAGE

How To Have Fun While You Save . . .

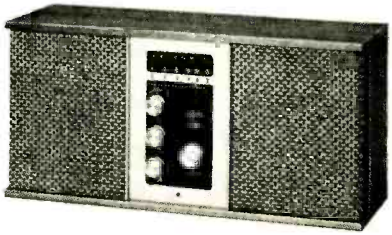
30-Watt Solid-State FM/FM Stereo Receiver . . . Your Best Buy In Stereo



Kit AR-14
$99.95
(less cabinet)

High Performance At Lowest Cost Features 31 transistors, 10 diodes for cool, natural transistor sound; 20 watts RMS, 30 watts IHF music power @ ±1 db, 15 to 50,000 Hz; wideband FM/FM stereo tuner, plus two preamplifiers; front panel stereo headphone jack; compact 3⅞" H x 15¼" W x 12" D size; simple 20-hour kit assembly. Custom mount it in a wall, or either Heath preassembled cabinets (walnut $9.95, beige metal $3.95). 16 lbs.

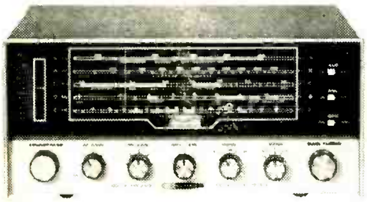
NEW! Deluxe Solid-State FM/FM Stereo Table Radio



Kit GR-36
$69.95

Tuner and IF section same as used in deluxe Heathkit transistor stereo components. Other features include automatic switching to stereo; fixed AFC; adjustable phase for best stereo; two 5¼" PM speakers; clutched volume control for individual channel adjustment; compact 19" W x 6½" D x 9¼" H size; preassembled, prealigned "front-end"; walnut cabinet; simple 10-hour assembly. 17 lbs.

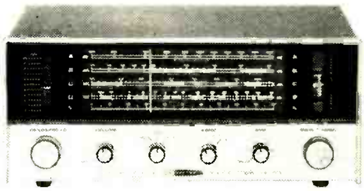
5-Band AM/Shortwave Radio



Kit GR-54
$84.95

Compare It To Sets Costing $150 & More! 5 bands cover 200-400 kHz, AM and 2-30 MHz shortwave. Features tuned RF stage; crystal filter for razor sharp selectivity; separate product detector for SSB & CW, plus AM diode detector; switchable BFO control; ANL; AVC; "S" meter; 4" x 6" speaker; headphone jack; antenna trimmer; charcoal gray metal cabinet; includes SWL antenna. 25 lbs.

4-Band AM/Shortwave Receiver



Kit GR-64
$37.95

Hear Live Broadcast From Hundreds Of Foreign Countries, Voice of America, Radio Moscow, hams, ship-to-shore, plus popular AM. Covers 550 kHz to 30 MHz in 4 bands. Boasts 4-tube superhet circuit plus 2 silicon rectifiers; 5" speaker; BFO control; "S" meter; bandspread tuning; headphone jack; AM rod antenna; charcoal gray metal cabinet. 15 lbs.

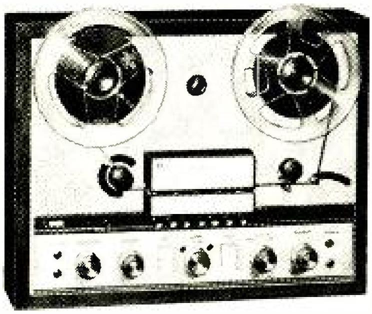
New! Heathkit 60-Watt Solid-State Guitar Amplifier

Kit TA-16
$129.95

All The Features Guitarists Want Most . . . 60 watts peak power; two channels, one for accompaniment, accordion, organ or mike, the other has variable reverb and tremolo for lead guitars; 2 inputs per channel; two foot switches for reverb & tremolo; two 12" heavy-duty speakers; hum reduction switch; one easy-to-build circuit board with 13 transistors, 6 diodes — total kit assembly time 12 hours; 28" W x 9" D x 19" H leather-textured black vinyl cabinet of ¾" stock; 120 v. or 240 v. AC operation; extruded aluminum front panel; chrome-plated knobs. 52 lbs.

Build Your Own Heathkit® Electronics

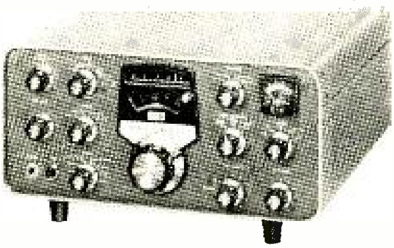
NEW Heathkit® /Magnecord® 1020 4-Track Stereo Recorder Kit



Kit AD-16
$399.50
(less cabinet)

Save $170 by doing the easy assembly yourself. Features solid-state circuitry; 4-track stereo or mono playback and record at 7½ & 3¾ ips; sound-on-sound, sound-with-sound and echo capabilities; 3 separate motors; solenoid operation; die-cast top-plate, flywheel and capstan shaft housing; all push-button controls; automatic shut-off; plus a host of other professional features. 45 lbs. Optional walnut base $19.95, adapter ring $4.75

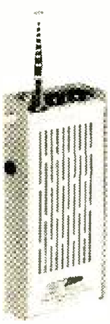
New! SB-101 80-10 Meter SSB Transceiver — Now With Improved CW Transceive Capability



Kit SB-101
$360.00
(less speaker)

Now features capability for front panel switch selection of either the USB/LSB standard 2.1 kHz SSB filter or the optional SBA-301-2 400 Hz CW filter . . . plus simplified assembly at no increase in price over the already famous Heathkit SB-100. Also boasts 180-watt P.E.P. input, 170 watts input CW, PTT & VOX, CW sidetone, Heath LMO for truly linear tuning and 1 kHz dial calibrations. 23 lbs. SBA-301-2, 400 Hz CW filter . . . $20.95. Kit HP-13, mobile power supply . . . $59.95. Kit HP-23, fixed station supply. $39.95

2-Watt Walkie-Talkie



Assembled
GRS-65A
$99.95

New . . . Factory Assembled. Up to 6 mile range; rechargeable battery; 9 silicon transistors, 2 diodes; superhet receiver; squelch; ANL; aluminum case. 3 lbs. 117 v. AC battery charger & cigarette lighter charging cord $9.95. Crystals $1.99 ea.

NEW Portable Phonograph Kit

Kit GD-16
$39.95

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CIRCLE NO. 16 ON READER SERVICE PAGE

TIPS

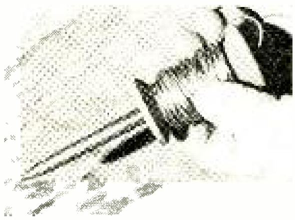
(Continued from page 26)

FIBER OPTICS CAN PUT LIGHT WHERE YOU WANT IT—EVEN AROUND CORNERS

Use a soldering gun on a component you cannot see, and more harm than good can come of your work, especially if the component is a transistor which is easily damaged by heat. There are plastic fiber optic light guides available that will light your way with a pencil-thin beam of light so that you can work in the tightest and most poorly lit areas of a chassis. When light is focused on one end of a light guide, it is transmitted to the other end with very little loss in intensity, even if the guide is bent in a circle. A small penlight flashlight can be used as a light source, and an alligator clip can be taped to the light guide so that you don't have to hold the guide while you're working. One source of fiber optic light guides is Edmund Scientific Co., Barrington, N.J.; they cost about 65 cents a foot. —*E. S. Connors*

CONVERT BALL-POINT PEN TO SOLDER HOLDER AND FEEDER

Are you muscle-bound from juggling a soldering gun in one hand and a 1-lb. roll of solder in the other? You can lighten the load in at least one hand with a ball-point pen and an empty thread spool. Remove the top, cartridge, and spring from the ball-point pen, and press-fit the plastic pen shell into the hole in the spool. It may be necessary to ream the hole in the spool for the shell to fit. Glue the shell and spool together. Now, wrap a small supply of solder onto the spool, and thread the free end of the solder through your new solder feeder as shown. —*Glen F. Stillwell*



WHITE PAINT KEEPS ELECTRONIC EQUIPMENT COOL

If you have to run your equipment while it is exposed to the sun, chances are that the combined heat from the inside and from the outside will cause tuned circuits to drift, shorten component life, and induce other thermal problems. A coat of white paint applied to the outer surfaces of your equipment cabinet will reflect a large portion of the sun's heat and reduce the heat level within the cabinet. —*William C. Bakewell, WB6GHB*

NEW LITERATURE

To obtain a copy of any of the catalogs or leaflets described below, simply fill in and mail the coupon on page 15.

"1967 Altec Playback Stereo Components & Systems" is the title of a 12-page multicolor catalog announced by *Altec-Lansing.* Illustrated and described are the "world's first all-silicon transistor stereo FM receiver"; speaker systems, both full size and bookshelf; playback speaker components; and new high-style equipment cabinets. Specifications are included.

Circle No. 85 on Reader Service Page 15

ATV Research has announced the availability of its 1967 closed-circuit TV catalog, a 20-pager which presents a wide variety of TV camera kits (both tube and transistor), as well as a full complement of focus/deflection coils, monitors, lenses, vidicons, tripods, and other essential TV items.

Circle No. 86 on Reader Service Page 15

Features, specifications, and prices of professional test equipment for servicing radio, TV, hi-fi and electronic communications equipment are detailed in a new 12-page (8½" x 11") brochure issued by the *B & K Division* of Dynascan Corporation. Highlighted are two instruments for testing and repairing both color and black-and-white TV sets: the Model 1076 "Analyst" and the Model 465 CRT rejuvenator/checker. The brochure also tells you how to use equipment to solve specific problems.

Circle No. 87 on Reader Service Page 15

"Great Scott" greets you from the cover of *H. H. Scott*'s 1967 Guide to Compact Stereo. The informative full-color folder includes complete descriptions, specifications, and photos of this company's new line of stereo "compacts."

Circle No. 88 on Reader Service Page 15

A two-color data sheet offered by *The Triplett Electrical Instrument Company* describes its hand-size, battery-operated Model 666-R volt-ohm-milliammeter. Both electrical and mechanical specifications are included on the data sheet, which is 3-ring-punched for inclusion in a reference binder. The Model 666-R features only one selector switch, three resistance ranges, and five voltage ranges.

Circle No. 89 on Reader Service Page 15

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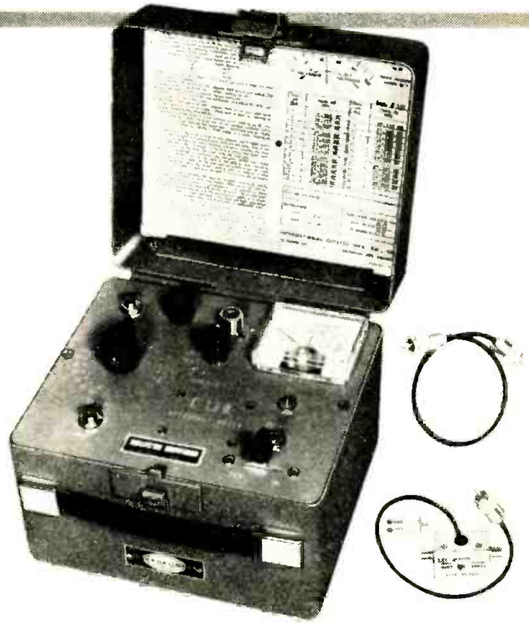

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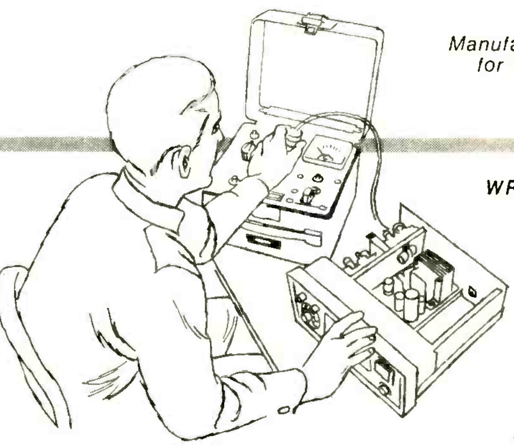

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CIRCLE NO. 17 ON READER SERVICE PAGE

OPERATION ASSIST

Through this column we try to make it possible for readers needing information on outdated, obscure, and unusual radio-electronics gear to get help from other P.E. readers. Here's how it works: Check the list below. If you can help anyone with a schematic or other information, write him directly—he'll appreciate it. If you need help, send a postcard to Operation Assist, POPULAR ELECTRONICS, *One Park Avenue, New York, N.Y. 10016. Give maker's name, model number, year of manufacture, bands covered, tubes used, etc. State specifically what you want, i.e., schematic, source for parts, etc. Be sure to print or type everything legibly, including your name and address. Because we get so many inquiries, none of them can be acknowledged.* POPULAR ELECTRONICS *reserves the right to publish only those items not available from normal sources.*

Weston Model 269 meter, circa 1943. Operating manual needed. (Dominick J. Argano, Bettmar 16749, Roseville, Mich. 48066)

Hickok Model RF05 oscillograph, series "E". Schematic and operating manual needed. (J.E. Forester, 10870 Dehmel Rd., Birch Run, Mich.)

Inter-Mark Model CR-11 transceiver. Schematic needed. (Jesse W. Couch, Box 472, Matador, Tex. 79244)

TT-41-/TXC-1B transceiver, surplus, Model TXC, ser. 29. Training manual =TM11-2258 needed. (Dallas H. Waltman, 17 E. Mason Ave., Alexandria, Va. 22301)

Hoffman Model 895 VHF 19" TV receiver, ser. B117036, chassis 185, circa 1950. Schematic, operating manual, and trouble-shooting data needed. (Bruce Lowell, 715 N. Sierra Dr., Beverly Hills, Calif. 90210)

BC-375-D transmitter, surplus. Schematic needed. (Alfonso B. Ebanks, TUSLOG Det-16, Box 422, A.P.O., New York 09289)

Seeburg "Master" amplifier, type MA1-66; 117 volts, 60 cycles; has 5 tubes. Schematic needed. (Jeffrey Colbert, 109 N. Oak St., Sparta, Ill.)

Lincoln Model L2754T transceiver, circa 1959. Schematic, parts list, coil data, and operating manual needed. (Al Johnson, 3262 Towers Court South, Columbus, Ohio 43227)

Standard Model SR-Q110EL transceiver; tunes 3 bands. Schematic, operating manual, and source for parts needed. (J.H. Huestis, 220 First St., Summerside, P.E.I., Canada)

Admiral Model C2226N TV receiver, chassis 22A3, circa 1953; has 21 tubes. Schematic needed. (James D'Amato, 2665 Marion Ave., New York, N.Y. 10458)

E.H. Scott "Phantom Deluxe" receiver, circa 1936; tunes 550 kHz to 50 MHz on 5 bands; has 28 tubes. Speaker or 925-ohm field coil with 1¾" voice-coil opening needed. (Edward E. Fontaine, 183 Oak St., Gardner, Mass. 01440)

Electronic Measurements Corp. Model P.F.1083 photoflash battery tester. Schematic and parts list needed. (James H. Kuntz, 18-21 Ditmars Blvd., Long Island City, N.Y. 10005)

Zenith Model 5-J-217 receiver, circa 1930; tunes 550 kHz to 18 MHz on 2 bands; has 5 tubes. Schematic and source for parts needed. (Curtis A. Cook, 2712 Woodland, Des Moines, Iowa 50312)

Midwest Model KC-16 receiver, ser. 11610FO; AM, FM and s.w. Schematic needed. (Robert Sauvé, C.P. 32, Granby, Shefford, Canada)

(*Continued on page* 96)

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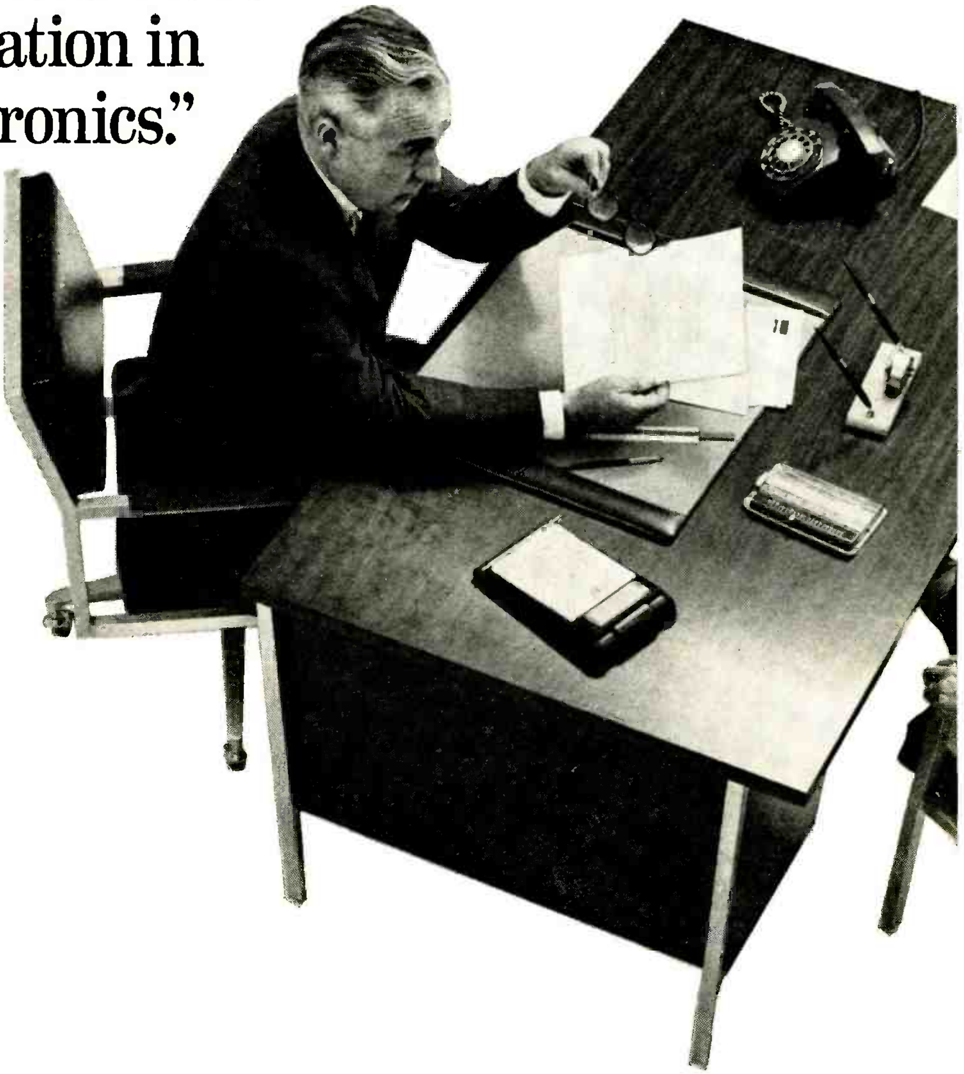
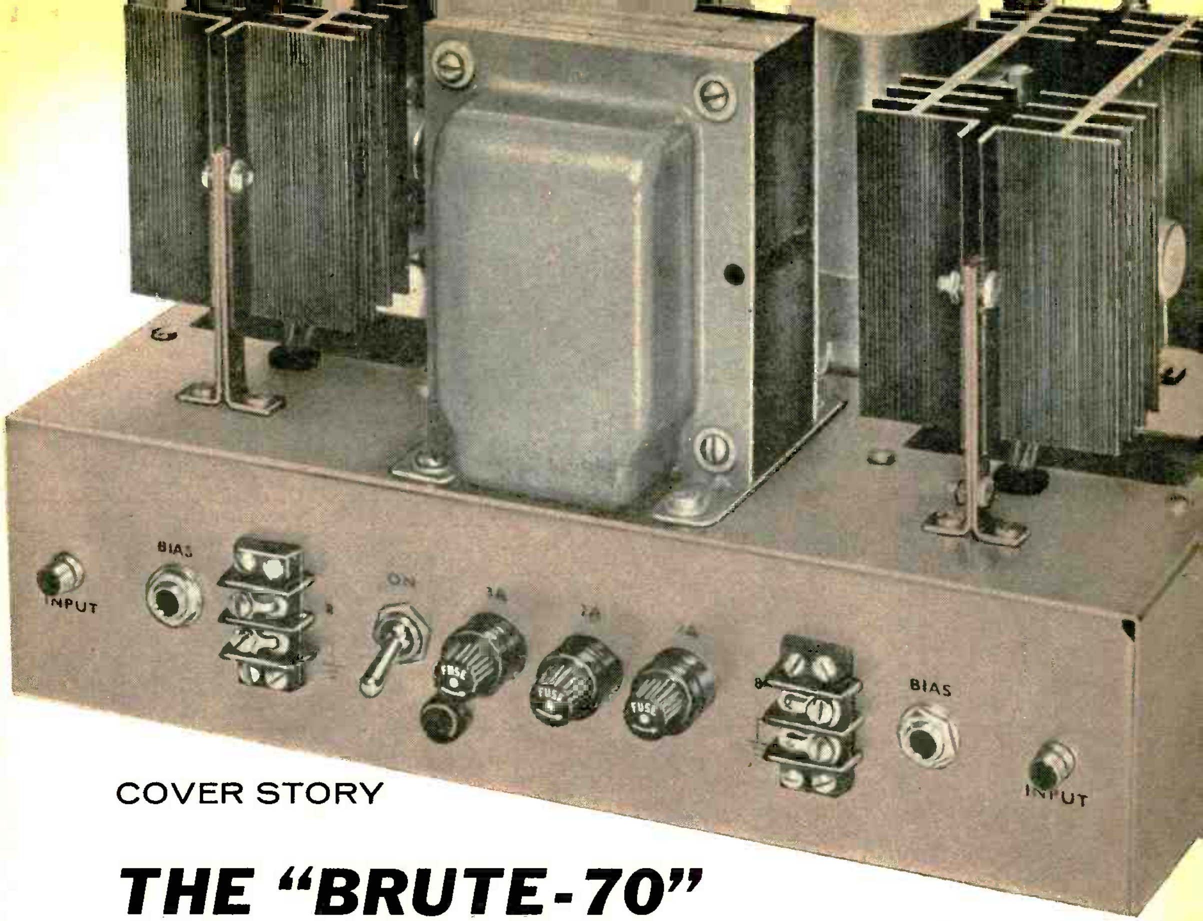
CIRCLE NO. 15 ON READER SERVICE PAGE

"He's a good worker. I'd promote him right now if he had more education in electronics."





COVER STORY

THE "BRUTE-70"

SOLID-STATE POWER AMPLIFIER FOR MONO OR STEREO HI-FI

By E. G. LOUIS

IN THE NEVER-ENDING search for hi'er fi, audio fans and other experimenters are constantly upgrading their equipment. If the time has come for you to improve the amplifier portion of your system, or if you want to start a new system, you are in a position to benefit from the "Brute-70" solid-state 70-watt hi-fi amplifier, especially if you like to build your own equipment and want to keep your costs down. You can build two Brute-70's and a common power supply, all on one chassis, to obtain an unusually good stereo amplifier—the specifications are most impressive.

The amplifier gets its name from the fact that it puts out a "brute" 70 watts of power—that is, 70 root-mean-square (r.m.s.) watts. If you build a stereo version, as shown here, and if you rate the amplifier by adding both channels together, and use the peak watts figure (r.m.s. watts x 2 = peak watts), like some manufacturers do, you will wind up with a whopping 280 watts. But don't be fooled, the power is still only a brute 70 watts (r.m.s.) per channel.

Unlike many power amplifiers, the Brute-70 is able to deliver most of its full-quality sound at all volume levels, not just at its full rated output. You can listen to the authority of the bass drum and the command of a bugle or to the quiet mood setting background music of Roger Williams or Mantovani without a worry about distortion. Total harmonic distortion is less than 1% at any power level, and less than 0.25% within generally used levels. Frequency response is flat within 1 dB from a low of 5 Hz all the way up to 25 kHz . . . and it drops off only 3 dB at 50 kHz. It has been demonstrated that amplifiers with essentially flat frequency response well beyond the upper limit of hearing (15,000 to 20,000 Hz) have a minimum amount of phase distortion within the audible range. To the purist, distortion of any kind is undesirable. Another type of distortion is avoided here by using a class AB mode of operation instead of class B. Class AB amplifiers do not have the inherent crossover distortion of class B amplifiers.

Based on an RCA-developed design, the outstanding performance of the Brute-70 can be attributed to the use of sophisticated circuitry made possible by the availability of high-quality silicon semiconductors. The circuit is a direct-coupled, transformerless, quasi-complementary configuration with a built-in 35-dB negative feedback system. There is also a built-in short-circuit proof feature which protects both the driver and the output stages from high currents and excessive power dissipation. Use of silicon devices makes the amplifier more tolerant of heat; stability is maintained at ambient temperatures up to 71°C (160°F). And, as if this weren't enough, the mechanical construction, in conjunction with a couple of diodes, provides a thermal feedback loop to enhance stability.

Sound expensive? It should be, but it isn't. Although a veritable Rolls Royce among power amplifiers, the Brute-70 can be assembled for a little over 50 cents per watt.

BRUTE-70 SPECIFICATIONS

Power Output	70 watts r.m.s. per channel
Class	AB
Power Gain	68 dB
Hum and Noise	down more than 60 dB from 1 W
Total Harmonic Distortion	less than 0.25% @ 1 kHz and 70-W output; less than 0.8% @ 20 Hz to 25 kHz from 0 to 70 watts
Frequency Response	5 Hz to 25 kHz ± 1 dB; down 3 dB at 50 kHz
Input Impedance	100,000 ohms
Output Impedance	8 ohms
Sensitivity	0.8-V input for 70-W output
Other Features	short- and open-circuit-proof; direct-coupled series-connected output stage; no output or driver transformers; all-silicon solid-state circuit

This circuit is based on an RCA design described in Data Bulletin ATC-408. A preamplifier of comparable quality to match the Brute-70 is in the works and will be published in an early issue.

How It Works. Only 0.8 of a volt input signal is needed to drive the amplifier to its full 70-watt output. The signal from a tuner, preamp, or other suitable source is fed into the amplifier at *J1* (Fig. 1) and capacitively coupled to *Q1*. Resistor *R1* increases the amplifier's effective input impedance to 100,000 ohms. Capacitor *C1* serves as a d.c. blocker and signal coupler. Transistor *Q1*'s bias is a function of the setting of *Zero Adjust* control *R13*, and the values of *R2, R3,* and *R4*, as well as the applied voltages.

Control *R13* is adjusted to obtain zero volts at point *F* under no signal conditions. A close examination of this circuit reveals that a d.c. feedback loop from *R13* to *Q1* exists. Current through *R13* affects the voltage applied to the emitter of *Q1,* which in turn affects the amount of current in all of the other transistors and *R13*. (All stages are direct-coupled.) Quiescent voltage at point *F* is maintained to within ± 0.1 volt.

Capacitor *C3* and resistor *R5* provide an a.c. negative feedback path to *Q1,* on the order of 35 dB, and give the amplifier its flat frequency response. Capacitor *C4* bypasses some of the higher frequencies across *C3* and *R5* and prevents over-dissipation of the predrivers. Not shown (usually not needed), is a 0.01 μf capacitor across *R6* to prevent overdrive if *Q2* has an unusually high beta.

The signal from *Q1* is direct-coupled to the modified Darlington pair predriver stage (*Q2* and *Q3*). The Darlington circuit is noted for its high gain and high impedance. It has a minimum loading effect on the input stage, and, with *Q1,* provides all of the voltage amplification for the entire amplifier. Later stages do not provide any voltage gain, but they function as current amplifiers, and bring the impedance down to accommodate an individual 8-ohm speaker or speaker system. From *Q3*, the signal is direct-coupled to a complementary pair

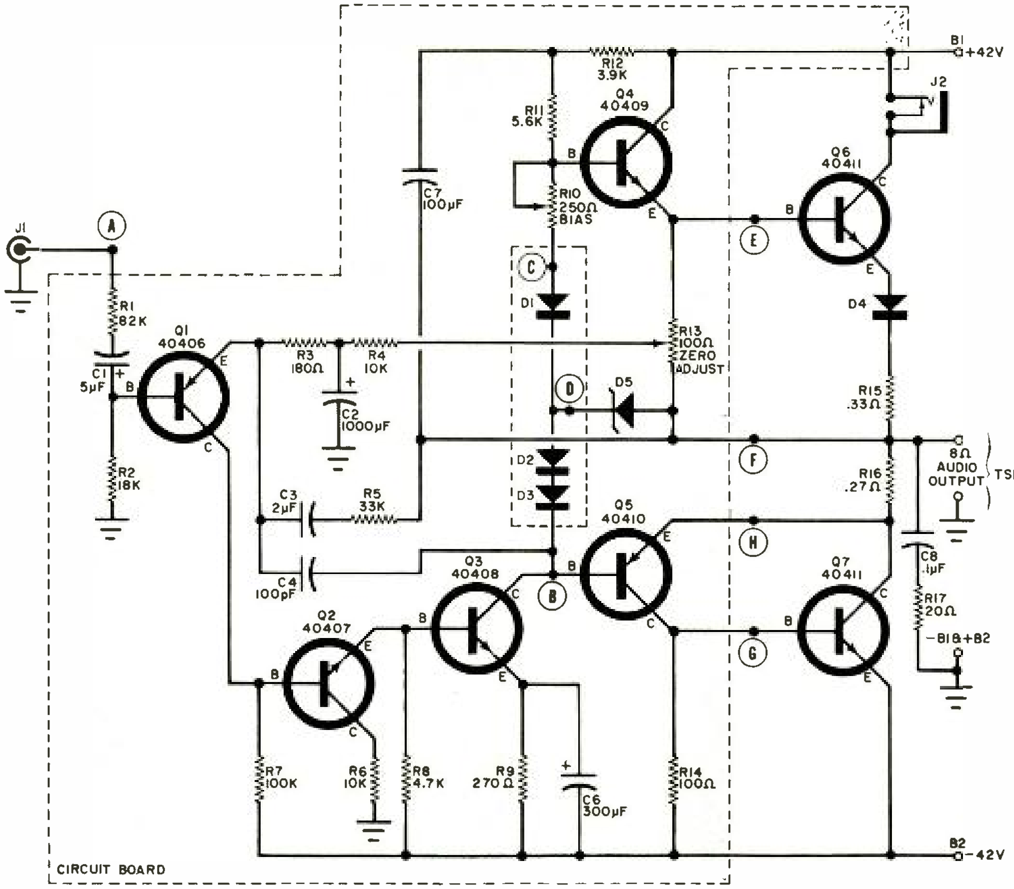


Fig. 1. All components within the tinted area are mounted on a printed circuit board. Diodes D1, D2, and D3, and transistors Q6 and Q7 are mounted on heat sinks. Stability and low distortion can be attributed to a.c., d.c., and thermal feedback loops. Zener diode D5 helps make the amplifier short-circuit-proof.

AMPLIFIER PARTS LIST
(per channel)

C1—5-μF, 15-volt electrolytic capacitor
C2—1000-μF, 3-volt electrolytic capacitor
C3—2-μF, 6-volt electrolytic capacitor
C4—100-pF, 50-volt ceramic capacitor
C5—Not used
C6—300-μF, 6-volt electrolytic capacitor
C7—100-μF, 50-volt electrolytic capacitor
C8—0.1-μF, 100-volt capacitor
D1, D2, D3—1N3754 diode
D4—1N1612R diode
D5—4.7-volt, 1-watt zener diode (1N1519, or similar)
J1—Phono jack
J2—Closed-circuit phone jack
Q1—40406 silicon pnp transistor
Q2—40407 silison npn transistor
Q3—40408 silicon npn transistor
Q4—40409 silicon npn transistor, with heat sink
Q5—40410 silicon pnp transistor, with heat sink
Q6, Q7—40411 silicon npn power transistor
R1—82,000 ohms
R2—18,000 ohms
R3—180 ohms
R4, R6—10,000 ohms
All resistors ½ watt, unless otherwise stated
R5—33,000 ohms
R7—100,000 ohms
R8—4700 ohms
R9—270 ohms
R10—250-ohm, ½-watt trimmer potentiometer
R11—5600 ohms
R12—3900 ohms
R13—100-ohm, ½-watt trimmer potentiometer
R14—100 ohms
R15—0.33 ohm, 10 watts—see text
R16—0.27 ohm, 10 watts—see text
TS1—Two-terminal barrier-type terminal strip
*1—Etched circuit board**
1—7" x 12" x 3" aluminum chassis (Bud AC-408, or similar)
2—Heat sinks (Delbert Blinn X-010-D-3)
Misc.—1" standoff spacers (4), hookup wire, shielded wire, diode clips, brackets, etc.

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*A pre-etched and screened printed circuit board is available for $2.75 ($5.50 for two) from DEMCO, 219 W. Rhapsody, San Antonio, Texas 78216. A complete kit of parts, including heat sinks, but less chassis and power supply components, is available for $25 per channel.

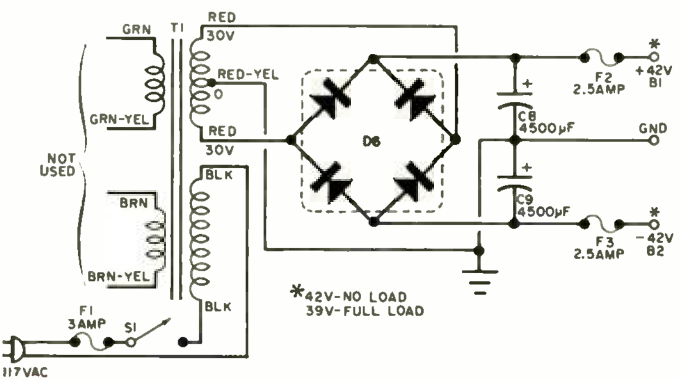
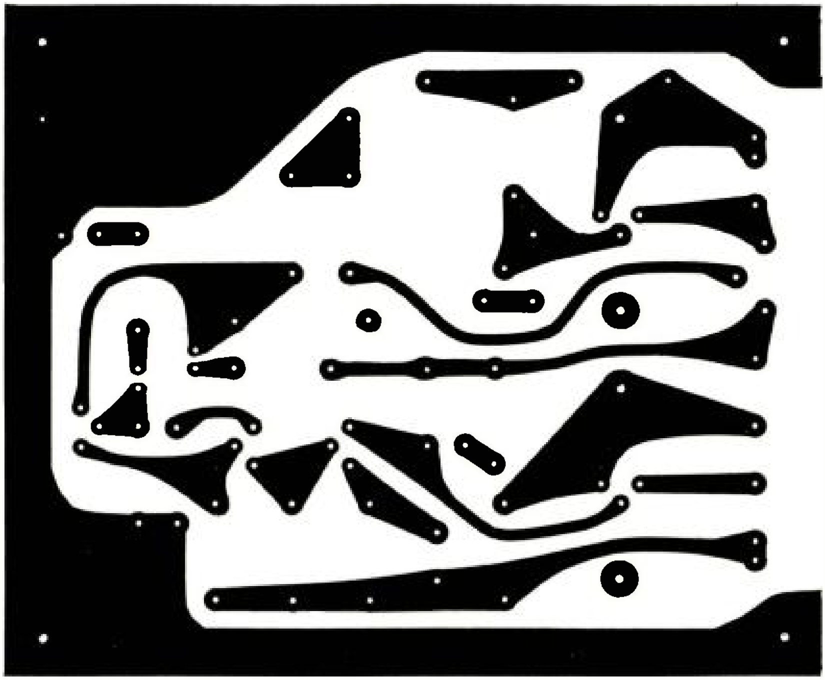


Fig. 2. Positive and negative supply voltages are balanced with respect to ground through a 60-volt center-tapped winding. Try using 2-ampere, fast-blow fuses for F2 and F3. If they don't stand up, use the 2½-ampere size shown here.

Fig. 3. Actual-size photo of printed circuit board. High power and high gain characteristics make lead dress critical. Point-to-point wiring on a perforated board may be used if proper lead dress and parts layout is maintained.



of transistors (*Q4* and *Q5*) which are used to direct-drive the two series-connected power transistors.

Capacitor *C7* performs two functions: first, it decouples the power supply to remove ripple voltage from the predriver and driver stages; and second, it provides a bootstrap voltage to increase the drive voltage to *Q4*.

Bias voltage adjustment for the complementary driver stages is provided by diodes *D1*, *D2* and *D3* and by *Bias Control R10*. The diodes are connected thermally to the output transistor heat sinks to establish a thermal feedback circuit. This thermal feedback arrangement stabilizes the quiescent current of the output stages at its preset value for all case temperatures up to 100°C, thus protecting the driver and output transistors.

The *Bias Control* is adjusted to obtain 20 mA quiescent current in the collector circuit of *Q6*. An ammeter can be plugged into *J2* to measure this current. The forward voltage drop across three diodes (*D1*, *D2*, *D3*) and the voltage across *R13* provide the bias voltage necessary to maintain the output stages in class AB operation. The *Bias Control* permits adjustment for component variations.

Another benefit of the high-temperature compensation provided by the thermal feedback loop is the ability to maintain stability even with small-value resistors in the output stages—the less the resistance, the less the loss. In this case, it results in greater output.

Short-circuit protection is provided by a unique current-limiting circuit using zener diode *D5* in conjunction with resistors *R15* and *R16*. Both the driver (*Q4* and *Q5*) and the output (*Q6* and *Q7*) transistors are protected from high current and excessive power dissipation such as would be caused by a reduced load resistance or, in the worst case, a short circuit.

If a condition develops which causes a current to exceed 5 amperes through either resistor, (*R15* or *R16*), the following action takes place: during the negative-going output half-cycle, the small forward voltage across *D5* causes it to conduct in the forward direction; during the positive-going output half-cycle, the zener breakdown voltage is reached and the diode conducts once again, preventing further increase in voltage and further increase in output current.

This amplifier does not require a regulated power supply. A conventional full-wave center-tapped circuit as shown in Fig. 2 can be used to power either a stereo or mono rig. Transformer *T1* steps down the 117-volt line voltage to 60 volts. The center-tapped secondary hooked up to the bridge rectifier provides both a positive and a negative d.c. output voltage (*B1* and *B2*) which is balanced to ground.

Capacitors *C8* and *C9* serve as ripple filters, and help reduce distortion at low frequencies. Fuses are provided for both *T1*'s primary (*F1*) and the d.c. supply lines (*F2* and *F3*). Additional protection

POWER SUPPLY PARTS LIST

C8, C9—4500-µF, 50-volt electrolytic capacitor (Mallory CG452U50D1, or similar)
D6—6-ampere, 100-volt full-wave diode rectifier module (Motorola MDA952-2, or 4 1N1614R diodes, or similar)
F1—3-ampere slo-blow fuse
F2, F3—2½-ampere fast-acting fuse
S1—S.p.s.t. toggle switch
T1—Power transformer; 117-volt primary, 60-volt center-tapped 2.5 ampere secondary (Thordarson Meissner 24R105, or similar)
Misc.—Line cord and plug, extractor-type fuse posts (3), wire, solder, rubber grommet, etc.

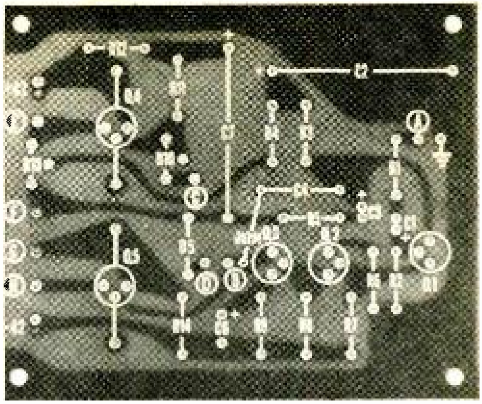


Fig. 4. Component layout on printed circuit board. The jumper lead (JUM) connecting C4 to Q3's collector can be eliminated by extending the foil conductor from C4 around the left end of resistor R5.

of the output transistors can be had by mounting a 100°C thermal cutout on one of the heat sinks of the output transistors and wiring the cutout in series with *S1*.

Construction. For a dual-channel stereo version of the Brute-70, you just double the number of components called for in the Parts List for the amplifier. The components for the power supply are the same for either a mono or stereo setup. A single chassis can be used to hold the mono or stereo amplifier, and the power supply.

Layout is reasonably critical, mostly because of the high gain and high power levels involved and the heat dissipation requirements. An actual-size photo of the foil side of the printed circuit board is shown in Fig. 3. You can purchase a ready-made circuit board (see Parts List) or etch your own.

If you are an advanced experimenter and are familiar with the requirements of proper lead dress for the audio circuits involved, you can assemble the components on a plain perforated board, but in any event you should not compromise on the heat sinks. Only those components included within the tinted area in Fig. 1 are mounted on the circuit board; see Fig. 4 for component layout.

Power transistors *Q6* and *Q7* and bias diodes *D1, D2,* and *D3* are mounted on the heat sinks as shown in Fig. 5. No, you are not seeing things—that's a mirror sitting on top of the amplifier to give

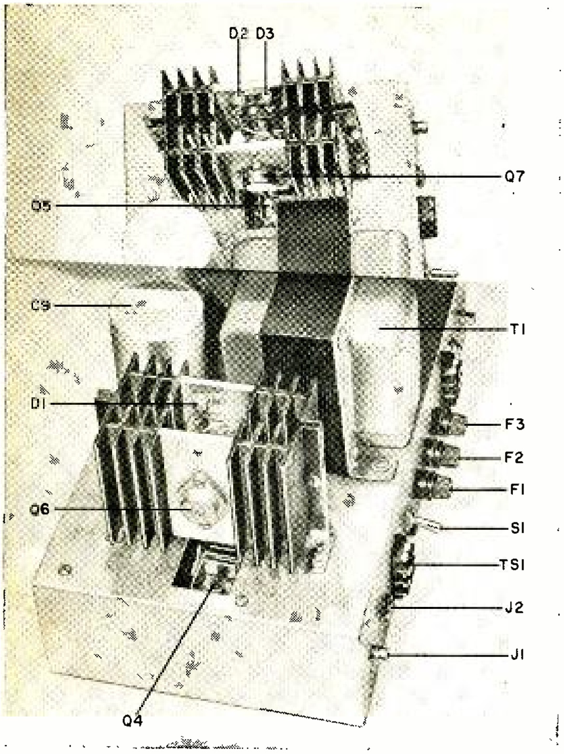


Fig. 5. Mirror standing on top of T1 shows D2 and D3 mounted on the back of the heat sink holding Q6. Other heat sink holds D1 and Q7. Note the cutouts in chassis to allow heat from Q4 and Q5 to escape.

you a view of what's behind the heat sinks in front of transformer *T1*. Note that diodes *D2* and *D3* and transistor *Q6* are mounted on one heat sink, and that *D1* and *Q7* are mounted on the other heat sink. Also note the cutout in the chassis to allow the heat from *Q4* and *Q5* to escape.

Mount power transistors *Q6* and *Q7* on their respective heat sinks using insulating washers, silicone grease, and appropriate fiber shoulder washers for the mounting screws. Bias diodes *D1, D2,* and *D3* are also mounted on the output heat sinks using RCA SA-2100 or other suitable metal clips: this is an important construction step which establishes the thermal feedback loop. Attach leads for later use below the chassis and circuit board connections. Assemble the heat sinks "back-to-back" on heavy-duty "L" brackets, or other suitable vertical supports. The thicker the brackets, the wider the spacing, and the better the heat dissipation.

Driver transistors *Q4* and *Q5* are equipped with integral heat sinks, as shown in Fig. 6. *Bias Adjustment* control *R10* and *Zero Adjustment* control *R13* are mounted on the foil side of the printed circuit board. Lead connections to the circuit board are identified by circled letters.

The power transformer (*T1*) specified in the Power Supply Parts List, and illustrated schematically in Fig. 2, is equipped with a pair of 6.3-volt filament windings which are not required by the amplifier. These filament leads should be taped to prevent accidental shorts, and tied to one side.

Follow the general chassis layout as shown in Figs. 5 and 7. Simply arrange the chassis-mounted components on the blank chassis and mark the places where the holes and cutouts should be.

The input and bias jacks, output terminals, power switch, and extractor fuse posts are all mounted on the front apron of the chassis. The assembled heat sinks, power transformer, and filter capacitors are mounted on top of the chassis. Finally, resistors *R15* and *R16,* full-wave rectifier module *D6,* and emitter diode *D4* are mounted on the underside of the chassis. The assembled circuit boards (only one board for mono) are also mounted inside the chassis on one-inch standoffs.

(*Continued on page* 86)

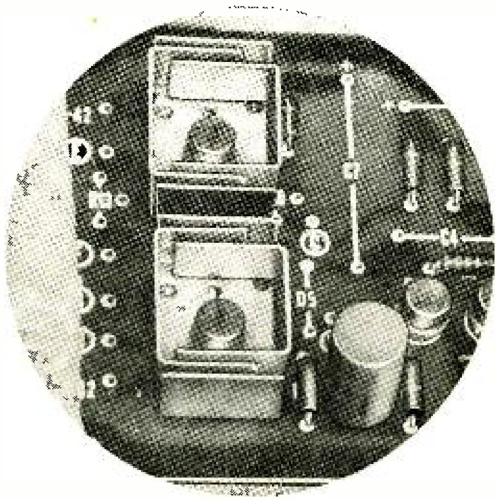


Fig. 6. Transistors Q4 and Q5 come equipped with heat sinks. These silicon transistors have good thermal stability, but proper venting is important.

MEET MR. FET...
the transistor that thinks it's a tube

By **LOUIS E. GARNER, JR.,** Semiconductor Editor

THIS LITTLE FELLOW AND HIS FAMILY ARE TAKING OVER SOLID-STATE

IT'S HARD to imagine, in the light of present scientific and technological achievements, that just a few short years ago there were no transistors and no integrated circuits. In fact, there are still many old-timers who remember the "prehistoric" age when there were no vacuum tubes, either. In those days, radio transmitters were weird spark-sputtering electromechanical monsters which bore a nostalgic resemblance to the fire-eating dragons of a yet earlier era.

Radio receivers were simple, too. A huge antenna hooked up to a couple of oversized coils, a tiny bit of mineral—galena—with a cat's whisker (fine wire), a pair of headphones . . . and that was the receiver. The galena, a crystal detector, was cheap, but it was insensitive and temperamental, too. It was on a quest for a better detector that Prof. J. A. Fleming developed the diode vacuum tube which, rightly enough, came to be known as the "Fleming valve."

A short time later Dr. Lee De Forest, inventor and scientist, added the control grid which, for the first time, enabled the vacuum tube to amplify, oscillate and detect electrical signals.

With the development of the vacuum tube came a giant industry with a record of spectacular achievements in radio broadcasting, electronic surveillance, computer technology, and industrial control. During the course of this industrial revolution, the vacuum tube was enlarged, miniaturized, modified and refined in many ways, including the addition of more electrodes. But there was a proverbial fly in the ointment. Most tubes generated so much heat that they had a relatively short useful life, and this resulted in a high failure rate for tube-type electronic equipment.

Then, early in 1948, Drs. Shockley, Bardeen, and Brattain—all scientists at the Bell Telephone Laboratories—announced the invention of a completely new device: a triode "crystal" which they claimed could amplify as well as detect electrical signals. Dubbed a

TRANSISTOR (from TRANsfer and resistor), the device was nothing more than a tiny cube of crystalline semiconductor material with two fine wire cat's whiskers. A minute voltage applied to the base crystal (thereafter called the *base*) controlled a much larger current flowing between the two whiskers, one of which was called the *emitter*, and the other a *collector*. The early transistors were expensive, noisy, and not too reliable. But these disadvantages were offset by their extremely small size, high efficiency and, potentially at least, manufacturing simplicity.

By 1951, long before this early point-contact transistor posed even a mild threat to the supremacy of the vacuum tube, a radically new type of transistor, the now common and widely used *junction transistor* was introduced.

Of Tubes and Transistors. Although a godsend in many ways, transistors brought a host of new problems to circuit designers. Essentially a current amplifier, the device could not be used as a direct replacement for the vacuum tube, which is a voltage amplifier. It had a low-to-moderate input impedance in contrast to the very high input impedance of vacuum tubes. In addition, because the transistor has a direct resistive connection between its *input* (base) and *output* (collector) terminals, a multiplicity of circuit feedback problems had to be solved.

Improved design methods were developed later, and transistorized receivers, amplifiers, transmitters, hearing aids, toys and industrial controls were produced in vast quantities. But there were still many circuit requirements where only high-impedance vacuum tubes could fill the bill, and many designers yearned for a miracle-like device—a transistor with tube-like characteristics.

As time went by, transistors got better and better. Output voltage and current ratings were being extended, as were the upper operating frequency limits. But no matter how the newer transistors were improved, they still had the basic characteristics of earlier types.

Meanwhile, back at the laboratory, scientists were experimenting with a new solid-state device, based on a molecular principle described by Lilienfeld as far back as 1928. Shockley, one of the co-inventors of the original transistor, had proposed a practical transistor-like device based on Lilienfeld's principle as early as 1948, but it was not until the mid 1950's that a workable device was developed in the laboratories, and practical, reliable units were not manufactured until the early 1960's.

The new device combined the most desirable features of the versatile vacuum tube and the efficient transistor. It had high input impedance and offered good isolation between input and output electrodes. Capable of high gain, it was, at the same time, as small as conventional transistors and extremely efficient. And, oddly enough, it exhibited at least one of the important operating characteristics of the vacuum tube—the control of a current by means of a varying electric field—in a solid-state medium rather than in a vacuum.

Identified by a variety of names—*Fieldistor, unipolar transistor*, and so on—during its gestation period, the device is now known as the *field-effect transistor* (FET). It is, indeed, a transistor which "thinks" and "acts" like a tube.

Meet Mr. FET. Pictorial and schematic representations of a triode vacuum tube, junction transistor, and field-effect transistor are illustrated in Figs. 1 through 3. Of the three schematic symbols, the FET symbol is the least standardized at present.

In a vacuum tube (Fig. 1), the plate current is simply a flow of free electrons which are literally "boiled" off of the cathode by the heated filament (in some high-power tubes, the filament is used directly) and are attracted by the positively-biased plate. The electrons leaving the cathode must travel through the intervening grid.

A negative bias on the grid establishes an electric field which tends to repel the electrons flowing from cathode to plate, limiting the plate current. The plate current can also be controlled, within limits, by the plate voltage. However, since the grid is much closer to the cathode than the plate, a smaller variation in grid voltage has essentially the same or greater effect on the plate current as a larger variation in plate volt-

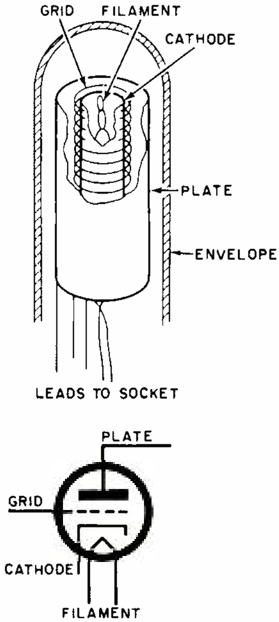


Fig. 1. Cutaway view illustrates the internal construction of a triode vacuum tube. The schematic symbol representing this tube is shown below the cutaway view.

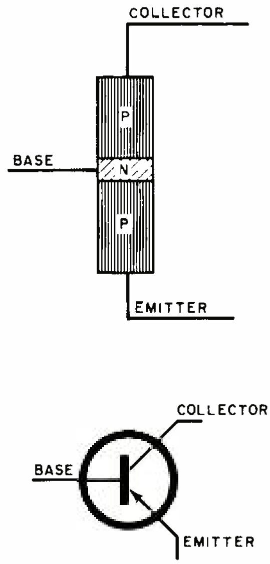


Fig. 2. Basic junction transistor cross section shows sandwich arrangement of semiconductor material for pnp unit. Note direction of arrow in the schematic symbol.

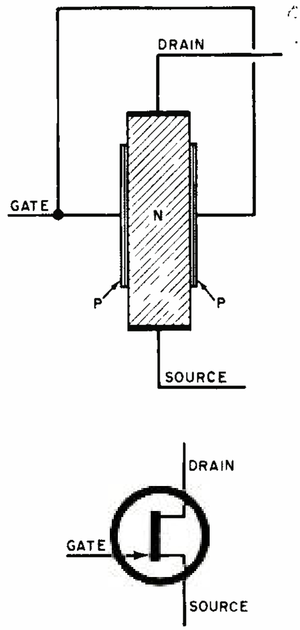


Fig. 3. Cross section of n-channel junction field-effect transistor shows p-type regions diffused into n-type substrate. Symbol has not been fully standardized yet.

age. It is this characteristic that enables a vacuum tube to amplify a signal.

Plate current saturation occurs when the plate is attracting all available free electrons. When this point is reached, a further increase in plate voltage does not cause a corresponding increase in plate current.

The basic junction transistor (Fig. 2) consists of three sandwich layers of two different semiconductor materials. Here, the emitter-collector current consists of a movement of two types of particles: electrons, which are negatively charged, and "holes" (essentially, the absence of an electron in an otherwise stable crystalline structure) which carry a positive charge. If the electrons predominate, they are called *majority carriers* and the holes *minority carriers*, with the material identified as an *n-type* semiconductor. By the same token, a material in which the positive holes predominate is called a *p-type* semiconductor.

The transistor's emitter-collector current is controlled by the injection of minority carriers into the base region. Since the base is quite thin, a relatively small current change there can control a much larger emitter-collector current. The junction transistor, then, is a current amplifying or control device, in contrast to the vacuum tube, which is essentially a voltage amplifier. In addition, since a base current flow, however minute, is essential to operation, the device must have a low input impedance.

The basic field-effect transistor consists of a slab of either *n-* or *p*-type semiconductor material with an electrode at either end, and two electrodes along the sides as shown in Fig. 3. Observe that the side electrodes are tied together and thus function as a single element. By convention, the terminal into which current is injected is called the *source*, and the output terminal is called the *drain*. The remaining electrode, which serves as a control element, is called the *gate*. Notice how FET terminology thus differs from that of both vacuum tubes and junction transistors.

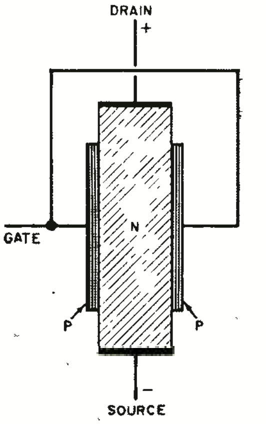


Fig. 4. Diffusion of p-type regions into n-type substrate provides a means of controlling the current flow between source and drain electrodes.

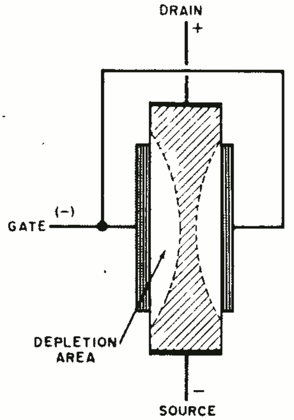


Fig. 5. When gate is reverse-biased, an electric field is set up to repel the current carriers, creating a depletion area and restricting region in which current flows.

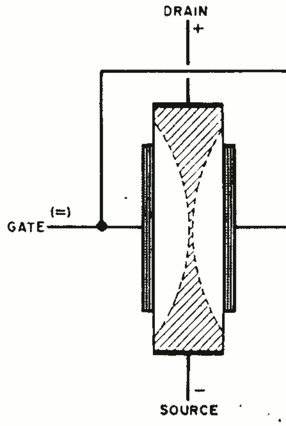


Fig. 6. As the reverse gate bias is increased, depletion areas spread into the channel until they meet, creating an almost infinite resistance between source and drain.

How the FET Works. The basic junction FET (JFET) is essentially a bar of doped silicon that behaves like any ordinary resistor. Refer to Fig. 4 and assume that the FET is made up of an *n*-type substrate (material). Then, current through the device will consist principally of electrons as majority carriers. Consider what happens when a d.c. voltage is applied to the source and drain electrodes, while the gate is at zero bias. Under these conditions the device behaves more or less like an ordinary resistor. Within limits, source-drain current flow is directly proportional to applied voltage.

Now suppose a reverse bias is applied to the gate. (This would be a voltage of the same polarity as the majority carriers; that is, negative for *n*-type material, positive for *p*-type material.) The gate voltage would then set up an electric field to repel the current carriers, and restrict the region through which

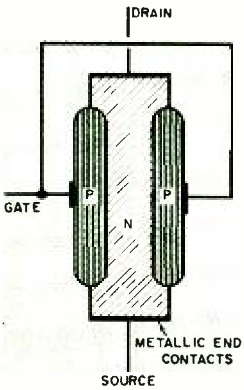


Fig. 7. A JFET can be manufactured by diffusing p-type gates on either side of an n-type substrate, and then attaching suitable electrodes.

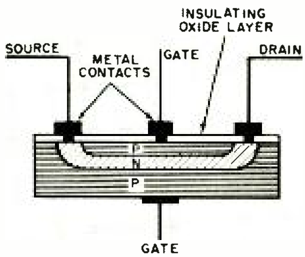


Fig. 8. This junction FET features single-ended construction. Here, an n-type channel is formed on one side only of a p-type substrate by photo-masking, etching, and impurity diffusion processes. The surface is covered with an insulating oxide layer through which holes are cut for electrode connections.

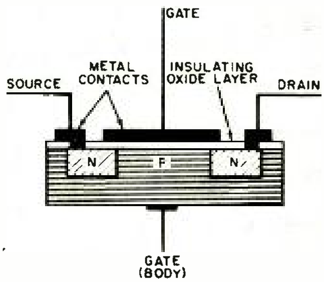


Fig. 9. Cross-section view of insulated-gate field-effect transistor (IGFET) shows gate metal contacts insulated by a thin layer of oxide which, together with the semiconductor channel, forms a capacitor. The metal contacts serve as one plate while the substrate material serves as other plate of capacitor.

they flow. This action is shown in Fig. 5. In essence, the current-carrying channel is depleted of current carriers within areas immediately adjacent to the gate electrode. Logically enough, the regions where current movement is restricted are termed the *depletion areas* (sometimes referred to as *zones* or *regions* rather than *areas*).

A further increase in the reverse gate bias further expands the depletion areas, as shown in Fig. 6, further reducing drain-to-source current. Thus, with a given fixed gate bias, the drain current will vary with the signal applied to the gate. Note, also, that since the gate is reverse-biased, the FET has a very high input impedance when there is little or no drain current flow. The FET behaves much like a vacuum tube in that drain current is controlled by an electric field set up by the gate voltage.

Consider what happens when the gate bias is zero and the source-drain voltage is gradually increased. Up to a point, drain current will increase linearly as in a resistor. However, the drain current flowing along the channel sets up an internal reverse bias along the surface of the gate. This, in turn, establishes an electric field which causes a gradual increase in the depletion areas similar to the effect produced by the application of an external gate bias. Eventually, the increase in the depletion areas, which tends to limit drain current, reaches the point where it counterbalances the drain current increase. From then on, there can be no further increase in drain current regardless of any further increase in drain-source voltage.

In effect, the drain current has reached *saturation* (that should be a familiar term!). The point at which this current limiting takes place is called the drain-source *pinch-off* voltage. And there is, as you might suspect, a pinch-off voltage for any given gate bias. With higher gate bias voltages, pinch-off occurs at much lower drain currents, of course.

If drain current is plotted against drain-source voltage for a given gate bias, a FET characteristic curve is developed. A family of such curves may be prepared by plotting drain-source current vs. drain-source voltage for a number of different gate bias voltages. When compared to corresponding families of vacuum tube characteristic curves, the typical FET is found to have characteristics which are virtually identical to those of a *pentode* vacuum tube.

The FET Family. Field-effect transistors are manufactured using techniques that are almost identical to those used in the manufacture of the familiar junction transistor. For example, a FET can be assembled by diffusing or alloying *p*-type gates on either side of an *n*-type substrate and then attaching suitable metallic electrodes, giving the appearance of Fig. 7.

From a production standpoint, it is often easier to carry out all diffusion and processing operations from one side of the substrate. This type of single-ended construction is illustrated in Fig. 8. Manufacture starts with a wafer of *p*-type material. Photo-masking, etching, and impurity diffusion processes form an *n*-type channel on one side of the material. A *p*-type gate is then diffused into the *n*-type channel, and the entire surface is covered with an insulating protective oxide layer, with holes etched through the oxide for the final metallic electrode connections.

If you have been wearing your "thinking cap," you may be wondering, at this point, just why the gate electrode is joined electrically to the channel material. After all, the gate is reverse-biased in use, causing the *p-n* junction to behave as if it were a dielectric. Furthermore, the operation of the device is based on the presence of a varying electric field on the gate and not upon the movement of current carriers from the gate to the channel region.

So, why not insulate the gate? Good question, but someone else thought of it before. As a matter of fact, insulated-gate FET's (IGFET's) are actually being produced by several major manufacturers. One type of construction is illustrated in Fig. 9. Here, the gate is insulated by a thin layer of oxide. The gate metal area is overlayed on the oxide and in conjunction with the insulating oxide layer and the semiconductor channel forms a capacitor. The metal area serves as the top plate of the capacitor, while the substrate material is the bottom plate.

In some cases, the IGFET's are as-

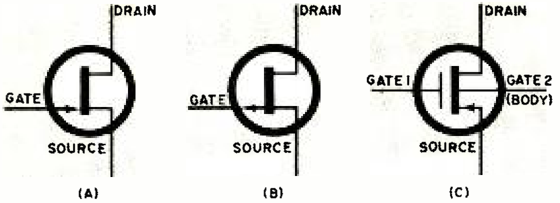


Fig. 10. Schematic symbols currently used for field-effect transistors include (a) n-channel JFET, (b) p-channel JFET, and (c) one form of p-channel IGFET.

sembled as tetrode devices, with the substrate body (often identified as *gate 2*) connected to a separate electrode. Since the drain and source are isolated from the substrate, any drain-to-source current in the absence of gate voltage is extremely low because, electrically, the structure is equivalent to two diodes connected back to back.

Insulated-gate FET's have extremely high input impedances—higher, in fact, than many vacuum tubes—but are very sensitive to stray electrical charges and can be destroyed by body static. Input impedances higher than *10 million megohms* are not uncommon. Manufacturers generally wrap IGFET leads in metallic foil, or supply them with the leads held together by a metal eyelet as a protective measure. Extra care must be taken during installation, wiring, and testing of the IGFET to prevent its destruction.

The junction field-effect transistor (JFET) shown in Figs. 7 and 8 can be made as an *n*-channel or a *p*-channel device. As with conventional junction transistors, JFET's are identified by the slightly modified schematic symbols shown in Figs. 10(a) and 10(b). With the source considered common, an *n*-channel FET requires a positive drain voltage and a negative gate bias; the *p*-channel FET is operated with a negative drain voltage and a positive gate bias.

As shown in Fig. 10(c), the IGFET is identified by an entirely different symbol. This general type of FET is offered in two basic forms and in many individual types with different electrical specifications and operating characteristics. Unlike the JFET, however, a given IGFET may require either a positive or negative gate bias, with respect to its source, depending on mode of operation.

In addition to regular FET's, light-sensitive FET's are being produced by a number of manufacturers. Called photoFET's, they are similar to conventional FET's but are equipped with transparent lenses that focus external light on their sensitive surface areas. The photoFET can be up to ten times as sensitive as a junction phototransistor, and has a better gain bandwidth factor, in addition to offering exceptional isolation between input and output circuitry.

Terminology. As with any new technology, a number of terms are used to describe FET devices, and their characteristics. Some terms are used primarily by manufacturers, others chiefly by circuit designers. Unfortunately, the terms

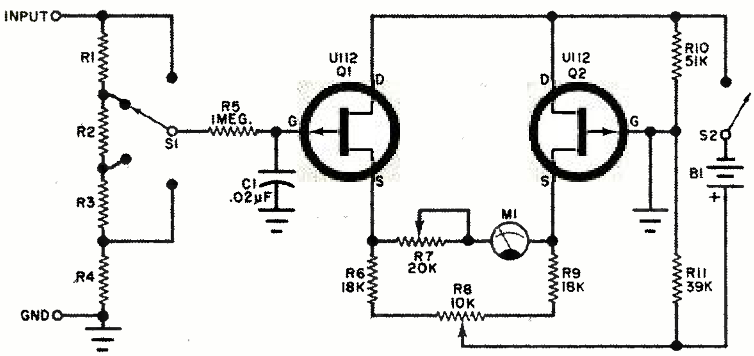


Fig. 11. This FET voltmeter, featuring a matched pair of Siliconix U112 FET's in a differential amplifier arrangement, has a sensitivity of 0.5-1.0 volt full scale.

JFETS FOR THE EXPERIMENTER

The following low-cost audio, r.f., and general-purpose junction field-effect transistors are suitable for experimenter projects

MANUFACTURER	TYPE	DESCRIPTION	PRICE	ORDER FROM
Motorola Semiconductor Products, Inc.	HEP-801	n-channel	$3.39	Allied Radio Corp.
	MPF103	n-channel	1.00	100 N. Western Ave.
P. O. Box 955	MPF104	n-channel	1.00	Chicago, Ill. 60680
Phoenix, Ariz. 85001	MPF105	n-channel	1.00	
Siliconix, Inc.*	U110	p-channel	1.00	Bill Shipe
1140 W. Evelyn Ave.	U112	p-channel	1.00	Siliconix, Inc.
Sunnyvale, Calif. 94086				
Texas Instruments, Inc.	2N3819	n-channel	3.75	Lafayette Radio Electronics
13500 North Central Expressway	2N3820	p-channel	3.75	111 Jericho Turnpike
Dallas, Texas 75222	TIS34	n-channel	3.75	Syosset, L.I., N. Y. 11791

**FET circuit ideas and applications data available without cost on request*

and symbols have not yet been fully standardized, with the result that different manufacturers may use different terms and symbols to represent the same thing.

During its early developmental stages, the FET was identified by different names. At various times it has been called a *Fieldistor, UNIFET*, and *Unipolar* field-effect transistor. The UNIFET and Unipolar terms were derived from the single-junction construction of the FET as contrasted to the two-junction (or *bipolar*) construction of the junction transistor.

The name Fieldistor is practically obsolete today. And so are the other names, although one firm still refers to its products as UNIFETS. Generally, junction-type units are simply referred to as FET's, although some firms use the more specific designation JFET.

Insulated-gate field-effect transistors are also called MOSFET's in recognition of the importance of the metal-oxide-semiconductor (MOS) insulating film used in their construction. But some designers refer to the same device simply as MOST. The latter could lead to an expression such as "Gosh, Mr. FET, you're the MOST."

At times, the full expressions used to identify a specific transistor may assume an awe-inspiring length. For example, a data sheet from one firm identifies a specific unit as a—hold your breath—*low-noise, n-channel epitaxial planar silicon tetrode field-effect transistor!*

In addition, not all manufacturers describe their products using the same specifications. A parameter which is considered important by one company may be completely ignored by another. As a general rule, however, the majority of manufacturers do give maximum voltage ratings, input and output capacitances, maximum power dissipation, and typical gate cutoff current. Many even specify the common source forward transconductance (in μmhos, as in tube specifications) for typical operating conditions.

Naturally, references are still made to *n*-channel or *p*-channel types, as well as to enhancement or depletion modes of operation. The fact that both *n*- and *p*-channel types are available permits FET's to be used in a variety of complementary circuits, a characteristic that FET's do not share with vacuum tubes.

Some firms, in striving to simplify matters, have adapted type designations to indicate the intended mode of operation of the device. Thus, *Type A* FET's are characterized for depletion-mode operation; *Type B* are intended for either depletion or enhancement modes; and, finally, the *Type C* designation is reserved strictly for enhancement-mode types. But please don't confuse these designations with Class A, B or C amplifiers!

Typical FET Applications. With high input and output impedances and other tube-like operating characteristics, FET's may be considered as almost the solid-state equivalents of vacuum tubes, and can be used in virtually identical circuits, provided power ratings are observed. The common source configura-

(Continued on page 94)

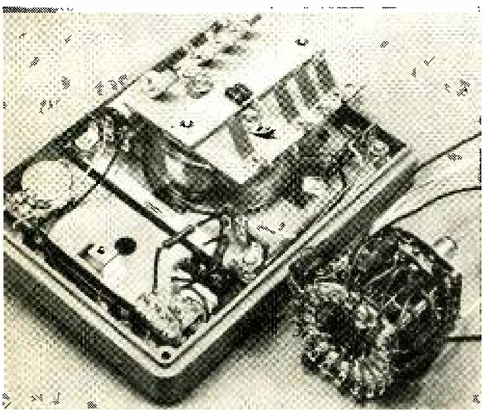
Wonder of Wonders—

A New VOM Kit!

KNIGHT-KIT OFFERS A VOM WITH TAUT-BAND METER

HOW MANY YEARS has it been since a manufacturer offered something really new in a VOM kit? The guesses range from two to ten years—the majority favoring the high side—because once you've put a 50-microampere meter movement in a VOM (20,000 ohms-per-volt, d.c.), there's nothing much left to do. But Knight-Kit (Allied Radio, 100 N. Western Ave., Chicago, Ill. 60680) didn't buy this philosophy, and its 1967 catalog disclosed a new VOM kit (Model KG-640—$39.95, kit; $59.95 assembled) featuring a taut-band meter movement.

Why "Taut-Band"? An inherent weakness of the D'Arsonval meter has always been the meter needle support—pivot, bearings, and spring. In the taut-band meter movement, these are eliminated, and a stretched (taut) thin band of metal is used to return the meter needle to zero. The taut-band meter is also "new" in terms of reasonable price, and it makes the meter more accurate and much more rugged.

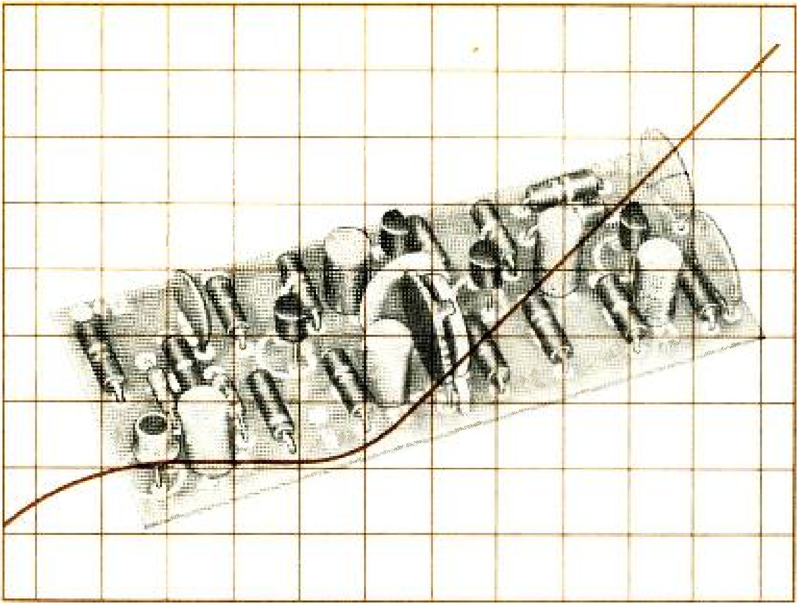


Prior to mounting the rotary switch, the KG-640 VOM is only 20 minutes away from final testing.

Scale Multiplier. Besides the meter movement, the Knight-Kit KG-640 has another innovation—a "Scale Multiplier" switch. This switching arrangement doubles the number of voltage and current ranges and permits really fine visual accuracy of the meter needle deflections (the meter also has a parallax-eliminating mirror). The d.c. voltage ranges which would nominally be 1.6-16-80-400-1600-4000 can be subdivided by the *Scale Multiplier* into 0.8-1.6-8-16-40-80-200-400-800-1600-2000-4000 volts, full scale. The a.c. voltage scale is similarly divided into 12 ranges and the current range into 10 full-scale increments between 80 μamperes and 16 amperes.

Assembling the Kit. Since you've probably put a lot of Knight-Kits together, there's no percentage in telling you about the ease of construction, the careful manual preparation, etc. Suffice it to say that the average builder can assemble this kit in just about three hours. The checkout is positive and foolproof, and if you make an error (we did by interchanging R2 and R3), you can trace it down in a few minutes.

The completed kit is a fine addition to the POPULAR ELECTRONICS laboratory. —30—



BUILD

CB "AUDIO LEVELER"

COMPRESSOR/PREAMPLIFIER BOOSTS CB MODULATION AND CURBS MIKE BLASTING WITHOUT DISTORTION

By **DANIEL MEYER**

HOW many times have you had to repeat a message during a CB radio conversation because you were too far away from the mike or weren't talking loud enough to put your message across clearly? Now you can come over loud and clear each time you hit the mike by merely adding an "Audio Leveler" to your CB rig.

The Audio Leveler is a low-distortion preamplifier which you connect between your mike—incidentally, it must be of the low-impedance variety used with transistorized equipment—and your transmitter MIC input to amplify weak signals while attenuating strong ones, thus producing a constant-level modulating signal to the transmitter. As a result, whether you talk very loud into the mike, or not loud enough when you move your head away from the mike, the transmitter "sees" a constant amplitude signal.

The Circuit. The Audio Leveler (Fig. 1) is a transistorized compressor circuit whose gain is automatically adjusted by the level of the speech input. It consists of *Q1*, the first amplifier; *Q2*, the gain-controlled stage; emitter follower *Q3*; a control amplifier, *Q4*; and a field-effect transistor (FET), *Q5*, which operates in the circuit as a varistor.

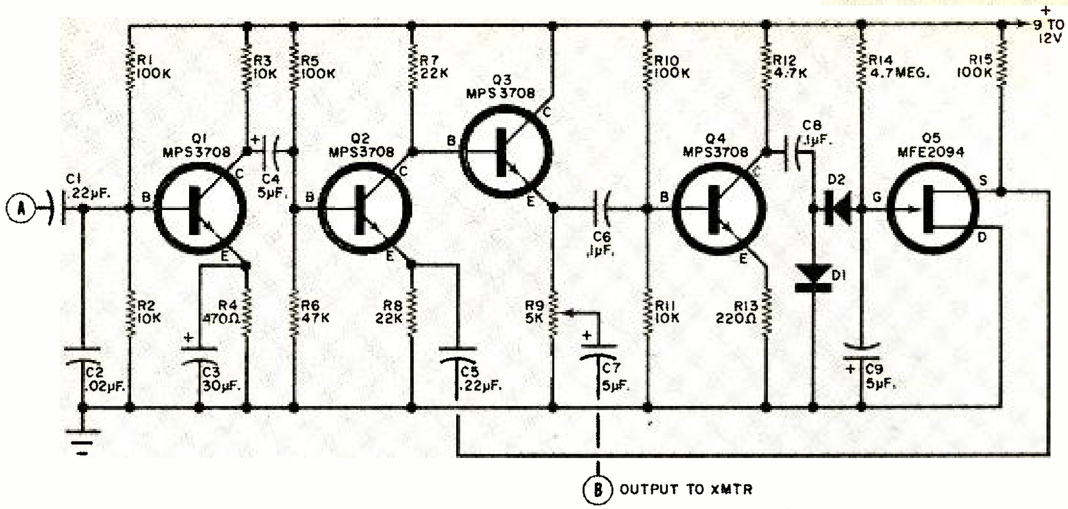


Fig. 1. The Audio Leveler takes advantage of the drain-source resistance characteristics of a FET, Q5, to control the amplifier gain automatically.

PARTS LIST

C1, C5—0.22-µF, 12-volt ceramic disc capacitor
C2—0.02-µF, 50-volt ceramic disc capacitor
C3—30-µF, 6-volt electrolytic capacitor
C4, C7, C9—5-µF, 15-volt electrolytic capacitor
C6, C8—0.1-µF, 12-volt ceramic disc capacitor
D1, D2—General-purpose germanium diode (1N34 or similar)
Q1, Q2, Q3, Q4—Motorola MPS-3708 transistor
Q5—Motorola MFE 2094 field-effect transistor
R1, R5, R10—100,000 ohms
R2, R3, R11—10,000 ohms
R4—470 ohms
R6—47,000 ohms
R7, R8—22,000 ohms
(*all resistors ½-watt, ± 10%*)
R9—5000-ohm PC-type trimmer potentiometer
R12—4700 ohms
R13—220 ohms
R14—4.7 megohms
*1—1½" x 3½" phenolic board, or etched and drilled printed circuit board (available for $1.50 postpaid from DEMCO)**

*A complete kit containing all parts, including the PC board, is available from DEMCO, Box 16297, San Antonio, Texas 78216, for $9 postpaid in the U.S.A.

The audio input from your mike is applied to the base of *Q1* through capacitor *C1*. The amplified output at the collector is coupled through *C4* to the base of *Q2*, whose gain is controlled by *Q5*. The output at *Q2*'s collector is direct-coupled to *Q3*, hooked up as an emitter follower to provide a low output impedance to the transmitter through *C7*.

The signal at *Q3*'s emitter is also amplified by *Q4* and applied through *C8* to the junction of *D1-D2*. When this signal is large enough to cause the diodes to conduct, the bias voltage on *Q5* starts going negative. Since the drain-source static resistance of a FET is a function of the gate-to-source voltage, and since *Q5* is in series with *C5*, *Q2*'s emitter bypass capacitor, the resulting change in the resistance of *Q5* causes more or less bypassing action.

A negative-going bias voltage on *Q5*'s

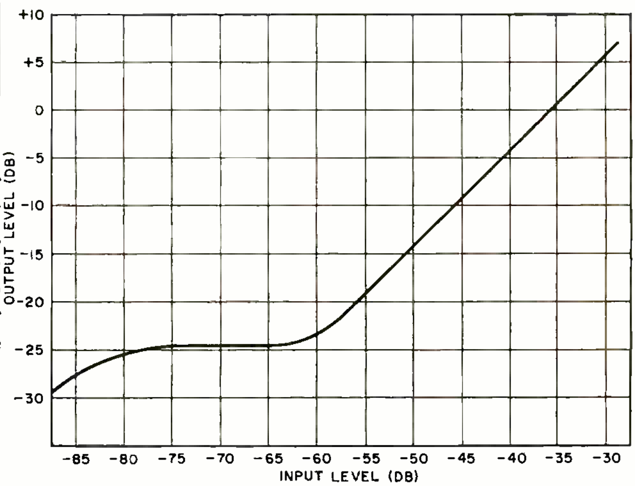


Fig. 2. Graphical representation of output signal level versus input signal level, in dB. The circuit has low distortion even with high-level inputs.

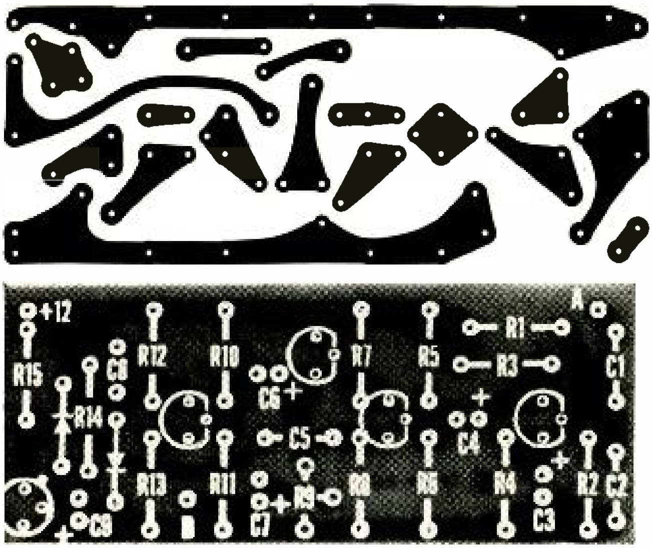


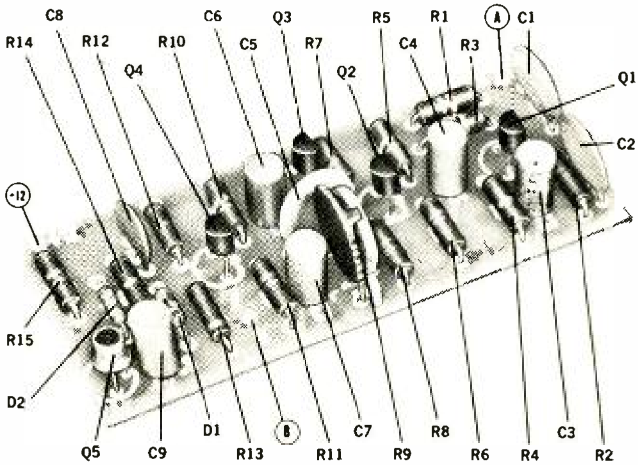
Fig. 3. Actual-size photo shows foil side of printed circuit board (upper left); component side of board is below it. Observe polarity markings when installing diodes and electrolytic capacitors. Also, position the transistors as shown.

gate results in a higher drain-source resistance, and this, in turn, acts to reduce the bypassing action of *C5* and limit the gain of *Q2*. Thus, as the signal level at the collector of *Q2* tries to increase, the control circuit acts to reduce the gain to its original value.

Figure 2 shows, graphically, the result of this action. The gain of the circuit increases only a few dB although the signal input level may be increasing by as much as 20 dB—about 10 times!

Construction. The entire Audio Leveler circuit can be assembled on a 1½" x 3½" printed circuit board or phenolic circuit board. An etched and drilled fiberglass printed circuit board (Fig. 3) is available (see Parts List). The board comes marked with the location of all components, and it is only necessary for the builder to insert the parts in the marked positions and solder the leads to the copper foil.

When installing the parts on the PC board, be sure to position the flat sides of *Q1* through *Q4* as shown in Fig. 3. Also, the locating tab on *Q5* must be oriented as indicated. The ground lead of this transistor (Fig. 4) must be cut off since it is not used. And be sure to observe the proper polarity when in-



Parts identification of the fully assembled printed circuit board includes input A, output B, and +12-volt supply connection point.

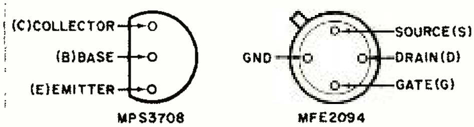


Fig. 4. These outline drawings show the terminal identification of the transistors used in the circuit. Ground terminal of the MFE2094 must be cut.

stalling the diodes and electrolytic capacitors.

If you prefer to make your own circuit board, you can still follow the parts layout shown, using the schematic (Fig. 1) as a wiring diagram.

Installation. Since the Audio Leveler goes between the microphone (remember, it can be used *only* with a low-im-

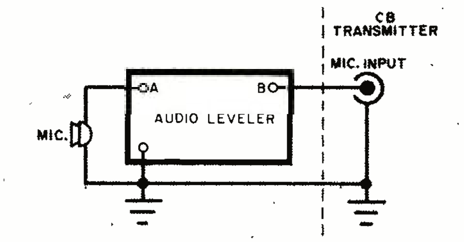


Fig. 5. Terminal A goes to the microphone and terminal B connects to the MIC input on the transmitter. The unit is grounded to the transmitter.

pedance mike) and your transmitter's MIC input (see Fig. 5), it can easily be installed in any rig.

If there's room inside the unit. mount the circuit board in any convenient spot, supporting it on standoff spacers. The photo on page 100 shows the Audio Leveler installed inside a Heathkit GW-

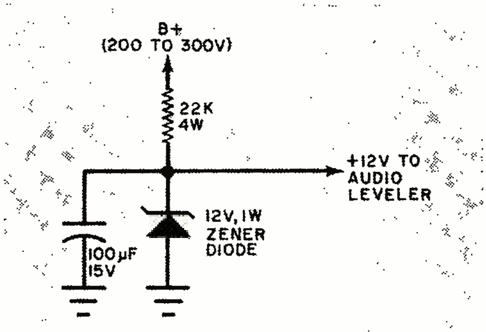


Fig. 6. This simple voltage divider can be used in a tube-type transceiver to obtain a 9-12 volt regulated output for operating the Audio Leveler.

14 transceiver. If lack of room does not permit this type of installation, the unit can be mounted in a small metal case and installed outside of the transmitter or VFO enclosure. Connection is between points *A* and *B* on the circuit board.

To use the Audio Leveler with a transistorized CB radio, connect a lead from the +12-volt power source to the +12-volt terminal on the circuit board, and another lead from the *common* terminal on the circuit board (negative side of *C3*) to the transmitter ground.

If the Audio Leveler is to be used with a tube-type transceiver, a 9-volt battery can serve as the voltage source. However, if you would rather operate the Audio Leveler from your transceiver's power supply, a circuit similar to that of Fig. 6 will provide the 12-volt d.c. power. But be sure to connect the resistor to the cathode of the rectifier rather than to the load side of the power supply to avoid overloading the set's filter system.

(*Continued on page* 100)

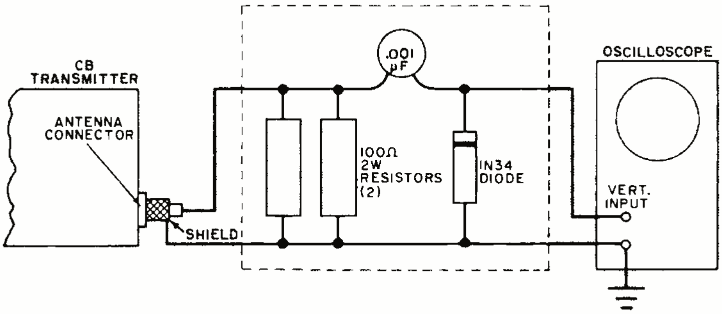
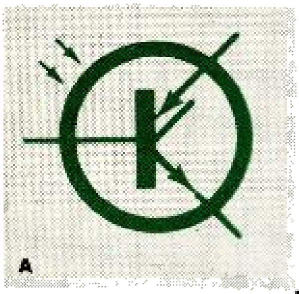


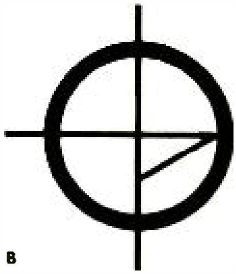
Fig. 7. The Audio Leveler can be tested and adjusted with an oscilloscope connected to the transmitter output through the network shown here. The gain is adjusted while observing the transmitter output.

SEMICONDUCTOR QUIZ

By WARREN TODD

With newer and more efficient semiconductor devices constantly being developed, electronic technicians and engineers alike are finding it increasingly difficult to keep up with the symbols representing these devices. If you can correctly identify ALL of the symbols (A-J) below by name (1-10), you're on top of the situation. Even if you can identify only eight, you deserve an "A" for being up-to-date with solid state.


A


B


C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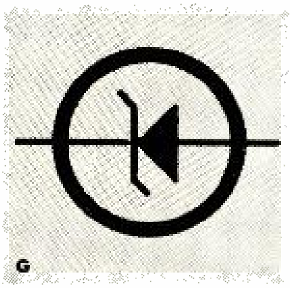
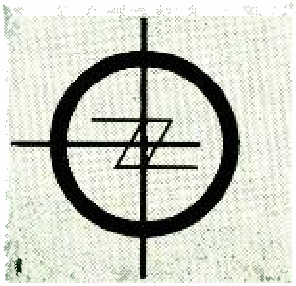

G


H


I


J

1 UJT ____	6 SCR ____
2 SUS ____	7 LASCR ____
3 SBS ____	8 JFET ____
4 DIAC ____	9 IGFET ____
5 TRIAC ____	10 ZENER ____

(*Answers on page* 118)

BUILD THE AMLIGNER

By DON LANCASTER

. . . A MULTIPURPOSE TUBELESS, TRANSISTORLESS, CORDLESS BC-BAND SIGNAL GENERATOR FOR THE RADIO AFICIONADO

A BROADCAST-BAND AM signal generator without test cables or even a line cord? Yes! And what's more, it uses no tubes, no transistors, no integrated circuits . . . nothing but a diode, a resistor, a coil, and a couple of capacitors.

Yet, here's an r.f. signal generator that you can use to signal-trace radio receiver troubles, to align the receiver i.f. and front end—provided you first calibrate the unit—and which, in conjunction with any broadcast-band receiver, can be used as a code-practice oscillator by merely substituting the on-off switch for an ordinary telegraph key.

And what's the miracle ingredient that makes all this possible? Nothing more than a low-power, short-range radio transmitter that sends out an r.f. carrier modulated by a 800-hertz tone signal which is picked up by a receiver placed about eight feet away. We call it, affectionately, the "AMLIGNER." You can build it for about $7.00.

How It Works. The AMLIGNER (Fig. 1) is basically a free-running relaxation oscillator operating at 800 hertz. The circuit is powered by a 22.5-volt battery,

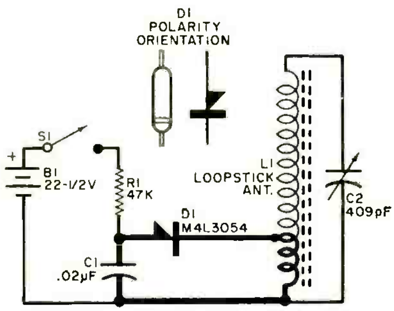
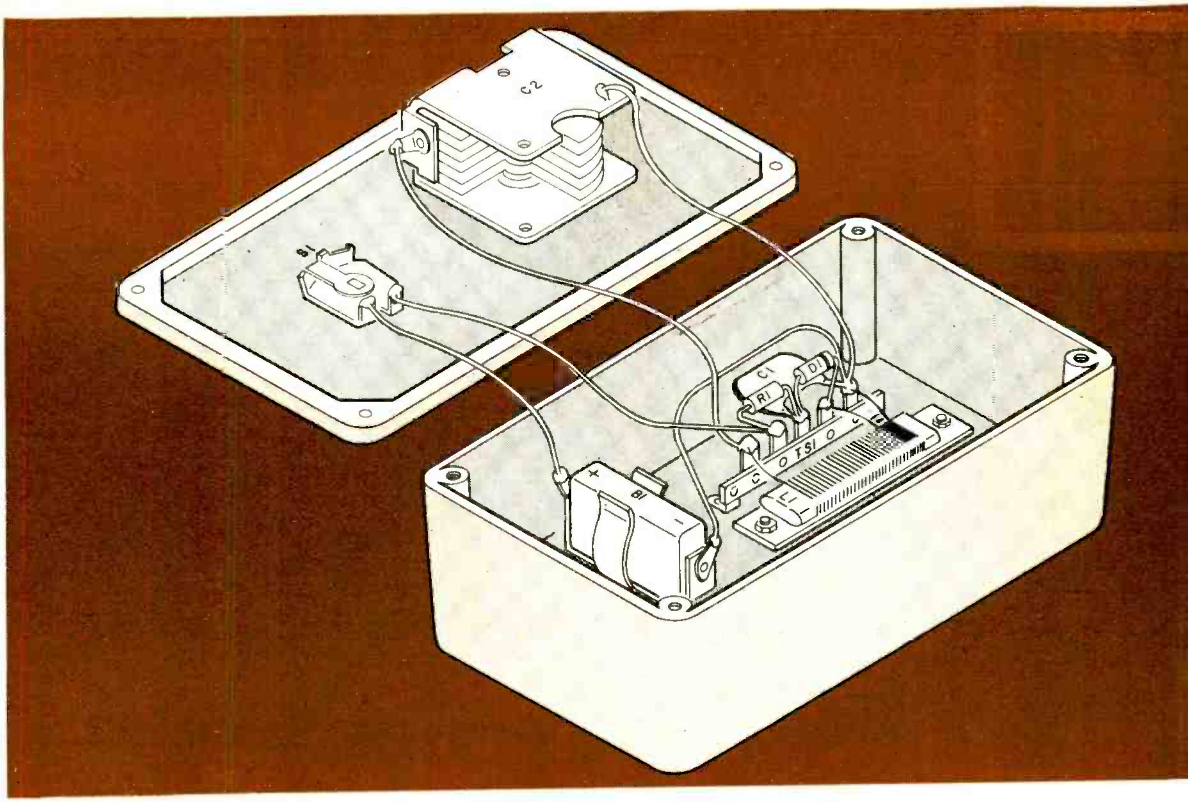


Fig. 1 The AMLIGNER is a free-running relaxation oscillator whose frequency is determined essentially by the value chosen for charging capacitor C1.

PARTS LIST

B1—22½-volt battery
C1—0.02-μF, 50-volt Mylar capacitor
C2—15 to 409 pF TRF variable capacitor (similar to Allied Radio 43 A 3524)
D1—Motorola M4L3054 four-layer diode (available from Allied Radio, Chicago, Ill.)
L1—Loopstick antenna (similar to J. W. Miller Company 2004)
R1—47,000-ohm, ½-watt resistor, ± 10%
S1—S.p.s.t. rotary switch
1—Plastic case and cover (similar to Harry Davies 240 and 241, or Allied Radio 42 D 7885 and 42 D 7887, respectively)
Misc.—¾" and 1¾" plastic knobs, #6 hardware or pop rivets, battery holder, 5-pin terminal strip, wire, solder, etc.



Housed in a plastic instrument case, the AMLIGNER can be assembled and wired in a matter of minutes. When wiring components to the terminal strip, be sure to observe polarity orientation of diode D1.

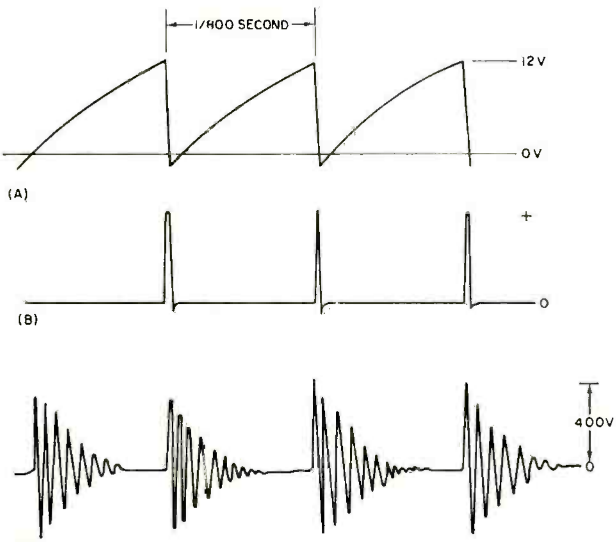


Fig. 2. Voltage and current waveforms include: (a) sawtooth voltage across C1; (b) a current pulse through D1; and (c) a ringing waveform across C2.

which is in series with switch *S1*, limiting resistor *R1*, and capacitor *C1*, shunted by *D1* and the primary of *L1*, a loopstick antenna. The "heart" of the circuit is *D1*, a four-layer diode which snaps on with a 12-volt forward bias and snaps off when the current through it drops below 1 milliampere.

With *S1* closed, *C1* begins to charge through *R1*. When the capacitor charge reaches 12 volts, *D1* avalanches and the capacitor discharges through the primary of *L1*. With *C1* discharged, *D1* turns off and does not turn on again until *C1* recharges to 12 volts. This on-off cycle occurs at a rate of 800 times a second, producing a sawtooth voltage waveform as shown in Fig. 2(a). The waveform of the current through *D1* is shown in Fig. 2(b).

As *D1* turns off, the sudden decrease of current sets up an oscillating current of a few hundred microseconds duration, and at the natural resonant frequency of the *C2-L1* tank circuit, producing the ringing waveform shown in Fig. 2(c).

(*Continued on page* 99)

We're looking for the men who want these well paid jobs!

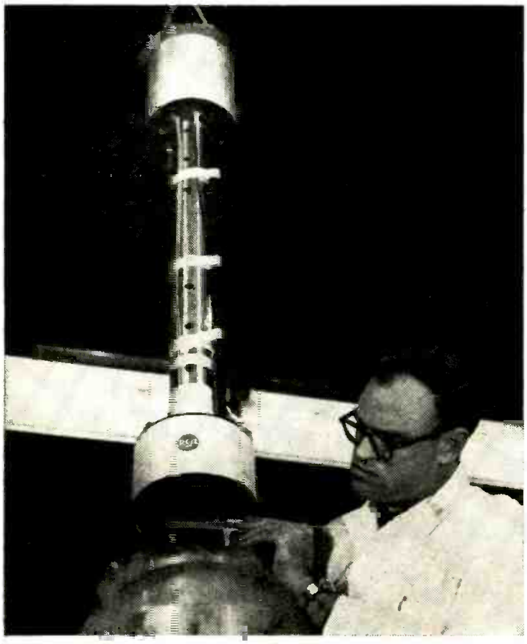
And RCA Home Training can help you qualify

Just mail card today for details

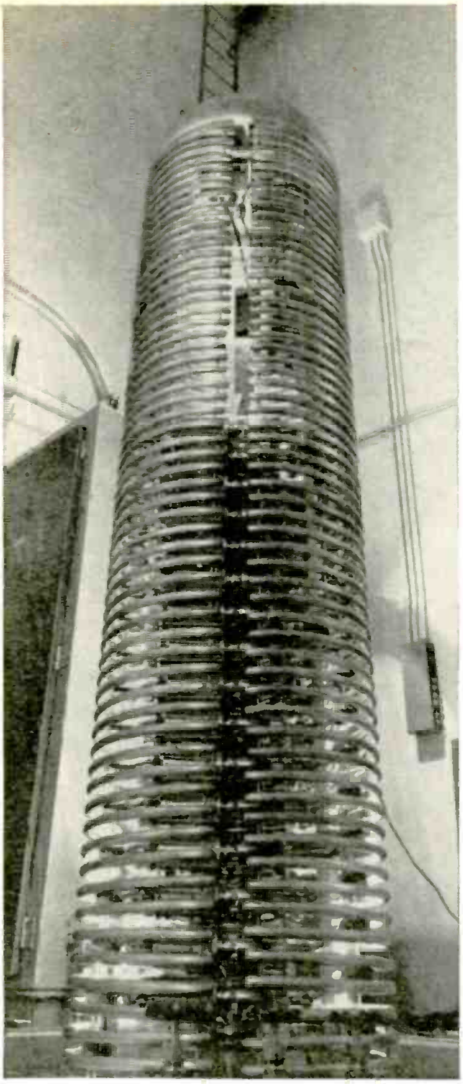
ZERO-BEATING THE NEWS

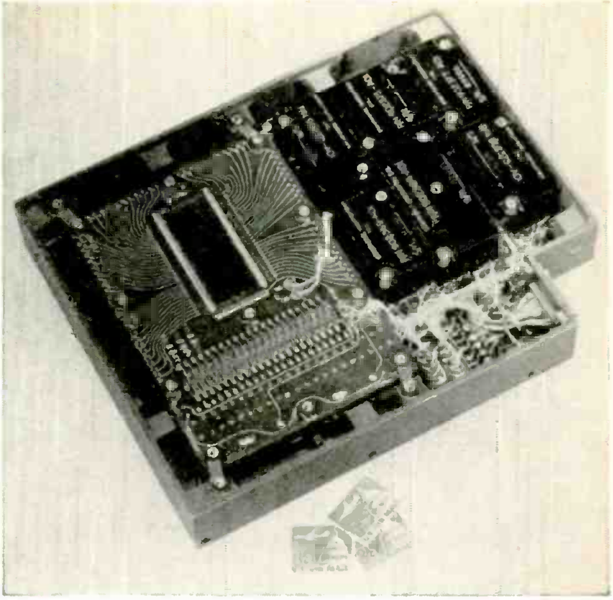
SOFT LANDING VERIFIED—With data taken by electronic strain gauges made by Baldwin-Lima-Hamilton Corp., Surveyor I's soft landing on the moon was verified and radioed back to earth. The strain gauges also provided important data on the bearing strength of the lunar surface.

"CIRCULAR POLARIZED LOOP VEE"—A new type of space age antenna (photo above) has been designed and built for the U.S. Air Force by Electronic Communications, Inc. Together with its associated satellite communications terminal equipment, this odd-shaped antenna will be used in airborne applications. It radiates up to 1000 watts of power in an omnidirectional pattern to provide optimum near-horizon communications coverage.



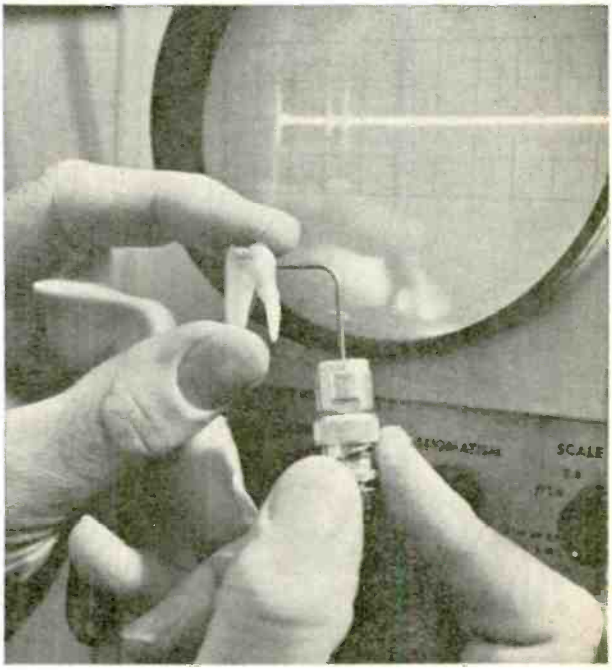
SUPERCONDUCTIVE MAGNETS—Pint-size magnets have been developed by RCA that can generate forces approaching those which bind matter together. The magnets are cooled in liquid helium to reduce the electrical resistance of their field windings to zero. Fields as high as 150 kilogauss are possible.





LITTLE GUY WITH A B-I-G JOB—A tiny memory unit built by Electronic Memories is hardly larger than 5 packs of cigarettes, yet it contains all the information needed to put Lunar Orbiter B into orbit around the moon, aim the cameras at the moon's surface and start them rolling. During Lunar Orbiter B's shuttle to the moon, the memory unit has the jobs of extending the antennas and solar panels, controlling the propulsion and attitude of the spacecraft, and starting the scientific experiments.

"DYNAMITRON" ACCELERATOR—An electron accelerator at the National Bureau of Standards provides electron beams at high currents and energies up to 1.5 mega-electron volts by using a high-power oscillator to drive a cascaded rectifier system. The unit will be used to develop radiation standards.



X-RAYS ARE ALMOST OBSOLETE—Dentists will soon be able to "see" into teeth without the use of potentially dangerous X-rays. Experiments at Battelle-Northwest show that ultrasonics can be used to produce X-ray-like pictures of bone, teeth and tissue.

INFORMATION CENTRAL

By CHARLES J. SCHAUERS, W6QLV

WELCOME to *Information Central.* I hope that as you read some of the answers to the questions selected for inclusion in this first column you will find one or more items of interest to you. Although I've stuck pretty close to the ham field for the past decade, I know that the hobbyist/experimenter has just as many—if not more—problems, many of which I hope can be solved through this medium.

The questions answered in the first few columns will be on topics of general interest: some pertain to SWL'ing, some to CB, some to general experimenting, and a few to repair and maintenance. As is my usual practice, I have deleted the name of the questioner in each case to elminate any chance of embarrassment.

Poor Signal Pickup. *I have a pair of Knight-Kit KG-225 solid-state wireless intercoms. These units work fine in the house and between the house and the garage. However, when they are hooked up between the house and the barn (about 2500 feet away), the signals are too weak for good loudspeaker volume. Is there anything I can do to increase the volume?*

First, make sure that the house and barn are both on the same side of your power line distribution transformer—sometimes they are not. If the same power line feeds both the house and the barn, check the line voltage at both units. Maximum output with this particular Knight-Kit is realized when the line voltage is 120 volts.

It is possible that the "tuning" of both wireless intercoms needs to be touched up. This is done by peaking up the coil shown in your kit wiring diagram as *L-1*. Put one of the units in "lock-to-talk" position and turn on an AM radio so that the intercom will pick up sound from the radio speaker. At the other unit, tune the slug in *L-1* with a square insulated alignment tool for best audio output.

In some cases, signal pickup can be improved when the chassis of the intercom is grounded. However, these units should be usable on quiet a.c. power lines for distances up to about one mile.

Electrified Fence. *I would appreciate your publishing a diagram for a transistorized electrified fence that I could operate from a six-volt "hotshot" battery. I am sure that there are other farmers besides myself, with cows or pigs, who would like to have the same information.*

The circuit diagram for a simple electric

EDITOR'S NOTE

The broadening spectrum and diversification of electronics has bred a variety of problems for the electronics experimenter/hobbyist. Not only are many individual components difficult to obtain, but the "information explosion" has created its own brand of headaches. There are just too many pieces of electronic equipment, too many circuit diagrams, and too many non-interchangeable components. No longer can the hobbyist expect friendly advice from the counterman at his local electronics emporium—he's lucky if he gets waited on. To keep abreast of the explosion, the hobbyist needs an extensive library, catalog file, cross-referencing index, and patience galore.

Is there a solution that might fit the scope of this problem? Possibly, and in an effort to disseminate useful information, POPULAR ELECTRONICS is pleased to announce a new monthly department—our version of a "question and answer" service—**Information Central.** This department will select about 20 questions each month from the reader inquiries received by POPULAR ELECTRONICS and answer them in print. The questions and answers will be those which the Editors feel are of greatest and broadest value to our audience.

Conducting our **Information Central** column will be Charles ("Chuck") J. Schauers, W6QLV. Chuck is the newest member of our Contributing Editor staff and is presently based in Luzern, Switzerland. A retired Lt. Colonel of the U.S. Signal Corps, he has been conducting a somewhat similar column in a ham radio publication for about nine years. Besides his enthusiasm, Chuck brings to **Information Central** a world of electronics experience (plus a law degree), plus proven performance in being a helping hand to the experimenter/hobbyist with a problem.

fence charger is shown in Fig. 1. Any good power transistor can be used in this circuit. Some obvious choices are: 2N255, 2N301, 2N618, or 2N2869. The base resistor should be adjusted to obtain a pulse rate of about 50 pulses *per minute*. For the range of values shown, you can go from 10 pulses to 100 pulses per minute.

The single fence wire must be insulated at each supporting pole and should be mounted low enough to prevent an animal from crawling under the wire. Make use of TV standoff lead-in insulators to hold the wire to the supporting poles. The wire should be No. 18 copper-clad steel. Build the unit in a metal box and arrange to protect the circuitry from the weather. The two

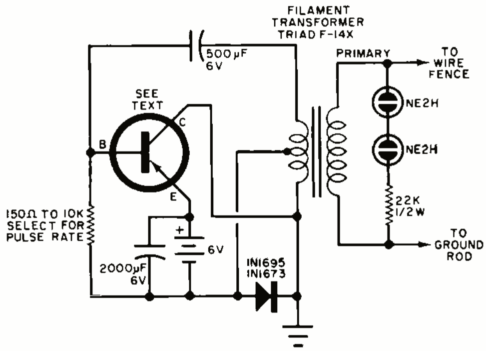


Fig. 1. Simple electric fence shocker.

neon lamps indicate when the unit is operating. Output is not lethal, but it will certainly keep the cows at home! A regular "hotshot" battery should last a long time—battery life depends upon the pulse rate chosen; the slower the rate, the longer the battery life.

Those readers who prefer to build a fence charger that operates from a 117-volt line should investigate the project published in POPULAR ELECTRONICS, December, 1964, p. 57.

Surplus SCR-274N to 20 Meters. *Where can I get some information on how to put my SCR-274N on 20 meters?*

The best article on converting this popular World War II radio set appeared in the April, 1949, issue of *QST*. Some issues may still be available, or possibly the ARRL has provisions to Xerox pertinent information.

Electric Door Switch. *This may seem like a foolish question, but please recommend a switch that I can use to turn on and off a low-voltage (6-volt) light bulb. The problem is that I do not want the switch to be visible.*

Probably your best bet is to bury a surplus Microswitch in the door jamb. As the door closes, the switch opens. If you're mechanically minded, you could probably do as well with a Grayhill "Silent-Action" Series 4002 miniature push-button switch.

CB Linear Amplifiers. *I have seen some ads for CB amplifiers and was wondering if such an amplifier is a worthwhile investment?*

I presume the ads you have seen pertain to linear amplifiers for use with your CB transmitter. Those advertisements are directed toward people holding business band licenses and operating in or around the same frequencies as your CB station. Use of a linear amplifier in conjunction with a CB station is illegal and can easily subject the user to a fine and/or loss of his station license.

Intermittent Lafayette HE-15. *I own a Lafayette HE-15A CB transceiver, and up to a few weeks ago, it was doing a fine job. Now the receiver is cutting out and I find it necessary to flip the transmit switch off and on to restore reception. What's the trouble?*

About 90% of the time—especially with these older CB units—your most likely source of trouble is in aging tubes. Run them through a good tube checker. If the tubes are okay, substitute a new coupling capacitor (0.01µF) between the 12AX7 and a 6V6GT output tube. Also suspect are the 22-pF and 100-pF coupling capacitors between the r.f. amplifier (receiver) and mixer (6U8A/6EA8). Last, but certainly not least, clean all switch contacts with a good TV tuner contact cleaner.

Ham QRM on Hi-Fi. *I recently built—from a kit—a popular all-transistor 50-watt-per-channel stereo amplifier. My son is a ham, and when he is on 15 meters, the hi-fi picks up everything he says. There must be some cure for this nonsense.*

Evidently your hi-fi setup is not bothered when your son is operating on some of the other ham bands. This may be a tip-off. I would first try the simple expedient of bridging each speaker output connection with a 0.001-µF capacitor—not enough capacity to affect your audio quality, but enough to bypass some of the r.f. signal pickup. If this does not work, try shielding your speaker lines. It will probably also be worthwhile to bypass the r.f. out of your a.c. input line to the hi-fi amplifier, which can be done by connecting two good-quality 0.01-µF ceramic capacitors together in series across the 117-volt a.c. line. Tie the center connection of the two capacitors to a good chassis ground. Also, install a similar filter at the ham rig.

Although this does look like a "tuned line" problem, there is a chance that the signal may be so strong that the tape recorder preamplifier and phono amplifier are giving you partial rectification of the ham signal. You can cure such a condition by inserting a 75,000-ohm resistor in series with the control grid of your tape recorder preamplifier. Bypass each of the grids to ground through a small-value (0.001-μF) ceramic capacitor. Unlike tube-type amplifiers, most transistor amplifiers do *not* have the tendency to pick up r.f. signals.

Upgrading the National NCX-3. *I have just purchased a second-hand NCX-3 transceiver and would like to know if there is anything I can do to improve its performance?*

Generally speaking, when the NCX-3 is operating up to snuff, there is little you can do to improve performance. However, there are some cases where better drive can be achieved without too much difficulty.

First, remove the 12BY7 driver tube and replace it with a 6GK6. The filament connections must be rewired as shown in Fig. 2. Using your instruction manual, first locate *R-11*. Change the value of this resistor to 100 ohms, 1 watt. Change resistor *R-13* to 100,000 ohms, ½ watt. Remove the ground connection from pin 3 of *V-4* and change

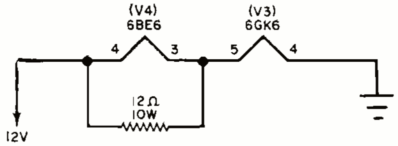


Fig. 2. Filament rewiring in NCX-3.

V-4 to a 6BE6 tube. Locate the brown wire going from pin 4 of *V-4* to pin 5 of *V-3*. Remove the wire from pin 4 of *V-4* and reconnect this wire to pin 3 of *V-4*. Connect a 12-ohm, 10-watt resistor from pin 4 of *V-4* to pin 5 of *V-3*. Now repeak all driver and mixer coils.

Telephone Pickup. *I would like to make my own inductive telephone pickup. Or, if it would be too much work, is there any particular one that you could recommend?*

A telephone pickup is nothing more than a small induction coil. You can make your own by winding 500 turns of No. 40 AWG enameled wire on a 2½-inch length of ¼-inch round or square soft iron stock. Glue a small suction cup to one end of the iron rod and connect the induction coil to your tape recorder or amplifier through a shielded lead—the lead must be grounded. However, why bother to go to all this trouble? You can get a good pickup for $1.19 from Lafayette Radio Electronics (99 C 6197), and a top-quality pickup is only $1.80 (28 C 7094). Allied Radio's phone pickup (15 A 8354) at $1.80 and Burstein-Applebee's (17 A 811) at $1.69 are also suitable.

Applying for a CB License. *What happens if I accidentally make a mistake in my FCC Form 505 when filing for a CB station license?*

There's a very small chance that you will make an error if you follow the details outlined in the 1967 COMMUNICATIONS HANDBOOK. This Handbook is now on most newsstands and the chapter on how to prepare your license application was written by Peggy Ploger, KLJ8033. However, if by any chance you do make a mistake, the Form 505 will be returned to you and you must reapply—and send them another $8 application fee.

Hi-Fi Speaker Mismatch. *I have a top-quality hi-fi speaker made in Europe and I notice that the voice coil is marked 5 ohms. Can I use this in conjunction with my hi-fi amplifier which only has a 8-ohm and 16-ohm output?*

Generally, a 3-ohm mismatch—presuming that you would connect the 5-ohm speaker to the 8-ohm terminals—will have an insignificant effect on the reproduction quality. It all depends on the amount of feedback within the amplifier itself; if the feedback level is too low, you may encounter some loss in efficiency. Of course, the whole problem would be solved if your amplifier had a 4-ohm output connection.

CB Rig Repairs. *I had some trouble with the transmitter portion of my CB base station. A friend tried to fix it, but a couple of days later a fellow CB'er told me I was off frequency. I took the rig to a service shop, and they charged me $27 for one crystal, transmitter alignment, and frequency check. Isn't this too much?*

No, it's just about right. For the expert service required in setting up a CB base station, you can expect a bench charge of at least $9 per hour. However, always make sure you have a signed slip from the service shop indicating what has been done to your CB rig. You will need this as an exhibit if the FCC should find that you're still off frequency.

What Have We Here? *A wise guy in my neighborhood has started using the expression "myriametric waves." What are they—plasmonics in disguise?"*

Nope, just plain old radio waves in the spectrum from 3 to 30 kHz, or 100,000 down to 10,000 meters. Plans for building a re-

(*Continued on page* 101)

Convert Your "All-American 5" For 120-Meter Marine Band

TWO NEW COILS WILL LET YOU SALVAGE YOUR UNUSED AM BROADCAST-BAND RECEIVER

By **JOHN G. CONNER,** W4PIO

FOR TEN BUCKS you won't get all the fancy features like bandspread tuning, "S"-meter indication, or automatic noise limiting. But if you live in a fairly good signal area and want to put up an appropriate antenna, you *can* pick up AM broacasts from fishing boats, U.S. Navy and Coast Guard services, and 160-meter ham stations with a converted All-American-Five broadcast-band radio receiver.

Conversion is simple, easy, and inexpensive. You simply substitute the old antenna and oscillator coils for new ones to get a tuning range of 1.7 to 5.5 MHz, and then do a little touch-up alignment. Conversion is pretty much the same for any broadcast-band receiver, although the All-American-Five variety (sets using 12SA7, 12SK7, 12SQ7, 50L6, and 35Z5 vacuum tubes) lends itself very nicely to this purpose. If you happen to have an old transformer-operated receiver with a stage or two of r.f. amplification, you'll find it just about ideal for conversion to the short-wave bands.

Preliminary Steps. First, you should get the schematic diagram for the receiver you want to convert. The diagram will bail you out if you do get into trouble. But if you can't get a diagram, don't let that stop you from enjoying this adventure. Remove the receiver chassis and put it on your workbench. Then check it out thoroughly to make certain it is in good working order.

If the set is pretty old, inspect the capacitors and replace any showing signs of physical deterioration. For peak performance, you can also replace the output tube (50L6) with a new one. If you have prior experience in aligning receivers, give the i.f. transformers a spot check and, if necessary, realign them by ear, using an appropriate insulated alignment tool. Remember to keep the volume level low enough to minimize the effects of the a.g.c. during alignment. If you have no prior experience with receiver alignment, forget it! Don't tamper with the transformer slug adjustments.

In most broadcast-band receivers, you'll find that the loop antenna on the cardboard backing is also the antenna coil. But there are a few sets around which use an independent antenna coil for r.f. tuning, and others are equipped with a loopstick antenna. Check the configuration of your receiver front end before beginning the actual conversion.

Remember that you don't have to physically remove either the oscillator or the antenna coil from the chassis. It is sufficient just to cut the leads going to these parts to disable them. Also, this practice makes it easy to restore the receiver to its broadcast-band status at any time.

Actual Conversion. The new oscillator and antenna coils can be mounted through any of the existing holes in the chassis. But, if necessary, drill a couple of ¼"-diameter mounting holes in the chassis near the existing coils. Position the oscillator coil (a J. W. Miller B-

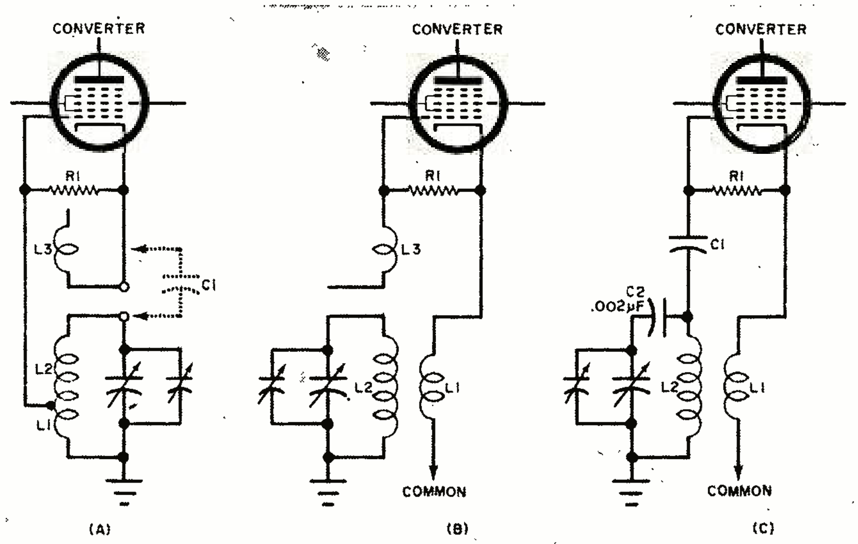


Fig. 1. Broadcast receiver oscillator circuit configurations include (a) tapped coil and (b) standard coil with "gimmick" winding. In converted oscillator (c), L3 is replaced by C1, and padder C2 is added.

5495-C or similar) as close as possible to the converter tube (12SA7), and keep the antenna coil (a J. W. Miller B-5495-A or similar) at a reasonable distance away from the oscillator to prevent interaction.

After mounting the coils, disconnect the ends of the leads going to the old coils and connect them to the appropriate pins on the new coils. If a lead is too short and will not reach, don't add to it; replace it with a new piece of wire of the proper length. And be sure to keep all leads as short and direct as possible.

Upon examining your receiver, you'll find one of the three oscillator configurations shown in Fig. 1, or some variation thereof. The tapped oscillator coil shown in (a) may include a "gimmick" winding (*L3*) which serves to bypass the r.f. component around the grid leak resistor (*R1*). If not, a capacitor (*C1*) will serve that function.

In Fig. 1 (b), the oscillator has two separate coils, *L1* and *L2*, in addition to gimmick *L3*. The third arrangement, shown in (c), replaces *L3* with *C1*. Since the short-wave coils are not equipped with the gimmick, your converted receiver must include *C1*, whose value should be 100 pF. Also note that a new capacitor, padder *C2*, has been added. The reason for this is explained in the instruction sheet that comes with the coil.

The secondary of the antenna coil is wired to replace the loop antenna as shown in Fig. 2 (b), and the primary goes between ground and the outdoor antenna. The before-conversion circuit is shown in Fig. 2(a).

(*Continued on page* 98)

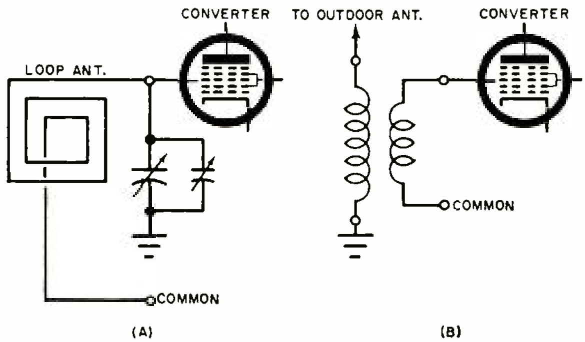


Fig. 2. In a standard BC receiver the loop antenna (a) or equivalent is replaced with a J. W. Miller r.f. coil as shown in (b). A suitable short-wave antenna must be hooked up to the coil primary for best results.

NBFM Routs 6-Meter TVI

Hams! Simple Conversion Adds Frequency Modulation to 50-MHz VFO

By **R. L. WINKLEPLECK,** WA9IGU

YOU SAY your neighbors are up in arms because of the massive dose of TVI that blankets the valley when you work your six-meter rig, even though you've tried every type of filter in the book? Have you tried the sure-fire narrow-band FM solution?

Most TVI caused by the radio amateur operating on six, and which cannot be cleared up by the usual techniques, can be traced to high-level amplitude-modulated signals. Thus, if your carrier is clean and your neighbor's TV reception goes haywire when you talk, it's time for you to switch over to FM transmission. Conversion is easy, quick, and inexpensive.

Even if you are planning the construction of a 6-meter transmitter, you might consider going FM, exclusively. For the AM modulator is always a significant expense item; and if you're shooting for high power, the AM modulator will take a big chunk of your budget.

This article will describe an inexpensive solid-state FM modulator that is equally efficient when used with a half-kilowatt job or a measly one-watter.

Simple Approach to FM. The simplicity of the FM modulator is due largely to the use of a "Semicap," a solid-state voltage-variable capacitor that replaces the old-fashioned reactance tube modulator circuitry. Essentially a diode, the Semicap's capacity varies inversely as the magnitude of the reverse bias voltage across it. Thus, if this voltage is varied, as by modulation, the Semicap's capacity is also varied. The device can therefore be used to vary the transmitter's tank circuit by merely connecting it across the VFO's frequency-determining capacitor. Simple, isn't it?

This principle also disproves the claim of some old-timers who believe that diode detector-type communications receivers cannot fully meet the requirements of FM. Since frequency-modulated signals are reproduced by slope detection, it is only necessary to tune slightly off-frequency on an AM receiver to pick up these signals clearly. Putting it another

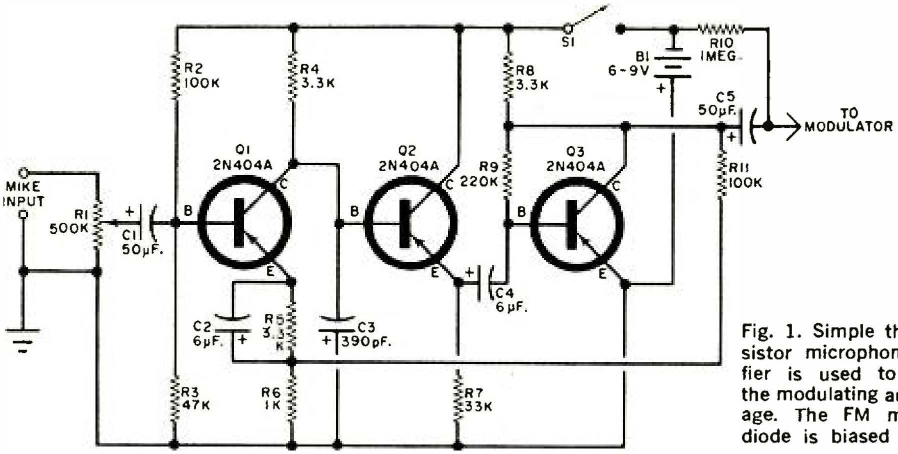


Fig. 1. Simple three-transistor microphone amplifier is used to provide the modulating audio voltage. The FM modulator diode is biased by R10.

way, if you tune in dead-on-frequency, you'll only pick up the carrier—which you'll hardly hear—but you'll pick up the modulated sidebands on both sides of the slope by off-frequency tuning. Of course, if you're too far off center and are tuning with a fairly selective receiver, your reception will be poor.

By means of on-the-air listening tests you can adjust the transmitter's sideband excursions for reasonably good reception on most ham receivers. Local contacts will have no trouble telling that you are coming over via FM since they must tune to one side of the signal peak to pick you up clearly. But the DX listener will hardly know what's going on. While DX'ing, you may note that occasionally, after several exchanges, your skip contact will give you a good signal report but add that there's something peculiar about your transmission he just can't quite describe.

AMPLIFIER PARTS LIST

B1—6- to 9-volt battery
C1, C5—50-μF, 12-volt electrolytic capacitor
C2, C4—6-μF, 12-volt electrolytic capacitor
C3—390-pF ceramic capacitor
Q1, Q2, Q3—2N404A transistor
R1—500,000-ohm potentiometer
R2, R11—100,000 ohms
R3—4700 ohms
R4, R5, R8—3300 ohms
R6—1000 ohms
R7—33,000 ohms
R9—220,000 ohms
R10—1 megohm
S1—S.p.s.t. switch
all resistors ½ watt

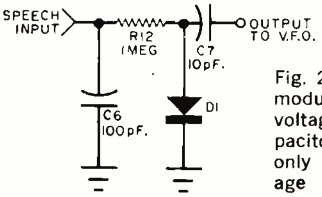


Fig. 2. Complete FM modulator, featuring voltage-variable capacitor D1, requires only a bias voltage for operation.

FM MODULATOR PARTS LIST

C6—100-pF mica capacitor
C7—10-pF mica capacitor
D1—6.8SC20 International Rectifier Semicap diode
R12—1 megohm, ½-watt resistor

Your transmitter must have VFO capabilities before it can be modified for FM operation—it's tough to swing a crystal. However, since 6 meters is rapidly becoming a VFO band, you might as well add an outboard VFO unit to your rig and change over to FM while you are at it. A six-meter VFO will start at some low frequency and then come up to 50 MHz by frequency multiplication. But bear in mind that as the basic VFO frequency is successively increased by a given factor, the amount of FM deviation due to modulation is increased by the same factor. Thus, it is important that a low-level signal be employed to drive the FM modulator to help cut down frequency deviation to a tolerable amount.

The Setup. To change over your AM transmitter to FM, you'll need a low-

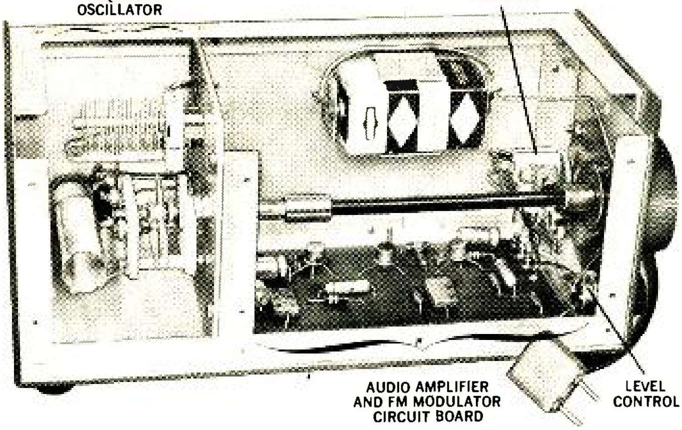
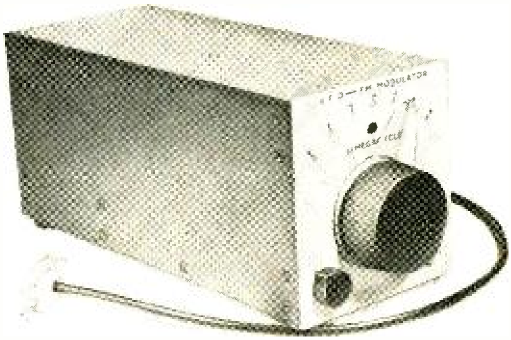


Fig. 3. The microphone amplifier and FM modulator are shown combined on a single circuit board in a passive variable-frequency oscillator case.

Shown below is the fully assembled VFO FM modulator with audio level control and connecting cable. A transmitter is converted from AM to FM by removing transmitter crystal and inserting cable plug in empty socket.



power microphone amplifier and, of course, the FM modulator we've been talking about. A simple one- or two-transistor audio amplifier of the inexpensive imported variety can be used as the mike amplifier. To get the needed high-impedance output, simply disconnect the output transformer leads and pick up your audio from the collector of the final stage through a 0.01-μF capacitor.

You may also consider using one of the new transistorized mikes to drive the FM modulator instead of getting a separate amplifier. If you prefer a home-built job, try the circuit shown in Fig. 1. It is a conventional three-transistor audio amplifier with limiting features. Limiting helps prevent excessive frequency deviation on audio peaks, and though not essential, generally improves signal quality.

Potentiometer *R1* allows you to adjust the microphone output for the correct frequency deviation before the audio is fed to the base of *Q1* through capacitor *C1*. Transistor *Q2*, hooked up as an emitter follower, drives output stage *Q3* through *C4*. Operating power is provided by *B1*, which also provides reverse bias for the modulator Semicap diode (see Fig. 2) through *R10*.

The FM modulator consists of capacitors *C6* and *C7*, resistor *R12*, and diode *D1*. Exhibiting a reasonably linear high-*Q* characteristic when reverse-biased, *D1* functions as a voltage-sensitive device. However, it conducts when forward-biased, causing both *Q* and linearity to deteriorate. It is important, then, to place a high enough reverse bias on *D1* to prevent high-level audio excursions from driving it into conduction. But since the applied audio voltage has a greater effect on *D1*'s capacitance at low bias levels, the bias should not be too high either. A satisfactory average voltage is that which powers the amplifier.

Since, in operation, the FM modulator shunts the VFO's tuning capacitor, the transmitter's r.f. must be kept from driving *D1* into forward conduction. This danger is minimized somewhat by the modulator design since *C7* is effectively in series with the VFO's tuning circuit and *D1*, thus dropping the r.f. voltage to a safe level.

Note from Fig. 1 that the modulator

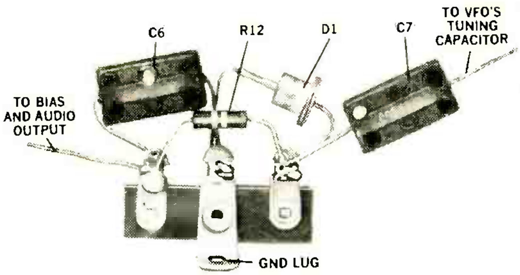


Fig. 4. Four components, when assembled on a terminal strip, comprise the complete FM modulator.

bias voltage is always *on* instead of being switched. This is so in order to maintain the VFO's calibration whether the transmitter is operating on AM or FM. The small leakage current produced has no measurable effect on the battery life.

Installation and Checkout. If space permits, the modulator and audio amplifier can be built on the same circuit board, and housed in the VFO unit (Fig. 3). Otherwise, the few modulator parts can be wired in the VFO as shown in Figs. 4 and 5, while the mike amplifier is put in its own enclosure and placed alongside of the VFO. Then these two units can be connected with a short length of shielded microphone cable or RG-58/U cable.

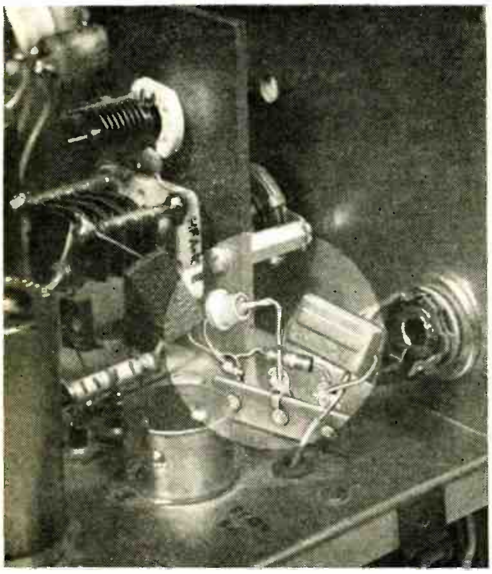


Fig. 5. The FM modulator (circled area) is shown installed in a Thor transceiver. The modulating audio signal is applied via the phone jack at right.

When you install the modulator, the added capacitance introduced will slightly lower the resonant frequency of the VFO. However, this circuit can be retuned by simply lowering the value of the VFO's calibrating capacitor.

If the FM modulator or amplifier is installed in a powered VFO, or in a transmitter with a built-in VFO, the bias and operating voltage can be taken from the transmitter's regulated plate voltage by using a voltage divider like the one shown in Fig. 6. The value of the dropping resistor may have to be increased or lowered to get the correct voltage. Try to get from 6 to 10 volts from the divider. And since this voltage is positive, it will be necessary to reverse the polarity of the diode (*D1*) from the position shown in Fig. 2. Otherwise, a 9-volt battery can be used as shown in Fig. 1.

After completing the conversion, call up a station on AM. When you make contact, switch the mike over to FM and set the amplifier level control to midpoint. If your contact reports weak audio, turn up the gain. If he reports overmodulation as evidenced by distorted or broken transmission, turn down the gain. If there's a slight roughness of the signal on FM that cannot be corrected with the amplifier level control, substitute a smaller capacitor for *C7* to drop more of the r.f. across it. This will usually do the trick.

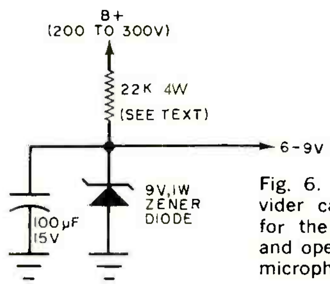


Fig. 6. This voltage divider can provide bias for the FM modulator, and operating power for microphone amplifier.

Your final adjustment should produce a narrow-band FM signal that is legal to use anywhere on 6 meters, and you can operate freely with the assurance that those phone calls from the neighbors will be for one of the other members of the family. —30—

SOLID STATE

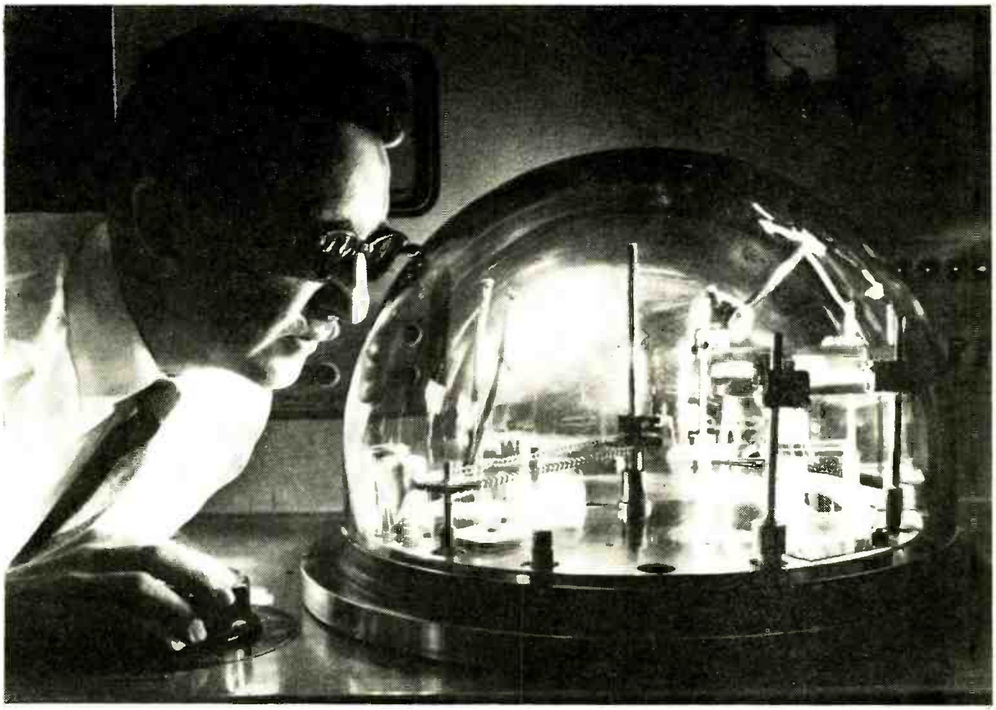
By LOU GARNER, Semiconductor Editor

A SIGNIFICANT breakthrough in the production of super-high-frequency (SHF) silicon transistors has been announced by the Bell Telephone Laboratories (Murray Hill, N.J. 07971). The new transistors, whose power gain is greater than 4 dB at 4 GHz, and whose cutoff frequency is above 7 GHz, have been developed with the aid of improved fabrication techniques which reduce their internal dimensions.

These improved transistors are fabricated by a "double-diffused" process. In it, the silicon crystal substrate is doped by diffusion with both *p*-type and *n*-type impurity elements. For example, arsenic-doped silicon (an *n*-type material) is first diffused with boron (a *p*-type impurity). This part of the silicon substrate becomes the *p*-type base layer of the final transistor. A strip in the top of the base layer is then diffused with phosphorus to convert it to an *n*-type emitter region.

High emitter efficiency is obtained by using a concentration of phosphorus at least 100 to 200 times the boron concentration in the rest of the base layer in the emitter strip. The final structure, then, has a collector substrate of arsenic-doped silicon, a boron-diffused base layer, and a phosphorus-diffused emitter region.

Although these new SHF transistors may not be available commercially for a while, their potential applications include possible uses in amateur radio gear, UHF TV boosters, microwave relay-station installations, phased-array radar systems, and satellite and space vehicle telemetry and communications equipment.



Dr. Rudolf Schmidt of Bell Telephone Laboratories adjusts the rate at which aluminum contacts, formed by vacuum deposition within globe-like chamber, are added to newly developed SHF silicon transistor.

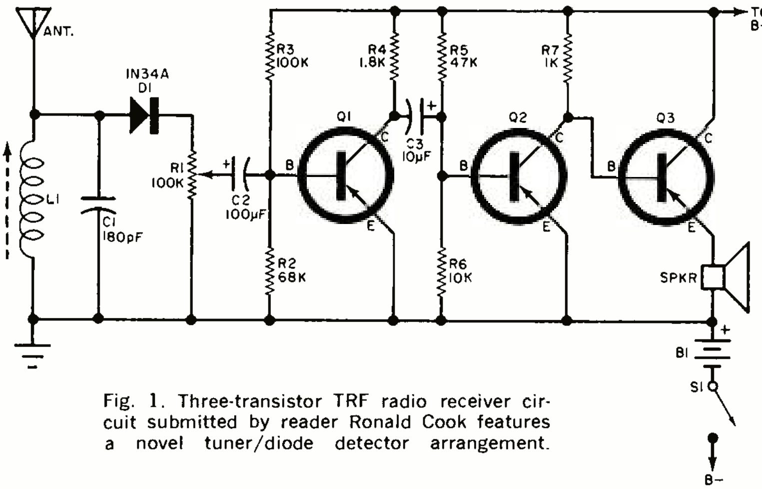


Fig. 1. Three-transistor TRF radio receiver circuit submitted by reader Ronald Cook features a novel tuner/diode detector arrangement.

Reader's Circuit. If there's any one circuit that stands out as the all-time favorite among our readers, it is the simple AM broadcast-band receiver. Typical of such receiver circuits is the TRF receiver illustrated in Fig. 1. Submitted by reader Ronald Cook (7 Montgomery St., Saugus, Mass. 01906), the circuit features a combination tuner/diode detector arrangement followed by a three-stage audio amplifier. Radio-frequency signals picked up by the antenna are selected by tuned circuit *L1–C1* and detected by *D1*. The signal across *R1*, the volume control, is applied through coupling capacitor *C2* to *Q1*'s base.

Transistor *Q1*'s base is biased by voltage divider *R2–R3*, while *R4* serves as its collector load. The amplified signal at the collector is coupled through *C3* to the base of *Q2*, biased by voltage divider *R5–R6*. Both *Q1* and *Q2* are hooked up in a common-emitter configuration. The output of *Q2* is developed across *R7*, the collector load, and direct-coupled to power amplifier *Q3*, whose base is biased by *R7*. Transistor *Q3*, wired as an emitter follower, furnishes direct drive to its PM loudspeaker voice coil load. Operating power is supplied by *B1*, a 6- or 12-volt battery, through s.p.s.t. switch *S1*.

Ronald has used standard components in his design. Coil *L1* is a variable-type loopstick antenna, *C1* a small fixed ceramic or mica capacitor, and *C2* and *C3* are 15- to 25-volt electrolytics. All resistors are half-watters; volume control potentiometer *R1* is a transistor circuit type. For diode *D1*, Ronald has chosen the familiar 1N34A. Transistors *Q1*, *Q2*, and *Q3* are general-purpose *pnp* types similar to GE's 2N107. On-off switch *S1* can be combined with *R1*, or it can be a separate s.p.s.t. unit. Battery *B1* is a regular 9-volt transistor type, but you could wire from four to eight penlight cells in series. Ronald suggests the use of a PM speaker with a high-impedance voice coil winding, and a 10′-long antenna.

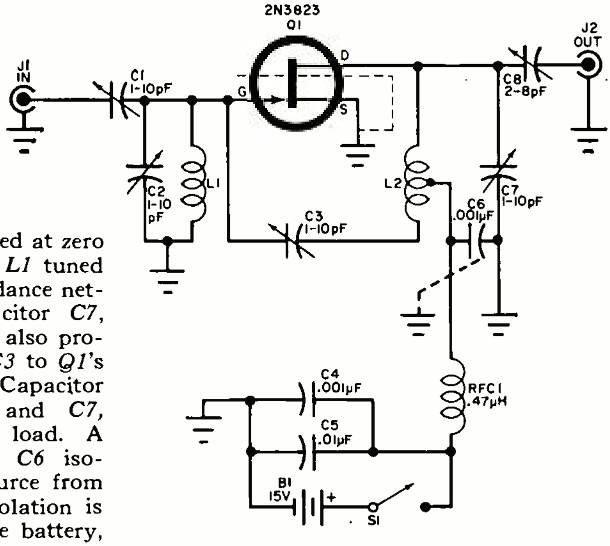
The circuit can be assembled on a small metal chassis, on a breadboard, or on a properly designed etched circuit board, as preferred. Depending on the characteristics of the transistors used, you may have to experiment with different bias resistor values until you come up with the right bias voltage.

Manufacturer's Circuit. Although the super-high-frequency transistors described in our introductory paragraphs will not be available for some time, you can learn a good deal about high-frequency transistor operation by experimenting with circuits like the 200-MHz r.f. amplifier in Fig. 2. The circuit can be modified for use as a buffer stage in a VHF transmitter or receiver, be adapted for use as an r.f. stage in an FM receiver, or—if desired—used "as is" for laboratory experiments.

Designed by engineers at Motorola Semiconductor Products, Inc. (Phoenix, Ariz. 85008), the circuit features a new moderately priced *n*-channel junction field-effect transistor (or JFET) with exceptional VHF characteristics. This JFET, a 2N3823, has a noise figure of only 2.5 dB at 100 MHz, an input capacitance of only 6 pF, a reverse transfer capacitance of just 2 pF, and a minimum forward transfer admittance of 3500 μmhos. It is useful at frequencies of up to 500 MHz.

Transistor *Q1* is used in a common-

Fig. 2. Newly developed by Motorola Semiconductor Products, this high-frequency r.f. amplifier utilizes an n-channel field-effect transistor and can operate in the 500-MHz range.



source configuration, and is operated at zero gate bias. Capacitor *C1*, and coil *L1* tuned by *C2*, form a 50-ohm input impedance network. Coil *L2*, tuned by capacitor *C7*, serves as the drain load. Coil *L2* also provides a feedback signal through *C3* to *Q1*'s gate for stage neutralization. Capacitor *C8*, in conjunction with *L2* and *C7*, matches the stage to a 50-ohm load. A r.f. choke (*RFC1*) bypassed by *C6* isolates the drain supply voltage source from the rest of the circuit. Further isolation is achieved by *C4* and *C5* across the battery, controlled by *S1*.

If you live in a small town, you may not be able to get all the parts required for this r.f. amplifier; but you can order them from one of the major mail-order houses. Coil *L1* is made from 1½ turns of No. 18 tinned wire, wound on a ¼"-diameter form and spread out about ⅜"; *L2* consists of 3½ turns of No. 18 tinned wire wound on a ⅜"-diameter form, and spread out ½". This coil is tapped at 1¼ turns from the end that goes to the transistor's drain. The r.f. choke is a commercial 0.47-μH unit, and *J1* and *J2* are standard VHF coaxial connectors. Capacitors *C1*, *C2*, *C3*, *C7*, and *C8* are good-quality ceramic trimmers, while *C4*, *C5*, and *C6* can be either ceramic or mica types. A 15-volt battery and a s.p.s.t. switch are required for the power supply.

As in all VHF circuits, layout and wiring are extremely critical. Appropriate layout, wiring, and construction techniques should be observed. Keep signal and ground leads short and direct, and make all grounds to a common point. Shield the areas indicated by the dashed lines in Fig. 2; note that one shield cuts across *Q1*, isolating the drain electrode. Once the circuit wiring has been completed and checked, the adjustable capacitors must be set for proper tuning and impedance matching with both the source and load, and to achieve stage neutralization.

Transitips. If reader mail is any indication, most readers find the Darlington circuit especially fascinating. And with good reason—for it is one of the simplest and most versatile of all multistage direct-coupled transistor circuits. So, although this circuit has been discussed briefly in past columns, a more detailed review might be worthwhile at this time.

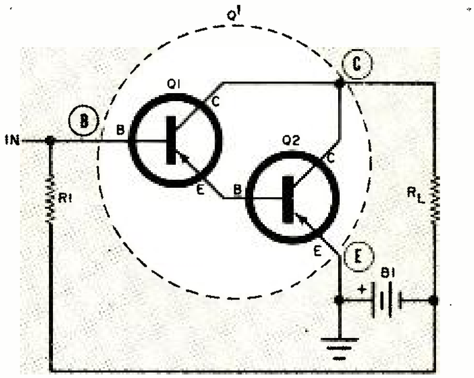


Fig. 3. Packaged in a single case, this Darlington pair can be treated as a single transistor by making the input and output connections as shown.

In its basic form, the Darlington circuit consists of two transistors with the emitter of the first connected directly to the base of the second, and having both collectors tied together, as shown in Fig. 3. The transistor pair (*Q1* and *Q2*) becomes, in effect, a "super" transistor (*Q'*), for the configuration has only three active connections: base (of *Q1*), collector (*Q1* and *Q2* together), and emitter (of *Q2*). This is indicated in the diagram by the dashed circle.

From a practical standpoint, this direct-coupled pair can be treated as a single transistor, with appropriate base bias (through *R1*), load *RL*, and input and output con-

(*Continued on page* 102)

ON THE CITIZENS BAND

By **MATT P. SPINELLO,** KHC2060, CB Editor

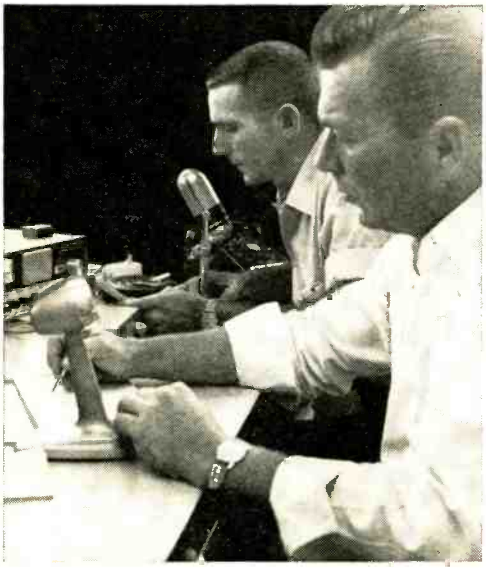
CB CLUB SUCCESS STORY

EXACTLY ONE YEAR AGO this month we lauded the Allied Louisiana Emergency Radio Team in Baton Rouge for the first time—for its volunteer efforts during hurricane "Betsy." Organized only five months prior to the disaster, the ALERT group was highly commended for its participation in emergency assignments that were issued around the clock. After another year of growth, emergency service to those in need, and receiving a charter through the State of Louisiana, the ALERT group is now solidly established, recognized and respected by local and area authorities. ALERT's immediate response to hundreds of calls for assistance in the past year has drawn much deserved attention to the group, which now numbers well over 100 members.

Photos by Baton Rouge Sunday Advocate

Betty Ballard and Joni Betz handle call for assistance at control center of Allied Louisiana Emergency Radio Team in Bellemont Motor Hotel.

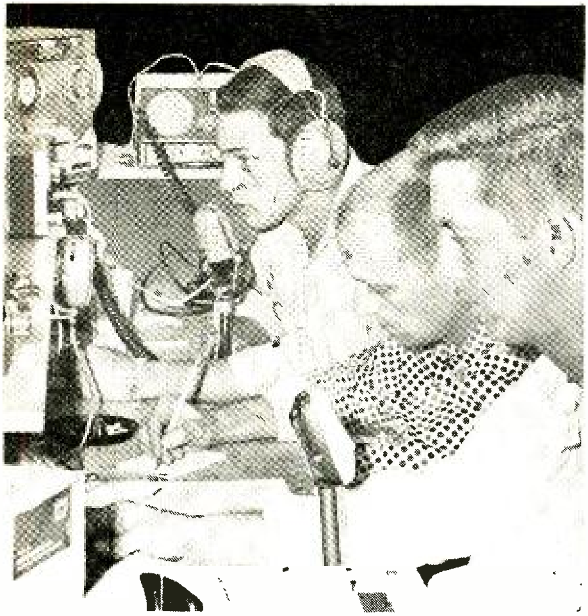
Licensed by the FCC as KMR5905, the ALERT control center is operated from a room donated by the Bellemont Motor Hotel, from which assigned members monitor channels 9 and 23. The crew of monitors includes salesmen, barbers, welders, businessmen, newspapermen, printers, policemen, housewives, and secretaries. ALERT Control is prepared to immediately furnish Civil Defense, Red Cross, or law enforcement agencies with more than 50 mobile units to help in any emergency situation.



ALERT members Jim Greer (left) and Jim Hancock man network communications from West Baton Rouge sheriff's office during "Operation Safeguard."

In addition to the group's work during Hurricane "Betsy," helping to serve the needs of some 3000 evacuees, ALERT participated in "Operation Safeguard," involving the lifting of the chlorine barge which drew national attention.

At least a portion of ALERT's success as an organized emergency unit, and a group now familiar to thousands of Louisianans, must be credited to the organization's continuing efforts to inform area residents and agencies of the worthwhile aspects of CB radio for emergency and public service communications needs. In line with your CB Editor's proposals on how to create a positive CB image (OTCB, October, 1966), ALERT has been one of the few CB clubs across the country to keep area news media, law enforcement and public service agencies informed of their progress, activities, and emergency assists.



George Weimer (left) and Fred Betz (center) are shown at Civil Defense Headquarters during "Operation Safeguard." At right is Jim Kimball of CD.

Some of the praise for spreading the word must fall upon the shoulders of Curtis B. Lauret, Jr., ALERT's public relations director. For example, Curtis has forwarded news, periodic bulletins, and photographs to our desk practically since the day someone decided to form a radio team and name it "ALERT."

One of the largest promotional boosts bestowed upon the ALERT team appeared in the *Sunday Advocate* (a Baton Rouge newspaper) in an article titled "ALERT, Ready and Standing By. . .". The ALERT story was spelled out to Louisiana readers in minute detail. Multiple kudos go to *Sunday Advocate* Editor Charles H. Lindsay for (a) recognizing and reporting the value of CB radio in the hands of organized users (b) devoting much space to making the group's cause known and (c) presenting the facts correctly—an important ingredient usually overlooked by the few news sheets across the country which have used CB radio mentions as filler material or with negative subtitles to draw readers.

Curtis Lauret, ALERT public relations director, uses his mobile CB radio to report an accident.

In a letter recently distributed by public relations director Lauret, he stated that

A motorist in need gets communications aid from an ALERT mobile unit and member Darron Sanchez.

ALERT's objectives are: (1) to promote the furtherance of the public welfare through the application of two-way CB radio communications; (2) to aid and abet normal communications media in time of local or regional emergency, disaster, or individual need, all on a voluntary basis; and (3) to promote general understanding among non-radio users as to the potential of the Citizens Band Radio Service.

Club News. Emergency squad members of the *5-11 Radio Club, Inc.*, Pittsburgh, Pa., were called into service at 11 p.m. on a recent Saturday night to help locate missing 6-year-old Eugene Forrest. Fifteen squad members equipped with walkie-talkies and Portapacks joined Pittsburgh police with canine corps to search for the boy. By 11:30 p.m., the search party had swarmed into the woods below Olympia Park. Dense foli-

(*Continued on page* 112)

ENGLISH-LANGUAGE BROADCASTS TO NORTH AMERICA

FOR THE MONTH OF FEBRUARY

Prepared by ROBERT LEGGE

TO EASTERN AND CENTRAL NORTH AMERICA

TIME—EST	TIME—GMT	STATION AND LOCATION	FREQUENCIES (MHz)
7 a.m.	1200	Copenhagen, Denmark	15.165
7:15 a.m.	1215	Helsinki, Finland	15.185 (Tues., Sat.)
		Melbourne, Australia	9.585
6 p.m.	2300	London, England	6.195, 7.13, 9.51
		Moscow, U.S.S.R.	7.15, 7.205, 9.665, 9.685
6:45 p.m.	2345	Tokyo, Japan	11.78, 15.135
7 p.m.	0000	London, England	6.195, 7.13, 9.51
		Moscow, U.S.S.R.	7.15, 7.205, 9.665, 9.685
		Peking, China	15.06, 17.68
		Sofia, Bulgaria	6.07
		Tirana, Albania	7.263
7:30 p.m.	0030	Budapest, Hungary	6.235, 9.833
		Johannesburg, South Africa	9.675, 11.88
		Kiev, U.S.S.R.	7.12, 9.665 (Mon., Thurs., Fri.)
		Stockholm, Sweden	5.99
7:50 p.m.	0050	Vatican	5.985, 7.25, 9.645
8 p.m.	0100	Berlin, Germany	5.96, 6.16
		Havana, Cuba	6.17
		London, England	6.195, 7.13, 9.51
		Madrid, Spain	6.13, 9.76
		Moscow, U.S.S.R.	7.15, 7.205, 9.665
		Prague, Czechoslovakia	5.93, 7.115, 7.345, 9.55
		Rome, Italy	6.01, 9.63
8:15 p.m.	0115	Berne, Switzerland	5.965, 6.12, 9.535
8:30 p.m.	0130	Bucharest, Rumania	6.08, 7.195
		Cairo, U.A.R.	9.475
		Cologne, Germany	6.075, 9.735
		Hilversum, Holland	9.59
9 p.m.	0200	Lisbon, Portugal	6.025, 6.185
		London, England	6.195, 7.13, 9.51
		Moscow, U.S.S.R.	7.15, 7.205, 9.665
		Stockholm, Sweden	5.99
10 p.m.	0300	Bucharest, Rumania	6.08, 7.195
		Budapest, Hungary	6.235, 9.833
		Buenos Aires, Argentina	9.685 (Mon.-Fri.)
		Havana, Cuba	6.135, 6.17
10:30 p.m.	0330	Accra, Ghana	6.11
		Prague, Czechoslovakia	6.095, 7.115, 7.345, 9.55

TO WESTERN NORTH AMERICA

TIME—PST	TIME—GMT	STATION AND LOCATION	FREQUENCIES (MHz)
6 p.m.	0200	Melbourne, Australia	15.22, 17.84
		Tokyo, Japan	15.135, 15.235, 17.825
6:50 p.m.	0250	Taipei, China	15.125, 15.335, 17.72
7 p.m.	0300	Moscow, U.S.S.R.	9.54, 11.755, 15.18
		Peking, China	9.457, 11.82, 15.095
8 p.m.	0400	Sofia, Bulgaria	6.07
8:30 p.m.	0430	Budapest, Hungary	6.235, 9.833
8:45 p.m.	0445	Cologne, Germany	6.145, 9.735
9 p.m.	0500	Berne, Switzerland	5.965
		Moscow, U.S.S.R.	9.54, 9.64, 11.755

SHORT-WAVE LISTENING

By HANK BENNETT, W2PNA/WPE2FT
Short-Wave Editor

MISINFORMATION VERIFIED

IN THE December, 1966, issue, we published an item concerning the *Voice of the Himalayas*, Katmandu, Nepal. Testing was to begin "soon" with two 100-kW transmitters, probably on or near 7105 kHz. Your Short-Wave Editor did not check this item out for accuracy, depending, instead, on the reliability of the short-wave bulletin in which the information was found. This publication, put out by an overseas organization, had always been a reliable source, and it seemed a needless expenditure of time to verify the item.

However, it appears that the American Shortwave Listener's Club had published a feature in one of its bulletins entitled "Flashback," which excerpted items from a three-year-old bulletin, providing a nostalgic look at the past for those who like to reminisce. The overseas organization, shorthanded due to vacations and with volunteers assisting, picked up the item without realizing that it was, in fact, a much outdated one. When it was printed, other clubs and organizations the world over, including this column, picked it up and used it also. Needless to say, the overseas organization printed a retraction of the item, with an explanation, shortly afterward.

Incidentally, we have just received word from one of our top monitors on the West Coast that a station, thought to be *R. Nepal*, has been noted on 4600 kHz with a woman speaking in native language but with a signal too weak to read. The schedule reportedly is 1220-1420.

DX Award Honor Roll

The following DX'ers are the first to have their names listed on the DX Award Honor Roll. The figures at the right indicate the number of countries, states, and Canadian provinces verified, in that order.

Ed Fellows (WPE7BLN) Seattle, Wash.	200	....	12
L. E. Kuney (WPE8AD) Detroit, Mich.	150	50	10
Chuck Edwards (WPE4BNK) Fort Lauderdale, Fla.	150	50	10
Richard Markell (WPE6DXC) Los Angeles, Calif.	150	50	....
Frank Scolaro, Jr. (WPE2LUZ) Yonkers, N. Y.	150	50	....
Nathan Rosen (WPE2CY) New York, N. Y.	150	50	....

While on the subject of misinformation, in the November, 1966, issue we listed a station WBBH in New Brunswick, N.J., operating with 50 watts on 4970 kHz. The address was given as RPO 914 (an address to which a report had been sent and from which a QSL had been received), and the operator as the Courtland School of Music. We also stated that it was "not a pirate station."

Several of our monitors made further checks and asked discreet questions about

(*Continued on page* 113)

AMATEUR RADIO

By HERB S. BRIER, W9EGQ
Amateur Radio Editor

CW IS DEAD (?)

THE OTHER DAY I read a magazine article that urged readers to send a letter to the FCC saying that CW was obsolete and recommending that the FCC eliminate code from the amateur license examinations. You can overhear the same story in the phone bands—especially above 50 MHz—and from some would-be amateurs. With minor variations, the theme is always the same: "No one uses CW any more except a few old fogies, who aren't with it, you know."

Communications reports coming back from Vietnam say that the only way some of our military operators are able to get radio messages through the thick wave-absorbent jungles (even over distances of only a few miles) is by using CW. When the VC jams a radio circuit, the jamming frequently disrupts radiophone and radioteletype communications, but skilled CW operators usually manage to get their messages through. No wonder so many MARS (Military Affiliate Radio System) programs stress code operation.

Shelving public service considerations, code proficiency pays off for the amateur in other ways. First, it gives him more room to spread his wings. The big difference between a Technician and General Class license is eight words of CW per minute. No doubt, many Technicians (at 5 wpm) would remain on the VHF's even if they had Extra Class licenses, but as long as they have Technician licenses, they have no choice.

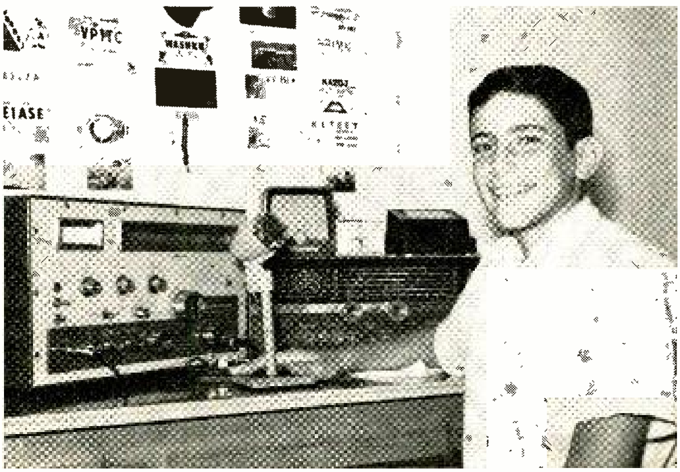
The ham who goes on phone as soon as he gets his General license without becoming proficient on CW cuts down his horizons. Watt for watt, a CW transmitter costs far less than a phone transmitter. In addition, CW has a 17-dB advantage over straight AM phone and 8-11 dB over SSB. Twenty watts of CW can do the job of 1000 watts of AM or 250 watts of SSB.

What the figures above mean in practice has been verified by the record of W9EGQ on 20 meters. Running 75 to 150 watts, I frequently work several DX stations on CW when there are very few phone DX signals to be heard, and those that are heard are difficult to raise even using my kilowatt amplifier.

"We agree that CW may get out a little better than phone," some phone men say,

(*Continued on page* 105)

AMATEUR STATION OF THE MONTH



Steve Natinsky, WA5MAC, of Dallas, Texas, operates on 15 meters with a home-built, 2-element rotary beam, a Heathkit "Apache" transmitter, and a Hallicrafters SX-110 receiver. First a Novice, and now a General, Steve has worked 49 states and 27 countries in the two years he has been a radio amateur. A free one-year subscription will go to WA5MAC for submitting the winner for February in our Amateur Station of the Month photo contest. To enter the contest, send us a clear picture of your station with you at the controls, and some details on your ham career and on the equipment you use. Mail your entry to: Amateur Radio Contest, c/o Herb S. Brier, Amateur Radio Editor, P.O. Box 678, Gary, Indiana 46401.

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PE-72

THE "BRUTE-70"

(Continued from page 46)

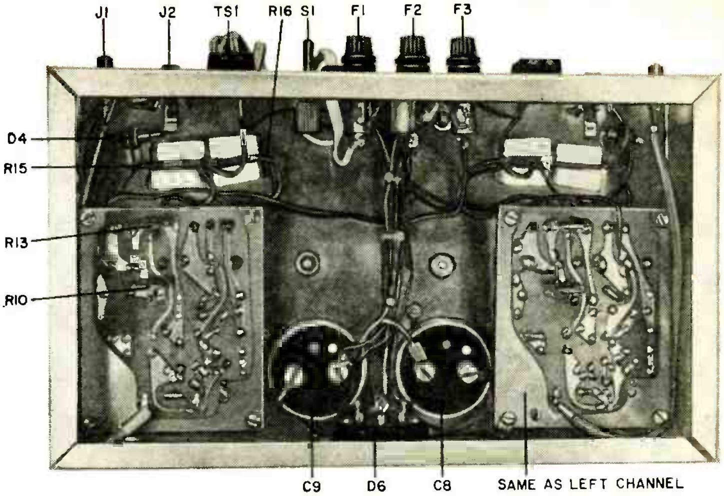

Fig. 7. If you cannot get the values specified for R15 and R16, you can wire two resistors in parallel to obtain the desired wattage and resistance, as shown here. Note the almost mirror image of one channel to the other . . . they are identical.

The chassis improves shielding of the input stages and minimizes extraneous hum and noise pickup. Don't forget the rectangular cutouts on top of the chassis to permit air circulation around driver transistors *Q4* and *Q5*.

If you can't get 0.33- and 0.27-ohm, 10-watt resistors (*R15* and *R16*), you can use two pairs of 0.68-ohm, 5-watt resistors wired in parallel, as shown in Fig. 7.

Recheck the circuit boards and the heat sink assemblies. Then install and wire the power supply components. Install the standoff spacers for the circuit boards and mount the heat sink assemblies, as well as the balance of the parts that go on the front of the chassis. Mount the remaining below-chassis components, and wire them in.

Finally, install and wire the circuit boards. Do not connect the base and emitter leads of power transistors *Q6* and *Q7* just yet. Use shielded cable between input jack *J1* and the input connection point *A* and ground on each of the two circuit boards.

Be sure that polarities have been observed, that there are no accidental shorts, that bias jack *J2* is insulated from the chassis, and that proper size fuses are installed in the holders. Adjustable pots *R10* and *R13* must be accessible.

Adjustment. Only two adjustments per channel must be made after the wiring is completed. A general-purpose VOM will be needed for this step. If you have built the two-channel stereo version, adjust each channel separately.

(Continued on page 92)

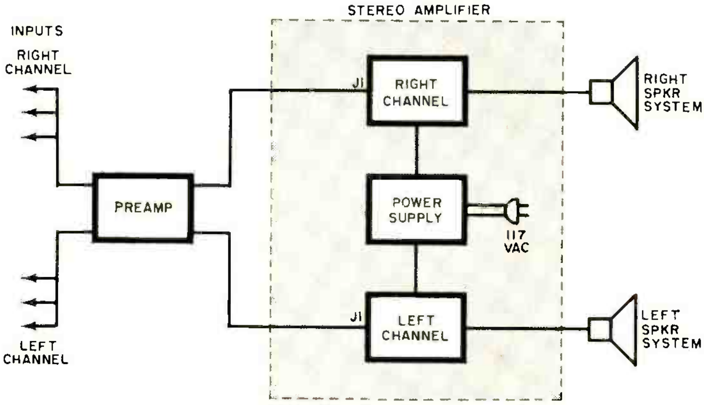

Fig. 8. Typical stereo installation using hi-fi components. While a speaker or speaker system can be connected directly to the amplifier, a preamp is needed to control and select the signals from a tuner, record player, or any other source.

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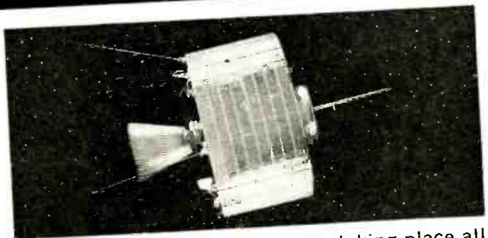

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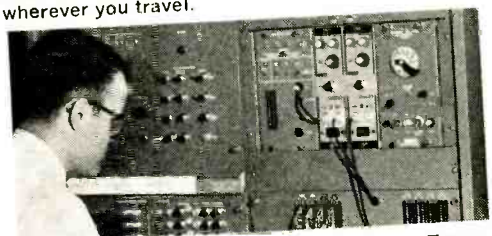


Train for a career in Electronic Controls, Transmitter Operation, or get your FCC License—a **"must"** in communications work. All included in your Master Program.

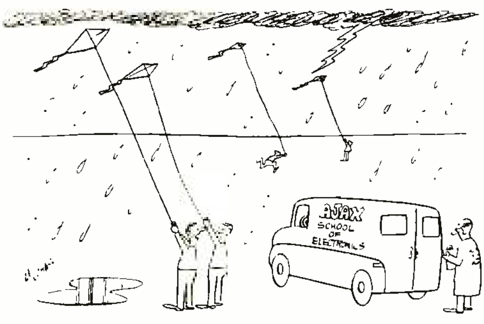
First, short input jack *J1* with a clip or dummy plug. Do not as yet connect a speaker, or other load, but do connect a d.c. voltmeter across the output terminal *TS1*. Plug in the line cord and turn on the amplifier. Little or no d.c. voltage should be measured, even with the voltmeter switched to the lowest range. If a d.c. voltage is measured, adjust *Zero Adjustment* control *R13* to reduce this voltage as close to zero as possible. If you are unable to obtain a low voltage setting, there is either a wiring error or one of the components is defective. Check out the circuit and/or replace the defective component before going any further.

Second, turn the power off, discharge the filter capacitors, and connect the base and emitter leads of power transistors *Q6* and *Q7*. Connect a milliammeter to a phone plug and insert it into *Bias Jack J2* to measure *Q6*'s collector current. Switch the amplifier back on. Adjust *Bias Control R10* for a reading of 20 mA. Finally, recheck the *Zero Adjustment* control setting.

An important point: be sure that your speaker system is capable of handling 70 watts per channel. Otherwise, you may end up with a puff of smoke and burnt-out voice coils.

Although the amplifier needn't be "babied," it should be installed where there is a reasonable amount of air circulation—this *doesn't* mean near a hot air duct. Conventional installation and interconnection techniques can be used as shown in Fig. 8.

A preamplifier of comparable quality to match the Brute-70 is in the works, and will be presented in an early issue of POPULAR ELECTRONICS. —30—



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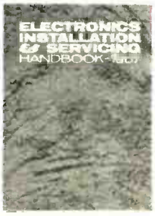

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MEET MR. FET

(*Continued from page 53*)

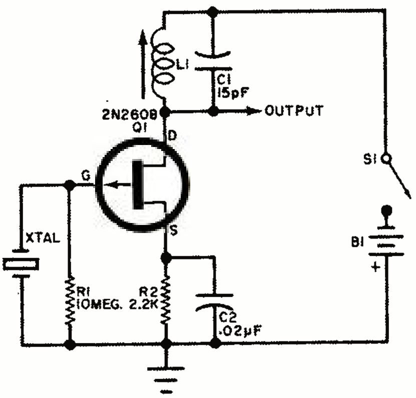


Fig. 12. This high-frequency crystal-controlled oscillator employing a Siliconix 2N2608 p-channel FET has a useful operating range of 1 megahertz.

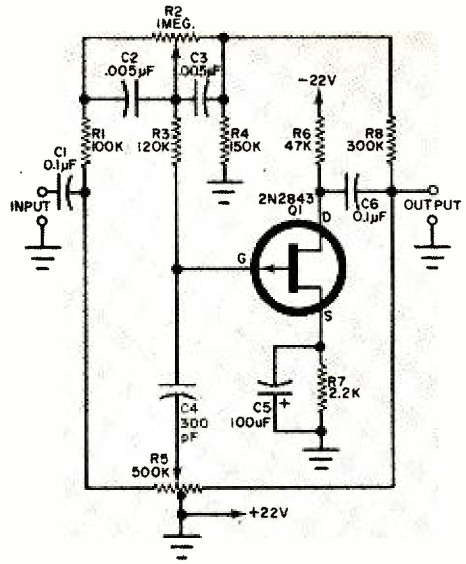


Fig. 13. Modified Baxandall hi-fi tone control employs a single p-channel FET (Siliconix 2N2843). Separate bass and treble controls are provided.

tion is the most popular, and corresponds to the common-cathode tube circuit arrangement. Typical FET circuits are illustrated in Figs. 11 through 14.

Figure 11 is a FET voltmeter with a matched pair of *p*-channel FET's (*Q1* and *Q2*) used in a differential amplifier arrangement. In general, FET voltmeters compare favorably with good-quality VTVM's.

A high-frequency crystal-controlled oscillator employing a *p*-channel FET is shown in Fig. 12. Gate bias is provided, as in a vacuum tube circuit, by source resistor *R2*, bypassed by *C2*. The feedback needed to start and sustain oscillation is furnished by the FET's interelectrode capacity as well as by stray wiring capacities.

Figure 13 features a single *p*-channel FET, *Q1*, in a modified Baxandall hi-fi tone control circuit which can be used as part of a stereo control center. Potentiometer *R2* serves as the bass control, and *R5* as the treble control.

Finally, a simple preamp circuit using an IGFET (MOSFET, or MOST, take your choice) is given in Fig. 14. Here, gate bias is provided by a 22-megohm resistor, *R1*, returned to the drain electrode.

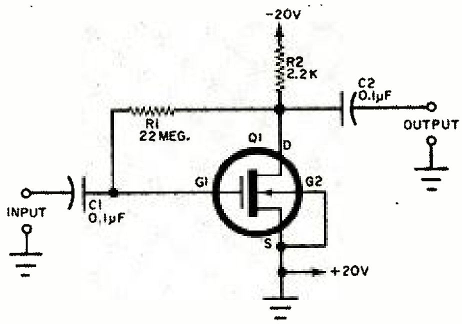


Fig. 14. Definitely not recommended for the experimenter, this single-stage preamplifier features an insulated-gate field-effect transistor (IGFET).

These circuits illustrate a few of the many practical applications of the FET. They are not intended for use in construction projects as shown, since some component values might have to be changed to compensate for the use of different FET's. In any case, only an experienced technician should attempt to use an IGFET in the application shown in Fig. 14. Practical FET projects will be covered in future issues.

One thing is certain: Mr. FET is a real "comer," and should have a brilliant future! -30-

LETTERS (*Continued from page 12*)

year and a half ago) where it didn't win anything because the judges thought it was a kit. I hope to win first place next spring with a modified version.

ARTHUR BARTON
Mayville, Mich.

We're rooting for you, A.B., to take first place next year. We'll consider the Van de Graaff generator, David, if you promise not to electrocute yourself in the meantime. If the TC didn't pack a jolt, you would be disappointed, so keep your distance. By the way, did you see the "Supercharged Salt Shaker" in the May, 1966, issue? Chances are good, A.J., that you will be seeing more computer circuits in computers and in things other than computers. Look what's happening to the new integrated circuits put out by Fairchild, Motorola, and others. Prices on some of them are down to about 80 cents each. And just in case you missed it, the December, 1966, issue shows how to build a working model of a binary counter and a logic demonstrator using these new advanced-type components. Nice work, all of you. And hang on to those old copies of P.E.; many issues are out of print.

EDITORIAL BALANCE?

Why not do away with all those useless articles in your magazine on CB, SW, and DX, and devote these pages to more construction projects?

ROBERT WALKER
Los Angeles, Calif.

I would like to thank you for putting that article in the May, 1966, issue on "SWL Antennas for the 'Forgotten Man'." I bought the Mosley RD-5, and on 15 meters I now get signals I never knew were there. I highly recommend it for the ham-band DX'er.

AL VIGEANT, WPE2OLR
Irvington, N.J.

I would like to state that I thoroughly enjoy your SWL section. In fact, this is the only reason I take P.E. Keep up the good work, and use as much SWL news as you deem advisable. For me, it cannot be too much.

WALT GREEN
Davenport, Iowa

Citizens Band Radio is as yet an untapped national resource. In times of emergency, it can supplement regular communications facilities if CB'ers are trained and properly organized. As it is, CB'ers have already done much to earn the respect of their communities, and your CB Editor, Matt Spinello, is doing a great job in publicizing the valuable activities of CB organizations throughout the country.

GEORGE BROWN
Brooklyn, N.Y.

Can't please everybody . . . but we try. —30—

ASSIST (*Continued from page 34*)

Simpson Model 303 VTVM. Operating manual and source for probes needed. (Herman W. Frisch, 14602A S. Avis Ave., Lawndale, Calif. 90260)

Philco Model 43410 receiver, tunes on 3 bands; has 8 tubes. Schematic and operating manual needed. **Emerson** receiver, ser. AM-1 226768, circa 1939; tunes 6 to 18 MHz; has 7 tubes. Schematic and source for parts needed. **Silvertone** Model 4786 receiver, ser. 308821; tunes 1.8 to 18 MHz on 3 bands; has 10 tubes. Schematic needed. (Wesley M. Ridgway, Jr., Rt. #1, South Shore, St. Charles. Mo. 63301)

Philco Model 37-630 receiver, circa 1936; tunes on 2 bands; has 5 tubes. Schematic, operating manual, and source for parts needed. (John Newman, 3528 N. Plainfield Ave., Chicago, Ill. 60634)

Hallicrafters Model SX-140 receiver; tunes 80 to 6 meters; has 5 tubes. Schematic, operating manual, and alignment data needed. (Dave Charles, 6790 S. Ontario Cir., Littleton, Colo. 80120)

Zenith Model 10S669 receiver, circa 1937; tunes s.w.; has 10 tubes. Schematic needed. (P.J. Yudell, 1829 Bronson Ave., Hollywood, Calif.)

R-1155A receiver, surplus; tunes 75 kHz to 18 MHz; has 10 tubes. Schematic and technical manual needed. (Bob Porter, Box 18 "E", Bolton, Ontario, Canada)

Webcor "Royal Cornet" tape recorder; has 5 tubes. Schematic, operating manual, and source for parts needed. (Tim Stanis, 7142 Roland, Normandy, Mo.)

Edison Model 74000 "Voicewriter": records on wax cylinders; has 2 tubes. Schematic and operating manual needed. (I. Keksis, 30 Amaron Ave., Rexdale, Ontario, Canada)

Conar Model 70 tube tester. Operating manual needed. (Rodney Guilfoil, 2353 Larkin St., San Francisco, Calif. 94109)

Potter Model 905 magnetic tape handler. Schematic and operating manual needed. (L.J. Stengel, 1023 Samuel St., Louisville, Ky. 40204)

RCA Victor Model R-52 receiver; tunes BC. Source for power transformer needed. (John H. Moser, 1911 Woodruff N.W., Massillon, Ohio 44646)

Heathkit Model FM-3A FM tuner. Construction manual needed. (Mark Weber, 9119 Manchester Rd., Silver Springs, Md.)

Radio City Products Model 310 tube tester, series 3 and 4; has 1 tube. Schematic and operating manual needed. (Ted Kingston, Box 380, Strathmere, N.J. 08248)

Crosley receiver, chassis 285364, circa 1942; tunes on 3 bands; has phonograph input; 10 tubes. Schematic and tube layout chart needed. (Edward Rojowski, 12685 McDougall, Detroit, Mich. 48212)

Detrola Model B211108 receiver, circa 1932; tunes 550 kHz to 15.7 MHz; has 7 tubes. Schematic needed. (Bob Soltysiak, 1472 Maplelawn SW, Wyoming, Mich. 49509)

ARN-5C/R-430 receiver, surplus; has 11 tubes. Schematic and conversion data for changing it to FM receiver. (Bill Bodkin, 46 Speedwell St., Dorchester, Mass. 02122)

Triangle Electric Model 1680-997 receiver; tunes 550 kHz to 18 MHz on 3 bands; has 6 tubes. Schematic needed. (John M. Rosenbaum, 25245 Roosevelt Rd., South Bend, Ind. 46614)

Motorola Model B-19-19A receiver; has 14 tubes. Schematic, operating manual, crystal, and operating frequency needed. (Hal Schardin, 3227 Cleveland St. N.E., Minneapolis, Minn. 55418)

Hickok Model 610 TV and signal generator; tunes 0 to 230 MHz; has 7 tubes. Schematic and operating manual needed. (Dan Freeman, 180 "B" W. Hillsdale Blvd., San Mateo, Calif. 94403)

Ray-Dor Model RH-1 receiver. Schematic needed. (Bradford Van Luipen, 421 Cooper Ln., Chester, N.J. 07930)

Mackay Radio Model 205B receiver; tunes 2 to 12 MHz; has 14 tubes. Schematic and crystal to receive 2134 kHz needed. (Murray Richardson, Eastport, Maine)

TDQ transmitter. Conversion data for operation with 8-MHz crystals needed. (Herman Frisch, 14602 S. Avis Ave., Lawndale, Calif. 90260)

Superior Model 85 dynamic tube tester. Tube chart needed. (William Gay, 7034 Los Santos, Long Beach, Calif. 90815)

Zenith Model 1005 receiver; tunes 0.55 to 18 MHz. Source for power transformer needed. (Richard F. Bob, Federal Aviation Agency, Bethel, Alaska 99559)

Gonset Model 3002 converter, circa 1952; tunes from 3 to 30 MHz on 3 bands; has 4 r.f. tubes. Schematic needed. (Cpl N.J. Rushmer, RCAF Station, Chibougamau, P.Q., Canada)

3E6 and 1LA6 loktal tubes needed. (George I. Roberts, 356 Concord Dr., Maywood, N.J.)

RCA Model 106 electrodynamic loudspeaker, circa 1930. Schematic needed. (L.J. Feltes, Rt. 1, Saukville, Wis. 53080)

SCR-522 receiver, surplus. Source for oscillator tuning capacitor needed. (Glenn, WA8KRP, 24622 Curie, Warren, Mich. 48091)

Mohawk "R.L. Midgetape 44" tape recorder. Schematic needed. (Michael M. Wahl, 2922 Sheridan Ave., Miami Beach, Fla. 33140)

Electronic Designs Model 100 VTVM, circa 1945. Schematic needed. (Leonard Gilbert, 236 E. 16 St., Brooklyn, N.Y. 11226)

Zenith Model 6-S-229 receiver, circa 1930; has 6 tubes. Schematic and parts list needed. (Chris D. Lochner, 1102 N.E. 117 St., Miami, Fla. 33161)

Hallicrafters Model S 20R receiver, circa 1940; tunes 550 kHz to 40 MHz. Schematic and alignment data needed. (Kendall Smith, 1632 Graefield, Birmingham, Mich. 48008)

Precise Model 116 tube tester. Tube chart needed. (Larry Stout, Box 242, Spring Arbor, Mich. 49283)

Zenith Model 7S529 receiver; tunes 550 to 18,000 kHz on 3 bands; has 7 tubes. Schematic needed. (Gary A. Jones, 26714 Haverhill, Warren, Mich. 48091)

Weston Model 772 analyzer. Schematic and operating manual needed. (Mike Martin, Rt. 3, Box 360, Fredericksburg, Va. 22401)

Eicor Model 15 tape recorder, circa 1950; has 5 tubes. Source for tape head needed. (Dave Tanguay, 6920 Cora St., Des Plaines, Ill. 60018)

RCA Model 9K2 receiver; tunes 150 kHz to 60 MHz on 5 bands; has 9 tubes. Operating manual and source for parts needed. (Bill Weatherman, 12830 Montague, Pacoima, Calif. 91331)

Heathkit Model O-9 oscilloscope, circa 1954. Construction and operating manuals needed. (Greg Dockter, 335 Reed, NDSU, Fargo, N.D. 58102)

Knight 38K185 VTVM, circa 1960. Schematic or operating manual needed. (Joseph E. Lynch, 53 E. Dewey Ave., North Lake, Ill. 60164)

"Globe Chief" Model 90-A transmitter; tunes 160 to 10 meters. Schematic, operating manual, and modulator data needed. Sammamish High School Radio Club, J.W.A. Shibley, 100 140 St., S.E., Bellevue, Wash. 98004)

Neutrowound Model 1927 receiver; has 6 tubes. Schematic and operating manual needed. (Ernest Mehner, Jr., Dorchester, Wis.)

Sylvania handbook entitled "Performance-Tested Transistor Circuits" wanted. (Joe Schumacher, 223 Redrock Dr., San Antonio, Tex. 78213)

LM frequency meter. Source for tuning dial mechanism and main tuning capacitor needed. (David Wendt, 610 N. Harrison St., Stoughton, Wis. 53589)

Zenith Model C724W receiver, circa 1963. Schematic and parts needed to convert to police and aircraft receiver. (R.E. Bahnsen, 138 Rosalind Pl., Toledo, Ohio 43610)

Harvey-Wells R-9A "Bandmaster" receiver, circa 1956; tunes 80 to 10 meters. Schematic and operating manual needed. (Doug Barnes, 3510 Snowglen, Lansing, Mich. 48917)

Green-Brown power supply, ser. H-4588. Schematic needed. (Clyde Gage, 338 Elm St., Westfield, Mass. 01085)

Aerotech Model ATC 100 CB receiver; has 9 tubes. Operating manual, schematic, and frequency of crystal in the mixer portion needed. (Robert Cunningham, 4043 Valley Ridge Rd., Dallas, Tex. 75220)

Philco Model 610 receiver, circa 1930; tunes BC and 2.5 to 17 MHz on 3 bands; has 5 tubes. Schematic and parts source needed. (Harold Feightner, 216 Carroll Dr., Warner Robins, Ga. 31093)

Pierce Model 560 magnetic belt recorder, circa 1953. Schematic and service manual needed. (H. Velme, 1236 Garfield, Denver, Colo. 80206)

—30—

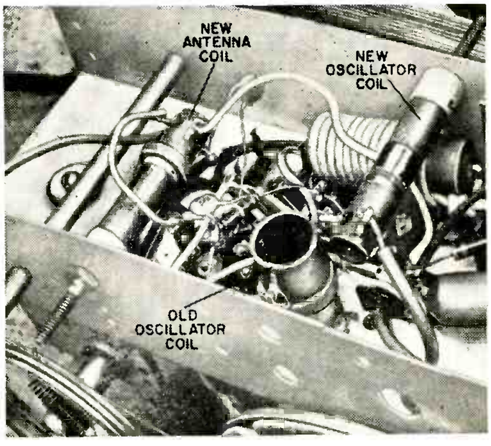
CONVERT ALL-AMERICAN 5

(Continued from page 72)

Adjustment. The alignment of any receiver can be a tricky task. But if you proceed slowly and carefully, you should have no problem. Attach a 25-foot length of hookup wire to the free end of the antenna coil and extend the other end of the wire out the window or across the hall to get maximum signal pickup. Turn the set on, and advance the volume control sufficiently to pick up atmospheric noise or static. If no static is heard, go over your connections.

Tune another receiver to a local station on the high end of the band (around 1600 kHz). Then, with the tuning capacitor of the converted receiver fully meshed, adjust the oscillator coil slug, while rocking the tuning capacitor, until you pick up the same station, which should appear at the low end of the dial. If you have trouble getting the station, try readjusting the oscillator trimmer capacitor while rocking the tuning capacitor. Now tune the slug in the antenna coil for maximum signal.

Tune the converted receiver to pick up a station near the middle of the dial, and again readjust the antenna coil slug, if necessary, for maximum gain. Retune the set to 1600 kHz and readjust the antenna coil slug for the best average gain at the two dial settings. —30—



Under-the-chassis view of a converted marine band receiver shows location of the antenna and oscillator coils. The old oscillator coil is made inoperative but is not physically removed from the circuit.

THE AMLIGNER

(*Continued from page* 61)

Also, the discharge of *C1* through the primary of *L1* induces a rapidly changing voltage in the coil. This voltage is stepped up by transformer action, placing a potential of several hundred volts across tuning capacitor *C2*.

Adjustment of capacitor *C2* determines the frequency of the r.f., carrier which is independent of battery voltage. Since *L1* is an antenna as well as a transformer, it radiates an r.f. energy that can be picked up on any nearby broadcast receiver. The power radiated is well within the limits allowed by FCC regulations.

Construction. The circuit must be housed in a non-metallic box. A plastic instrument case is just about ideal for this purpose, but you could use a Masonite or wooden case. Simply follow the pictorial diagram (p. 61). Be sure to keep the leads on *C1, D1,* and the primary of *L1* as short as possible to prevent excessive signal losses in the middle of the band. And, of course, observe polarity when hooking up the battery and diode.

The circuit should perform well with just about any loopstick you care to use, but you'll no doubt encounter performance variations from loopstick to loopstick. The one in the Parts List is quite suitable for this application. You'll also find some performance variations in tuning capacitors, requiring that you custom-calibrate your own dialplate against the frequencies of local radio stations, or with the aid of a signal generator.

Operating Hints. When using the AMLIGNER, place it as far away from the receiver as you can so that it will operate on the weakest signal possible. This procedure will insure sharp tuning.

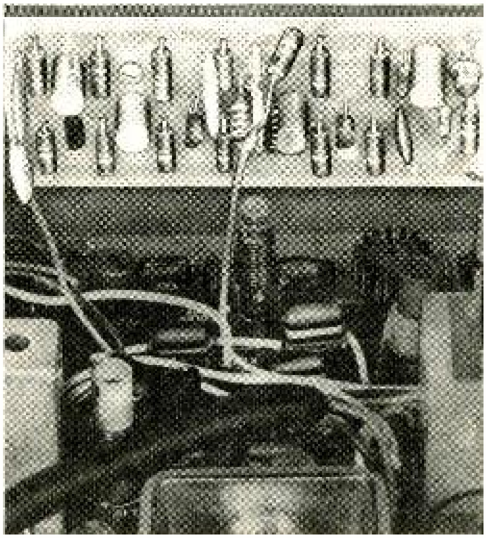
For best results when making oscillator tracking adjustments or car radio antenna trimmer adjustments, always use frequencies at the high end of the dial (around 1600 kHz). Before attempting to adjust the receiver i.f., make certain the AMLIGNER has been properly calibrated for the desired i.f. -30-

CB "AUDIO LEVELER"

(*Continued from page* 58)

Testing and Adjustment. The Audio Leveler can be tested and adjusted with the aid of an oscilloscope, or by direct on-the-air transmissions.

If a scope is employed, it must be connected as in Fig. 7 (a demodulator probe could also be used in the test lead between transmitter and scope if one is available.) With the transmitter turned on, adjust potentiometer *R9* for maximum undistorted output on the oscilloscope while you talk into the microphone at a distance of from 6 to 12 inches. If the circuit has been properly adjusted, the signal level on the scope will show only a negligible increase when you talk into the mike from a closer distance.



The circuit board can be mounted externally, or put inside the transmitter cabinet. It is shown here installed in a Heathkit Model GW-14 transceiver.

The other test method is to have another CB'er monitor your transmissions while you slowly advance the setting on *R9*. When your monitor detects a deterioration of speech quality, back off slightly on the adjustment until the quality is restored. This is the proper setting. —30—

INFORMATION CENTRAL

(*Continued from page 70*)

ceiver to tune these frequencies will be featured in the Spring Edition of the 1967 ELECTRONIC EXPERIMENTER'S HANDBOOK.

What's a DIN? *In the hi-fi salons, I see some European tape recorders with the word DIN—what does it mean?*

This is the abbreviation for "Deutsche Industrie Norm." Roughly speaking, DIN is the standard for the German electronics industry. With regard to audio equipment and tape recorders, these standards have been established and accepted by most manufacturers for plugs and sockets, two to seven pins, input and output terminals. DIN standards are also being used to some extent in England and Japan.

R/C'ers See Red. *What do radio control enthusiasts mean when they say they are on the red channel?*

It's common among R/C'ers to use color codes instead of channel numbers or frequencies. Brown is usually identified as 26.995 MHz, red is 27.045 MHz, orange is 27.095 MHz, yellow is 27.145 MHz, green is 27.195 MHz, and blue is 27.255 MHz.

North of the Border Bargains. *Since I live in the western part of Canada, I must buy most of my radio parts by mail order. But those American prices scare me. Isn't there a Canadian Olson's?*

Sure there is; it's ETCO Electronics, 464 McGill Street, Montreal 1, P.Q. Get on the ETCO mailing list for its seasonal catalogs and 99¢ specials. —30—

"I need half a dozen thingamajigs, a couple of do-funnys, and three or four whatchamacallits."

SOLID STATE

(*Continued from page* 79)

nections, as shown. In fact, a number of semiconductor manufacturers have packaged Darlington configurations in a single case, giving the resulting combination a single transistor type number.

The prime advantage of a Darlington circuit is its *gain.* In general, the overall gain of a Darlington arrangement is *the product of the gains* of the individual transistors making up the circuit. For example, if *Q1* has a gain of, say, 20, and *Q2* a gain of 30, the combination, *Q′*, acts as if it were a single transistor with an overall gain of 20 x 30—or *600!*

One other important advantage of the Darlington pair is its high input impedance. For example, the input base-emitter impedance of *Q′* approximates *Q2*'s base-emitter impedance multiplied by *Q1*'s gain. Thus, if *Q2* has an input impedance of, say, 500 ohms and *Q1* has a gain of 20, the resulting input impedance is 500 x 20, or 10,000 ohms!

Unfortunately, these theoretical approximations do not always hold true in practical circuits, for transistors are not "perfect" devices. Hence, the actual gain and input impedance values may be less than expected, on the basis of this rough calculation. Since the leakage current of the Darlington circuit is a function of the individual transistor gain, if both *Q1* and *Q2* are high-gain devices and *Q1* has a moderately high leakage, *Q2* may be driven to saturation by leakage currents alone!

Despite these limitations, a number of manufacturers have successfully marketed production-type Darlington pairs with a consistent overall gain of up to 5000 or more. And at least one firm offered a three-stage Darlington circuit, similar to that shown in Fig. 4 with an overall gain of—

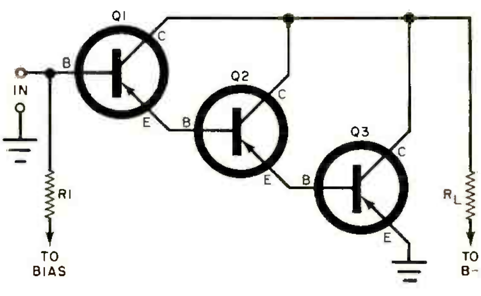


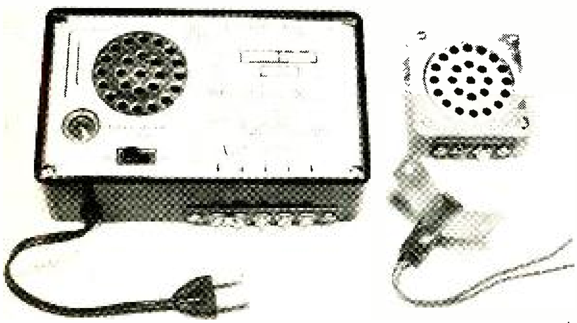
Fig. 4. This unusual three-stage Darlington circuit is capable of producing gains of up to 50,000, using standard medium-gain junction transistors.

hold your breath—*50,000!* Although it is no longer available as a standard production item, the three-stage ultra-high-gain Darlington circuit enjoyed a period of popularity when standard transistors were relatively expensive, and, in general, were low- to medium-gain devices.

In practice, Darlington circuit configurations can be assembled using either *pnp* or *npn* types, with the resulting "super" transistor having the overall polarity characteristics of the types chosen. For example, with *pnp* types used, *Q′* is biased as a *pnp* transistor. Both small signal and power types can be used.

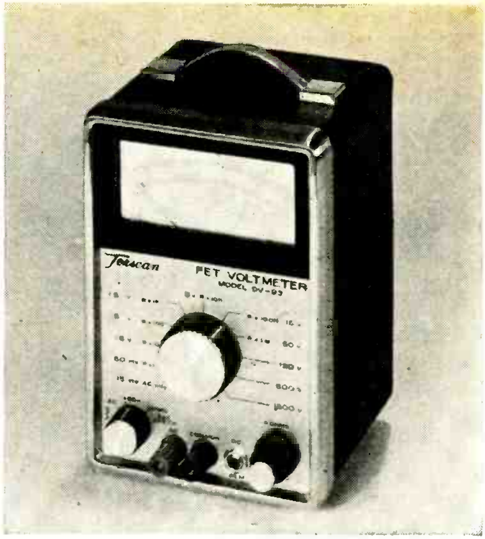
With leakage a potential problem, *Q1* should be chosen for minimum leakage and, in general, silicon transistors are preferred over germanium types for this application. If the Darlington circuit is designed with care, it can be an extremely useful circuit, providing the desired gain with a high input impedance.

Product News. A medium-priced solid-state general-purpose alarm system has been introduced by the Electronic Products Company (Box 8485, St. Louis, Mo. 63132). The basic components include a control panel with a built-in alarm speaker (optional external speakers can be added),



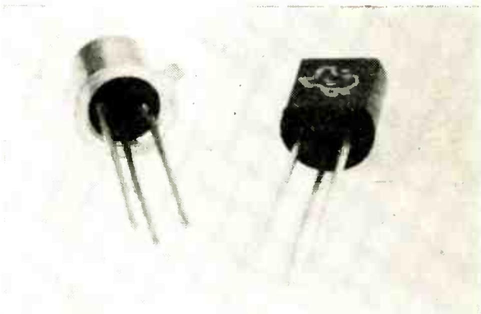
and suitable remote sensor/detectors. Designed for fail-safe operation, the unit can be employed as a burglar alarm, fire alarm, power failure alarm, or freezer failure alarm, depending on the types of sensors selected.

The Texscan Corporation (51 Koweba Lane, Indianapolis, Ind. 46207) has announced the production of a new multi-purpose FET voltmeter. Designated Model DV-93, the instrument combines the functions of a d.c. voltmeter, a.c. voltmeter, r.f. millivoltmeter and an ohmmeter. It is calibrated to measure r.f. signals ranging up to 3 MHz, but will measure frequencies up to 5 MHz. The DV-93 provides a maximum sensitivity of 50 millivolts full-scale on d.c.,



15 millivolts full-scale on a.c., and 25 ohms mid-scale for resistance measurements. Available in both a.c.- and battery-powered units, the DV-93 features a mirrored scale and is priced at $239.00.

A new family of plastic-encapsulated silicon transistors has been introduced by Texas Instruments, Inc. (13500 N. Central Parkway, Dallas, Texas 75222). The transistor leads follow a standard TO-18 pin terminal outline rather than the "in-line" arrangement generally employed for plastic



types, thus permitting the new units to be employed as direct replacements for their can-enclosed counterparts.

Philco has now joined GE in announcing the introduction of a table model AM radio receiver featuring integrated circuits. In the Philco version, over 50 resistors, 26 transistors, and 2 diodes are diffused on a pair of monolithic IC chips. Only a few external components—the tuning capacitor, antenna, speaker and battery—are required to complete the receiver.

Until next month . . .

—*Lou*

AMATEUR RADIO

(*Continued from page* 84)

"but CW is no fun." To refute that, there is plenty of evidence that CW operation provides the maximum participation in the various contests sponsored by the ARRL and other amateur organizations. Normally, there are more CW than phone entries, and not all the participants are "old fogies," either, if the number of new WA and WB calls means anything.

As Bud, K9WQS, sums it up, "When I first got my General ticket, I operated AM, SSB, and 2-meter FM, but after a few months I got tired of phone and shifted to CW. At first, it was slow going; but with regular use and a bug, my speed gradually reached 25 wpm. I do work phone occasionally, but I like CW better."

Upcoming ARRL Contests. The 14th Annual Novice Roundup is scheduled for 6 p.m., local time, February 4, to 6 p.m., February 19. The 33rd Annual International DX Competition will take place February 4-5 and March 4-5 for phone operation, and February 18-19 and March 18-19 for CW, between 0001 and 2400, GMT, each period. Log sheets for both events are available from the American Radio Relay League, Inc., 225 Main St., Newington, Conn. 06111.

To participate in the Novice Roundup, you operate a total of 40 hours on any or all Novice bands and work all comers. You send a "personal" number and your ARRL section identification to each con-

(*Continued on page* 110)

Steve (WA9IZR), Pat (WN9MWR), and Vern Malott (WA9KAG), Michigan City, Ind., can operate from 160 to 2 meters, AM, CW, SSB, FM, mobile or fixed.

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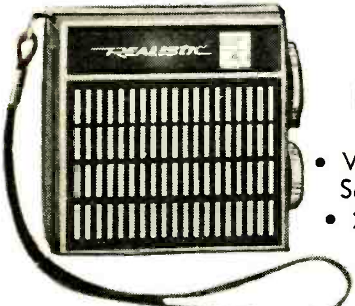

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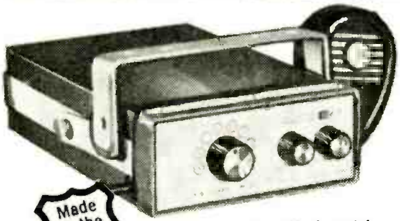

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tact, and you receive a number and section in return. You add the number of QSO's and the highest code speed on your ARRL Code Proficiency Certificate, then multiply the sum by the number of different sections worked for your score. Certificates will be awarded to the high Novice scorer in each ARRL section. All other classes of amateurs are cordially invited to work Novices during the Roundup to help build high scores.

In the DX Contest, U. S. and Canadian hams work the world, sending signal reports and the names of their states (including Alaska and Hawaii), provinces, or territories to each DX station worked. The DX station sends a signal report followed by the transmitter power. A complete exchange earns three points; one-way reception, two points. Only one contact per station per band counts. Then U. S. and Canadian operators multiply the QSO points by the sum of the different countries worked per band, while the DX stations multiply point total by the sum of the states and provinces worked per band.

NEWS AND VIEWS

Randy Crews, WA8SVP, 1293 Northport Circle, Columbus, Ohio, is a big DX man, being a regular on the football team "to keep my mind off those DX pile-ups." Randy worked 49 states as a Novice. Now, after nine months as a General, he is WAC and WAS with 65 countries included in 1300 contacts. An E. F. Johnson "Viking II" transmitter running 180 watts, a Hy-Gain 14-AVQ vertical antenna, and a Drake 2-B receiver do the work. Randy is president of the school radio club and is also a pheasant and duck hunter . . . **Bob Novas, WN2YSR,** 38 Loretta Court, Englewood Cliffs, N.J., has a 10-wpm code certificate; the minute he is sure of 13 wpm, he is going for his General. In two months, Bob's 40-watt E. F. Johnson "Navigator" transmitter, Mosley V-46 vertical antenna, and Hammarlund HQ-100A receiver have garnered QSL's from 10 states, with more on the way . . . **Jimmy Hall, WB4AMT,** Richmond, Va., says it's wonderful to be selected as the "Amateur Station of the Month" (November, 1966). He continues to be surprised at the number of people who tell him about seeing his picture in the magazine.

Chris Anderson, WN8UML, 19303 Farmington Rd., Livonia, Mich., used a variety of equipment his first few months on the air. Starting out with a borrowed Johnson "Adventurer" transmitter feeding an inverted-V antenna and a Hammarlund HQ-129A receiver, he worked five states and Canada. Now, using a home-brew seven-watter and a Drake 2-B receiver, Chris has nine states and 147 contacts—all on 80 meters . . . **Mike Wilke,**

ANNUAL BANQUET

The Lake County (Indiana) Amateur Radio Club, Inc., will hold its 14th annual banquet at 6:30 p.m., CST, on February 11, at Teibel's Restaurant, where U.S. Routes 30 and 41 intersect. There will be entertainment and prizes as well as food. Tickets are available ($4 each) from William DeGeer, WA9MOE, 3601 Tyler St., Gary, Ind. 46402.

Randy Crews, WA8SVP, hunts DX on the air and game birds in the fields. As a DX'er, he is WAC and has 65 countries worked. See text on p. 110.

WB4AQL, 3607 Cambridge Rd., Montgomery, Ala., has three antennas, inverted-V's for 40 and 20 meters and a straight dipole on 80 meters. His "Globe-Chief 90" transmitter and Knight-Kit R-100 receiver chalked up 38 states on 80 and 40 meters. This was done with two crystals, but a VFO is in the works. Also, a Heathkit HW-32 SSB transceiver is on the way to be connected to that 20-meter antenna . . . Although it would seem to be about two years late, the **Southern Cayuga County Amateur Radio Club, WB2NOD,** Box 685, Moravia, N.Y., is conducting a postal-card poll on "incentive licensing." If you're interested, vote "yes" or "no" on a post card and mail it to the club.

If you need a Maryland contact on any amateur band up to the 220-MHz band, check **W3EAX,** of the **University of Maryland Amateur Radio Association,** College Park, Maryland. The equipment available includes a pair of E. F. Johnson "Navigators" (40 watts, CW), an SSB exciter, and a couple of high-power amplifiers for the lower frequencies, where a Windom antenna is used—except on 21 MHz, where a 3-element beam is used. The receiver is a National NC-303. Two elements on "6," five elements on "2," and 16 elements on "1¼" round out the antenna farm. With many operators available, W3EAX is often on the air, usually on low-power CW. The low power doesn't slow them down much, if 15 countries worked in one week, plus WAS, WAC, and 69 countries confirmed means anything . . . **W. Page Pyne, WA3EOP,** 540 North Locust St., Hagerstown, Md., who supplied the above information on W3EAX, is also active in Maryland. He and Howard, WA3ECQ, are active in all the VHF contests from a local mountaintop, from which their Heathkit "Twoer" covers a radius of 100 miles.

The Canadian Centennial Year (1967) is being celebrated by Canadian amateurs replacing the VE or VO prefix of their call-signs with 3C or 3B, respectively—if they wish . . . If you have transmitted or received a signal over a distance which, divided by the transmitter input power, equals or exceeds 1000 miles, send details to the QRP Club Awards Manager, **Robert L. Henrich, WØGWT,** 2938 Homewood Ave., St. Charles, Mo. 63301, with a large, stamped envelope, and you will receive a Thousand-Mile-Per-Watt certificate. Send a quarter, and Bob will mail the certificate in a mailing tube. According to the last QRP Club "Newsletter," **John, WA8LDH,** has qualified for the award by working W5OLH and several other Texas stations on 50 MHz using a 140-milliwatt transmitter . . . On Election Day, November 8, 1966, Chicagoland mobile amateurs cooperated in

"Operation Eagle Eye." Whenever a report of election difficulties reached "Eagle Eye" headquarters, a mobile manned by two lawyers and the operator was radio-dispatched to the polling place. **Bill Burke, W9VX,** coordinated the amateur participation.

Keith Beebe, WA4QOO, 4899 100th Way North, St. Petersburg, Fla., is proud of being a member of the A1 Operator's Club. Running 55 watts from a home-brew transmitter into a 20-meter beam, 31' high (it was higher before the last hurricane) and a 40-meter inverted-V, Keith has 49 states and 70 countries worked; his receiver is a Lafayette KT-320.

The first step towards seeing *your* "News and Views" or photo in this column is your responsibility. Send that letter today. Also, keep the club bulletins coming. The address is: Herb S. Brier, W9EGQ, Amateur Radio Editor, POPULAR ELECTRONICS, P. O. Box 678, Gary, Ind. 46401.

73, Herb, W9EGQ

ON THE CITIZENS BAND

(*Continued from page* 81)

age, thorn bushes, and steep inclines hampered operations, in addition to a light drizzle that began to fall after midnight. Despite the odds, at approximately 2:30 a.m. the communications control point hit the air with: "Control to all units—the boy has been found!" Eugene was safe, but cold and hungry.

Troy (N.Y.) CB'ers are still he-hawing over the apparent good time had by all during the Second Annual Donkey Ball Game held by the *Troy Area CB Club* on CB Field Day. Over 200 CB'ers attended from Massachusetts, Connecticut, Vermont, and various sections of New York State. Club members spent many long hours in preparation for the event, building and supplying such necessities as a first aid tent, communications control tent, sheltered admission gate, refreshment stand, p.a. system, display tables, souvenir stand, two generators, a beacon light—and 14 donkeys. Final reports indicated that although some riders left the playing field with sore spots and split seams, the game was exactly as advertised—hilarious!

The *Ramsey County 5-Watters CB Club* (St. Paul, Minn.) claims to be the oldest and largest CB club in the St. Paul/Minneapolis area. The objectives of the 50 members include strict adherence to club and FCC rules, and promotion of interest in CB radio operation. Their calling channel is 9, and they have a CB emergency unit associated with the Red Cross. Current officers are: Tom Zine, KGF2516, president; Ray Olson, KGF1435, secretary/treasurer; and Sharon Miller, KGF2561, publicity chairman.

I'll CB'ing you!

—Matt, KHC2060

SHORT-WAVE LISTENING

(*Continued from page* 83)

this station. Your Short-Wave Editor, and others, tried to contact them by telephone and found that there was no listing either for the station or for the school. Further correspondence to the station was returned by the post office as being undeliverable.

We checked with music houses in the area, and with Rutgers University and the research department of their library. We also checked with the New Jersey State Broadcasters, all to no avail. No one had ever heard of WBBH.

Finally, one of our monitors contacted the Federal Communications Commission's field engineering office in New York City. Their first reply was that the call-sign WBBH had never been issued. After further queries, the FCC stated that WBBH was an unlicensed station which had their operations terminated by the FCC.

So far as we know, William Graham, WPE2LMU, of Binghamton, N.Y., is the only person who logged and actually verified WBBH, a modern-day (yes, now we admit it!) pirate station. The existence of a printed QSL card; the announcing—on the air—of a definite address; creation of a fictitious front—the Courtland School of Music; all these things made for the perpetration of a most fanciful hoax.

CURRENT STATION REPORTS

The following is a resume of current reports. At time of compilation all reports are as accurate as possible, but stations may change frequency and/or schedule with little or no advance notice. All times shown are Greenwich Mean Time (GMT) and the 24-hour system is used. Reports should be sent to SHORT-WAVE LISTENING, P.O. Box 333, Cherry Hill, N.J., 08034, in time to reach your Short-Wave Editor by the fifth of each month; be sure to include your WPE identification, and the make and model number of your receiver. We regret that we are unable to use all the reports received each month, due to space limitations, but we are grateful to everyone who contributes to this column.

Afghanistan—*R. Kabul* has moved to 11,760 kHz (replacing 11,865 kHz) and is noted in East Coast and Midwest areas at 1900-1905 with Eng. news. Another new frequency is 7200 kHz, heard from 1130 s/on with Indian-type native-language vocals; three long, high-pitched pips are given at 1230 with a clear ID in native language.

Aldabra Island—The BBC is sending a survey team to this island, located 250 miles northwest of

SHORT-WAVE ABBREVIATIONS

AIR—*All India Radio*	N.A.—North America
anmt—Announcement	R.—Radio
BBC—British Broadcasting Corporation	s/off—Sign-off
Eng.—English	s/on—Sign-on
ID—Identification	VOA—Voice of America
kHz—Kilohertz	xmsn—Transmission
	xmtr—Transmitter

Madagascar, to study the feasibility of locating a relay station here as part of a plan to improve the BBC World Service.

Angola—*R. Clube do Congo Portugues* has a new frequency and schedule as follows: 4860 kHz at 0600-0800, 1100-1400, and 1700-2200 (weekdays) and 0800-2000 (Sundays.) *R. Clube de Mocamedes* has this new schedule: 0600-0900 on 5015 and 7230 kHz, and 1700-2300 on 5015 and 9515 kHz. All xmtrs are 1000-watters.

Bolivia—Station CP38, *Radioemissoras Altiplano,* La Paz, 5042 kHz (listed for 5045 kHz) was noted at 0330-0430 in Spanish with Latin American and N.A. rock-type music with Spanish lyrics. Groups of ads are followed by 10-15 minutes of music.

Canada—The new Eng. schedule for *R. Canada* reads: 0725-0800 in Afro-European Service on 5990 and 9630 kHz (and on 9770, 11,925, and 15,390 kHz via BBC); 0825-0935 in Australasian Service on 5970 and 9630 kHz; 1215-1313 in N.A. and Antilles Service on 5970 and 11,720 kHz; 1215-1313 to Europe on 11,720 and 15,365 kHz, and 2115-2152 on 9630, 11,720, and 15,320 kHz; 1834-1915 to Africa on 11,720, 15,320, and 17,820 kHz; 2258-2330 to Caribbean and Latin American areas on 5990, 9625, and 11,810 kHz; and to Northern Canada at 0058-0230 on 5970, 9625, and 11,720 kHz, 0230-0706 (with French) on 9625 and 11,720 kHz, 1055-1215 (with French) on 5970 kHz, 1516-1529 on 11,720 kHz, 1631-1659 (with French) on 11,720 kHz, and 2158-2250 (with Eskimo) on 5970, 9625, and 11,720 kHz. (If you would like to be placed on *R. Canada's* mailing list for a complete schedule, write to P.O. Box 6000, Montreal, Quebec, Canada—*Ed.*)

One of Canada's lesser-known stations is CKZN, St. Johns, Newfoundland, 6160 kHz, 300 watts. Beamed to Labrador, it can be heard in extreme northeast U.S. areas early in the morning.

China—Foochow, 4975 kHz, is weak to fair at 1123 in Chinese. Chungyang (*R. Peking* Home Service), 15,030 kHz, has dictation-speed news in Chinese at 0100-0145.

Costa Rica—Station TIQ, *R. Casino,* Puerto Limon, 5955 kHz, has Eng. at 0515-0545 with many old U.S. records and frequent time checks. From anmts given, one would assume that they are trying to reach the Eng.-speaking audience in the Caribbean Islands.

Bill Parkinson, WPE2NAM, of Northport, N.Y., operates his Hammarlund HQ-100A receiver. In just over two years, Bill has 41 countries verified; he considers VLT4 in New Guinea as his best catch.

Ecuador—On 3308 kHz, there is definitely a low-powered Ecuadorian with s/off at 0452. ID's are given very infrequently, but a complete ID is given at s/off although it is usually too weak to copy.

Egypt—*R. Cairo* has this new schedule: to N.A. in Eng. at 0130-0300 on 9475 kHz; to Middle East in Arabic at 0300-0800 on 9460 kHz; to N. Africa in Arabic at 1400-0015 on 9550 kHz; to Europe in Arabic at 1745-1830, in Italian to 1930, in French to 2030, in German to 2145 and in Eng. to 2315 on 9475 and 11,965 kHz; to Central Africa in Arabic at 0400-0600 on 7100 kHz; and to South America in Portuguese at 2330-0030 and in Spanish to 0130 on 11,980 kHz. Reports go to P. O. Box 1186, Cairo.

Formosa—The latest schedule from the *Voice of Free China* for Eng. shows 0250-0350 on 7130, 11,825, 15,345, and 17,890 kHz; 1000-1045 on 7130, 9655, 9685, 11,825, and 11,860 kHz; and 1530-1610 on 7130, 9685, 11,725, 11,825, 15,125, 17,775, and 17,890 kHz.

France—Paris has Eng. beamed to Brazzaville at 0515-0530 on 9500 and 11,960 kHz, and at 1100-1115 on 17,850 and 21,650 kHz; to the Far East (relayed by Brazzaville) at 1300-1330 on 15,245 and 17,740 kHz; and to Africa (relayed by Brazzaville) at 1915-1930 on 15,130 and 17,740 kHz.

Ghana—*R. Ghana*, Accra, now has Eng. at 0300-0345 on 6070 and 6130 kHz; at 0330-0430 on 6110 kHz; at 0430-0515 on 9545 and 9760 kHz; at 0530-0730 on 3240 kHz; at 0600-0645 on 9760 kHz; at 0715-0800 on 9545 kHz; at 1330-1430 on 17,910 kHz; at 1400-2215 on 6130 kHz; at 1500-1545 on 17,910, 21,545, and 21,720 kHz; at 1645-1730 and 1815-1900 on 15,285 kHz; at 2000-2100 on 9760 and 11,800 kHz; and at 2045-2215 on 9545 kHz.

Guatemala—The station being reported on 3379 kHz is *Escuelas Radiofonica Chortis*, Jocotan. It runs five hours daily and closes at 0203. Reports may be sent in Eng., Spanish or French to Jocotan, Dep. Chiquimula, Guatemala.

India—The General Overseas Service in Eng. from *All India Radio* is given at 0030-0130 on 6180, 9740, 11,710, and 11,760 kHz. An *AIR* outlet in either New Delhi or Bombay is noted on 9535 kHz with news in Eng. and a solid signal at 1230-1235.

Indonesia—Indonesian regional stations on 3325 and 4930 kHz have been heard around 1220-1226. Both operate dual to Ambon on 7140 kHz. Locations have not been ascertained, however; Palankaraya and Biak are both listed for 3325 kHz, Medan and Tandung-Pinang are both listed for 4930 kHz.

Israel—News in Eng. from Tel Aviv has been rescheduled on 9795 kHz, starting at 2115. This will parallel the usual 9009-kHz channel. Other changes: the Sunday morning xmsns of *Kol Israel* have been cancelled; French is now aired daily at 2045-2115 on 9009 and 9725 kHz, and additional Eng. is broadcast on 9009 kHz *only* at 2015-2030.

Korea (North)—Pyongyang has been heard in Eng. at 0100 on 14,520 kHz, and in Korean (but they may use Eng. also) at 1045 on 6479 kHz. If you can't log the latter channel, 7578.5 kHz may be somewhat easier to pick up.

Mozambique—A very rarely reported station is *Aqui Beira, Mocambique a Radio Pax, Emissora Catolica*. It was noted on 7205 kHz at 0401 s/on. Numerous gongs, religious programs, and some pop tunes were featured. The power is listed as being only 50 watts.

Netherlands—Eng. from Hilversum is now scheduled to N.A. at 1655-1715 and 2030-2050 on 15,425 and 11,730 kHz, at 2055-2150 (except Sundays) on 9590 and 6085 kHz, at 0125-0220 on 9590 kHz (Bon-

SHORT-WAVE CONTRIBUTORS

Tom Feeney (*WPE1GZC*), Newport, R. I.
Richard Grab (*WPE2HYM*), Woodside, N. Y.
Bill Scorso (*WPE2LKP*), New Milford, N. J.
William Graham (*WPE2LMU*), Binghamton, N. Y.
Kenneth Coyne (*WPE2LSI*), Long Beach, N. Y.
Bill Hafner (*WPE2OJJ*), West Islip, N. Y.
Bill Snyder (*WPE2ONK*), Levittown, N. Y.
Robert Fisher (*WPE2OPL*), Syracuse, N. Y.
Peter Macinta, Jr. (*WPE2ORB*), Kearny, N. J.
Jeffrey Plotkin (*WPE2ORN*), Brooklyn, N. Y.
Robert Eddy (*WPE2OTB*), Troy, N. Y.
Bruno Colapietro (*WPE2OWO*), Endicott, N. Y.
Ed Kowalski (*WPE3AK*), Philadelphia, Pa.
Kenny Stern (*WPE3FDZ*), Philadelphia, Pa.
Howard Silverstein (*WPE3GYL*), Philadelphia, Pa.
Robert Wilkner (*WPE4ACP*), Pompano Beach, Fla.
Grady Ferguson (*WPE4BC*), Charlotte, N. C.
Bruce Churchill (*WPE4EVD*), Chula Vista, Calif.
Dan Henderson (*WPE4GW*), Laurel, Md.
Richard Hall (*WPE4ISJ*), Louisville, Ky.
Stewart MacKenzie (*WPE6AA*), Huntington Beach, Calif.
Robert Palmer (*WPE7BB*), Spokane, Wash.
Mike Clapshaw (*WPE7BSJ*), Port Angeles, Wash.
Robert French (*WPE8FGH*), Bellaire, Ohio
Gary Williams (*WPE8GEH*), Detroit, Mich.
Robert Wright (*WPE8JCF*), Brighton, Mich.
Norm Wald (*WPE9LAC*), Skokie, Ill.
A. R. Niblack (*WPE9KM*), Vincennes, Ind.
John Beaver, Sr. (*WPEØAE*), Pueblo, Colo.
Paul Mandel (*WPEØEMK*), Creve Coeur, Mo.
Charles Laddish (*VE7PE1BA*), Vancouver, B. C., Canada
John Banta, Bay Shore, N. Y.
Karl Bullock, Pontotoc, Miss.
David Gross, Syosset, N. Y.
Philip Harkin, Sherman Oaks, Calif.
Glenn Hauser, Albuquerque, N. M.
Bob Hill, Washington, D. C.
William King, Panama City, Fla.
Eugene Miller, Bronx, N. Y.
A. E. G. Penny, Montreal, Quebec, Canada
Edward Ramras, Queens Village, N. Y.
Bill Siegel, St. Clair Shores, Mich.
Canadian Broadcasting Corp., Montreal, Quebec, Canada
R. Nederland, Hilversum, Holland
R. Switzerland, Berne, Switzerland
Sweden Calling DX'ers Bulletin, Stockholm, Sweden

DX COUNTRIES AWARDS PRESENTED

To be eligible for one of the DX Countries Awards designed for WPE Monitor Certificate holders, you must have verified stations in 25, 50, 75, 100, or 150 different countries. ("Letters of Certification" will be issued to those who have over 150 countries verified, in steps of 10.) The following DX'ers recently received their awards.

TWO HUNDRED COUNTRIES VERIFIED

Ed Fellows (WPE7BLN), Seattle, Wash.

ONE HUNDRED AND FIFTY COUNTRIES VERIFIED

Frank Scolaro, Jr. (WPE2LUZ), Yonkers, N. Y.
Chuck Edwards (WPE4BNK), Fort Lauderdale, Fla.

ONE HUNDRED COUNTRIES VERIFIED

Joe Stauhs (WPE2SW), Belleville, N. J.
Edward Tompkins (VE3PE1ZJ), Toronto, Ontario, Canada
Charles Matterer (WPE6DGA), San Leandro, Calif.
Bob Crowell (WPE4HKO), Fort Walton Beach, Fla.

SEVENTY-FIVE COUNTRIES VERIFIED

Daniel Dravet (VE2PE1EB), Montreal, Quebec, Canada
Reg Firth (WPE2GFO), Amsterdam, N. Y.
Robert French (WPE8FGH), Bellaire, Ohio
Ron Kusmack (VE4PE4U), Winnipeg, Manitoba, Canada

FIFTY COUNTRIES VERIFIED

Bob Ulmer (WPE2LRG), Bloomfield, N. J.
Alan Raylesberg (WPE2MKW), Bayside, N. Y.
Roger Greene (WPE2NFC), Bronx, N. Y.
Mike Tilbrook (WPE3FTZ), Pittsburgh, Pa.
Steve Curfman (WPE9GWK), East Alton, Ill.
David Lund (WPEØAUO), Sioux City, Iowa
John Swenson (WPE4ITV), Annandale, Va.
Mike Finigan (WPE4ISQ), Monroe, N. C.
Richard Pistek (WPE9HOA), Chicago, Ill.
Jim Gordon (WPE9HHZ), Monroe, Wis.
Robert King (WPE5DWN), Bartlesville, Okla.
Stanley Mayo (WPE1GMF), Portland, Maine
David Meisel (WPE4IRS), Charlottesville, Va.
David Smith (WPE1GBC), Everett, Mass.
Michael Woloch (WPE3GHS), Baltimore, Md.
Perry Davis (WPE2MQS), Jamaica, N. Y.
Viktor Decyk (WPE1FCD), Colrain, Mass.
Gary Fredricks (WPE7CGG), Eugene, Ore.
Ron Hopkins (VE7PE7P), Trail, British Columbia, Canada
Frank Halpin (WPE2GRC), Queens Village, N. Y.
Bruce Reynolds (WPEØEKU), Warrensburg, Mo.

TWENTY-FIVE COUNTRIES VERIFIED

Ronald Hartwig (WPE5ELA), Midland, Texas
Rick Jemison (WPE9HLZ), Des Plaines, Ill.
Walter Pyne (WPE3ETH), Hagerstown, Md.
Mark Lewis (VE3PE2HK), Downsview, Ontario, Canada
John Leimseider (WPE1GJT), Westport, Conn.
Robert Sommers (WPE2MGC), Kew Gardens, N. Y.
Peter Golden (WPE1GSK), Gardiner, Maine
Chris Lobdell (WPE1GCI), Reading, Mass.
James Thompson (WPE1GDW), New Bedford, Mass.
Floyd Hale (WPE2HGN), Chittenango, N. Y.
Pat Laird (VE5PE5F), Swift Current, Saskatchewan, Canada
Doyle Simmons (WPE4AGI), Taylors, S. C.
Robert Braunwart (WPE7CJQ), Moses Lake, Wash.
Anthony Navarro (WPE6GHO), Hayward, Calif.
Bertram Adams (VE3PE2AE), Brampton, Ontario, Canada
Rev. T. L. Jackson (WPEØEFC), St. Louis, Mo.
Gizella Szilagyi (WPE8ILO), Cleveland, Ohio
James Pogue (WPE9HLJ), Farmland, Ind.
Paul Judkins (WPE4ISO), Herndon, Va.
Steve Payne (WPE5EMS), West Monroe, La.
John Rosenbaum (WPE9HTO), South Bend, Ind.
Ross Lambert (WPE2MFS), Riverdale, N. Y.
Alan Coles (WPE2NUY), Leonia, N. J.
Timothy Armstrong (WPE6GGJ), Suisun, Calif.
Alvan Fisher (WPE1GHE), Newton, Mass.
James Peshock (WPE5DQD), Richardson, Texas
Bruce Bublick (WPE2OTK), Passaic, N. J.
Lance Collister (WPE3GZK), Lancaster, Pa.
Arthur Martin (WPEØEJY), St. Paul, Minn.
Robert Wilson (VE3PE2GA), Ottawa, Ontario, Canada
John Poulsen (WPE4HZE), Selma, Ala.
Mike Diekhoff (WPEØETY), Lincoln, Nebr.
Carl Durnavich (WPE9IFO), Riverdale, Ill.
Mark Dokulil (WPE6GCI), Reseda, Calif.
Mitchell Herbach (WPE2NJI), Brooklyn, N. Y.
Randy Drescher (WPE4JCB), Sarasota, Fla.
Ted Greisiger (WPE1FXL), Danbury, Conn.
Robert Lauzon (WPE2MWS), Pittsford, N. Y.
Barron Littlefield (WPE1GRG), Bristol, Conn.
Charles Laddish (VE7PE1BA), Vancouver, British Columbia, Canada
Calvin Bright (WPE8ISA), Grass Lake, Mich.
Harry Becker (WPE2NPR), Millburn, N. J.
Mike Esposito (WPE2MFQ), Brooklyn, N. Y.
Stanley Forsman (WPE6GIN), Santa Cruz, Calif.
Richard Fisher (WPE2NUB), Whitestone, N. Y.
Edward Geiselman (WPE9GZX), Culver, Ind.
Kenneth Gallagher (WPE2OUE), New York, N. Y.
Samuel Gold (WPE6DXA), San Francisco, Calif.
Steve Jones (WPE4IOW), Lawrenceburg, Ky.
Robert King (WPE5DWN), Bartlesville, Okla.
Robert Mackintosh (VK2PE2K), Kingswood, N.S.W., Australia
Howard Marcus (WPE1FYQ), Milton, Mass.
Patrick Martin (KL7PE3W), Seward, Alaska
Dave Mateyka (WPE9HLU), Steger, Ill.
Gurmen Schimke (WPEØEQO), Wolford, N. D.
Jerry Toporek (WPE3GRU), Cheltenham, Pa.
Richard Ardini (WPE1GVT), Medford, Mass.
Robert Thacker (WPE8ISX), Dayton, Ohio
Bram Cadsby (VE3PE2BT), Toronto, Ontario, Canada
Bill Parkinson (WPE2NAM), Northport, N. Y.
Bob Brandle (WPENQP), Madison, N. J.
Arthur Borradaile (WPE2NNZ), APO, New York, N. Y.
John Baer (WPE1GTJ), Hamden, Conn.
Paul Baker (WPE3FWO), Waynesboro, Pa.
Cal Craig (WPE8IUR), Parma Heights, Ohio
James Conrad (WPEØENQ), Waterloo, Iowa
Raymond Cader (ZS1PE1Z), Simonstown, Cape Town, South Africa
Barry Deal (WPEØESV), Ord, Nebr.
Stuart Grade (WPEØDDO), Sioux City, Iowa
Randy Hill (WPEØELW), Liberty, Mo.
Richard Houlis (WPE3GOK), Monessen, Pa.
Jim Homan (WPEØEUS), Florissant, Mo.
Bob Hertzberg (WPE9IIK), Mequon, Wis.
Arlton Handy (WPE1GPH), Falmouth, Mass.
Eugene Kramer (WPE9IGC), Freeburg, Ill.
Thomas Lachajczyk (WPE9HJO), Chicago, Ill.
William Lauritzen (WPE1GTU), Malden, Mass.
Ronald Miller (WPE6GLB), Santa Ana, Calif.
Bill Migley (WPE8JEL), Lancaster, Ohio
Walter O'Brien (WPE2OXZ), Clark, N. J.
Kendall Porter (WPEØEVD), Overland Park, Kan.
Harry Phair (WPE2OJH), Long Island City, N. Y.
John Richards, Jr. (WPE6GAX), Palo Alto, Calif.
Kirk Randall (WPE4IQI), McLean, Va.
John Sheatsley (WPE8JDC), Toledo, Ohio
Stephen Toder (WPE2NYR), Kingston, N. Y.

aire relay), and at 1855-2020 Sundays ("Happy Station Program") on 9590 and 6085 kHz. The "DX Juke Box" program for DX'ers is presented in Eng. on Thursdays at 0142, 0742, 1442, 1912, 2012, 2112, and 2142. Other "Happy Station Program" xmsns in Eng. are beamed to New Zealand at 0555-0720 on 11,730 and 9715 kHz; to Australia at 0725-0850 on 11,730 and 9525 kHz; to S. Asia and Europe at 1425-1550 on 17.810, 15.425, and 6020 kHz; and to Africa and Europe at 1555-1720 on 21.625, 11.730, and 6020 kHz. This program is broadcast on Sundays only.

New Hebrides—*R. Port Vila*, 3905 kHz, has been logged on the West Coast at 0639 with dance vocals, at 0640 with Eng. news, into French at 0650, classical music to 0704, and news in French to 0711 s/off. Their regular schedule is Eng. and French from 0615 to 0715 weekdays.

New Zealand—Station ZL19, Wellington, 11.830 kHz, has news in Eng. at 0330 and 0500, weather at 0400, and music in between.

Norway—*R. Norway*, Oslo, is scheduled to Greenland, North and Central America, and Africa at 1300-1430 and 1450-1630 (Eng. at 1600-1630) on 15.175, 21,655, 21.730, 25.730, and 25.900 kHz.

Pakistan—*R. Pakistan*, Karachi, has news in Eng. at 0210-0220 on 15.202 kHz, and dictation-speed news at 1335-1350 on 17.846 kHz.

Papua—Station VL8BD, *R. Daru*, Daru, 3305 kHz, is being heard in Eastern and Midwest areas at 1110-1200 with Polynesian and U.S. music and comments in vernacular, and with an occasional Eng. ID.

Peru—Station OAX4Q, *R. Victoria*, Lima, 6022 kHz, is audible though weak at 1055 with an ID in Spanish. Station OBX4G, *R. Excelsior*, Lima, has moved from 6150 kHz to 6045 kHz and is generally excellent in Spanish at 1100. Many of these long-distance signals on the 49-meter band will drop out rapidly as darkness turns to dawn.

Jim Chocklett, WPE4IDH, of Wilson, N.C., is primarily a medium-wave DX'er. His record: 72 verifications from 26 states and 7 countries. On the short waves, Jim has 17 countries verified out of 19 heard. He uses a Lafayette HE-30 receiver.

Philippines—The xmsn from 2330 to 0030 on 15.385 kHz has been switched to 11,855 kHz. This is another seasonal change made particularly for listeners in countries to the west.

South Africa—A late on-the-air frequency change notice stated that 11.880 kHz would be used in place of 11,900 kHz for *R. South Africa*'s Eng. xmsns to N. A. and Canada at 2326-0325. The schedule lists 9679 kHz as being a parallel channel, but no change notice was given for this channel. The United Kingdom and Europe xmsn at 2155-2257 on

POPULAR ELECTRONICS

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11,785 kHz is received well as far west as Rocky Mountain areas.

Sweden—*R. Sweden* now has Eng. xmsn's daily at 0900-0930 to Europe and Middle East on 6065 and 21,690 kHz; at 1100-1130 to Europe and Far East on 6065 and 9705 kHz; at 1230-1300 to Africa and Far East on 9705 and 21,690 kHz; at 1400-1430 to S. Asia and Eastern N.A. on 11,810 and 17,840 kHz; at 1600-1630 to Eastern and Western N.A. on 11,705 and 17,840 kHz; at 1900-1930 to Africa and Middle East on 11,705 and 11,840 kHz; at 2015-2045 to Europe and Eastern N.A. on 6065 and 11,705 kHz; at 2245-2315 to Far East and South America on 7270 and 11,705 kHz; at 2330-0000 to Europe on 1178 kHz (medium wave); at 0030-0100 and 0200-0230 to Eastern N.A. and at 0330-0400 to Western N.A. on 5990 kHz; and at 0515-0545 to S. Asia on 11,705 kHz.

Switzerland—*Switzerland Calling* has now adopted the use of kilohertz in place of kilocycles in their schedules. The newest schedule of Eng. xmsns reads: to Eastern N.A. at 0115-0300 on 5965, 6120, and 9535 kHz; to Western N.A. at 0500-0645 on 5964 kHz and at 1500-1645 on 15,130 kHz; to Japan and Far East at 0700-0845 on 9670, 11,775, and 15,320 kHz; to Australia, New Zealand, and S. E. Asia at 0900-1045 on 15,305, 17,800, and 21,520 kHz; to Africa at 0900 on 17,770 and 21,460 kHz; to United Kingdom and Ireland at 1100-1245 on 9665 and 11,865 kHz and at 1845-2030 on 6045 and 7220 kHz; to India and Pakistan at 1300-1445 on 15,305, 17,845, and 21,520 kHz; and to Near and Middle East areas at 1500-1645 on 9655, 9665, 11,715, and 15,305 kHz. A new nondirectional xmsn is given weekdays only at 0700-0815 on 6165 kHz.

U.S.A.—The *VOA* has been found on 26,040 kHz from 1345 to 2215/close, direction of beam not ascertained at press time. Eng. newscasts were noted at 2100 and 2200.

The *Voice of the Blue Eagle* was logged on 11,620 kHz on a Saturday from 2240 to 2335 s/off while retransmitting programs of WCUB, 980 kHz, Manitowoc, Wis. Reception was verified by WCUB, which reportedly had been unaware of the relay.

Vatican City—A new frequency for *Vatican Radio* is 11,700 kHz, noted with Eng. at 1700 and 1755. Also new is 11,770 kHz, heard at 1638-1658, dual to 15,135 kHz, in Arabic.

Venezuela—A newly reported station is YVNL, *R. Miranda*, Los Teques, 6000 kHz, noted at 1000-1040. Numerous commercials and time checks were heard.

R. Mundo, Maracaibo, 4860 kHz, seems to ID as YVNB rather than YVQE when logged at 0357 s/off. —30—

QUIZ ANSWERS

(*Quiz appears on page* 59)

1 — J UJT (unijunction transistor)
2 — B SUS (silicon unidirectional switch)
3 — I SBS (silicon bidirectional switch)
4 — D DIAC (diode, a.c. semiconductor)
5 — H TRIAC (bidirectional switch for a.c.)
6 — C SCR (silicon controlled rectifier)
7 — A LASCR (light-activated silicon-controlled rectifier)
8 — E JFET (junction field-effect transistor)
9 — F IGFET (insulated-gate field-effect transistor)
10 — G ZENER (voltage regulator diode)

ELECTRONICS MARKET PLACE

COMMERCIAL RATE: For firms or individuals offering commercial products or services. $1.00 per word (including name and address). Minimum order $10.00. Payment must accompany copy except when ads are placed by accredited advertising agencies. Frequency discount: 5% for 6 months; 10% for 12 months paid in advance.

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CANADIANS—GIANT Surplus Bargain Packed Catalogs. **Electronics, Hi-Fi, Shortwave, Amateur, Citizens Radio.** Rush $1.00 (Refunded). ETCO, Dept. Z., Box 741, Montreal, **CANADA.**

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JAPAN & Hong Kong Electronics Directory. Products, components, supplies. 50 firms—just $1.00. Ippano Kaisha Ltd., Box 6266, Spokane, Washington 99207.

CANADIANS, TRANSISTORS AND PARTS. Free catalogue contains reference data on 300 transistors. J. & J. Electronics, Dept. PE, Box 1437, Winnipeg, Manitoba.

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BUG DETECTOR: WILL DETECT AND LOCATE SURREPTITIOUS TRANSMITTING DEVICES IN CONFERENCE ROOMS, HOME AND OFFICES, ETC. WRITE FOR DETAILS. WJS ELECTRONICS, 737 NORTH SEWARD, HOLLYWOOD, CALIF. 90038.

TRANSISTORIZED Products Importers catalog. $1.00. Intercontinental, CPO 1717, Tokyo, Japan.

RADIO – T.V. Tubes—33¢ each. Send for free catalog. Cornell. 4213 University, San Diego, Calif. 92105.

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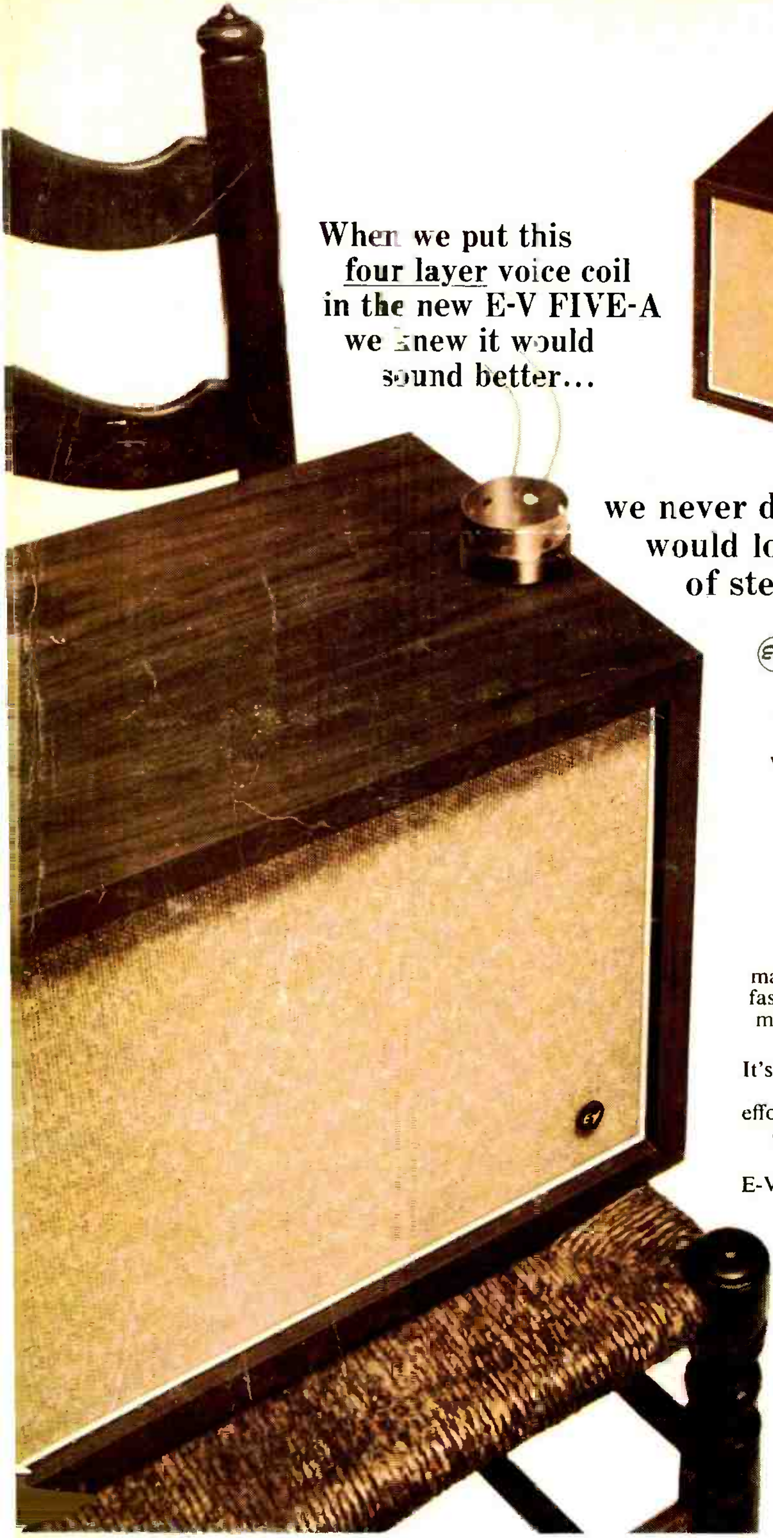

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