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POPULAR ELECTRONICS

VOLUME 29 NUMBER 6

DECEMBER, 1968

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Advertising Manager

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Advertising Service Manager

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ZIFF-DAVIS PUBLISHING COMPANY

Editorial and Executive Offices
One Park Avenue, New York, New York 10016
212 679-7200
Midwestern Office
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312 726-0892
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GERALD L. TAYLOR

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213 CRestview 4-0265; BRadshaw 2-1161
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Japan: James Yagi
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CIRCLE NO. 10 ON READER SERVICE PAGE

letters
FROM OUR READERS

BAD CHOICE FOR COVER STORY?

I was rather disturbed to note that your choice for the September, 1968, cover story was "Build G-Force Accelerometer for your Car." I'm sure that you are aware that more people have been killed in traffic accidents than in all the combined wars the U.S. has fought, and that the greatest killer of young people up to age 21 is auto accidents. Then, why feature a device that encourages someone to floor the accelerator every so often to see how high a reading he can get on your ingenious device?

Now, no such primitive devices as dangling trinkets from the rear view mirror are necessary for the hot-rodder—POPULAR ELECTRONICS has come through with an advanced accelerometer that measures G-forces in tenths of a gravity! Won't it be fun to take off from every traffic light, since a quantitative comparison is now feasible?

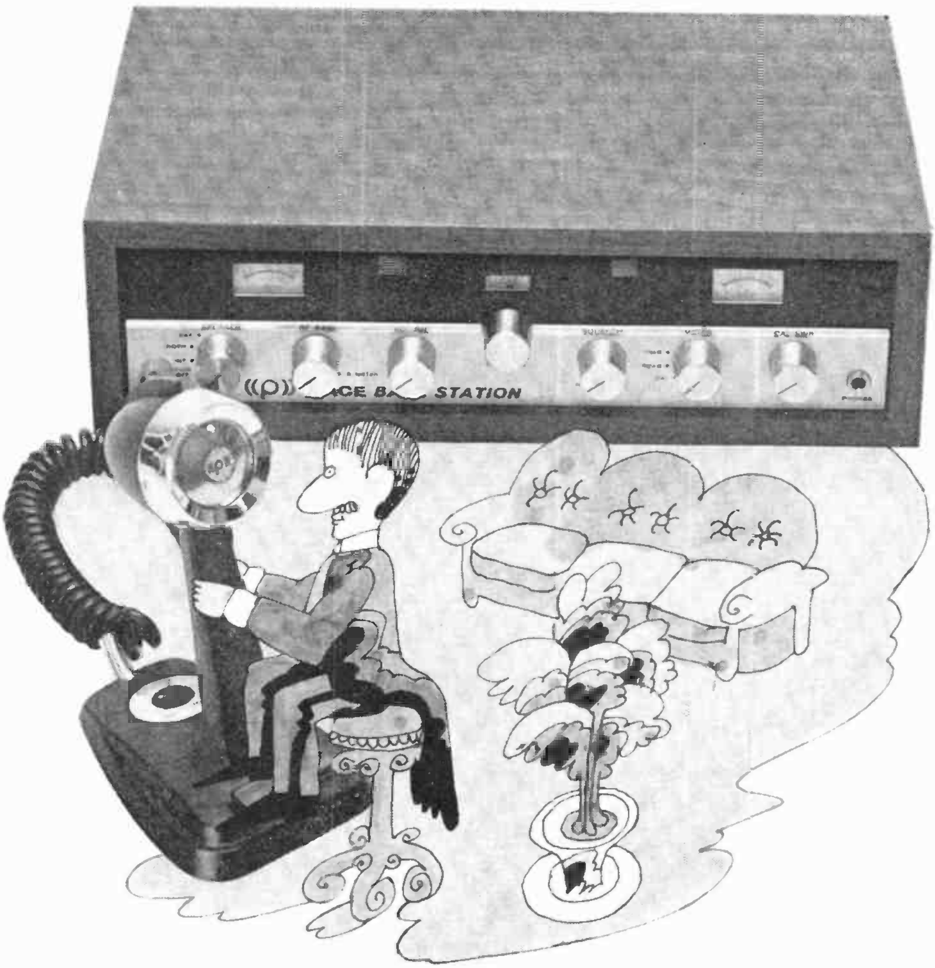
"Ah, but you have us wrong," you say. "This device is very useful for testing a car's brakes." But, it's funny the way you show a photo of a car patching out in a cloud of burning rubber on the cover. The implication is clear.

EDWARD W. HOLMES
Washington, D.C.

To clear the air, we are aware that some people will probably do as Mr. Holmes points out—with or without the "G-Whiz" in their cars. Because of this awareness, the article deliberately belabors the point of safety. Accordingly, you will find on page 34 of the article the following statement: "Before testing the G-Whiz, make sure that you can observe all traffic safety laws." The article then goes on to describe how the G-Whiz is to be used in complete safety, stressing safe driving and economy. The fact that some people will "burn rubber" when taking off at traffic lights does not in itself speak badly of the G-Whiz—these people were burning rubber long before the G-Whiz was available, and they are not likely to change until they get into a serious accident or become mature enough to realize the hazard they create.

WHOOPS! PARDON OUR GOOF

Since the appearance of "The Basic Mono Amplifier" article in our September, 1968 issue, quite a few readers have written to inform us of errors in the article. Instead of publishing all of these letters, we felt it would be simpler to enumerate the errors and



conversation piece.

Just look at the Pace Base! Forget for a second that it's the complete CB two way radio that needs no extras. What makes it more unusual is how it looks. So attractive, so decorative. With wood grained cabinet and elegant over-all appearance, even the lady of the house likes to have it around. The Pace Base Station is neat—and complete. Included in one unit are standing wave ratio meter, power meter, S meter and variable output control mike. All for $330.00.

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CIRCLE NO. 29 ON READER SERVICE PAGE

LETTERS

(*Continued from page 8*)

corrections. Referring to the Parts List on page 68, change the values for C3 and C7 to read 0.047 μF (also change the value of C6 in the schematic diagram to 0.01 μF). In Fig. 2 on page 69, C1 is incorrectly called out; change to read C3. Then on page 70, Fig. 3, change C3 to C7.

ELECTRIC SHOCK ELIMINATOR WANTED

How about publishing plans for an electric shock eliminator project? What I have in mind is a device that would shut off the current if a person were to grab a live wire accidentally when he was grounded or standing in a puddle of water. This is just the type of protection I'm looking for.

HUGH CAMPBELL
Ottawa, Ontario, Canada

Such a project is already in the works, but we are deferring publication of construction details until after it has undergone exhaustive testing to insure that it will work properly. After all, it wouldn't do to have an electric shock eliminator that only occasionally eliminated shock hazard. If an electric shock eliminator is feasible, it will appear in print at the earliest possible date.

OVERSEAS READER SERVICE

Is the information service provided by your "Reader Service Page" available to readers of POPULAR ELECTRONICS outside the United States? And, if so, under what conditions may I obtain this service?

M. AYAZ QURESHI
Hazara, W. Pakistan

Our Reader Service Page is a convenience to both the readers of POPULAR ELECTRONICS and to the manufacturers of products of interest to the readers. It puts one in touch with the other. Due to the volume of inquiries received by the manufacturers, there is a natural tendency to provide information only to "sales prospects." Unfortunately, this frequently does not include readers in foreign countries and even occasionally Canada. Some manufacturers are selective and will only send product information to interested parties in countries where trading in dollars is permitted.

UFO CLUB MEMBERS WANTED

I'm interested in forming a club consisting of hams, SWL's, and electronics experimenters who have a common interest in UFO's. This group would map UFO sightings, monitor radio frequencies that might possibly be used by UFO's, review sightings, etc.

HENRY GAC, WPE8JST
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Any interested parties, write directly to Mr. Gac.

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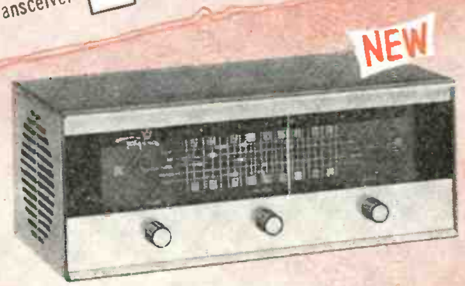
Temperature compensated superheterodyne police receiver gives a lot of listening for the money. Features built-in transistorized squelch.

Models PR-155B (152-174 MHz) PR-35B (30-50 MHz) $59.95



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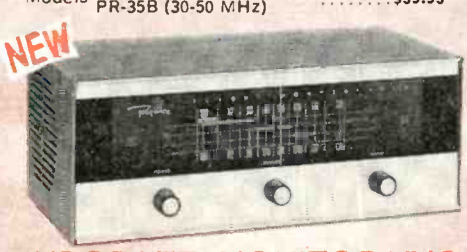

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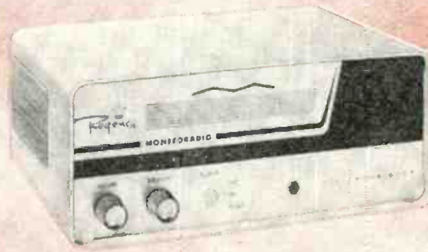

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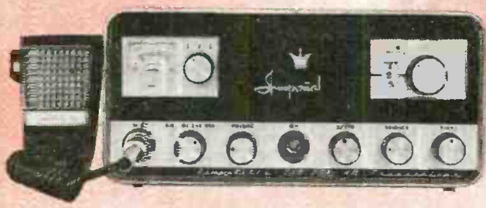

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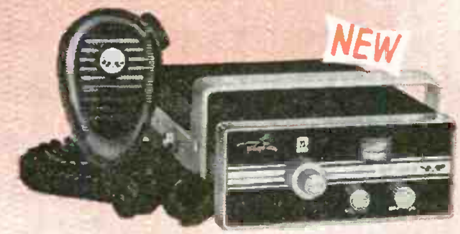

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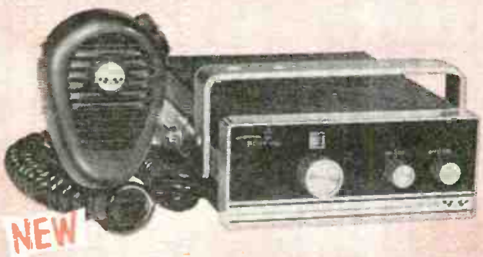

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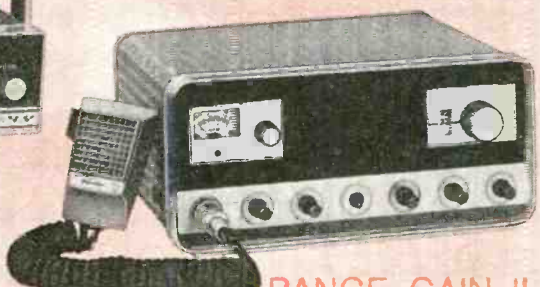

RANGE GAIN II

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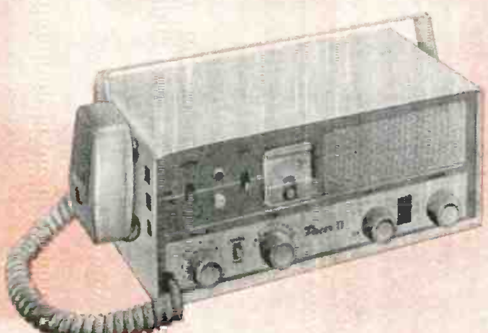

PACER II

11 crystal controlled channels with 23 tunable receiver for base or mobile use, are built into this economy package. The handsome front panel is full of goodies that enable you to "personalize" this radio to your CB needs...............**$110.00**

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ELECTRONICS library

QUIET

TRANSISTOR CIRCUIT MEASUREMENTS

by Donald P. Leach

This book was written to provide the student of electronics with the practical experience necessary to understanding semiconductor circuits. It contains 31 realistic experiments ranging in application from network analysis to digital logic in integrated circuits. The experiments are written to provide a maximum degree of flexibility and therefore to complement any good semiconductor textbook with enough material for a one-year semiconductor technology course. Each experiment has a theory section, a preparation section, and a preliminary report.

Published by McGraw-Hill Book Co., 330 West 42 St., New York, N. Y. 10036. Soft cover. 269 pages. $5.50.

RCA RECEIVING TUBE MANUAL, RC-26

Basic technology, operating characteristics, ratings, and testing of receiving tubes are discussed in six well-illustrated and easy-to-read chapters in this new manual. Also included: an Application Guide for use in selecting the optimum tube type for a given application; a Technical Data section that provides data and curves for all RCA receiving tubes; a design chart for resistance-coupled amplifiers; etc. A section on circuits illustrates many practical applications of electron tubes and has several circuits that, when connected together, make up a complete color TV receiver. The explanations covering these stages provide a good basic understanding of the operation and interaction among the various circuit stages of current types of color TV receivers.

Published by RCA Electronic Components, Harrison, N. J. 07029. Soft cover. 656 pages. $1.75.

SOURCEBOOK OF ELECTRONIC CIRCUITS

by John Markus

This encyclopedic information-retrieval center can tell you within minutes where to find complete design information on any one of more than 3000 different circuits. Essential construction and adjustment details, design precautions, and other application data are

(*Continued on page* 109)

POPULAR ELECTRONICS READER SERVICE PAGE

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12. a

TAKE ONE 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 or 115.

Everything in electronics from color-TV receivers, to stereo systems, to CB transceivers is described in catalog number F1766C available from *Sears, Roebuck and Company.* This colorful 68-page catalog lists brand-name equipment such as Fisher Radio, Harman-Kardon, Electro-Voice, Ampex, and E. F. Johnson, in addition to Sears' own brand. Sections in the catalog are given over to descriptions of fine hi-fi cabinetry and furniture ensembles, accessories for TV, FM, and CB reception, and even non-electrical musical instruments. Among the special-interest items listed are electronic organs, background music and public address systems, elegant decorator telephones, short-wave receivers, and electrical instruments and instrument amplifiers.

Circle No. 75 on Reader Service Page 15 or 115

A new 21-page, two-color catalog, number 680, containing mechanical specifications and electrical and performance data about their current tape heads is available from *Michigan Magnetics.* A selection from the heads illustrated in the catalog will meet almost all requirements for full-, half-, quarter-, and eight-track heads, as well as those for cassettes. In case information about tape heads not detailed in the catalog is desired, a data sheet is included that can be filled in and sent to the manufacturer.

Circle No. 76 on Reader Service Page 15 or 115

The theme of the "How To Select A Recording Tape" catalog available from *Audio Devices, Inc.*, is a timely combination of tips for the use, care, and selection of professional-quality recording tapes and accessories. The 24-page catalog describes performance characteristics of the five Audiotape formulations, and explains how each meets specific needs in recording and playback. Also included is a chart that illustrates the variety of types and lengths of tapes and reel sizes for each formulation. A table of recording times for various tape lengths and recorder speeds, plus a chart that matches the tape type with use are presented—all in non-technical language.

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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 or 115.

SOLID-STATE FM STEREO COMPACT

Big system sound is designed into the small space of the *Heathkit* Model AD-27 Component Compact FM stereo system. The system is composed of a modified Model AR-14 stereo receiver by Heathkit, a BSR McDonald Model 500 four-speed automatic turntable, and a diamond stylus pickup by Shure. The amplifier provides 15 watts/channel music power output with a frequency response of ±1 dB from 12 to 60,000 Hz; 45-dB channel separation; harmonic and IM distortion of less than 1%; 4- to 16-ohm output impedance; tape output; and front panel headphone jack. The tuner has four i.f. stages; a 5-μV sensitivity; —45-dB hum and noise; and less than 1% distortion. In addition, the tuner features adjustable phase control, stereo indicator light, 20-dB channel separation, and filterd outputs for beat-free taping. The components are housed in an attractive walnut cabinet with a solid walnut Tambour door.

Circle No. 78 on Reader Service Page 15 or 115

WIDE-BAND OSCILLOSCOPE/VECTORSCOPE

The Model CRO-4, made by the *Jackson Instrument Company,* is said to be the only oscilloscope/vectorscope in the medium-low-cost class that can measure waveform amplitudes as easily as a VTVM or VOM. With a 5" screen, the instrument has an easily removable graticule with two sets of calibrations (like a meter scaleplate) for the "readout" and a switch to select voltage range and peak-to-peak magnitude for direct reading on the graticule. Technical specifications: vertical amplifier response out to 5.8 MHz, ±3 dB; 5.8-mV r.m.s./cm sensitivity; 0.06-μsec rise time; 1500-volt acceleration voltage; 5-500,000-Hz horizontal sweep-frequency range. The instruction manual includes extensive application information with set-by-set vectorscope test instructions and pattern photos.

Circle No. 79 on Reader Service Page 15 or 115

SOLID-STATE INSTRUMENT AMPLIFIER

Knight-Kit's Model KG-387 "piggyback" instrument amplifier and speaker system includes a full complement of controls and features for the "in" combo group. The acoustically designed speaker system has two Jensen 12" heavy-duty speakers, while the amplifier is designed with field-effect transistors to assure low noise level and distortion-free performance. Technical specifications: 90 watts peak (30 watts continuous) sine-wave output power; 90-dB minimum bass boost at 80 Hz; 20 dB at 10,000 Hz treble variation; 0-50% variable reverb depth; 0-75% variable tremolo 2-10-Hz variable tremolo speed; 60 dB below rated output signal-to-noise ratio; 40-μV input sensitivity for rated output; 500,000-ohm input impedance. Controls include volume, treble, bass, tremolo, intensity, tremolo rate, and reverb depth.

Circle No. 80 on Reader Service Page 15 or 115

EIGHT-TRACK STEREO TAPE PLAYERS

Orrtronics, Inc., recently introduced a pair of 8-track stereo tape players specifically designed for use in car or boat. The "Automate 8 + 4" is the luxury model, featuring a built-in negative/positive ground conversion switch, exclusive mounting bolts to reduce the possibility of theft, and reversible gimbal mounting brackets for under-the-dash or floor hump mounting. Standard with this model is a lighted track selector bar, plus fingertip tone and balance controls for maximum richness of sound. Also being introduced is the economy "Special 8" model, with the same performance and sound as the "Automate 8 + 4." Standard E.I.A. type III tape cartridges are used in both models.

Circle No. 81 on Reader Service Page 15 or 115

COMPLETE WORKSHOP IN ONE TOOL

A single tool, *Vaco Products Company's* "Plierench," can be used as a socket wrench, open-end wrench, monkey wrench, pipe wrench, slip-joint pliers, lineman's pliers, small vise, wire cutter, and tool maker's clamp. Unique construction of this tool allows its jaws to remain parallel in all positions. Due to a built-in 10-to-one gear ratio, it provides one ton of gripping power in all posi-

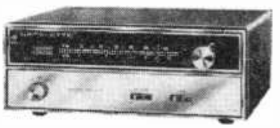
PRODUCTS *(Continued from page 22)*

tions to prevent slipping. Two models are available: No. 86060, 7" long; No. 86070, 8½" long. Accessory parts, such as standard pipe jaw, large pipe jaw, and internal-external jaws, are also available.

Circle No. 82 on Reader Service Page 15 or 115

TUNER AND AMPLIFIER COMPANIONS

Fully automatic stereo-mono switching, FET front end, and built-in AM and FM antenna systems are featured in *Lafayette Radio Electronics'* new Model LT-225T AM/FM stereo tuner. The tuner's companion, Model LA-450T amplifier, complements it with 25 watts / channel output power. Both units are fully solid state. The FM sensitivity (IHF) is 3 μV; capture ratio, 3 dB; image rejection, 55 dB; i.f. rejection, 80 dB; signal-to-noise ratio, —55 dB; and stereo separation, 30 dB. Technical specifications for the amplifier include a frequency response for 20-20,000 Hz of $\pm$1.5 dB at 1 watt; harmonic distortion, 1% or less; hum and noise, from —53 to —60 dB; and input sensitivity, 3 μV (tuner and auxiliary, 250 μV). The 4-, 8-, and 16-ohm outputs are all fused for maximum protection.



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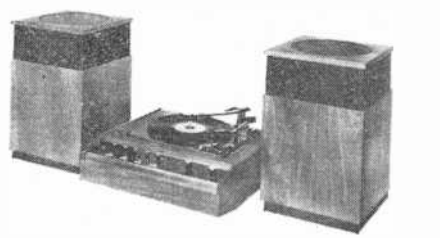
SOLID-STATE COMMUNICATIONS RECEIVER

Up to 12 plug-in crystals can be used for multi-channel operation in the "Professional" VHF public safety/marine/business/ industrial high-band communications receiver by *International Communications & Electronics, Inc.* The receiver has a self-contained power supply that regulates whether operated from a 12-volt d.c. or a 117-volt a.c. source, reverse-voltage protection, fiberglass printed circuit boards, and a 3" × 5" speaker. Technical specifications: 0.3-μV sensitivity; better than 60-dB adjacent-channel rejection; 20-mA squelched current drain when operated on 12 volts d.c.

Circle No. 84 on Reader Service Page 15 or 115

LOW-COST STEREO SYSTEM

Harman-Kardon's Model SC2350 compact music system recreates concert-hall realism with full scope and dimension, regardless of room size, acoustics, or speaker placement. This is accomplished through the use of the specially designed Model HK-50 omnidirectional speaker systems that come with the SC2350. Through the proper combination of direct and radiated sound energy, the listener obtains the full stereo effect—even if the speaker systems are hidden behind the sofa. In addition to the speaker systems, the SC2350 music system includes a Garrard four-speed automatic turntable with a low-distortion phono pickup and a high-performance AM/FM receiver. Integrated circuits and planetary dial tuning are employed in the tuner section of the receiver. The amplifier develops 50 watts (IHF) output power. The entire system sells for less than $400.



Circle No. 85 on Reader Service Page 15 or 115

POLICE/AIRCRAFT MULTIBAND PORTABLE

Now, for only $44.95, you can pick up AM/FM police and aircraft radio broadcasts with *Lafayette Radio Electronics'* new four-band portable receiver, stock No. 99-3550W. The receiver covers the 108-136-MHz AM-VHF aircraft band, the 88-108-MHz standard FM broadcast band, the 147-174-MHz police and weather band, and the 540-1600-kHz standard AM broadcast band. Features of the new receiver include a telescoping rotary antenna (for VHF), a ferrite bar antenna (for AM), and tuning, band-selecting, tone, and on/off/a.c./battery controls. The receiver can operate on four C cells or a.c. line power.

Circle No. 86 on Reader Service Page 15 or 115

FM MUSIC WITHOUT COMMERCIALS

Now you can listen to continuous uninterrupted music on your FM radio with the SCA Music Demultiplexer available from *Winlund Electronic Mfg. Co.* The demultiplexer adapter attaches easily to any FM radio, allowing you to hear the hidden channels many FM stations broadcast for hotels, restaurants, small stores, and other commercial establishments. (NOTE: Use of this adapter in other than private homes is prohibited by law.) Once attached to your FM receiver, you can listen to either regular programming or the hidden channel with just the flip of a switch. Other controls include mute, output level, and tuning. The demultiplexer comes complete with two 36" shielded cables and a one-year guarantee.

Circle No. 87 on Reader Service Page 15 or 115

CIRCLE NO. 15 ON READER SERVICE PAGE→

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Western Radio TV
San Francisco
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San Francisco Radio
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Chicago
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Electronic Dist.
Joseph Electronics
Olsen Electronics Inc.
Decatur
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Allied Radio Corp.
La Salle
Klaus Radio Electronics
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Fort Wayne
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Adrian
Wedemeyer Elect. Supply
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Olsen Electronics Inc.
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Lansing
Wedemeyer Elect. Supply

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Schaak Elect. Supply

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Mid-States Dist.
St. Louis
Olive Elect. Supply
Olsen Electronics Inc.
Springfield
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Edmund Scientific Co.
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Belco Dist. Inc.
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Lafayette Radio Elect. Corp.
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Warren Radio Inc.
Greensburg
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King of Prussia
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Meadville
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SOUTH CAROLINA
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Wholesale Radio Supply
Charleston Heights
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TEXAS
Dallas
Olsen Electronics Inc.

UTAH
Ogden
Manville Supply Co.
Salt Lake City
Manville Supply Co.
O'Loughlin's Radio TV

VIRGINIA
Falls Church
Lafayette Radio Elect. Corp.
Hampton
Gex Audio Center
Virginia Beach
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WASHINGTON
Seattle
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Vancouver
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WEST VIRGINIA
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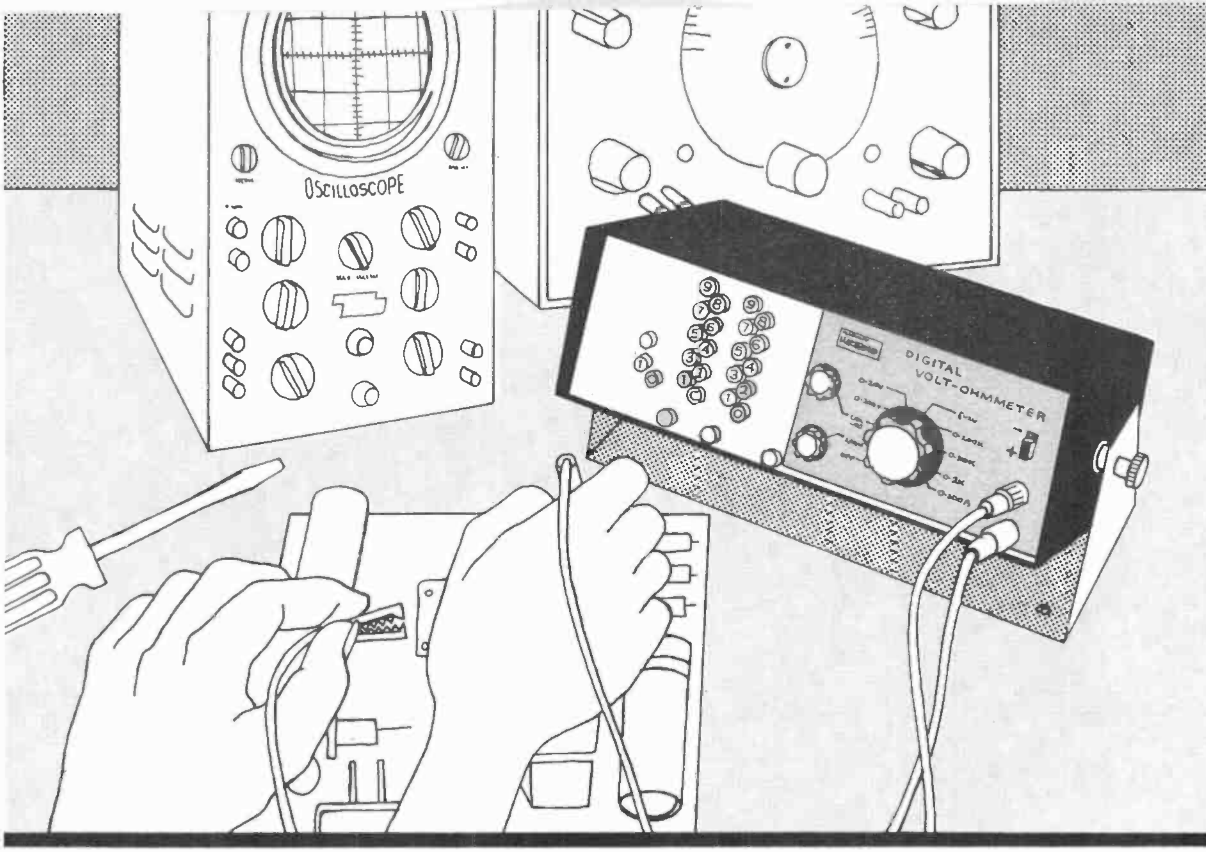
CIRCLE NO. 44 ON READER SERVICE PAGE



Build the Popular Electronics Digital Volt-Ohmmeter

COMPLETE CONSTRUCTION DETAILS IN THIS ISSUE

COVER STORY
BY DON LANCASTER

For less than the price of many transistor multimeters, you can now build your own real digital volt-ohmmeter. Gone forever will be your days of having wobbly meter pointers, reading the wrong scales, or trying to read accurately from a cramped and highly nonlinear ohms scale. There will be no more problems caused by VOM circuit loading or bent or broken pointers resulting from circuit overload.

You can just clip the DVM to your circuit and read volts or ohms as they brightly and unquestionably pop up on the front panel of the instrument. Just clip and read—instantly! It's that simple.

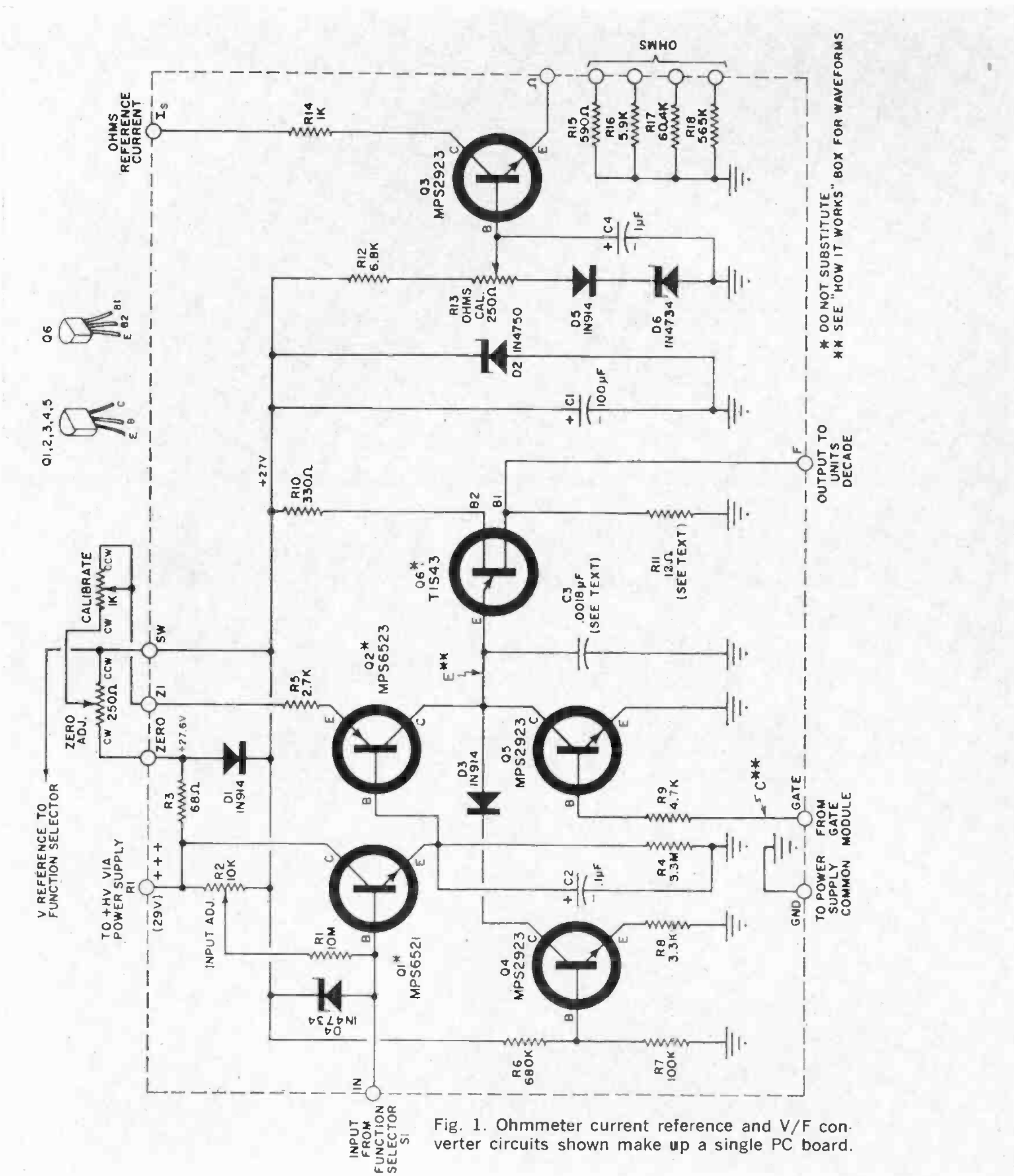


Fig. 1. Ohmmeter current reference and V/F converter circuits shown make up a single PC board.

This DVM is no slouch on performance either. It has better than ±1 percent accuracy over most portions of the seven available scales. It is self-zeroing and automatically self-calibrating. Three voltage scales, 0-2, 0-20, and 0-200 volts are provided, each at reasonably high impedances—in fact, you can read down to 10 millivolts with ease. Four ohmmeter scales, useful from one ohm to over 200,000 ohms, are also available. If you like, you can easily add extra outside circuits to measure digitally anything you can convert into a 0-2-volt d.c. signal, including a.c. voltage and current, d.c. current, speed, and temperature.

Like its far more expensive brothers, this DVM is a multiple-slope integrating device. This means it averages the input signal over a relatively long measuring time. It's done in a way that automatically rejects all a.c. line-induced hum and noise and also eliminates practically all other high-frequency noise that may be present. The instrument is essentially "blind" to 60-Hz hum and only measures the d.c. component of the input, even if hum or noise is present. All this is done automatically—all you do is watch a continuous output display that updates its readings fifteen times a second.

While not a beginner's project, the extensive use of integrated circuits makes the construction of the DVM relatively straightforward and easy on a module-by-module basis. A complete kit is available as well as individual circuit boards, dialplates, and individual module kits. If you'd rather build things on your own, all parts are obtainable on the market, and complete preparation details of all the circuit boards are given here. Either way, when you're done, you'll have a real DVM—at a fraction of the cost of commercial equivalents and with performance untouched by anything analog.

V/F MODULE PARTS LIST

C1—100-µF, 25-volt electrolytic capacitor
C2—0.1-µF, 35-volt Mylar or tantalum capacitor
C3—0.0018-µF, 50-volt Mylar or polystyrene capacitor (see text)
C4—1-µF electrolytic capacitor
D1, D3, D5—1N914 silicon computer diode or equivalent
D2—1N4750 1-watt, 27-volt zener diode
D4, D6—1N4734 1-watt, 5.6-volt zener diode
Q1—Transistor (Motorola MPS6521, do not substitute)
Q2—Transistor (Motorola MPS6523, do not substitute)
Q3-Q5—Transistor (Motorola MPS2923)
Q6—Unijunction transistor (Texas Instruments TIS43, do not substitute)
R1—10-megohm
R3—68-ohm
R4—3.3-megohm
R5—2700-ohm
R6—680,000-ohm
R7—100,000-ohm
R8—3300-ohm
R9—4700-ohm
R10—330-ohm
R11—12-ohm
R12—6800-ohm
R14—1000-ohm
R15—590-ohm
R16—5900-ohm
R17—60,400-ohm
R18—565,000-ohm
(all resistors ¼-watt; R15–R18 1% precision)
R2—10,000-ohm trimmer potentiometer (CTS type U-201 or similar)
R13—250-ohm trimmer potentiometer (CTS type U201 or similar)
Misc.—3" x 3-¼" PC board, PC terminals or eyelets (14) (optional), aluminum mounting bracket (see Fig. 11) with hardware, solder.
Note:—The following are available from Southwest Technical Products, 219 W. Rhapsody, San Antonio, Texas 78216: etched and drilled printed circuit board, #155V, $3.25; complete kit of all above required parts, #CV-155, $16 postpaid in USA.

Construction. The project has been broken down into five modules plus the case and some panel components. Module 1 is the voltage-to-frequency (V/F) converter. Modules 2 and 3 are decimal counting units (DCU's) described in the February 1968 issue of POPULAR ELECTRONICS, or you can use the improved, low-power versions described in the Winter 1969 ELECTRONIC EXPERIMENTER'S HANDBOOK.

Module 4 is the gate circuit, which simultaneously provides the 0, 1, and overrange counting needed to complete the digital display. Module 5 is the power supply.*

It is best to construct each module separately following the details very carefully. Each module has its own parts list and schematic. If you prefer to purchase circuit boards or partial kits, details are given in the parts lists.

Voltage/Frequency Converter. This circuit, shown in Fig. 1, is the "heart" of the DVM and converts the input d.c.

**Important: The circuits labeled GND throughout this project are not actually ground connections and should not be connected to the metal case. They are common connections constituting an individual circuit and grounding them to the case may produce circulating currents which interfere with the operation of the meter. The metal case should be either left floating or connected to the SW terminal on the V/F module. This is one side of the input signal and is actually the reference point for the system.*

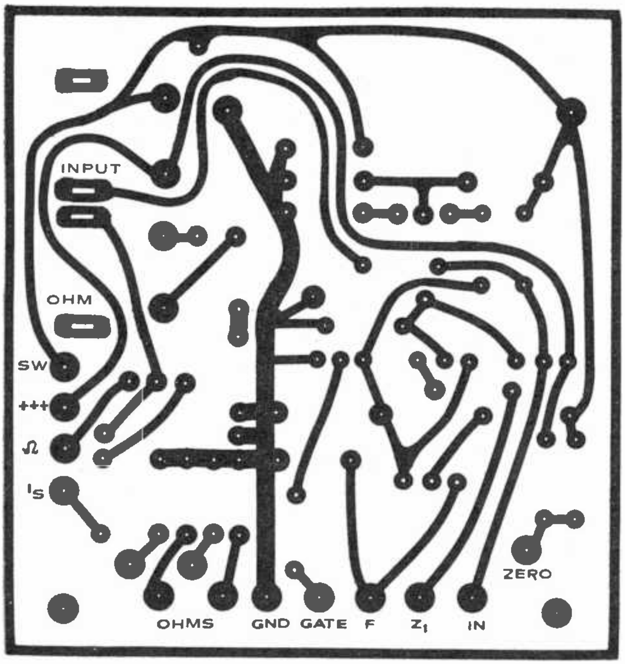


Fig. 2. If you make your own V/F converter-ohmmeter current reference PC board, carefully copy this actual-size etching guide.

On the cover, just behind the Digital Volt-Ohmmeter, can be seen another advanced experimenter's test set using POPULAR ELECTRONICS' low-cost digital readout (see our February 1968 issue or the 1969 Winter Edition of ELECTRONIC EXPERIMENTER'S HANDBOOK). This particular unit is a frequency counter capable of indicating from 1 Hz to 2 MHz in five ranges. It is now in the final design stage and complete construction details will appear in a forthcoming issue of this magazine.

signal to a series of pulses that are counted by the DCU's.

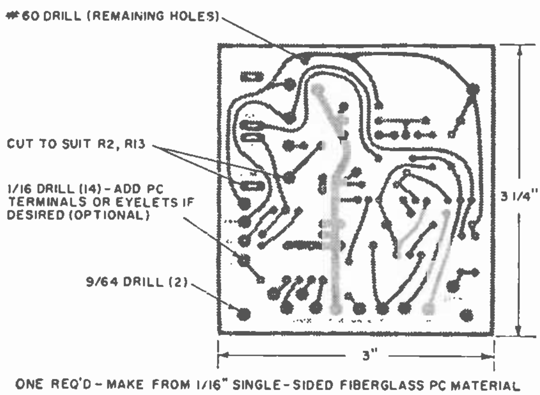
You can purchase the printed-circuit board for this module or you can make one using the actual-size layout shown in Fig. 2 and following the drilling details of Fig. 3. File or multiple-drill the slots required for the two trimming potentiometers (*R2* and *R13*). If you wish, you can add optional terminals or eyelets to make wiring easier.

Components are installed on the board as shown in Fig. 4. Be sure to install all semiconductors properly and double-check electrolytic capacitor polarities. Be especially careful not to interchange *R2* with *R13*.

Gate Module. This is actually the control center of the DVM. The start and stop signals for the V/F converter and the reset signals for the various counting circuits are generated in this module. The schematic for this module is shown in Fig. 5.

A printed-circuit board is suggested for this module. You can purchase one (see Parts List for Fig. 5), or you can etch and drill your own following the actual-size layout shown in Fig. 6 and the drilling information shown in Fig. 7. Don't forget to install the two jumpers on the component side of the board as shown in Fig 7. Do not use a drill larger

Fig. 3. Place etched and cleaned board foil-side up on a block of scrap wood, carefully locate and mark hole centers, and drill all the way through from foil side.



than #67 for the IC mounting holes. Optional eyelets or PC terminals can be added where indicated.

Mount the components as shown in Fig. 8. Use a low-wattage soldering iron and fine solder when mounting the IC's. The rectangular IC's are identified by a notch and dot at one end, while the round IC's have either a flat or a dot at pin 8.

Power Supply. The power supply is not assembled on a PC board, but is wired point-to-point at one end of the chassis. The schematic is shown in Fig. 9. A conventional tube-type transformer is used. The 250-volt, center-tapped secondary has two functions. It provides the 125-volt a.c. reference, and its output is

HOW IT WORKS

V/F CONVERTER

The block diagram for this module appears here while the complete schematic is shown in Fig. 1. The waveforms are keyed to test points shown on the diagrams.

The 0-2-volt input from the function selector is subtracted from a +27-volt supply generated by the power supply module and regulated by zener diode *D2*. Thus the input voltage at the V/F converter actually varies from +27 to +25 volts as the instrument input goes from 0 to +2 volts. *Note that all input signals are referenced to +27 volts and not to the power supply common (GND).*

Diode *D4* provides reverse polarity and overload protection for the circuit. Transistor *Q1* is an emitter follower that provides a high input impedance. Transistor *Q2* is a complementary emitter follower that bucks out the offset produced by *Q1* and causes a voltage identical to the input voltage to appear across *R5* and the front-panel CAL 1.35 control. The current through these resistors can be set for a constant input voltage by adjusting the CAL 1.35 control. Practically the same current appears at *Q2*'s collector as flows through *R5* and the CAL 1.35 control. Transistor *Q2*'s output current is then proportional to the original input voltage. Transistor *Q2*'s output current drives a conventional unijunction sawtooth oscillator consisting of UJT *Q6* and integrating capacitor *C3*. A series of pulses at *B1* of *Q2* changes in ***frequency*** as the input voltage changes in ***amplitude***. These output pulses are sent to the 0-199 digital counter and display modules.

The UJT oscillator is turned on and off by gating transistor *Q5*. This transistor is driven by the Gate module and allows the oscillator to run for 16.7 milliseconds and then shorts it out for the next 50 milliseconds and keeps this up continuously, recycling 15 times a second. The frequency produced by the oscillator is determined by the input voltage. The time this frequency is produced is determined only by the Gate module and *Q5*. As a result, the oscillator generates 0 to 199 pulses for a 0-1.99-volt input signal, once each measurement interval. This is how the digital display appears to be reading the actual value of the input signal.

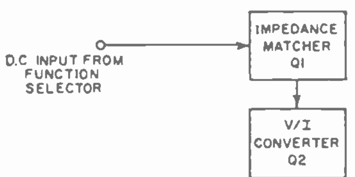
There would be a slight linearity problem if the current on *Q2* were allowed to go down to zero. Thus a little more emitter voltage (about 0.3 volts) is added by the front-panel ZERO potentiometer to remove a correspondingly constant amount of collector current (about 100 microamperes) all the time. This shifts the operating point of *Q2* to a more linear region but still lets 0-2 volts of input produce 0-200 pulses per 16.7 milliseconds at the output.

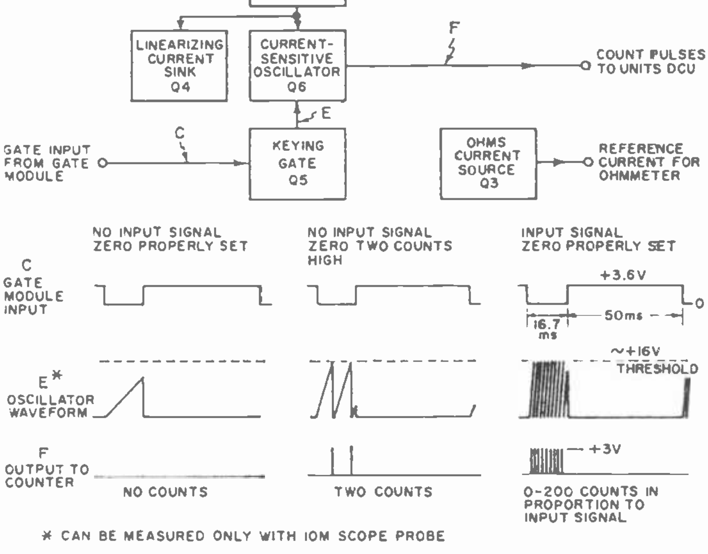
The extra 100 microamperes of current is "dumped" into the collector of *Q5*, which is biased to act as a current sink.

The current source for the ohmmeter is also on the V/F board, but it is a completely separate circuit. The collector current of transistor *Q3* is either 0.01, 0.1, 1, or 10 milliamperes, depending on the resistor selected for its emitter circuit (*R15*, *R16*, *R17*, or *R18*). These resistors are not quite decade multiples of each other, because they compensate for slight circuit nonlinearities.

Base current for *Q3* is regulated by *D6*, temperature-compensated by *D5*, and adjusted over a limited range by *R13*. Resistor *R14* prevents oscillation but otherwise does not affect the output current.

Many hours of design went into this particular V/F circuit, which is far less expensive than the usual operational-amplifier V/F converters used in commercial gear. It is of utmost importance that you neither substitute transistors for *Q1*, *Q2*, or *Q6*, nor attempt any modification of the circuit unless you consider yourself an expert in analog-to-digital converter design.





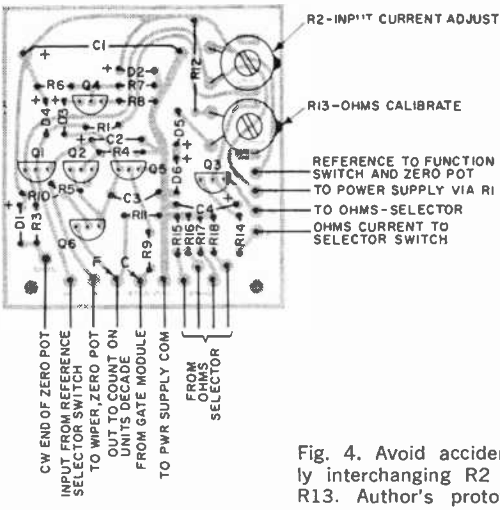


Fig. 4. Avoid accidentally interchanging R2 and R13. Author's prototype is shown in photo, right.

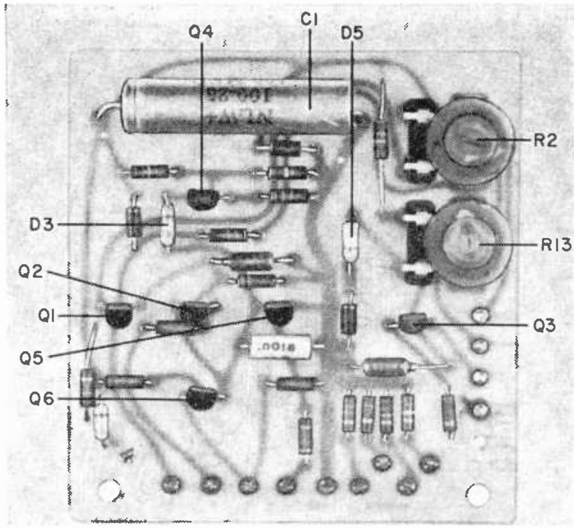
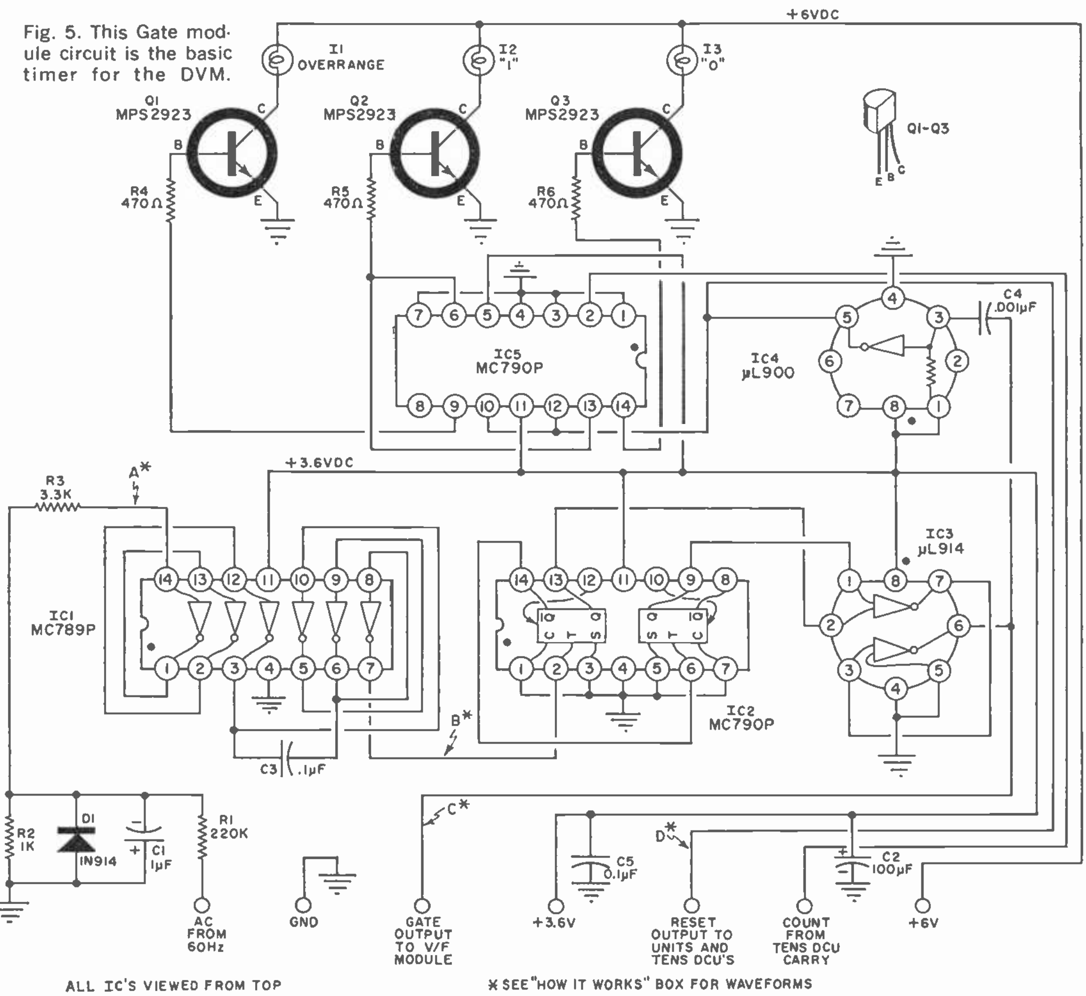


Fig. 5. This Gate module circuit is the basic timer for the DVM.



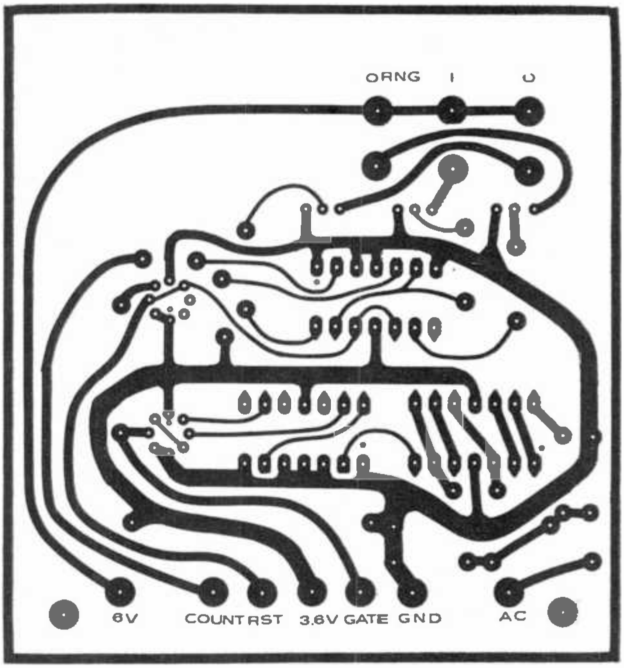
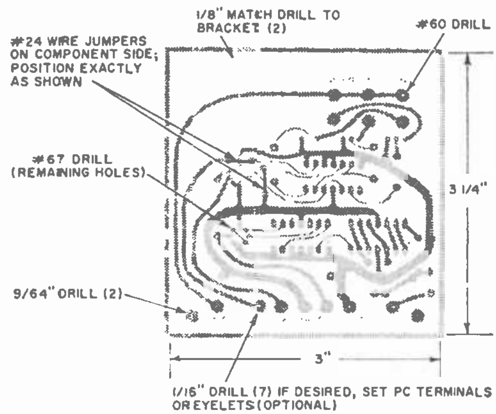


Fig. 6. Actual-size etching guide must be copied exactly as shown to insure proper component fit. Small dots near solder terminals indicate IC indexes.

Fig. 7. Proper location of hole centers and selection of drills are critical for the Gate module board. Once holes are drilled, immediately install jumpers.



also rectified to provide a 30-volt d.c. supply. Resistor *R1* is a voltage dropping resistor which dissipates a large amount of power and must be located where the heat produced will do no damage.

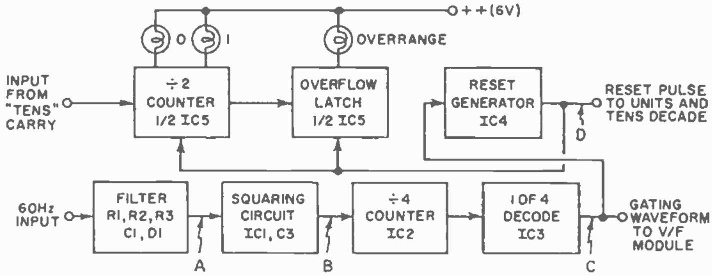
The power from the "filament" winding of *T1* is rectified to provide 6-volt and 3.6-volt d.c. supplies. Rectifier *RECT1* is a full-wave bridge. Capacitors *C2*, *C3*, and *C4* provide filtering for the d.c., and diodes *D3*, *D4*, and *D5* drop the rectified voltage from 6 to 3.6 volts. The unrectified voltage from the 6.3-volt winding is also used for the pilot or decimal-point lamps. Resistor *R2* is in series with this supply to reduce the voltage on the lamps so that they do not glow brighter than the counting lamps.

Most of the power supply components can be mounted on terminal strips or a component board as shown in Fig. 10. The rest of the components are mounted on the chassis.

Assembly. To mount the modules in the chassis, aluminum support brackets such

GATE MODULE PARTS LIST

C1—1-μF, 25-volt electrolytic capacitor
C2—100-μF, 10-volt electrolytic capacitor
C3—0.1-μF, 10-volt ceramic disc capacitor
C4—0.001-μF, 50-volt Mylar capacitor
C5—0.1-μF capacitor
D1—1N914 silicon computer diode or equivalent
I1-I3—6.3-volt, 50-mA pilot lamp and lens assembly, two orange and one red (Southwest Technical Products #0-6.3 and #R-6.3 respectively, or equivalent)
IC1—Integrated circuit (Motorola MC789P)
IC2, IC5—Integrated circuit (Motorola MC790P or MC791P)
IC3—Integrated circuit (Fairchild μL914)
IC4—Integrated circuit (Fairchild μL900)
Q1-Q3—2N5129 transistor or Motorola MPS2923
R1—220,000-ohm, ½-watt resistor
R2—1000-ohm, ¼-watt resistor
R3—3300-ohm, ¼-watt resistor
R4-R6—470-ohm, ¼-watt resistor
Misc.—PC board, 3" x 3-¼", PC terminals or eyelets (7) (optional), #24 jumpers (2), solder, lamp bracket (see Fig. 12), mounting bracket and hardware (see Fig. 11).
Note:—The following Gate module parts are available from Southwest Technical Products, 219 W Rhapsody, San Antonio, Texas 78216: etched and drilled printed circuit board #155G, $3; complete kit of all necessary parts #CG-155, $10.85 postpaid in USA.



HOW IT WORKS

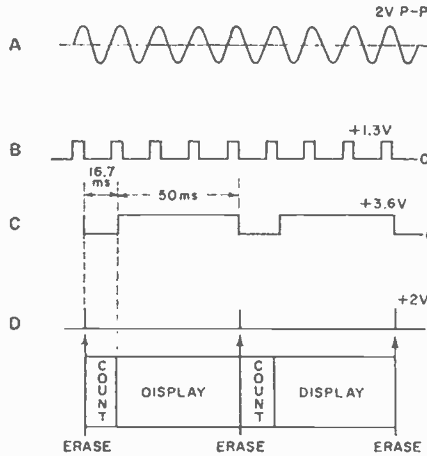
GATE MODULE

This module is a three-in-one board. First, it's a gate generator that produces the on-for-one, off-for-three gating waveform used in the V/F; it's also a reset generator that automatically provides a short pulse the instant the V/F is told to start producing a new count; and finally, it contains an 0, 1, overrange counter used to complete the 0-199 digital display. The complete schematic is shown in Fig. 5.

The gate waveform is generated by filtering the 60-Hz supply to obtain a smooth sine wave. The filter removes any noise from the power line that might cause inaccuracies, while *IC1*, a hex inverter, produces a rectangular wave with a fall time sufficiently steep to trigger the next stage. Capacitor *C3* provides positive feedback to improve the square-wave form.

The next stage, *IC2*, is a divide-by-four counter consisting of two JK flip-flops connected as cascaded binary dividers. Dual-gate *IC3* is a 1-of-4 decoder producing a gating waveform that is grounded for 16.7 milliseconds (one 60-Hz period), and positive for the next 50 milliseconds (three 60-Hz periods). Since this process takes up four 60-Hz cycles, the frequency of the composite waveform is ¼ of 60 Hz, or 15 Hz; hence the 15 measurements per second.

The gate output is routed to the V/F converter and to a half-monostable reset generator consisting of *C4* and buffer *IC4*. This circuit generates a very brief (about 2 microseconds) reset pulse which erases the display before the V/F converter can produce its first output pulse. The reset pulse goes to the two decimal counters as well as resetting the 0, 1, overrange portion of this module.



The 0, 1, overrange counter, *IC5*, has two flip-flops. One is a binary divider; the second is a latch that goes on when full scale is reached, regardless of how many more counts arrive. This counter takes the output of the ten's DCU and converts what would be an 0-99 display into an 0-199 plus overrange capability.

A power-line gate may be expected to be accurate to ±0.05%, while the digital 0-199 display used is only inherently accurate to ±0.5%. Thus, the instrument accuracy is determined by the display and the V/F accuracy. Without a far more expensive V/F circuit, extra decade modules or a more precise time base will not increase the instrument's accuracy.

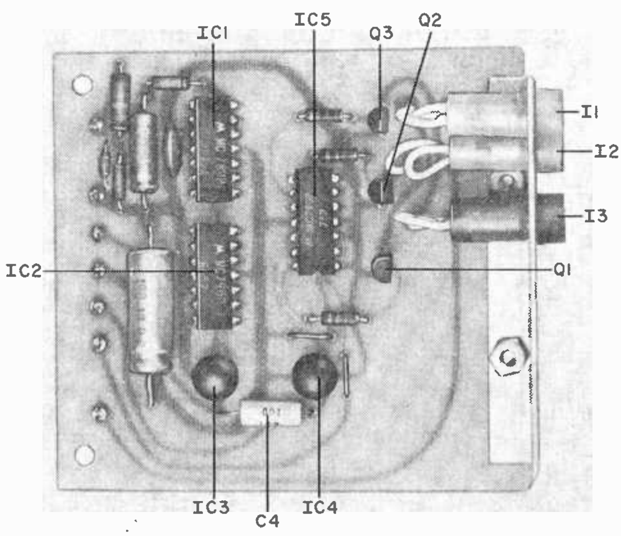


Photo of author's prototype shows properly wired Gate module board with indicator lamps and bracket in place and optional solder terminals at left; external wiring can be soldered directly to board.

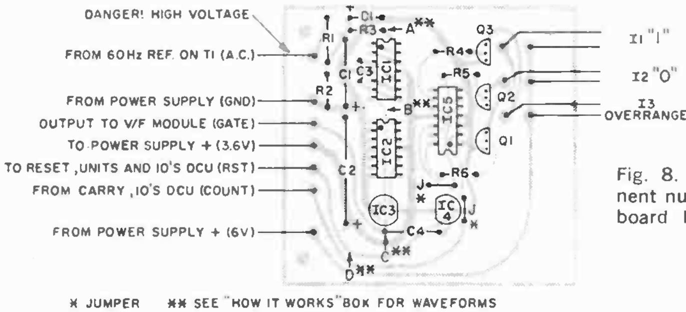


Fig. 8. Double and triple check component numbers, values, and orientation on board both before and after soldering.

as those shown in Fig. 11 can be used. The photos show how these brackets are used for support.

A three-hole bracket is required for the indicator lamps of the gate module. This can be fabricated as shown in Fig. 12. (One of the brackets supplied with the DCU kit can be used as a guide.) Use orange plastic covers for the 0 and 1 bulb, and a red one for the overrange indicator.

The complete schematic for the DVM is shown in Fig. 13. The photos show the assembly used by the author, although any other similar neat arrangement can be used. While layout is not critical, be sure to keep the instrument neat and compact to minimize the chance of wiring error. Be sure to use very short, heavy ground connectors. A ground buss of #12 solid wire between modules is strongly recommended.

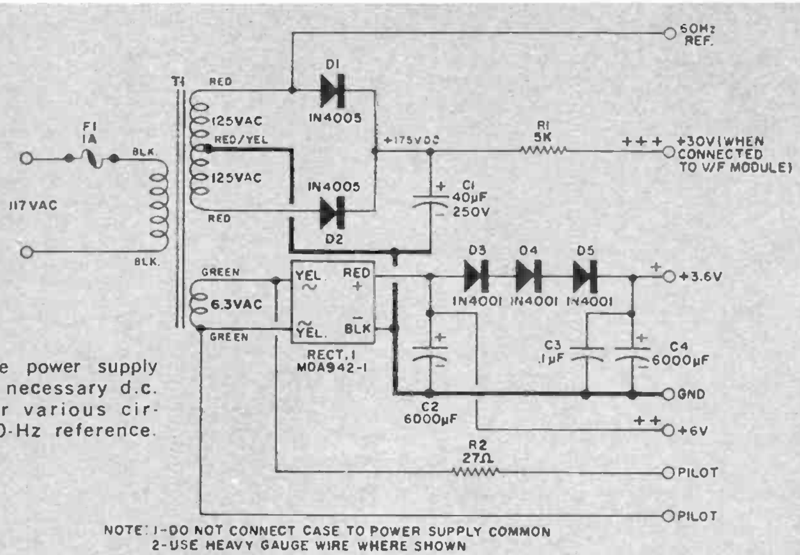


Fig. 9. Single power supply provides all necessary d.c. voltages for various circuits and 60-Hz reference.

POWER SUPPLY PARTS LIST

C1—40-µF, 250-volt electrolytic capacitor
C2, C4—6000-µF, 10-volt electrolytic capacitor
C3—0.1-µF, 10-volt ceramic disc capacitor
D1, D2—1-ampere, 600-volt silicon diode (Motorola 1N4005 or similar)
D3-D5—1-ampere, 50-volt silicon diode (Motorola 1N4001 or similar)
RECT1—1.5-ampere, 50-volt, full-wave silicon molded bridge assembly (Motorola MDA942-1 or similar)
F1—1-ampere fuse and fuseholder
R1—5000-ohm, 10-watt resistor
R2—27-ohm, ½-watt resistor
T1—Power transformer, secondary 250 volts CT @ 25 mA. 6.3 volts 1 ampere (Knight 54E-2008, Stancor PS8416, Thordarson 22R39 or similar)
Misc.—16-point (8 on each side) terminal board assembly with mounting hardware, a.c. line cord, strain relief, mounting hardware for T1 and F1, wire, solder, mounting clips for capacitors, etc.
Note:—Complete kit of all power supply parts available from Southwest Technical Products, 219 W. Rhapsody, San Antonio, Texas 78216. #CS-155, $10.70 postpaid in USA.

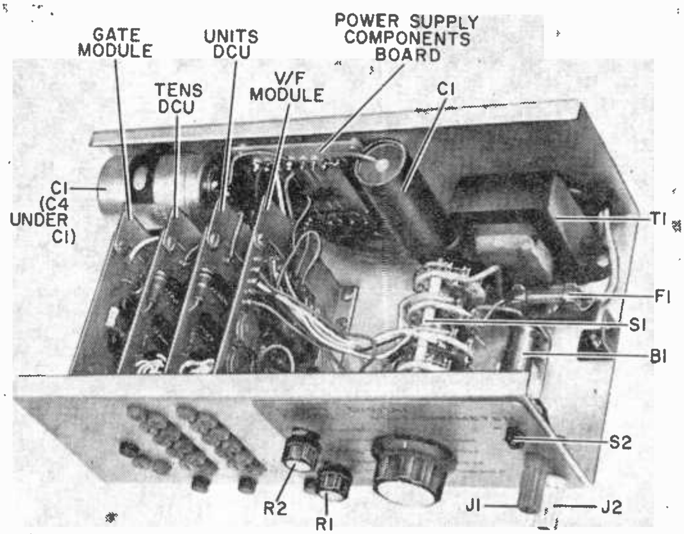


Fig. 10. Power supply circuit is located along rear apron of chassis. Modules are at left, while CAL and ZERO controls, range/function switch, polarity selector are at right.

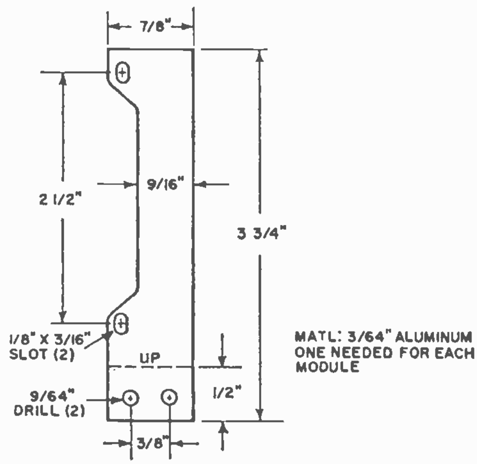


Fig. 11. If necessary, to avoid interference with components or wiring, deepen the notched cutout.

It is best to use color-coded wiring to minimize wrong connections and facilitate any possible troubleshooting. The resistors associated with *S1* may be assembled directly on the switch before installation. Also, use green-colored lenses on the decimal-point indicators.

The 1.35-volt reference cell (*B1*) is mounted wherever convenient within the chassis. Note that there are two types of mercury cell: those for general-purpose use and those for standard or voltage-reference purposes. Make sure that you get the latter. The accuracy of the DVM will be no better than the accuracy of the calibration standard.

Setup and Calibration. After a careful wiring check, the DVM may be plugged in and *S1* placed in the ZERO position. One digit in each column should light brightly and continuously. Turning the ZERO control through its entire range should change the display from 000 to 030. At about the mid-point of the control, the reading should be 001.

The proper setting of the ZERO control is the position immediately before

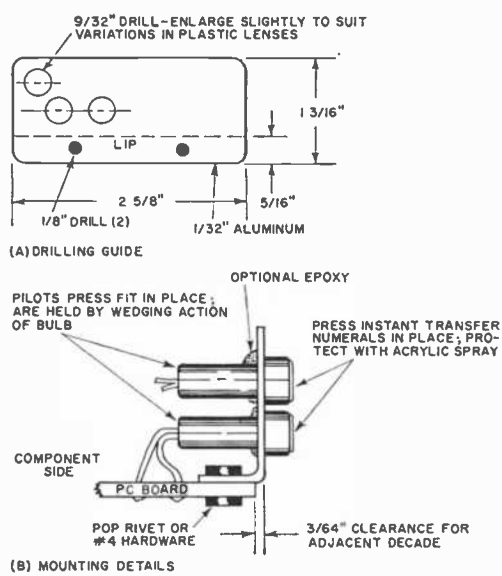


Fig. 12. Arrange lamp mounting holes in two closely spaced, staggered columns to obtain small size.

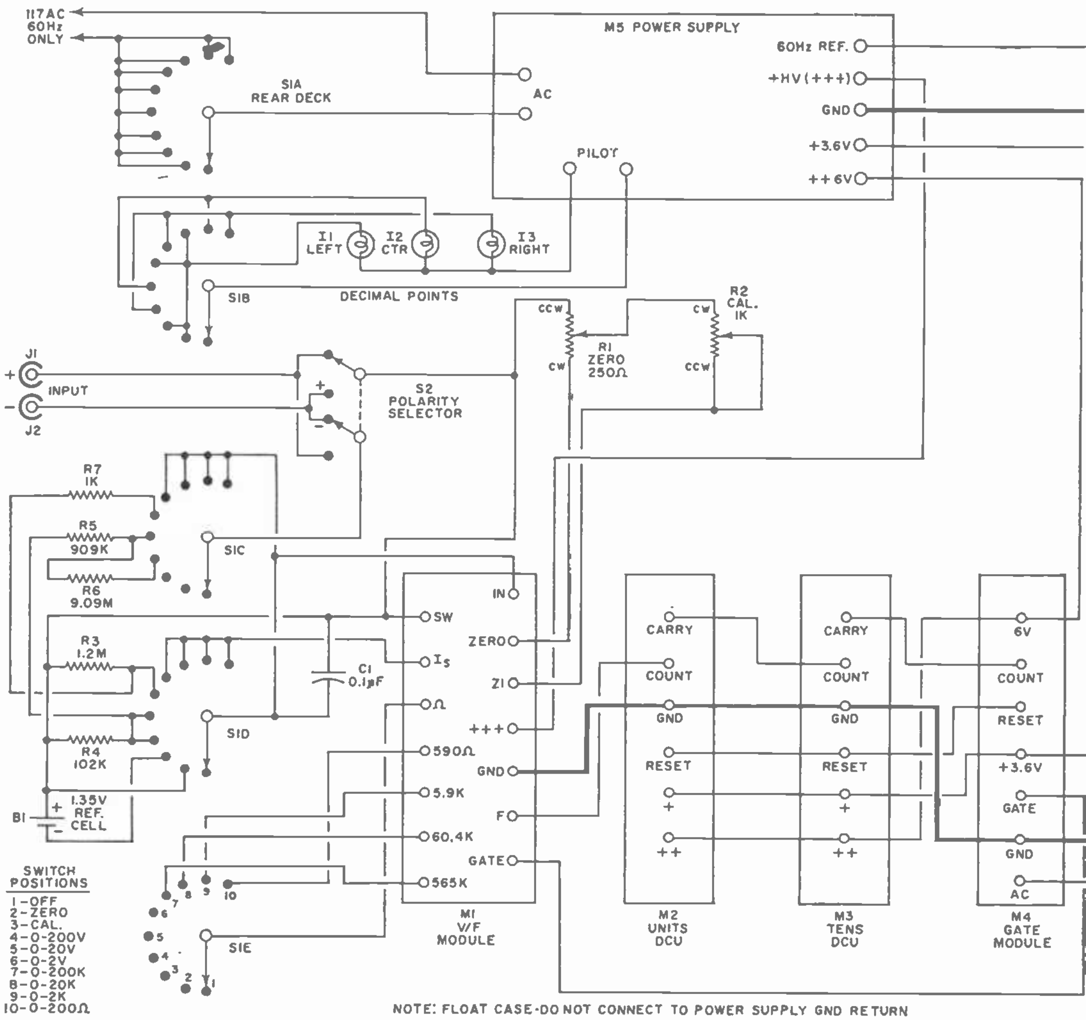


Fig. 13. The heavy line connecting the GND terminals in this overall wiring diagram is NOT a chassis ground; it is a convenient floating common bus.

COMPLETE DVM PARTS LIST

B1—1.35-volt AA mercury reference cell
C1—0.1-µF, 50-volt Mylar capacitor
I1-I3—6.3-volt, 50-mA pilot lamp.
J1, J2—5-way binding post, (red and black)
M1—V/F module (see text)
M2, M3—Decimal counting unit. See POPULAR ELECTRONICS February 1968 or Winter 1969 ELECTRONIC EXPERIMENTER'S HANDBOOK (see note).
M4—Gate module (see text)
M5—Power supply (see text)
R1—250-ohm, 2-watt linear potentiometer
R2—1000-ohm, 2-watt linear potentiometer
R3—1.2-megohm, ¼-watt resistor
R4—102,000-ohm, ¼-watt, 1% precision resistor
R5—909,000-ohm, ¼-watt, 1% precision resistor
R6—9.09-megohm, ¼-watt, 1% precision resistor or series resistor combination
R7—1000-ohm, ¼-watt resistor
S1—Five-deck, five-pole, ten-position, nonshorting rotary switch
S2—D.p.d.t. slide switch
Misc.—Vinyl clad aluminum case and support assembly, ¾" knobs (2), 1-½" knob (1), backup plate for controls, dialplate (optional), mounting hardware, brackets for M2, M3, (see Fig. 11), wire, solder, 1300- to 1500-ohm precision resistor, green jewels (2), etc.
Dialplate:—Hard anodized aluminum dialplate available from Reill's Photo Finishing, 4627 N 11th St., Phoenix, Ariz. 85014. In black and silver, $3.00; in red, gold, or copper, $3.45, postpaid in USA. Stock #DVM-1.
Note—Kits for the decimal counting units are available from Southwest Technical Products, 219 W. Rhapsody, San Antonio, Texas 78216 for $12 each, postpaid in USA. A complete kit of all above parts, including a punched and machined, vinyl-clad case and support assembly, but less dialplate and B1 is available from the same source for $79.50 plus postage for 6½ pounds.

HOW IT WORKS

OVERALL OPERATION

The function selector includes switch *S1* and its associated circuits. Here all input signals are converted to 0-2-volt d.c. voltages across a one-megohm resistance. When measuring 2 volts d.c. or less, the signal is applied directly to the remainder of the circuit. Above 2 volts, the signal is attenuated by 10 or 100. For ohms measurement, a calibrated and temperature-compensated current source supplies 0.01, 0.1, 1, or 10 mA to the input terminals. The voltage drop across the resistance (between 0 and 2 volts) is then an accurate measure of the resistance. For example, 1 mA of current through a 1600-ohm resistor produces a voltage drop of 1.6 volts. Because maximum ohmmeter current is only 10 mA on the lowest range (less on the higher resistance ranges), you can safely measure most current-sensitive devices without fear of damage.

For calibrating and zeroing the instrument, the function selector switch connects either a 1.35-volt mercury standard battery or a short circuit to the input.

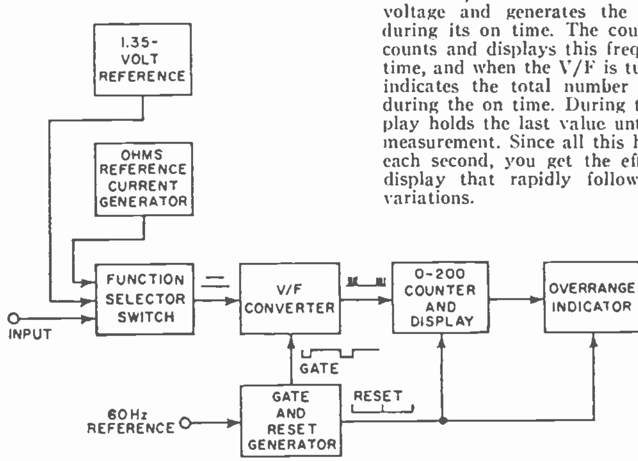
The 0-2-volt d.c. signal from the function selector is fed to a voltage-to-frequency (V/F) converter. This is a current-driven unijunction oscillator whose output frequency is proportional to the input voltage. Unlike industrial V/F converters, this one runs "open loop" and relies on calibration and inherent linearity rather than on complex and expensive feedback schemes for accuracy. Linearity, range, and resolution are more than adequate for the one-part-in-200 digital display used.

The output of the V/F converter drives a 0-199 counter/display (DCU's) and turns on a red overrange indicator when full scale is exceeded.

If this were the entire circuit, the digital display would be a blur of numbers that would just keep on adding up the output pulses from the V/F converter. Additional circuitry, called the gate-and-reset generator, continuously turns the V/F converter off and on and erases the old display before presenting an up-dated one.

In the gate and reset generator, the 60-Hz power from the line is used to generate a signal that turns the V/F converter on for one-fourth of the time and allows the display to show the results for three-fourths of the time. Immediately after the V/F converter is turned on, a very brief reset pulse is generated to erase the counter display before the new results can arrive at the DCU's.

The V/F converter then averages the input voltage and generates the pertinent frequency during its on time. The counter/display module counts and displays this frequency during the on time, and when the V/F is turned off, the display indicates the total number of pulses generated during the on time. During the off time, the display holds the last value until reset for the next measurement. Since all this happens fifteen times each second, you get the effect of a continuous display that rapidly follows the input-voltage variations.



you get the 001 reading. If you turn the control down all the way, you'll pick up some serious low-scale errors.

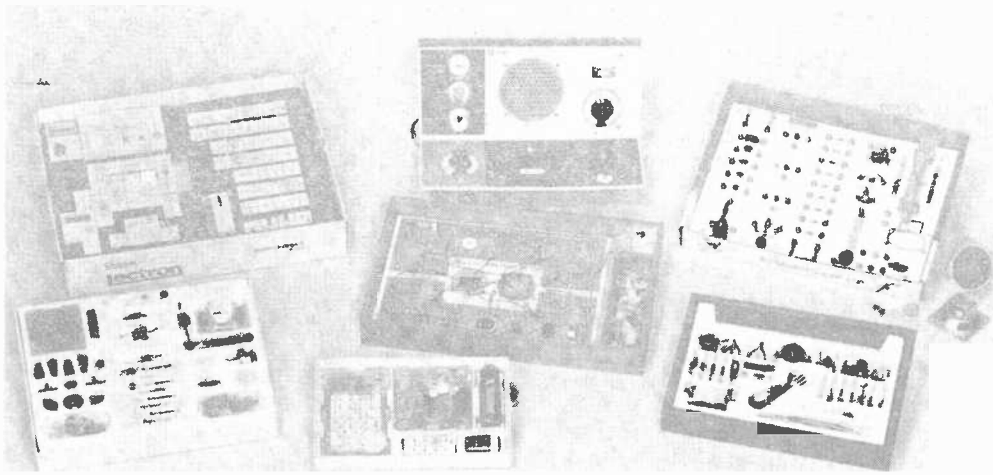
After zeroing, switch to the CAL 1.35 position. When the CAL potentiometer is turned through its entire range, the indicator should go from about 1.20 to about 1.50 with 1.35 at about the middle of the range. If you cannot get the readings low enough, or if 1.35 is at the *lower* end of the control, add one or two 500-pF mica capacitors across integrating capacitor *C3* in the V/F module till you get the proper range.

Very rarely, it may be necessary to change the value of *R11*. This occurs because of variations in the characteristics of *Q6*, the unijunction transistor. If the V/F converter oscillates but does not drive the counter, either increase or decrease the value of *R11* (in a range of 6.8 to 22 ohms) until proper operation is obtained.

Always rezero the instrument before calibrating. The settings will be remarkably stable after a few minutes' warmup. A slight interaction between the CAL 1.35 and the ZERO controls is normal, so always recheck the ZERO setting after calibrating.

To check zeroing, short test leads together, and misadjust zero control to get an 001 reading. Switch *S1* to 0-2 range. The reading should stay at 001. Remove the short. If the reading

(*Continued on page* 108)



CHRISTMAS PREVUE of KITS FOR BEGINNERS

LEARNING ELECTRONICS FUNDAMENTALS IS EASY

BY HOWARD G. McENTEE

EDUCATIONAL electronic kits can solve the problem of what to get for the school-age youngsters on your gift-giving list this season. Such kits serve a two-fold purpose. Like ordinary toys, they occupy play time. But even more important, they are educational.

Few people are aware of the large variety of educational electronic kits on the market this season, much less the ingenuity that has gone into their design. A glance at the table on page 45 will reveal the variety available. But this table cannot possibly show all of the many ingenious features incorporated in each kit and in the kits in general, nor is there enough space in these pages to describe each kit in detail. Therefore, a general description will have to suffice.

Some of the kits available require a good deal of preassembly, while others are ready to use as soon as you take them out of their boxes. Naturally, each kit has certain advantages and disadvantages. For example, the youngster who uses a ready-to-go kit can obtain the results described in the manuals in about 30 minutes. However, the several hours required for preassembly in some of the kits provide valuable wiring experience. Whether fortunate or unfortunate, only one of the kits investigated required soldering of any kind.

Spring fasteners of many types are common in the kits (except in two cases). These fasteners seem to be reliable. Whether this would be the case after repeated use (or if corrosion were to set in) could not be determined in our relatively short test period.

For evaluation purposes, three projects from each of the kits available were selected for testing. In most cases, those selected were the more complex of the projects described in the kit manuals. All of the projects tested worked, some excellently, others passably. Here are the test results and some observations:

● *Electronic Science Lab* (Allied Radio Corp.)—most complex of the kits tested. The instruction manual describes 100 projects, all of which operate on rectified voltage from the a.c. line. The projects selected for testing were a broadcast receiver (weak audio output suggested the need for a good antenna and ground), a boat horn (also weak output), and a light meter. Setup times for the projects were, respectively, 20, 25, and 20 minutes—a little longer than usual—but the work involved provides practical wiring experience.

A few projects in this kit employ hybrid transistor (or crystal diode) and vacuum-tube circuits. Included in the kit are a perforated assembly panel, peg-mounted coil-spring connectors, and hookup wire color-coded according to length. The instruction manual illustrates all suggested projects, but not all projects are accompanied by a schematic diagram. The manual should have included a comprehensive project index.

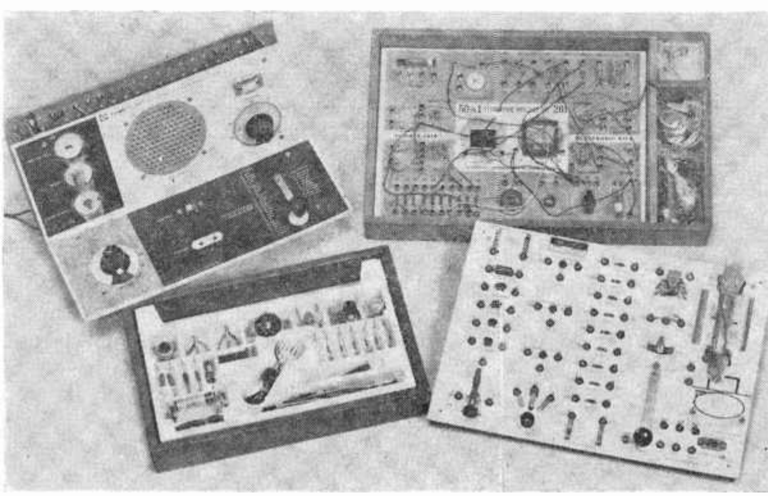
● *Denshi-Block Model DR-IIA* (Aristo-Craft)—a most unusual project kit. The instruction manual lists 30 projects, all of which are solid state and battery operated. The projects selected for testing included a two-transistor broadcast receiver; code practice oscillator (with a very low-frequency output signal); and a Morse code radio transmitter. Setup time for the projects was from five to ten minutes.

keys are permanently embossed on the tops of the cubes.

Each suggested project is accompanied by a schematic diagram, but it would have helped if component values were also listed on the drawings. There is some difficulty in extracting the cubes from the project frame due to their small size and the tight fit caused by the springs. The project frame and its cover are compact enough to fit in a coat pocket.

● *Jr. Series Electronic Workshop "19" Model JK-27* (Heath Company)—requires a considerable preassembly time. All 19 projects are solid state and battery powered. The projects selected for testing were a three-transistor broadcast receiver, transistor/relay timer with indicator lamp, and an "electric eye." Respectively, setup times were 15 (including time required for removal of excess wax from the r.f. tuning coil and application of Lubriplate to the slug screw), 12 and 7 minutes.

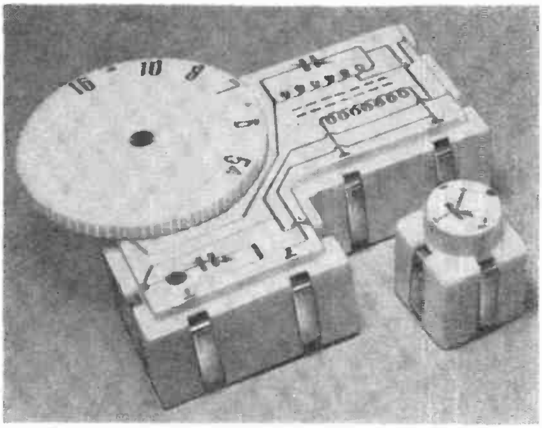
This kit requires that 68 coil-spring connectors be mounted on the assembly board before you can set up your first project. However, this is a one-time-only job, and once done, the projects go to-



Kits that require wiring include, clockwise from top left, Allied Radio "Electronic Science Lab;" Radio Shack "Science Fair"; Heath "Jr. Series Electronic Workshop"; Philmore "Educational Electronics Kit." Note variety of layouts employed.

Most of the projects in the instruction manual are radio receivers or radio-oriented circuits. Projects are set up with the aid of a plastic frame and individual component cubes. All cubes (except one large block containing a tuning capacitor and loopstick antenna) measure ⅝" on a side. Component symbols and number

gether in a very short time. The leads of every component on the assembly board are numbered, keyed to the separate charts provided for each of the projects in the instruction manual. The charts show the lengths of hookup wire needed for interconnections between components. The instruction manual, which includes



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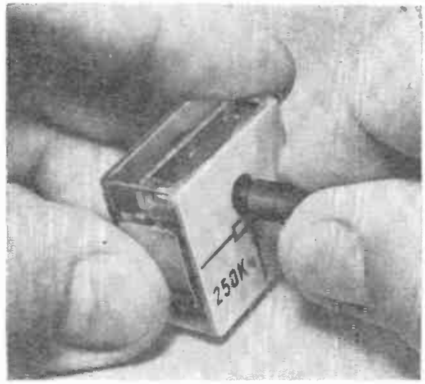
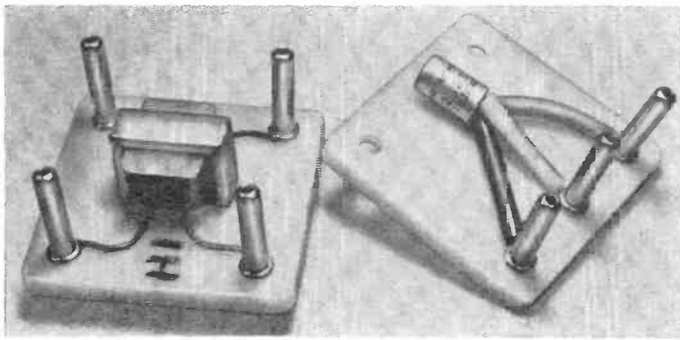


B

Ingenious packaging methods devised to limit damage from extensive handling of components are illustrated here. In **A** and **E**, Denshi-Block cube and tuning block illustrate ribbon-like spring conductors. Most elaborate packaging is demonstrated in **B** and **D** for Raytheon-Lectron series kits; blocks can contain single components as in **B** or an entire subcircuit as in **D**. All small parts in Philmore kits are mounted on plug-in plastic plates and terminated in metal connector posts as in **C**.



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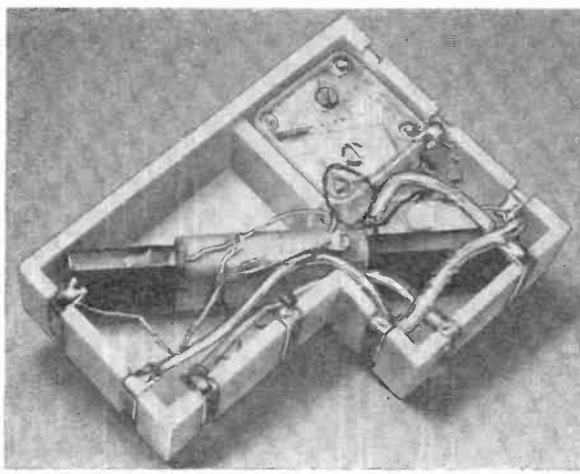
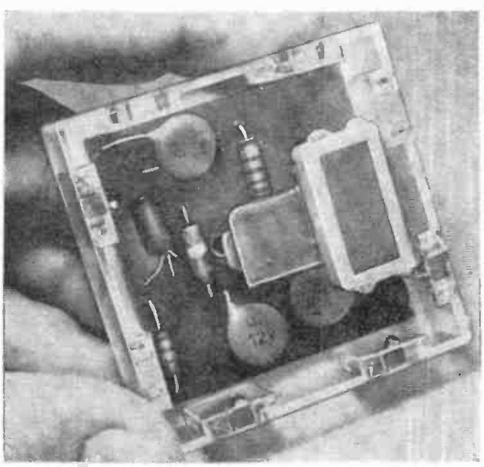


E



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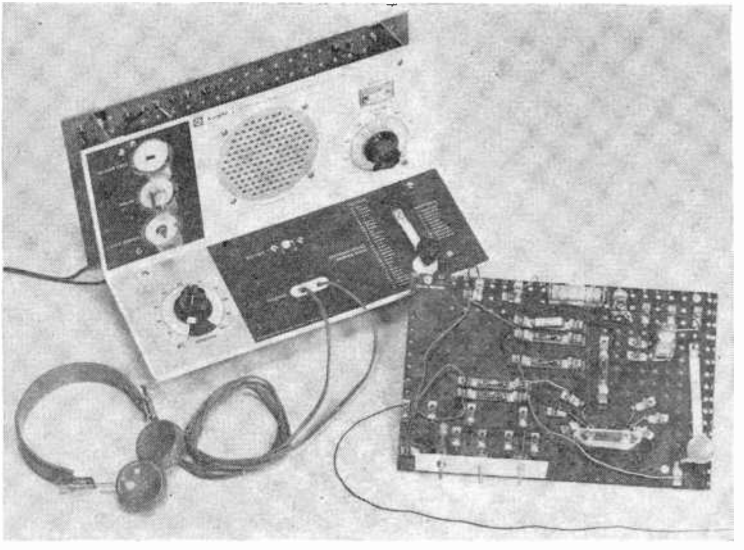


Shown here with Knight-Kit "Electronic Science Lab" (left) is the Lafayette Radio Electronics "Transistor Experimenters Kit"—the only kit requiring soldering equipment.

a complete set of schematic diagrams with component values listed, shows the properly set up board for each project.

● *Electronic Educational Kit* by Norelco (H.H. Smith)—rather simple preassembly on this one. The instruction manual lists 30 projects, all of which are battery powered. Projects selected for testing were a three-transistor broadcast receiver; a two-transistor "tell-tale" light; and an acoustic relay. Performance of the receiver was very good. Setup times for the projects were 50, 25, and 25 minutes, respectively. Considerable time is used placing the individual circuit cards and spring-and-pin connectors on the assembly board.

Although this kit is designed to operate from two 4.5-volt batteries, a standard 9-volt battery clip is provided. The tuning capacitor, switch, and loudspeaker are attached to the assembly board with brass rivets and rubber grommets. The instruction manual shows large full-color photos of many of the projects in addition to a complete set of schematic diagrams that are coded to the parts list.

Of interest in this kit are the little "pants" (plastic insulation) that are slipped over the leads of the transistors to protect them from lead breakage.

● *Transistor Experimenters Kit* (Lafayette Radio Electronics)—another long assembly time kit and this is the only kit tested that required soldering. However, the instruction manual provides an excellent section on how to solder; so, the experimenter obtains practical soldering and wiring experience.

The assembly and instruction manual lists 20 projects, all solid state, and all battery operated. The projects tested were a two-transistor regenerative receiver; a two-transistor voice-operated alarm; and a photocell relay. The first project consumed almost 25 minutes to set up, the great majority of the time spent in cutting and stripping the hookup wire to be used. However, the other two projects tested went together in 15 minutes each—thanks to the cut and stripped hookup wires taken from the first project.

This kit is unusual in that 22.5 volts d.c. is required for each project.

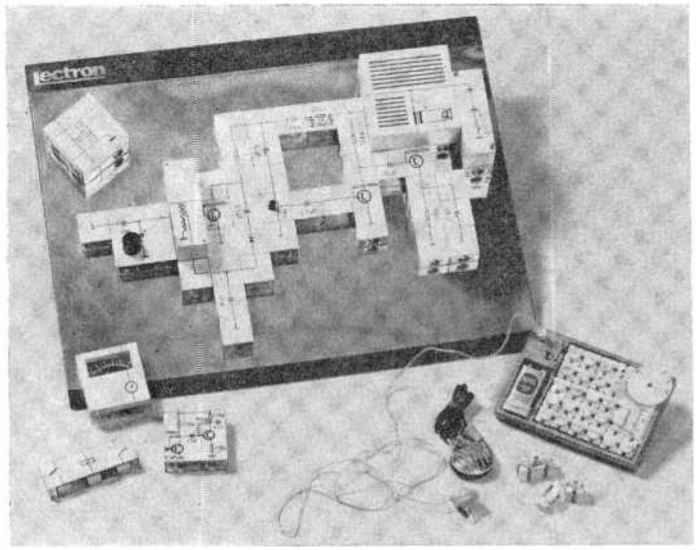
● *Educational Electronics Kit* (Philmore)—no preassembly required for this kit. The instruction manual lists 20 experiments, again all solid state and all powered by batteries. From this kit, a two-transistor broadcast receiver, a code practice oscillator, and a wireless microphone were selected for testing. The latter two worked satisfactorily, but the receiver's reception was scratchy (not entirely the fault of the earphone provided), although intelligible. Setup times averaged between 8 and 15 minutes.

Project setup time is very short—definitely the fastest of all the kits that actually require wiring. The number of components supplied (four capacitors

EDUCATIONAL ELECTRONIC KITS

NAME OF KIT AND SOURCE	EXPERIMENTS	NUMBER OF TRANSISTORS	TYPE OF INDICATOR	NUMBER OF SPEAKERS	RELAY/ PHOTOCELL	PREASSEMBLY TIME	WHERE MADE	PRICE
Electronic Science Lab. Allied Radio Corp. 100 N. Western Ave. Chicago, Ill. 60680	120	3 plus 1 vacuum tube	Lamp and Meter	1	Yes/Yes	3¼ hrs.	U.S.A.	$29.95
Denshi-Block DR-IIA Aristo-Craft Miniatures 314 Fifth Ave. New York, N.Y. 10016	30	2	None	None	No/No	None	Japan	$22.95
Jr. Series Model JK-27 Electronic Workshop "19" Heath Company Benton Harbor, Mich. 49023	19	3	Lamp	2	Yes/Yes	2½ hrs.	U.S.A.	$13.95
Educational Electronic Kit[1] by Norelco Herman H. Smith, Inc. 812 Snediker Ave. Brooklyn, N.Y. 11207	23	3	Lamp	2	No/Yes	30 min.	Holland	$21.95
Transistor Experimenters Kit Lafayette Radio Electronics 111 Jericho Turnpike Syosset, N.Y. 11791	20	2	Lamp	None	Yes/Yes	3¼ hrs.	U.S.A.	$18.95
Educational Electronic Kit Philmore Mfg. Co., Inc. Richmond Hill, N.Y. 11418	20	2	None	None	No/Yes	None	Japan	$17.95
Science Fair Radio Shack 730 Commonwealth Ave. Boston, Mass. 02215	50	2	Meter and lamp	1	Yes/Yes	None	Japan	$17.95
Raytheon-Lectron Series Kits[2] Raytheon Company 141 Spring St. Lexington, Mass. 02173	50*	4	Meter and lamp	1	No/Yes	None	Germany	$17.95- $25.95

[1] Also available from Lafayette Radio Electronics; Allied Radio Corp.; and Edmund Scientific Co., 300 EDSCORP Building, Barrington, N.J. 08007.
[2] Available from Allied Radio Corp., Lafayette Radio Electronics, and better toy stores.
* The number of experiments is the total number described in the assembly manual for the largest kit in the series.



Raytheon-Lectron (upper left) and Denshi-Block kits form a class by themselves. Components in each are housed inside plastic, component-keyed cubes or blocks. Raytheon-Lectron kit is large and easy to work with, while Denshi-Block is compact and portable.

and six resistors, for example) is rather skimpy, but the projects outlined in the instruction manual are basic "beginner" types. This is a good starter kit, especially if your youngster is of pre-high school age. Hookup wires, color coded as to size, are equipped with slip-on connectors that mate with posts on the component assemblies. The instruction manual provides a pictorial assembly of each experiment, plus a complete set of schematic diagrams with component values individually listed on the diagrams.

● *Science Fair* (Radio Shack)—comes completely preassembled with a large number of the components mounted to the assembly board. All leads are terminated in coil-spring connectors. The kit is all solid state and battery powered. Projects selected for testing were a broadcast receiver, a transistor tester, and an experimenter circuit consisting of a solar cell, meter, and potentiometer. The receiver worked well with no problems encountered. In the case of the transistor tester, the two transistors had to be interchanged before positive results could be obtained (one of the transistors had very high leakage), and the last of the three lacked sensitivity. Setup times were 22, 10, and 15 minutes respectively.

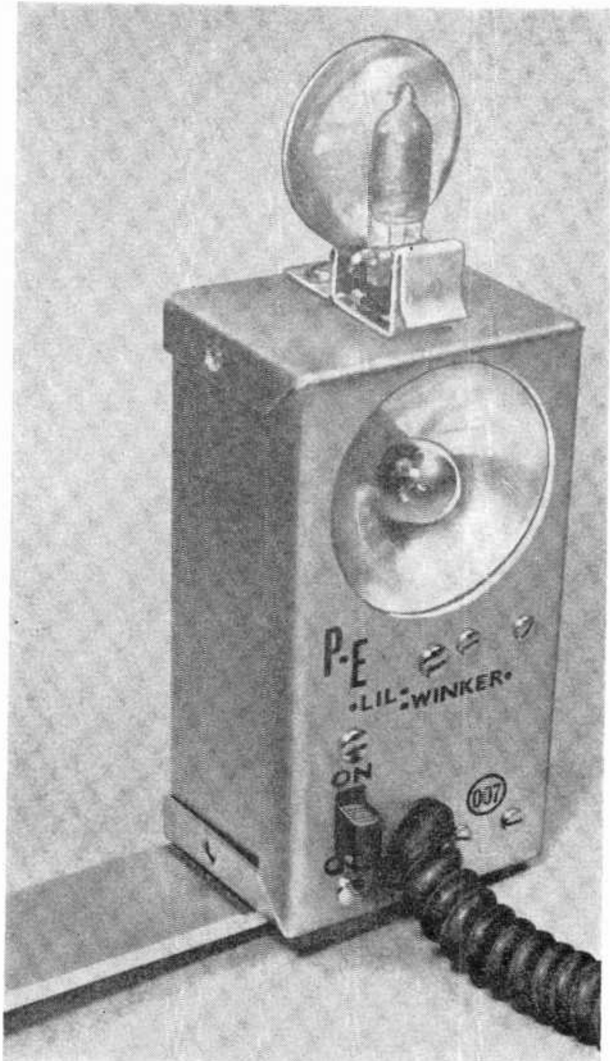
Fifty projects are outlined in the instruction manual, complete with schematic diagrams that are coded and number-keyed to the component connectors provided.

Setting up the individual projects is reasonably quick, but it would be a lot quicker if the hookup wires were supplied with their ends pretinned. One feature worthy of mention is that the assembly board comes housed in a sturdy wood tray that provides protection against kit damage.

● *Raytheon-Lectron Educational Kit* (Raytheon Company)—certainly the super-deluxe experimenter kit. As with the Denshi-Block kit mentioned earlier, this kit is made up of individual component blocks that are simply set on the assembly board without the need for wires interconnecting the components. The big difference is that these are larger blocks and easier to handle.

The instruction manual lists 50 projects with schematic diagrams and component values. The projects chosen for evaluation included a three-transistor broadcast receiver, a photocell circuit, a

(*Continued on page* 111)



BUILD LI'L WINKER

FILL-IN LIGHT DOUBLES AS BC FLASH

BY LYMAN E. GREENLEE

A MAJOR PROBLEM faced by the amateur photographer is getting the proper lighting for taking pictures. Flashbulbs are good, of course, for taking pictures of subjects that are a sufficient distance from the camera. When it comes to close-ups, however, flashbulbs create harsh shadows and highlights and the problem is to get more even lighting.

In most cases, such light is not conveniently available. This is where the "Li'l Winker" comes in. This useful, low-cost gadget is ideal for preventing that washed-out look in close-ups by providing a brief flash of incandescent light. However, standard flashbulbs can also be used in the Li'l Winker.

How It Works. A 22.5-volt battery, *B1* in Fig. 1, charges a large-valued capacitor, *C1*, through current-limiting resistor *R1*. Charging time with a fresh battery is about 15 seconds—30 seconds with an older battery that has lost some of its "punch". When the SCR is not conducting, it represents an open circuit and no current flows through *I1* (or through *SO1* if a flashbulb is being used). However, when a low-level positive pulse is applied to the gate of the SCR, it starts to conduct immediately and allows the charge on *C1* to flow through the lamp, producing a flash. Because the gate circuit of the SCR represents a very small load, there is little chance of the

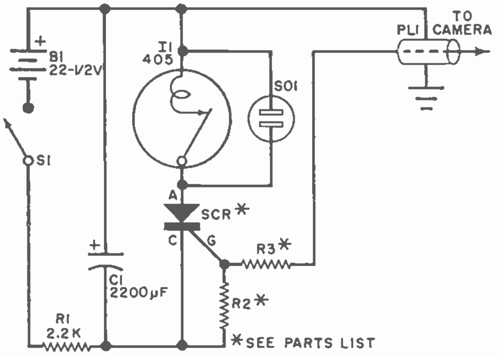


Fig. 1. The circuit will not operate until the gate of the SCR is triggered by a pulse from the camera's internal flash battery.

PARTS LIST

B1—22.5-volt battery (NEDA 215)
C1—2200-µF, 25-volt electrolytic capacitor (Sprague type 39D or similar)
I1—6.5-volt flasher bulb (GE405 or similar)
PL1—Flash fitting and length of cable (to fit camera)
R1—2200-ohm
*R2—1000-ohm**
*R3—1500-ohm** } *All resistors, ½ watt*
S1—S.p.s.t. switch
SO1—AG-1 flashbulb socket
*SCR—Silicon controlled rectifier (GE X1 or similar)**
Misc.—Metal case 2" x 4" x 1⅝" with snap-on back cover, 1¾" aluminum reflector with screw-in bulb holder (salvaged from old flashlight), one-teaspoon aluminum measuring spoon, four-lug terminal strip, 3/16" rubber grommet, mounting hardware, solder, wire etc.
**If GE type C10F2 SCR is used, R2 is 470 ohms, R3 is 15,000 ohms.*

camera's shutter contacts becoming pitted or burned.

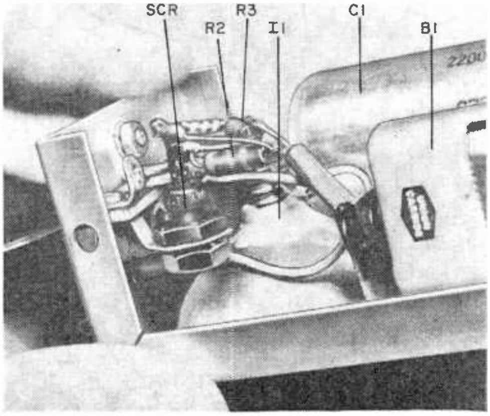
Since the flasher bulb is rated for 6.5 volts, its use in a 22.5-volt circuit might be questioned. Actually, the bulb has a built-in heater-type contact that opens and cuts off the current when it reaches a certain critical value. Thus the bulb produces a very brilliant flash due to the high voltage each time the SCR is fired, but it does not burn out.

Construction. The Li'l Winker is assembled in a 2" × 4" × 1⅝" metal case as shown in the photos. A circular hole, just large enough to accommodate a screw-type reflector salvaged from an old flashlight, is cut at one end of the front of the case. Two smaller holes are cut at the other end: one ½" × ¼" for the switch and the other a circular hole for a 3/16" rubber grommet. Mount the battery holder and switch *S1* as shown in the photos. Mount the reflector using epoxy cement.

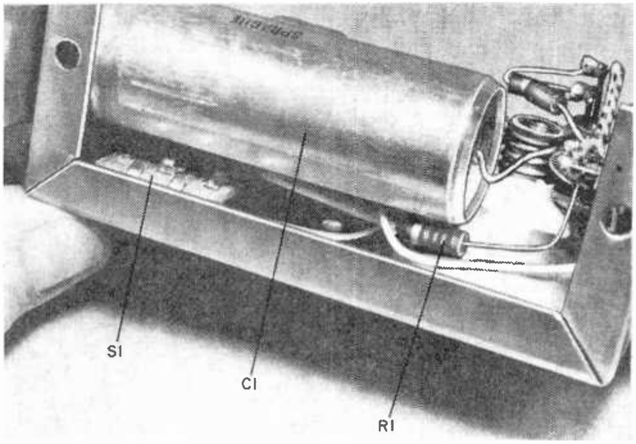
The flashbulb reflector, mounted on the top of the case, is made from a circular teaspoon-size aluminum spoon, bent so that an AG-1 flashbulb holder can be mounted directly in front of it. The reflector and the flashbulb holder must be positioned so that, when the flashbulb is in the holder, it is properly positioned in front of and on the center line of the reflector. The rear surface of this reflector can be coated with a dull black paint.

A four-lug terminal strip is mounted inside the case (under the reflector). Capacitor *C1* lies lengthwise in the case with its positive terminal soldered to a lug opposite the terminal strip. The SCR is secured by a large soldering lug which is held by the nut on the anode side and attached to the end lug on the terminal strip.

The connection between Li'l Winker and the camera is made with a flash fitting and a length of cable. These can be obtained from a camera supply store, making sure that the fitting mates with the outlet on your camera. Pass the loose end of the cable through the rubber grommet, then wire the Li'l Winker



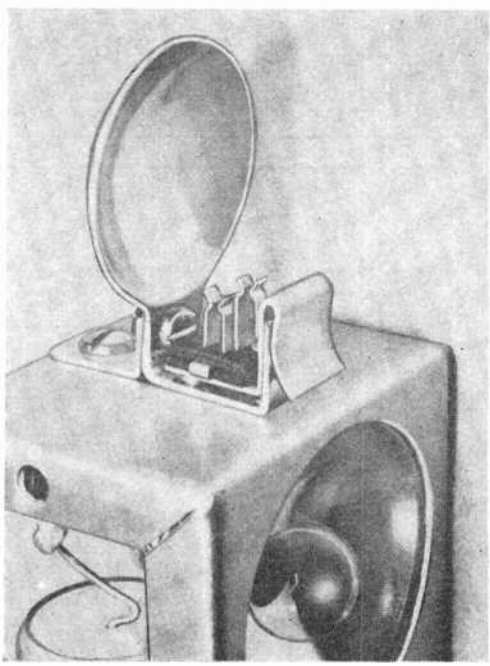
The bulk of the components are wired point-to-point on the terminal strip. The coaxial cable to the camera enters the chassis via a small rubber grommet.



Storage capacitor C1 extends the length of the small chassis. One end is tied to the terminal strip; the other end is connected to the common ground (chassis) via a small soldering lug. Resistor R1 is connected between the terminal strip and power switch S1.

as shown in Fig. 1. Make sure that all components clear the back cover.

A length of 1/8" aluminum strip can be used to mount the Li'l Winker to your camera. Obtain a thumbscrew fitting, either at a camera shop or from a discarded camera, and mount it at the far end of the aluminum strip so that the flash unit can be attached to the camera. The Li'l Winker is then secured to the other end. The author used a six-inch length of aluminum.



The "hot" lead to the AG-1 flashbulb socket is passed through a hole in the top of the chassis. The other connection is made through the spring clip.

Operation. Photographic results depend on so many variables that you will need to take several trial shots to determine the best exposure time and distances for use with the wink light. Generally, the camera should be set for conventional flash, not for "speedlight." The duration of the wink-light flash approaches that of conventional flashes, but it does not produce as much light so don't expect to make good pictures at great distances or with slow film. Remember that you can always use a standard flashbulb, if necessary.

You will find that the wink-light feature eliminates that "washed-out" look on facial close-ups. When you use the wink light and a flashbulb simultaneously, put the shutter down an extra stop. Best results are obtained with a fairly slow shutter speed. Using a slow shutter speed also eliminates synchronization problems between the shutter and the light.

There may be occasions when *C1* does not completely discharge, in which case, the SCR may continue to conduct after the flash. This prevents the capacitor from recharging. The circuit will return to normal, however, if the switch is turned off momentarily and then on again. —30—

POPULAR ELEComics

He doesn't have a QSL so he sent you his social security number.

Watch it, Sammy—here comes the fuzz.

I think my mistake was sinking most of my money into the cabinet.

Instead of four 50-ohm resistors, I got'cha one 200-ohm. It was much cheaper.

BUILD A FET-QM

Improve selectivity with simplified Q-multiplier / amplifier

BY ROBERT N. TELLEFSEN, WØKMF

HAVE YOU BEEN THINKING of trading in your old communications receiver because its selectivity is about as broad as a barn door? If so, an expensive replacement receiver—even if it is a better model—may not be what you really need. Instead, the addition of a Q-multiplier to your present receiver may be just what the doctor ordered.

Now, for less than $10, you can build a Q-multiplier that incorporates a field-effect transistor stage to improve receiver selectivity and provide controlled regeneration. Called the "FET-QM," this device is completely self-contained (it even has its own line-independent power source), compact in size, and easy to use. A single coaxial cable connects the FET-QM to your receiver.

About the Circuit. The FET-QM incorporates a high-Q 455-kHz tuned circuit (*L1*, *C1*, and *C2* in Fig. 1). Additionally, amplifier stage *Q1* provides a facility for controlling regeneration.

Regeneration increases the Q of the tuned circuit and considerably improves receiver selectivity. Now, because the FET-QM is connected to the mixer plate, where the 455-kHz i.f. first appears in the receiver, its narrow passband determines the receiver's sensitivity. As a result, broadcast signals as close together as 5 kHz can be easily separated (see Fig. 2).

With the FET-QM switched out of the receiver, signals A and B will be heard. If you wanted to listen to signal A, signal B would interfere. Ideally, signal B

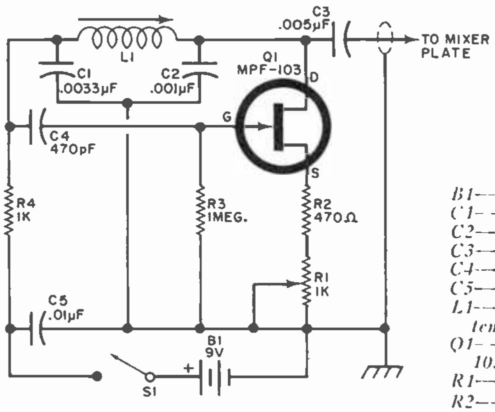


Fig. 1. High-Q 455-kHz tuned circuit (C1, C2 and L1) helps narrow passband of receiver, while R1 in source of Q1 provides means for controlling regeneration.

PARTS LIST

B1—9-volt battery
C1—0.0033-µF ceramic disc capacitor
C2—0.001-µF ceramic disc capacitor
C3—0.005-µF ceramic disc capacitor
C4—470-pF ceramic disc capacitor
C5—0.01-µF ceramic disc capacitor
L1—Adjustable slug-tuned broadcast band antenna coil
Q1—Plastic n-channel FET (Motorola MPF-103)
R1—1000-ohm linear taper potentiometer
R2—470-ohm
R3—1,000,000-ohm
R4—1000- to 1500-ohm (see text) } *all resistors, ¼-watt*
S1—S.p.s.t. switch, part of R1
1—4" × 2¼" × 2¼" aluminum utility box
2'—RG-58A/U coaxial cable
Misc.—Knob for ¼"-diameter shaft; knob for ⅛"-diameter shaft; 2 four-lug terminal strips; battery clip; hookup wire; hardware; solder; etc.

should be eliminated or at least considerably suppressed. So, the FET-QM is switched in, with the result that the passband narrows, and signal B now falls outside the half-power point. The FET-QM passes signal A and suppresses signal B, making the desired signal stand out.

Potentiometer *R1* controls the amount of regeneration produced by the FET-QM. With too much regeneration, the Q-multiplier goes into oscillation, and a steady squeal is heard from the receiver. Therefore, the optimum setting for selectivity is when *R1* is set just below the point of oscillation.

Construction. The circuit of the FET-QM should be housed inside a compact aluminum utility box. The TUNE control, *L1*, and the PEAK control, *R1*, should be mounted on the front of the box as shown in the photos.

Two terminal strips can be used for the mounting of the remaining parts, except for battery *B1*.

The battery can be mounted with a battery clip in a location where it will not interfere with the other components in the circuit.

When all parts are mounted, wire them together. Drill a hole in the rear of the box to accept a rubber grommet, pass one end of the coax through the grommet, and solder the coax into the circuit as shown in Fig. 1.

Assemble the metal box, and letter the two panel controls. Finally, mount a knob designed for ⅛"-diameter shafts over the coil's adjustment screw; a ¼" knob goes onto the shaft of *R1*. This completes the construction of the FET-

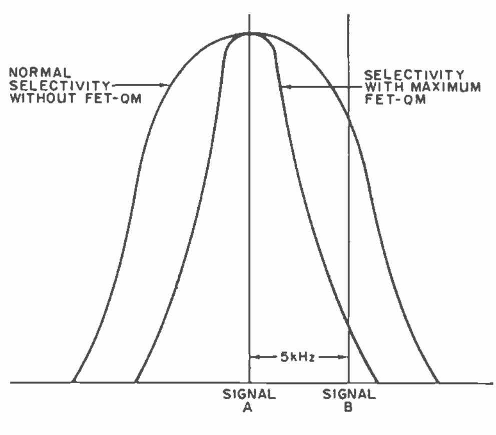


Fig. 2. Broadcast signals 5 kHz apart can be easily separated with the FET-QM in the receiver's circuit; unwanted signal B is greatly attenuated.

QM, and all that is left is to connect it to the receiver.

To connect the FET-QM to your receiver, first locate the plate lug of the mixer stage and solder one lead of a 0.005-μF capacitor to this lug. The other lead of the capacitor is then soldered to the center conductor of the coax. Ground the braid of the coax to the chassis near the tube socket. (In a.c.-d.c. receivers, ground the braid through a 0.005-μF capacitor to eliminate shock hazard.) If desired, phono jacks and plugs can be used to simplify connecting the FET-QM to the receiver.

WHAT IS Q-MULTIPLICATION?

The high selectivity provided by the FET-QM is the result of positive feedback (regeneration). The idea of attaching this circuit to the i.f. channel was proposed in 1952 by O. G. Villard and W. L. Rorden. In the circuit shown, the off-resonance of *C1*, *C2*, and *L1* becomes very high, and signals at this frequency pass through the i.f. strip unhindered. A Q-multiplication of 20-30 is not uncommon. Possibly, the phrase "Q-multiplication" is a misnomer since the actual Q of the i.f. strip remains unchanged, but signal frequencies slightly off-resonance in the strip are sharply attenuated.

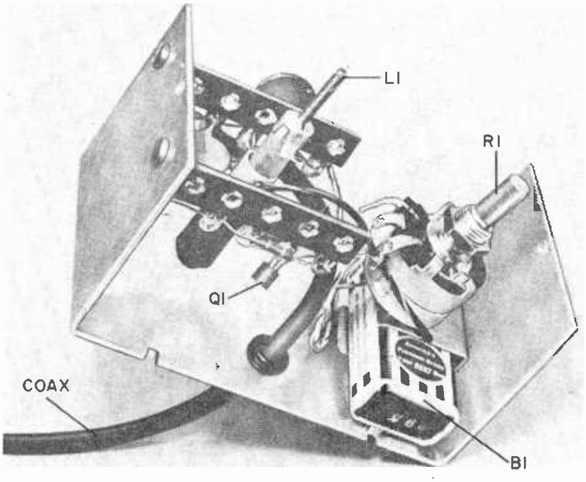


Fig. 3. Due to simplicity of circuit, two terminal strips can easily accommodate all small parts.

After the interconnection between the FET-QM and the receiver is accomplished, repeak the i.f. transformer. Be sure the FET-QM is turned off when touching up the transformer.

How To Use. Turn on your receiver, and tune in a weak, interference-free signal with the Q-multiplier turned off. If your receiver has an r.f. gain control, back it off a bit from maximum to prevent strong signals from forcing their way through the receiver and reducing the effectiveness of the FET-QM.

Turn on your BFO and adjust it for a beat note. Now, switch on the FET-QM, and set the PEAK control fully clockwise. Rotate the TUNE control until you hear a strong whistle; then back off on the PEAK control until the whistle disappears. Slowly adjust the setting of the TUNE control until the desired signal suddenly peaks. If necessary, the PEAK control can be advanced until the FET-QM almost goes into oscillation. This is the point of maximum selectivity, and any signals coming through the receiver will ring like a struck bell. The best setting is just below the point where the extreme ringing stops but where the desired selectivity is still present.

Even an inexpensive receiver can do surprising things with the addition of a Q-multiplier. When you build and use the FET-QM, you will probably find that the ideas you had about trading in your receiver for a better model were rather drastic. —30—

What's A Wobbulator?

TEST YOUR KNOWLEDGE OF LATEST TV DESIGNS

BY VIC BELL

(*Answers on page 121*)

1 It is sometimes difficult to see a TV picture outdoors because CRT phosphors are saturated by sunlight. TRUE_____ FALSE_____

2 A TV circuit with no flyback transformer has been developed using a piezoelectric material to "amplify" the flyback pulse. TRUE_____ FALSE_____

3 A deflection yoke stuck to the CRT neck can be loosened by applying a 60-Hz voltage to the horizontal yoke coils to generate heat. TRUE_____ FALSE_____

4 Pincushion correction circuits used in some color TV receivers correct a tendency for the picture to be "stretched" at the top and bottom center as compared to the top and bottom sides. TRUE_____ FALSE_____

5 If all TV networks used identical setup methods and a common, master 3.58-MHz oscillator for color broadcasts, the viewer's hue adjustment would be unnecessary when changing from station to station. TRUE_____ FALSE_____

6 TV film projectors use standard 24-frame film but project it so it is synchronized with TV's 60-Hz field rate. TRUE_____ FALSE_____

7 The mesa transistor was so named because its internal structure resembles a mesa in the desert. TRUE_____ FALSE_____

8 Plastic transistors are now replacing silicon and germanium transistors. TRUE_____ FALSE_____

9 A battery-powered oscilloscope operated in an isolated area, away from a.c. power lines, etc., would not display the familiar 60-Hz pattern normally found when you touch the scope's vertical input. TRUE_____ FALSE_____

10 The MOS transistor derived its name from the mossy appearance of the grown silicon inside the transistor. TRUE_____ FALSE_____

11 In functions, the triac is equivalent to three SCR's. TRUE_____ FALSE_____

12 Effective voltage (E_{eff}), average voltage (E_{av}), and root-mean-square voltage (E_{rms}) are all the same. TRUE_____ FALSE_____

13 At this time it is not possible to build a ceramic stereo phono cartridge with reproduction capabilities as good as a magnetic cartridge. TRUE_____ FALSE_____

14 Anechoic chambers are used to create "reverb" for recording. TRUE_____ FALSE_____

15 Doppler distortion is greater in small-diameter, wide-range speakers than wide-range, large-diameter speakers. TRUE_____ FALSE_____

16 A wobbulator is employed to sweep frequencies. TRUE_____ FALSE_____

BATTERY-POWERED FLUORESCENT LAMP

Extra brightness for your camping/boating trips

BY BEN RICHARDS

IT'S EASY to make an outdoor lighting system for your camping or boating trips. All you need is a 12-volt incandescent bulb and some wire to attach it to your car or boat battery. Unfortunately, there are some drawbacks to this approach: the intense point-source of light generated by a relatively small bulb can be very annoying to the eye; the amount of illumination delivered by such a bulb is limited in coverage, producing a small bright area surrounded by darkness; and the efficiency of such a lighting system is low. To get any appreciable amount of light, either a number of bulbs or a large, high-power bulb must be used. If you use either of these approaches, it won't be long before your battery gives out.

All these troubles can now be alleviated if you build the battery-powered fluorescent light described here. The light uses a 22-watt fluorescent lamp and

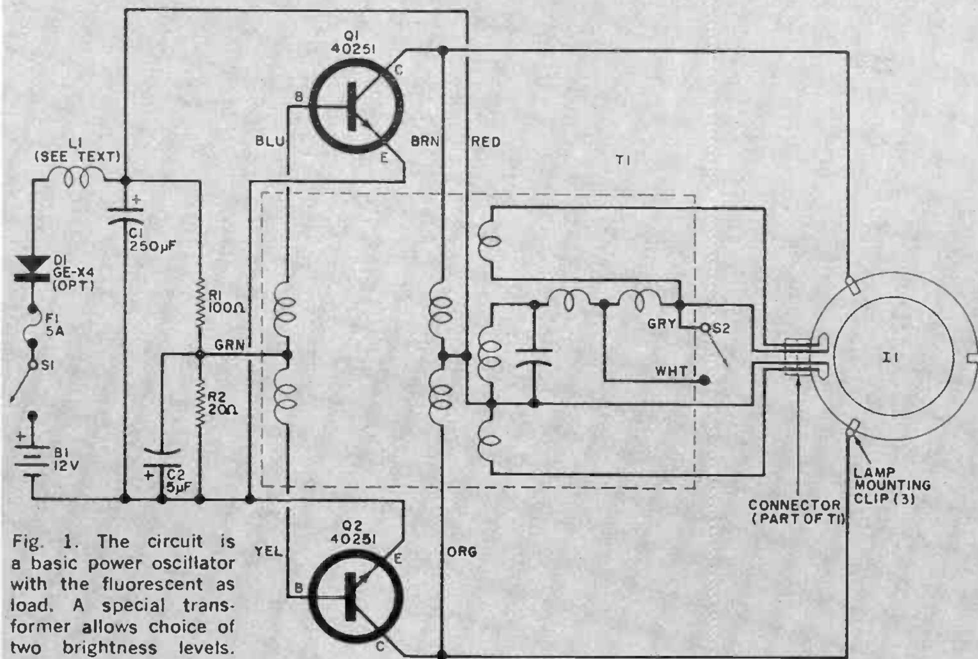


Fig. 1. The circuit is a basic power oscillator with the fluorescent as load. A special transformer allows choice of two brightness levels.

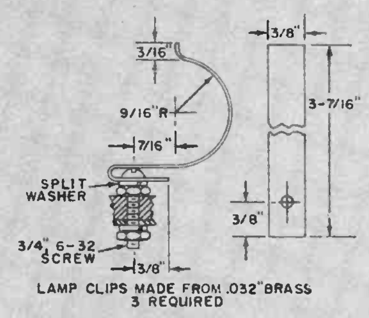


Fig. 3. Make three clips for mounting the fluorescent lamp. It is important that you get the correct curvature.

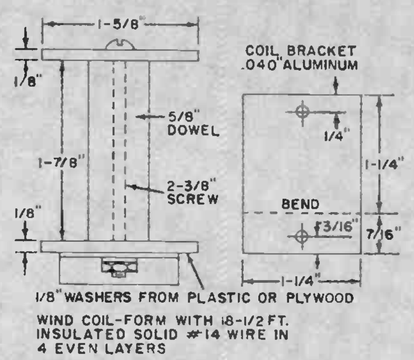


Fig. 4. Construction data for L1. Plastic tape can be wound over coil to keep it from unravelling during mounting.

works from a conventional 12-volt d.c. car, boat, or trailer battery. It produces large-area illumination without harsh glare and has two levels of illumination —bright, or subdued for extra-low battery drain. Efficiency is high, thus getting the most from the battery, and generated heat is almost non-existent. You can attach the fluorescent light to the end of a 20-ft, conventional two-conductor rubber-covered appliance cord and position it where it is needed.

Construction. A parts list is given on page 58 and a schematic in Fig. 1. Although almost any type of construction can be used, Fig. 2 and the photos illustrate the method used by the author. To duplicate this version, fabricate the wood and metal parts as shown. Note that there are two electrically isolated metal chassis, one for each power transistor. When drilling the holes for these transistors, make sure that both the base and emitter holes are large enough to prevent short circuits. Each transistor can be mounted directly on its chassis without using insulated mounting kits,

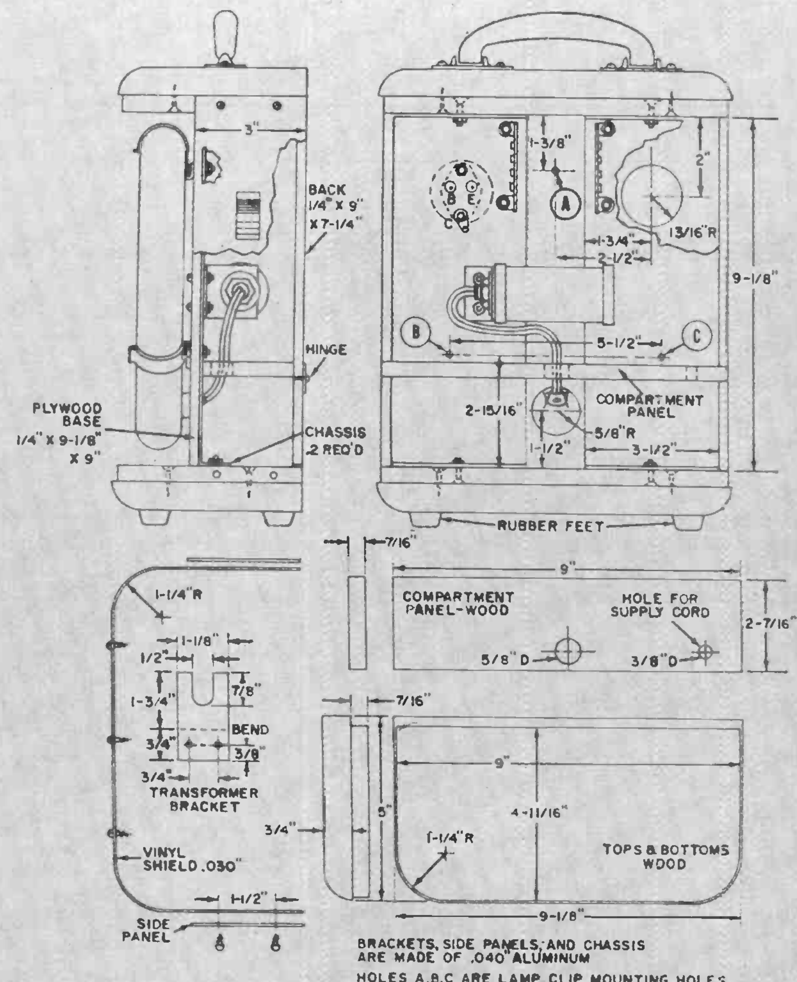
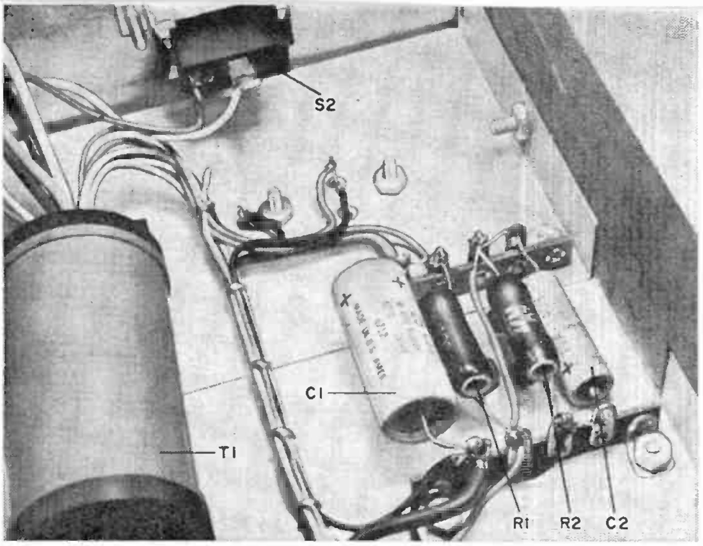


Fig. 2. If you want to duplicate the author's prototype, follow the construction details shown here. Note that the two transistors are mounted through the wooden front panel and the metal chassis. All wiring is done afer components are mounted.

since isolation is provided by the two independent chassis. Put a solder lug under one of the collector (mounting) screws of each transistor. Fabricate three lamp-holding clips as shown in Fig. 3, making sure that the edges are smooth and that they are shaped correctly.

Assemble the two chassis, the two four-lug terminal strips (no ground lugs), and the three lamp-holding clips to the plywood front panel. Note that the two chassis are spaced so that they do not touch either each other or the metal side panels to be mounted later. The tops of the two transistors fit through holes drilled in the wooden panel. At this time, make sure that holes have been drilled to mount the fuse holder (one screw), inductor *L1* (one screw), and transformer *T1* (two screws). If optional diode *D1* is to be used, drill a hole near one end of the fuseholder to support an insulated standoff. Use countersunk machine bolts to attach the 7/16"-thick wood top and bottom to the chassis ends. Then use countersunk wood screws to secure the 3/4"-thick top and bottom to the 7/16" top and bottom wood parts.



Resistors and capacitors are mounted between two terminal strips. Note how a wire harness makes for a clean, neat internal arrangement. This photo also shows the two isolated metal chassis and the method of wiring the power transistors. Both the emitter and base connections are soldered direct to the transistor leads; the collector connection is made to a solder lug under the collector (and case) mounting hardware.

A carrying handle can be secured to the top surface, but make sure that it does not cause a short circuit between the two metal chassis.

Attach the line-cord stowage compartment panel to the base-and-chassis assembly using wood screws. (A small magnetic door-latch assembly can be used to keep the stowage compartment door closed.) Assemble the entire cabinet to make sure that everything fits properly. Note that, of the three lamp clips, one is electrically connected to each chassis while the third is insulated by the wood front panel.

Construct inductor *L1* in accordance with Fig. 4. Using the photos as a guide, assemble all components in the cabinet and wire in accordance with Fig. 1. Note that the two "hot" lamp clips are connected automatically to their respective transistor collectors through the metal chassis. Be careful to observe the color coding on transformer *T1*. (The transformer is mounted to the chassis with an L bracket.) Connections to the transistor base and emitter leads are made by direct soldering. Use a long-nose pliers as a heat sink to avoid transistor damage while soldering. Do not mount resistors *R1* and *R2* too close to capacitors *C1* and *C2* to avoid heat damage to the capacitors. If the optional diode is used, it can be mounted on the chassis using a small standoff insulator at one end,

PARTS LIST

B1—Car, boat, or trailer 12-volt battery
C1—250-µF, 25-volt electrolytic capacitor
C2—5-µF, 150-volt electrolytic capacitor
D1—20 ampere, 200-PIV diode (General Electric X4 or similar) (optional)
F1—5-ampere, 3AG fuse
I1—22-watt, 7" circular fluorescent lamp (Westinghouse FC8T9/CW or similar)
L1—see text and Fig. 4
Q1, Q2—Transistor (RCA 40251)
R1—100-ohm, 5-watt, wirewound resistor
R2—20-ohm, 5-watt, wirewound resistor
S1, S2—S.p.s.t. switches (rocker-type preferred)
*T1—Ballast transformer**
Misc.—Wood, aluminum, brass strip, line cord, 4-lug terminal strips (2), fuseholder, machine screws, wood screws, transparent plastic shield, wire, solder, etc.
**An inverter-ballast transformer, Type EC-0501-LM, is available from Milwaukee Electromagnetics, P.O. Box 4476, Milwaukee, Wis. 53207, $9.60, postpaid.*

Front view of the completed cabinet. Clear vinyl shield wraps around entire front surface. Paint front panel flat white for best light reflection.

HOW IT WORKS

A.c. power to operate the fluorescent lamp from a d.c. source is generated by a pair of power transistors, operating in conjunction with a saturable transformer in a feedback-type power oscillator circuit.

Oscillation frequency is slightly above the audible range to avoid any annoying buzz from the device. A portion of the transformer winding can be shorted to provide high intensity.

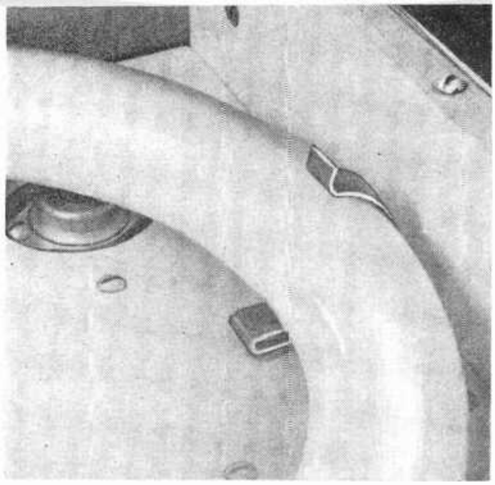
Were it not for the ballasting action of the transformer, lamp brightness would fluctuate excessively with small changes in input voltage and the lamp current could easily exceed its safe value. This happens because a fluorescent lamp acts like a voltage-regulator tube, or zener diode, and tries to maintain a constant voltage while the current through it varies. The type of lamp used has low-power filaments which are continuously heated to allow rapid self-starting and dimming.

Diode *D1* is optional and is used to prevent transistor damage if the d.c. supply leads are accidentally reversed. Inductor *L1* and capacitor *C1* minimize radio interference. Fuse *F1* is used to protect the wiring only. If the battery polarity were wrong, the transistors would fail before the fuse could blow. That is the reason for using diode *D1*.

with the other end connected directly to the fuseholder.

Once the lamp assembly has been checked electrically and mechanically, paint all exposed exterior surfaces any color desired and paint the surfaces surrounding the lamp flat white.

Attach the lamp connector (part of *T1*), then install the lamp in its three clips, making sure that it is a snug fit. Then mount the transparent plastic shield, clamp the line cord in its storage compartment, and attach the back and storage-compartment access door.

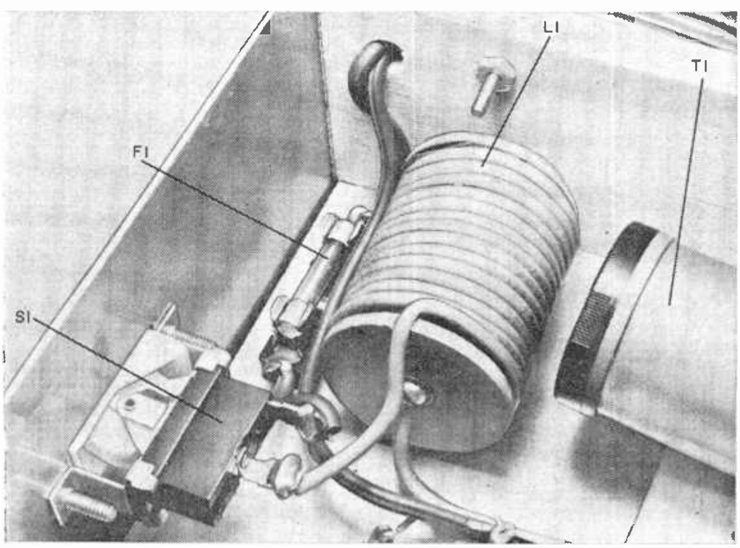


Fluorescent lamp is held by three clips (one shown here). Two of them are at same potential as the transistor collectors to aid fluorescent starting.

Testing and Use. Before placing the light in operation, carefully identify both the positive and negative input power leads. Connect the leads to a source of 12 volts d.c. capable of delivering at least 3½ amperes.

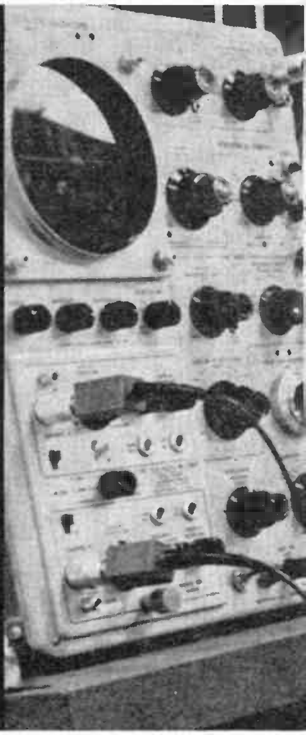
Turn switch *S1* on and note that the fluorescent lamp lights almost immediately. Current drain is about 3 or 3½ amperes when the lamp is started at high intensity (with switch *S2* closed). At low intensity, current drain should be about 1½ amperes when starting.

The author used a cigarette-lighter connector with a 20′ two-conductor (#16) appliance cord so that the light can be plugged into the cigarette lighter socket and positioned anywhere within 20 feet of the car. —30—



If optional diode D1 is used, mount it near the fuse and L1 (shown here).

How to become a "Non-Degree Engineer"



In today's electronics boom the demand for men with technical education is far greater than the supply of graduate engineers. Thousands of real engineering jobs are being filled by men without engineering degrees—provided they are thoroughly trained in basic electronic theory and modern application. The pay is good, the future is bright... and the training can now be acquired at home—on your own time.

THE ELECTRONICS BOOM has created a new breed of professional man—the non-degree engineer. Depending on the branch of electronics he's in, he may "ride herd" over a flock of computers, run a powerful TV transmitter, supervise a service or maintenance department, or work side by side with distinguished scientists on a new discovery.

But you do need to know more than soldering connections, testing circuits and replacing components. You need to really know the fundamentals of electronics.

How can you pick up this necessary knowledge? Many of today's non-degree engineers learned their electronics at home. In fact, some authorities feel that a home study course is the *best* way. *Popular Electronics* said:

"By its very nature, home study develops your ability to analyze and extract information as well as to strengthen your sense of responsibility and initiative."

Cleveland Method Makes It Easy

If you do decide to advance your career through home study, it's best to pick a school that *specializes* in the home study method. Electronics is complicated enough without trying to learn it from texts and lessons that were designed for the classroom instead of the home.

Cleveland Institute of Electronics concentrates on home study exclusively. Over the last 30 years it has developed tech-

niques that make learning at home easy, even if you once had trouble studying. Your instructor gives the lessons and questions you send in his undivided personal attention—it's like being the only 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 gets your lessons, so you read his notations while everything is still fresh in your mind.

Students who have taken other courses often comment on how much more they learn from CIE. Says Mark E. Newland of Santa Maria, Calif.:

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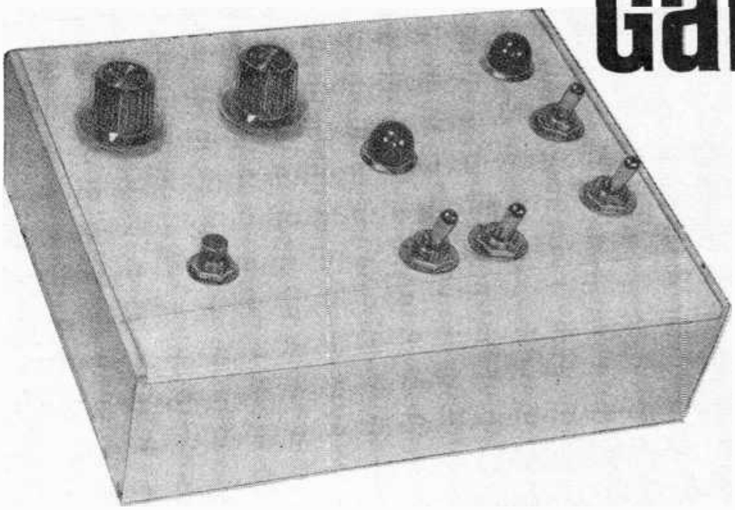
CIRCLE NO. 12 ON READER SERVICE PAGE



GADGET BOX -Mark 99

ELECTRONIC TOY IS ALSO EDUCATIONAL

BY JOSEPH J. TASHETTA

IN THIS MODERN AGE, two things should be expected of any toy that you give to your children. First, it should be an effective attention-occupier. Then, even more important, it should be educational. While many toys are effective attention-*getters*, children often lose interest in them after the initial novelty wears off. And few toys are really educational. The "Gadget Box," however, is one toy that fills both requirements.

Children, especially toddlers who are easily fascinated, won't quickly tire of the Gadget Box. This electronic "toy" is loaded with special effect controls. Flip a switch or press a button, and a siren sounds; flip another switch, and a metronome-like ticking is heard; twirl a knob, and the rate of ticking changes. Through the use of various controls and lights, the toy can also help to develop motor reflexes and teach basic logic.

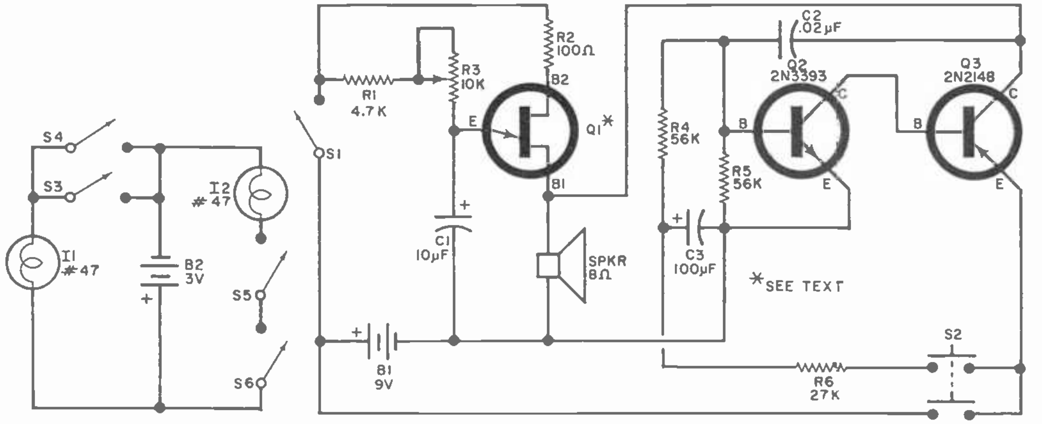
About the Circuits. The ticker circuit contains a unijunction transistor, *Q1*. Closing *S1* causes capacitor *C1* to begin charging through resistors *R1* and *R3*. At some time during the charge cycle (determined by the RC time constant of the circuit) the voltage at the emitter exceeds the voltage at *B2*, driving *Q1* into conduction. When *Q1* conducts, *C1* rapidly discharges through the UJT, causing a "tick" to be heard in the speaker.

This charge-discharge action repeats itself indefinitely as long as power is applied to the circuit. To vary the tick rate, you need only change the setting of *R3*.

The circuit containing transistors *Q2* and *Q3* is the siren. When *S2* closes, *C3* charges and switches on *Q2* and *Q3*. The output of *Q3* then provides regenerative feedback to the base of *Q2* to sustain oscillations. As *C3* charges, the output signal frequency increases. Conversely, as *C3* discharges, output frequency diminishes. The result is that the output signal wails up and down the scale like a real siren.

An independent circuit for developing the sense of basic logic is provided by the lamp and switch configuration shown in the schematic diagram. The circuit consisting of *I1, S3,* and *S4* makes up an OR circuit. Closing either of the two switches causes *I1* to glow; closing both switches still causes the lamp to glow.

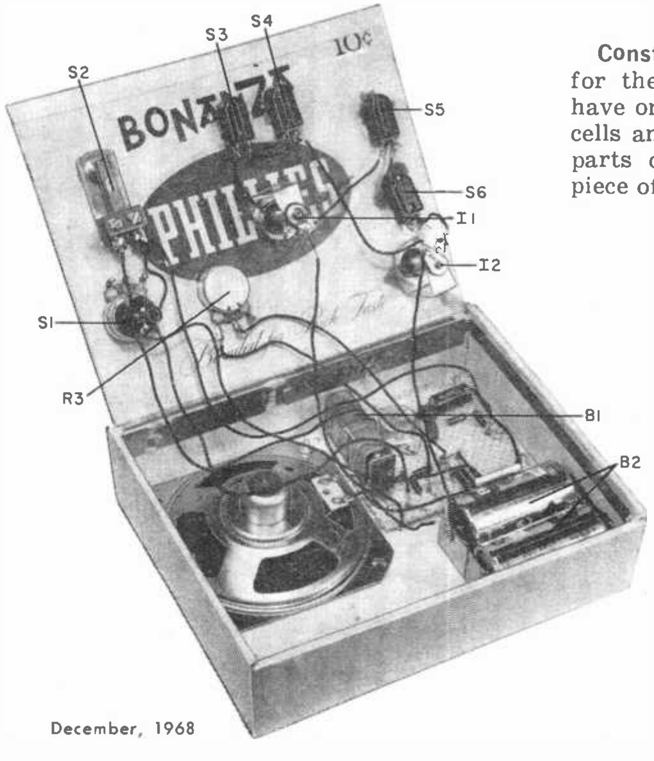
The circuit consisting of *I2, S5,* and *S6* forms an AND circuit. In this case both switches must be closed before the lamp will glow since closing just one switch will not complete the circuit.



PARTS LIST

B1—9-volt transistor battery
B2—Two 1.5-volt D cells
C1—10-µF, 10-volt electrolytic capacitor
C2—0.02-µF ceramic capacitor
C3—100-µF, 10-volt electrolytic capacitor
I1, I2—#47 lamp
Q1—General-purpose unijunction transistor (UJT)
Q2—2N3393 transistor
Q3—2N2148 transistor
R1—4700-ohm, ½-watt resistor
R2—100-ohm, ½-watt resistor
R3—10,000-ohm potentiometer (see text)
R4, R5—56,000-ohm, ½-watt resistor
R6—27,000-ohm, ½-watt resistor
S1—S.p.s.t. switch (see text)
S2—D.p.s.t. normally open momentary-action push-button switch (see text)
S3, S4, S5, S6—S.p.s.t. switch
SPKR—8-ohm PM speaker
Misc.—Cigar (or Bakelite or aluminum utility) box; battery holders; perforated board; flea clips; lamp sockets; hardware, hookup wire; solder; etc.

Unijunction transistor stage Q1 makes up the ticker, and stages Q2 and Q3 form the siren circuits. The AND circuit (left) consists of I2, S5, and S6; the OR circuit uses I1, S3, and S4.



Controls and lamps mount conveniently on lid, all other components on floor, of cigar box. After mounting speaker, affix rubber bumpers to bottom of box to allow the sound to come through.

Construction. Many of the parts needed for the Gadget Box you will probably have on hand. Except for the speaker, D cells and holder, lamps, and controls, all parts can be mounted on a 3"-square piece of perforated board, using flea clips

(*Continued on page* 109)

ON THE CITIZENS BAND

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

1968 MONITOUR RESULTS

IN ANSWER to one CB'er who questioned the meaning of the word "Monitour"—it is the abbreviated title given to an extensive Citizens Band radio *moni*toring *tour,* initiated and conducted by your CB Editor for the last twelve months. Armed with a Johnson Messenger 300 and rechargeable battery pack, we monitored CB transmissions in 13 cities (some of them twice), jetting nearly 30,000 air miles from coast to coast, and driving 25,000 road miles on the nation's tollways, expressways and back roads.

In addition to monitoring transmissions, we interviewed hundreds of CB'ers with many different occupations: hospital employees. policemen, taxi drivers, fruit peddlers, TV production personnel, engineers, ham operators, truck drivers, mailmen, airline stewardesses, filling station attendants, etc. Many non-CB users were found to be aware of the service and knowledgeable in many phases of CB operations.

Ron Voigt, veteran TV newscaster in the Denver, Colorado area, helped us kick off Monitour 68 early in the year by directing us to the best monitoring areas and putting us in contact with Active CB'ers. In Kansas City. Mo., George Martin, Chris Whitehead, and Mike Barelli, filled us in on area functions and directed us to active users of the CB system. None of the four are licensed CB'ers. And from Boston, Mass., Pat Hitchins. a TV production course graduate kept us posted on activities in her area until we managed to monitor in person.

Many reports were also received from short-wave listeners, police officers, and others interested in the public service aspects of CB, but not involved in actually using CB themselves. This volunteer information lends substantial proof to POPULAR ELECTRONICS' contention that Citizens Radio is not a dead horse. Public officials and agencies are becoming increasingly dependent on CB'ers in emergency situations. and the average citizen, though not a user of 2-way radio, is aware of the service and its many functions.

Cities visited over the last year were Denver, Colo.; Chicago, Ill.; Kansas City, Mo.; Salt Lake City, Utah; Aspen, Colo.; Fontana, Wis.; Oklahoma City, Okla.; Los Angeles and San Francisco, Cal.; Philadelphia, Pa.; New York, N. Y.; Hartford, Conn.; and Boston, Mass., in that order.

Areas revisited and monitored further during the same period were Denver, Chicago, Fontana, and New York. In August, we reported that Denver took top honors for the cleanest, best organized CB operations. California had the dubious honor of being the nation's largest CB trouble spot. Since then, we have changed our opinions somewhat.

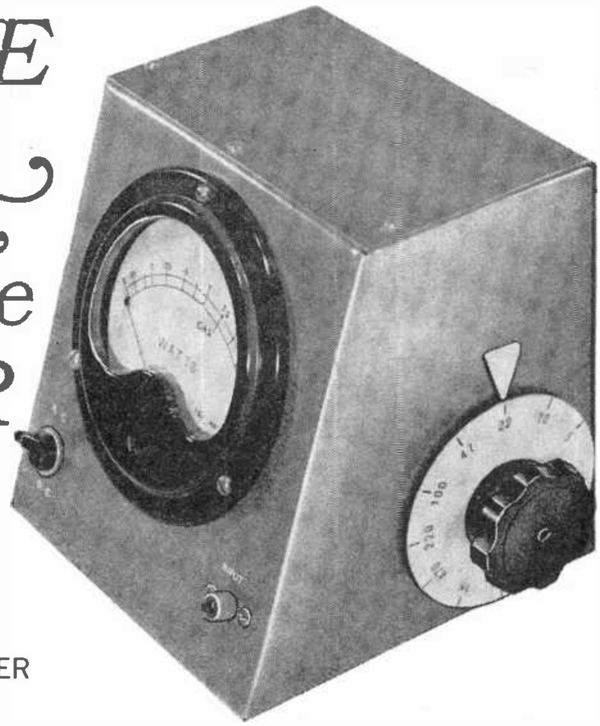
Monitoring results in Philadelphia, New York, Hartford, and Boston show that each of these areas has its own troublemakers, but in varying degrees. New York leads the East Coast in troublesome CB activity with violators using code names similar to those found in California.

"Pacifica" was a code name we heard often in West Coast monitoring, whereas New York violators, who attempted to dominate the area with CQ calls, referred more often to "Brooklyn Baccala" and the "Verazzano Vampire." Verbal shenanigans of this type throughout the U.S. are conducted, not so much by teenagers, as suspected by many, but by adult operators, some of them licensed, others merely "bootlegging" (purchasing CB equipment and not bothering to file for a license). These individuals are setting themselves up for stiff fines from the FCC, and possible jail sentences.

Philadelphia also has its problems, but according to Monitour statistics and mail reports, it has come a long way in solving them in the past. But then, as reported in this column frequently over the last six years, Pennsylvania has probably more active clubs than any of the other states.

(Continued on page 90)

UNIQUE POWER & Impedance METER



READ MAXIMUM OUTPUT OF AMPLIFIERS, SIGNAL GENERATORS AND LOW-POWER TRANSMITTERS

BY ROY HARTKOPF

MEASURING VOLTAGE, current or resistance is relatively easy; all you need is a VOM or VTVM. However, when it comes to measuring power, most experimenters run into trouble. One difficulty is that two independent variables must be measured at the same time: either voltage and current, voltage and resistance, or current and resistance. This may not be too difficult, but if you want to measure *maximum* output power of an amplifier, signal generator, or low-power transmitter, the problem is complicated by the fact that, when making the measurement, the load impedance must match the output impedance of the device being tested.

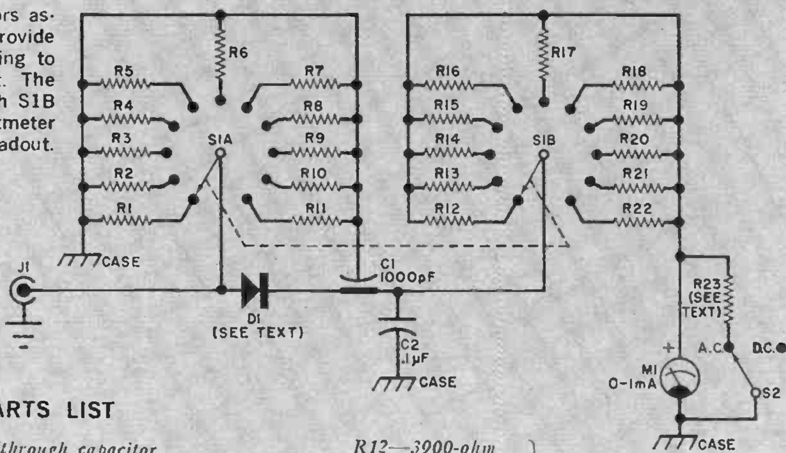
The "Power and Impedance Meter" described here is a low-cost, signal-powered instrument that measures power output from a few milliwatts to 3 watts and simultaneously (and automatically) matches the output impedance from 4.7 to 10,000 ohms. What is more, the meter has a frequency range from d.c. to about 150 MHz! It has no power supply or semiconductor circuitry; and does not require alignment or maintenance.

The power meter is very easy to use: simply connect it to the output to be measured and rotate a single switch until a meter calibrated in watts indicates a maximum value. This is the maximum power output and the switch position indicates the approximate output impedance of the circuit being tested. The test set can be modified easily to indicate output impedance almost exactly.

Construction. The Power and Impedance Meter is constructed in an enclosed metal case to prevent excessive radiation when the test set is used with a low-power transmitter. A sloping front panel is convenient but any other shape is satisfactory.

The load resistors associated with switch *S1A* (*R1* through *R11* in Fig. 1) should be 2-watt, non-inductive units whose tolerances are chosen for the amount of reading accuracy desired, keeping in mind that the ultimate accuracy depends on the meter movement itself. The ohmic values of the resistors shown in the Parts List were selected to cover most loading cases.

Fig. 1. The resistors associated with S1A provide impedance matching to circuit under test. The resistors used with S1B make up a voltmeter using M1 as the readout.



PARTS LIST

C1—1000-pF. feedthrough capacitor
C2—0.1-µF capacitor
D1—Germanium rectifier diode (see text)
J1—Phono jack or other coaxial fitting
M1—0-1-mA meter
R1—4.7-ohm
R2—10-ohm
R3—22-ohm
R4—47-ohm
R5—100-ohm
R6—220-ohm
R7—470-ohm
R8—1000-ohm
R9—2200-ohm
R10—4700-ohm
R11—10,000-ohm
$\}$ *These resistors 2-watt non-inductive*

R12—3900-ohm
R13—5600-ohm
R14—8200-ohm
R15—12,000-ohm
R16—18,000-ohm
R17—27,000-ohm
R18—39,000-ohm
R19—56,000-ohm
R20—82,000-ohm
R21—120,000-ohm
R22—180,000-ohm
R23—see text
$\}$ *These resistors ½-watt*

S1—3-pole, 11-position rotary switch (see text)
S2—S.p.s.t. switch
Misc.—tin-plated shield material, metal enclosure, large knob with pointer, hookup wire, solder, hardware, etc.

The switch can be assembled outside the case. Although only two 11-position decks are required, the author used a three-deck switch with the third one serving as support for one end of the meter resistors (*R12* through *R22*). Disassemble the switch and make up a U-shaped, tin-plated metal shield that covers the front deck of the switch (see photo). The front end of the shield is clamped (and grounded to the chassis) with the switch mounting hardware. Drill holes in the rear of the shield for the rear leads of the load resistors (which are soldered to the shield). The front leads of the load resistors are soldered to the appropriate terminals on the front deck of *S1*. Resistors *R12* through *R22* are mounted between the center and rear decks of the switch. Remove the rotor segment of the rear deck to prevent accidental shorting of resistors.

Drill a hole in the corner of the shield that will be closest to input jack *J1*. This hole should be capable of accepting feedthrough capacitor *C1*, which is soldered to the shield. One end of *C1* is used as a support for diode *D1*. Capacitor *C2* is then soldered in position, and the completed switch assembly is mounted in the chassis. Mount switch *S2* and input receptacle *J1* on the panel.

Almost any diode will suffice for *D1*, but there are two factors which must be considered. With three watts (d.c.) across a 10,000-ohm load, there are 173 volts across the diode. With the same power and impedance, the a.c. voltage is about 250 volts peak. All germanium signal diodes will fail at this voltage level. At the other extreme, 30 mW across a 5-ohm load produces less than half a volt across the diode, which is below the threshold of conduction for a high-voltage silicon diode. In practice, these two extremes are seldom encountered, and the author has found that a germanium rectifier having a 120-volt PIV rating will suffice for almost all conditions.

To calibrate the meter scale for indicating power in watts, gently remove the meter-face protective covering, and recalibrate the scale in accordance with Table I. When this is done, mount the meter in the case.

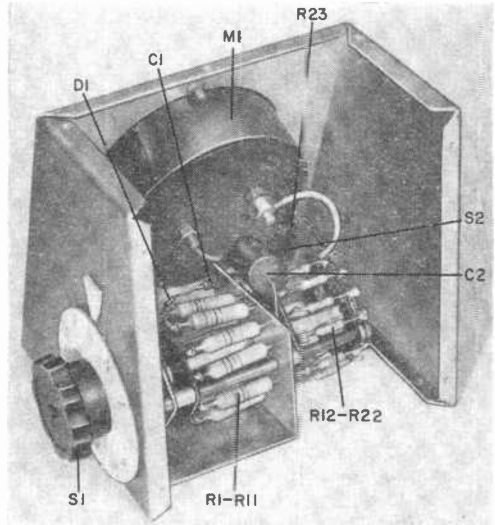
Because the r.m.s. value of an a.c. signal (assuming it is a sine wave) is only 0.707 of the peak value, it is necessary to have a shunt resistor in parallel with the meter during a.c. measurements. Since meters vary considerably in their internal resistance, the choice of this shunt resistor *R23* must be made to suit the meter you are using. To do this, connect a high-voltage supply and a potentiometer with a resistance of several thousand ohms in series with the meter. Adjust the potentiometer until the meter indicates exactly full scale (3 watts). Then connect various values of resistors across the meter terminals until the meter reads 1.5 watts (the CAL position on the scale).

TABLE I—METER CALIBRATION

WATTS	mA
3	1.0
2.5	0.91
2	0.82
1.5 (CAL)	0.707
1	0.57
0.75	0.5
0.5	0.41
0.25	0.29
0.1	0.185
0.05	0.13
0.01	0.057

Since the meter now indicates peak, rather than r.m.s., power, it cannot be expected to give exact results for inputs that are not sine waves. However, this method is used in most VTVM's and has proved to be quite satisfactory in practice, particularly at very high frequencies. Once *R23* has been selected, wire the test set in accordance with Fig. 1.

Operation. Connect input receptacle *J1* to the amplifier, signal generator, or low-power transmitter to be tested. Set *S2* to the AC position, and turn on the system. Rotate *S1* until the meter indicates the highest power output and read the switch position. For example, if the test set indicates maximum power of 1.5 watts at 470 ohms, you know that the device under test has an output impedance of 470 ohms (or close to it) and an output of 1.5 watts. If, on the other hand, you find that the meter indicates 0.5 watts in both the 220- and 470-ohm positions, the correct impedance is about 350 ohms and the power output is a little over one watt.



Mount the resistors, shield, C1, and D1 before installing the switch in the chassis. Grounding, through switch mounting hardware, must be tight!

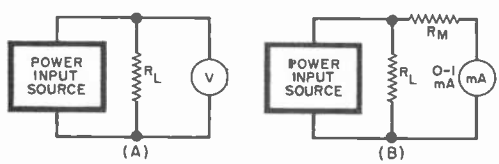


Fig. 2. Power measuring methods. (A) shows basic approach to measuring power, while (B) illustrates the method used in the Power and Impedance Meter.

Calibration Method. The Power and Impedance Meter uses the E^2/R approach to measuring power. The basic circuit is shown in Fig. 2(a). The power dissipated by R_L is E^2/R. Thus if R_L is 100 ohms and the voltmeter indicates 5 volts, the power is $5^2/100$ or ¼ watt. Because power is proportional to the square of the meter deflection, the scale is nonlinear. As an example, if the desired full-scale indication is 2 watts, then the 1-watt indication mark is $1/\sqrt{2}$ or 0.707 of full scale.

Assume that the meter in Fig. 2(a) indicated 10 volts full scale. With a 100-ohm resistor, the power is 1 watt. If the resistor is changed to 500 ohms, the

(*Continued on page* 110)

SOLID STATE

By LOU GARNER, Semiconductor Editor

LOW COST, versatility and availability have combined to make semiconductor devices more attractive than ever to consumer product designers and manufacturers. As a result, our holiday season this year may be the best yet for electronic gifts.

The Sears Christmas "Wish Book," for example, features several pages of electronic toys, ranging from a 3-transistor CB walkie-talkie at only $3.99 to a 10-transistor general-purpose base station which combines an AM and all-channel CB receiver with a channel-14 transmitter in a single unit at $26.99. Other low-cost CB transceivers are listed, as well as construction kits for AM and FM receivers, a telephone amplifier, and four different multi-project educational kits.

A number of inexpensive child-oriented solid-state record and tape cartridge players are offered at prices ranging from less than $10 to just under $40, and there is even a transistorized sound movie projector for only $17.88, including five continuous-loop film cartridges.

There are electronic gifts for teens and adults as well . . . a variety of solid-state tape recorders, AM, FM, and multi-band receivers, TV sets, phonographs, guitar amplifiers, and professional-quality CB transceivers. A buyer can choose a transistorized tachometer or an automatic multi-track stereo tape player for his car, an electronic organ, a transistorized watch, or a portable fish finder for his boat.

You'll find additional semiconductor-operated gifts in your local stores and in the catalogs of the larger mail-order electronic supply houses, such as Allied Radio, Lafayette, Newark or Radio Shack. You can select light dimmers, burglar and fire alarms, or intercoms for the home, solid-state controlled power tools for the craftsman, automatic telephone answering or dictation equipment for the professional man, d.c./a.c. power converters for the camper, or a radio compass/direction finder for the yachtsman. If your budget is small, you can buy a code-practice oscillator module for under a dollar or, if your bank account is as big as your heart, you can invest over twelve hundred dollars in a portable video recording outfit for the man (or woman) who "has everything."

Reader's Circuit. The electronic windshield wiper featured in our March issue ("Slow Kick Your Windshield Wipers," by Donald K. Belcher) seemed familiar to reader Jonathan J. Albers of 203 Madison Ave., Apt. 616, Convent Station, N. J. 07961. He had been using a similar device in his car for almost four years. Jonathan's circuit, illustrated in Fig. 1, differs from the one in the article in that it has an SCR rather than an electromagnetic relay as its basic control element.

In the schematic diagram, unijunction transistor UJT is wired as a free-running relaxation oscillator but it actually performs as a "one-shot" pulse generator. In operation, *C1* is charged through *R1, R2* and isolation blocking diode *D1* when *S1* is closed, at a rate determined by the total RC constant. As C1's voltage builds up, the UJT suddenly switches to a conducting state. The capacitor discharges through load resistor *R4* and a positive-going pulse is developed and applied to the SCR's gate, causing it to switch to a conducting state and shorting the UJT's d.c. supply. The UJT timing circuit remains inactive, then, until power is restored.

The SCR continues to conduct, operating the wiper motor, until d.c. power is removed or reversed by the return switch in the wiper mechanism. At this point, the wipers re-

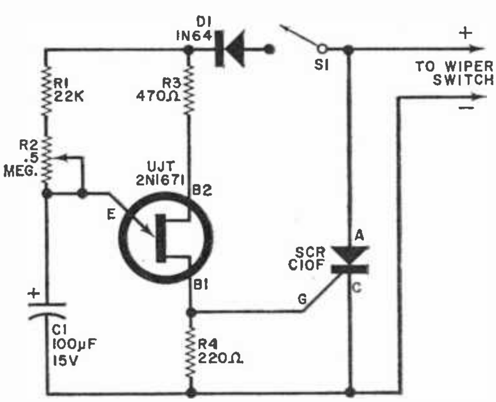


Fig. 1. The SCR supplies power to windshield wiper motor in this slow-kick control for so-so weather.

turn to their normal off position, the SCR reverts to its non-conducting state, and power is reapplied to the UJT circuit, restarting the timing cycle. As long as *S1* is closed, the action continues at a frequency determined by *C1*'s charging rate, and hence by *R2*'s adjustment. Readily available low-cost components are used in the control device. Except for linear potentiometer *R2*, all resistors are half watt.

Comparatively simple, the circuit can be assembled in a single evening. Neither layout nor lead dress are critical and the individual builder can use his choice of construction methods—etched circuitry, point-to-point wiring, or perf board. There is no need to heat sink the SCR since it has a low duty cycle. The completed circuit, after check-out, may be housed in a small metal or plastic box.

Final installation is a cinch. Mount the assembled unit where convenient, either above or below the dash, and connect its two leads directly across the existing wiper switch terminals, taking care to observe proper d.c. polarity. According to reader Albers, his circuit works effectively on *all* types of electric windshield wipers, including even the self-reversing "Mopar" types.

Manufacturer's Circuit. Suitable for use in a Science Fair project or as part of a complex control system, the over-voltage monitor circuit illustrated in Fig. 2 was abstracted from a recent issue of *Semiconductor Newsbriefs* (published by Motorola Semiconductor Products, Inc., P. O. Box 955, Phoenix, Arizona 85001). It can be assembled in a few hours at a total cost of well under five dollars.

The circuit is essentially a d.c. regenerative amplifier with complementary-coupled transistors. Normally, the circuit remains in a passive (non-conducting) state. However, if the supply voltage increases beyond the zener diode's (*D1*) rating, base bias is applied through current limiting resistor *R1* to *Q1*'s base, permitting this transistor to conduct. The collector current of *Q1*, flowing through load diode *D2*, develops sufficient forward voltage drop to furnish base bias current to *Q2* through limiting resistor *R2*. As *Q2* conducts, it serves as an additional base-bias source to *Q1* through *R3*. Through regenerative action, then, both *Q1* and *Q2* are driven to saturation quite rapidly, furnishing power to indicator lamp *I1*. Once triggered by an over-voltage condition, the lamp remains on, since the circuit is in a conducting state until its d.c. power source is interrupted momentarily by opening reset switch *S1*.

Higher (or lower) voltages may be monitored by using an appropriate zener diode and lamp (the specified zener has a 33-volt

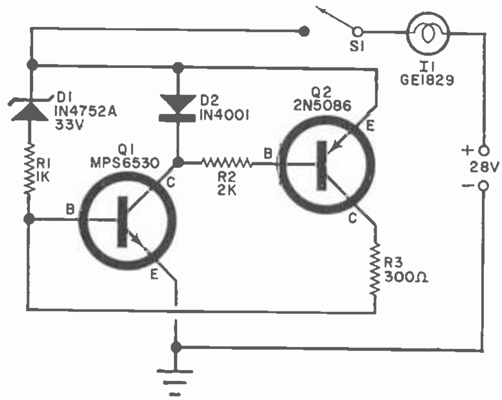


Fig. 2. If the supply increases beyond the zener diode rating, transistors saturate to light I1.

rating), adjusting component values where needed to limit transistor currents within safe values, and observing maximum voltage ratings. An audible signal may be obtained by using a suitable Mallory *Sonalert* device in parallel with *I1*.

Device Developments. A new solid-state ultraviolet sensor is now being offered by Clairex Electronics, Inc. (1239 Broadway, New York, N. Y. 10001). Identified as type 7UV10, the new unit, housed in a TO-5 case, exhibits negligible response to visible light, but has a cell resistance sensitivity as great as 100:1 when illuminated by a UV source. Modestly priced, the 7UV10 is suitable for use in laboratory instruments, "black light" burglar or intruder alarms, and specialized industrial control systems.

● Generally considered an undesirable characteristic in semiconductor devices, thermal runaway is used advantageously in a new explosive detonator developed by inventor F. A. Goss at the Sandia Laboratories (Albuquerque, New Mexico). The new device features an SCR chip with an explosive primer in direct contact with its junction area. In operation, the device cannot be fired unless a control signal is applied to its gate electrode at the same time that power is applied to the anode and cathode terminals. When triggered, thermal runaway takes place, fusing the junction and genrating sufficient heat to ignite the primer. With two signals required for operation, the new semiconductor detonator is much safer than conventional units which, quite often, can be fired accidentally by a stray electrical signal.

● Texas Instruments, Inc. has developed a new type of high-Q inductor small enough to fit direclly on the substrate of thick-film hybrid integrated circuits. Essentially

(*Continued on page* 90)

ENGLISH-LANGUAGE BROADCASTS TO NORTH AMERICA FOR THE MONTH OF DECEMBER

Prepared by ROGER LEGGE

TO EASTERN AND CENTRAL NORTH AMERICA

TIME—EST	STATION AND LOCATION	FREQUENCIES (MHz)
7:15 a.m.	Melbourne, Australia	9.58, 11.71
	Montreal, Canada	9.625, 11.72
7:45 a.m.	Copenhagen, Denmark	15.165
12:00 noon	London, England	21.61
6:00 p.m.	Montreal, Canada	9.625, 11.725, 15.19
6:45 p.m.	Tokyo, Japan	15.135, 17.825
7:00 p.m.	London, England	6.11, 9.58, 11.78
	Moscow, U.S.S.R.	7.15, 7.205, 9.685
	Sofia, Bulgaria	9.70
7:30 p.m.	Budapest, Hungary	6.235, 9.833, 11.91
	Johannesburg, South Africa	9.705, 11.875, 15.22
	Kiev, U.S.S.R. (Mon., Thu., Sat.)	7.15, 9.665, 9.685
	Stockholm, Sweden	5.99
7:50 p.m.	Brussels, Belgium	6.125
	Vatican City	6.145, 9.69, 11.895
8:00 p.m.	Berlin, Germany	9.50, 9.73
	Havana, Cuba	9.525, 15.285
	Madrid, Spain	6.13, 9.76
	Peking, China	15.06, 17.675, 17.90
	Prague, Czechoslovakia	5.93, 7.345, 9.63, 11.99
	Rome, Italy	6.01, 9.575
8:30 p.m.	Berne, Switzerland	6.12, 9.535, 11.715
	Bucharest, Rumania	6.185, 9.51, 11.94
	Cologne, Germany	6.075, 9.64
	Hilversum, Holland (via Bonaire)	9.59
	Tirana, Albania	6.20, 7.30
9:00 p.m.	Cairo, Egypt	9.475
	Lisbon, Portugal	6.025, 9.68, 11.935
	London, England	6.11, 7.13, 9.58
	Melbourne, Australia	15.32, 17.84
	Moscow, U.S.S.R.	7.15, 7.205, 9.685

TO WESTERN NORTH AMERICA

TIME—PST	STATION AND LOCATION	FREQUENCIES (MHz)
7:00 a.m.	Tokyo, Japan	9.505
6:00 p.m.	Melbourne, Australia	15.32, 17.84, 21.74
	Quito, Ecuador	9.745, 11.915, 15.115
	Taipei, Taiwan	15.125, 15.345, 17.89
	Tokyo, Japan	15.235, 17.825, 21.64
6:30 p.m.	Johannesburg, South Africa	9.705, 11.875, 15.22
7:00 p.m.	London, England	6.11, 7.13, 9.58
	Madrid, Spain	6.13, 9.76
	Peking, China	15.095, 17.675, 17.795
	Seoul, Korea	15.43
7:20 p.m.	Yerevan, U.S.S.R. (via Khabarovsk) (Tues., Wed., Fri., Sat.)	15.14, 15.18, 17.88
7:30 p.m.	Berlin, Germany	6.195, 9.65, 9.73
	Bonaire, Neth. Antilles	9.695
	Prague, Czechoslovakia	5.93, 7.345, 9.63, 11.99
	Stockholm, Sweden	11.705
8:00 p.m.	Havana, Cuba	9.525, 15.285
	Lisbon, Portugal	6.025, 9.68, 11.935
	Moscow, U.S.S.R. (via Khabarovsk)	9.54, 15.18, 17.88
	Peking, China	15.095, 17.675, 17.795
	Sofia, Bulgaria	9.70
8:30 p.m.	Bucharest, Rumania	6.185, 9.51, 11.94
	Budapest, Hungary	6.235, 9.833, 11.91
	Kiev, U.S.S.R. (Mon., Thu., Sat.)	7.175, 9.665, 9.685
8:45 p.m.	Berne, Switzerland	6.12, 9.72
	Cologne, Germany	6.145, 9.545
9:00 p.m.	Havana, Cuba	9.525, 11.76
	Tokyo, Japan	9.505
10:00 p.m.	Moscow, U.S.S.R. (via Khabarovsk)	9.54, 9.735, 11.755
10:30 p.m.	Havana, Cuba	9.655

SHORT-WAVE LISTENING

By HANK BENNETT, W2PNA/WPE2FT
Short-Wave Editor

OPEN LETTER TO RADIO CAIRO

United Arab Republic Radio and Television
P.O. Box 1186
Cairo, Egypt, United Arab Republic

Gentlemen:

By way of introduction my name is Hank Bennett. I am the Short-Wave Broadcasting Editor for POPULAR ELECTRONICS Magazine.

In recent weeks my desk has been deluged with complaints from our short-wave monitors. These complaints are lodged against *Radio Cairo*. Specifically, they deal with your apparent refusal to verify correct reception reports.

Without exception, our monitors claim that in return for comprehensive reception reports of *Radio Cairo*, they are receiving various booklets and pamphlets dealing with anti-Israeli propaganda, the Arab-Israel war. and the United Arab Republic charter. This is not what our monitors have requested. They have asked you specifically for verification of their correct reception reports as they sent them to you.

If *Radio Cairo* is to continue to send this unwanted propaganda in place of verification, we believe it is in the best interest of our monitors that no further reception reports be sent to your organization. May I suggest you modify your apparent non-verification policies. This letter will be published and read by more than one-quarter million readers.

Very truly yours,
(*Signed*) *Hank Bennett, WPE2FT*
Short-Wave Editor

(A copy of this letter has been sent to the station.)

Classical Musicals. Are you a classical music enthusiast? Why not combine your music appreciation with short-wave DX'ing? The following university stations in Mexico feature many programs of excellent classical music: XEXQ-OC, San Luis Potosi, 6045 kHz; XEUDS, Hermosillo, 6115 kHz; XERUU, Chihuahua, 6140 kHz; and XEYU, Mexico City, 9600 kHz. We should also include in this listing of good music stations the government-operated XEJG, Guadalajara, 4820 kHz.

Radio Free London. This new pirate station operating on 204 meters (approximately 1466 kHz) went on the air recently to mark the anniversary of the Marine Offenses Bill. The antenna was attached to the fire exit of the BBC TV studio in West London! A BBC TV staff member noticed the antenna and called police. When the police invaded the studio of *Radio Free London* they found seven young men and a girl in addition to a very simple transmitter. The equipment was using milk bottle tops for insulators.

The following Saturday the Free Radio Association Rally met at Trafalgar Square and marched, in the rain, to No. 10 Downing Street, chanting "Bring Back Caroline" outside the Prime Minister's home. During

Albert Madder, West Hill, Ontario, is registered with us and has certificate VE3PE2LZ. His #19 Mark 2 transceiver was built in Montreal for Army use.

DX STATES AWARDS PRESENTED

To be eligible for one of the DX States Awards designed for WPE Monitor Certificate holders, you must have verified stations (any frequency or service) in 20, 30, 40, or 50 different states in the U. S. The following DX'ers have qualified for and received awards in categories given.

TWENTY STATES VERIFIED

Walter O'Brien (WPE2OXZ), Clark, N. J.
Karl Schulte (WPE3HOO), Middle River, Md.
Jeffrey Stewart (WPE3HLV), Williamsport, Pa.
Richard Eddie (WPEØFFT), Webster Groves, Mo.
Thomas Cybula (WPE2PZJ), Maspeth, N. Y.
Art Studebaker (WPE9JDG), Seward, Ill.
John Karien (WPE3GOC), Franklin, Pa.
Chris Lobdell (WPE1GCI), Reading, Mass.
Gary Cooper (WPE7CQV), Nampa, Idaho
Craig Reinmuth (WPEØFDT), Lincoln, Nebr.
Les Schroeppel (WPE9IZL), Elmwood Park, Ill.
Robert Timm (WPE9JEB), Two Rivers, Wis.
Mark Levin (WPE2PNM), Brooklyn, N. Y.
Jeff Dunham (WPE7CRM), Seattle, Wash.
Marc Riddell (WPE3HGG), Williamsport, Pa.
Robert Spoerl (WPE4JSX), Louisville, Ky.
Allan Keizer (WPE2QCS), Brooklyn, N. Y.
Rev. John Pejza (WPE6HCP), Ojai, Calif.
Robert Scott (WPE8IFM), Auburn, Mich.
Steve Buffaloe (WPE4JID), Wartburg, Tenn.
Harold Wagner (WPE9HRS), Butler, Wis.
Larry Beat (WPE8JJX), Toledo, Ohio
Fred Raley (WPE5ENJ), Pine Bluff, Ark.
Victor Tan Yew Seng (9V1PE1B), Raffles Park, Singapore
Ken Ascher (WPE8JYA), Detroit, Mich.
Henry Gac (WPE8JST), Detroit, Mich.
Lee Cook (WPE5EXJ), Biloxi, Miss.
Richard Stevens (WPE2OVS), Rochester, N. Y.
David Jaffe (WPE2PZE), W. Orange, N. J.

THIRTY STATES VERIFIED

Don Kenney (WPE6AET), Westminster, Calif.
Bruce Collier (WPEØELA), Council Bluffs, Iowa
Kenneth Cohen (WPE2LZJ), Woodbridge, N. J.
Gerald Sullivan (WPE1GQY), Concord, Mass.
Mark Barfoot (VE3PE1ZT), Rexdale, Ont.
Donald Dmytryshyn (WPE1FSV), Pittsfield, Mass.
Clarence Hagerman (WPE2NRU), Delaware, N. J.
Allen Jones (VE3PE2AM), Islington, Ont.
Kendall Porter (WPEØEVD), Overland Park, Kansas
Thomas Gracie, Jr. (WPE2FXL), Collingswood, N. J.
Richard Ardini (WPE1GVT), Medford, Mass.
Paul Mayo (WPE2NJG), Brooklyn, N. Y.
Bill Migley (WPE8JEL), Lancaster, Ohio
Timothy Armstrong (WPE6GGJ), Suisun, Calif.
William Sprague (WPE8IRV), Saginaw, Mich.
Art Morris (WPE2OPJ), Fair Lawn, N. J.
Al Earnhardt (WPE4IJN), Charlotte, N. C.
Robert Griffin (WPE2PLQ), Nanuet, N. Y.
Bruce Gemmill (VE7PE1AD), Vancouver, B. C.
Robert Buckner (WPE2NMO), Rush, N. Y.
Fred Bourjaily (WPE8JIE), Seven Hills, Ohio
Ron Ponke (WPE8HZJ), Centerline, Mich.
Lee La Vigueur (WPE6GRN), Yucaipa, Calif.
Edward Shaw (WPE4JHP), Roanoke, Va.
Don Davis (WPE6FXQ), Monterey Park, Calif.
Alex Garcia (WPE2LXA), New York, N. Y.
Tony Bratton (WPE8FMX), Anderson, Calif.
David Greene (WPE4IUM), Pensacola, Fla.
Roy Carroll (WPE2QAA), Neptune, N. J.
Morris Klein (WPE3HKN), Pittsburgh, Pa.
David Miller (WPE9IZD), Terre Haute, Ind.
John Zaharek (WPE1GUM), Torrington, Conn.
Mitchell Hyman (WPE2OPK), Brooklyn, N. Y.
Mike Diekhoff (WPEØETY), Lincoln, Nebr.
Jack Bacon (WPEØFDJ), Bloomington, Minn.
Kevin Slater (WPE7CNF), Salem, Oregon
Romona Hagerman (WPE2OBV), Delaware, N. J.

FORTY STATES VERIFIED

Roger Thering (WPE6FUB), Barstow, Calif.
Charles Harris (WPE2OGK), Rochester, N. Y.
Richard Pistek (WPE9HOA), Chicago, Ill.
Jerry Starr (WPE8JAF), Youngstown, Ohio
Walter Miscichowski (WPE2BEH), Buffalo, N. Y.
Philip Smith (WPE8IIA), Kettering, Ohio
Jeff Steinwedel (WPE8IJV), Cuyahoga Falls, Ohio
William Sprague (WPE8IRV), Saginaw, Mich.
Samuel Gold (WPE6DXA), San Francisco, Calif.
Robert Platt (WPE9HZL), Elk Grove Village, Ill.
L. Eugene Purdum, Jr. (WPE3GRB), Westminster, Md.
Glen Jenkins (WPE4IVJ), Camp Lejeune, N. C.
Kendall Porter (WPEØEVD), Overland Park, Kan.

FIFTY STATES VERIFIED

Ronald Hartwig (WPE5ELA), Midland, Texas
Bill Sprague (WPE8IRV), Saginaw, Mich.
James McFadden (WPE2OKV), Pleasantville, N. J.
Dave Eaton (WPEØDVS), Aurora, Colo.
John Allen (WPEØDXW), Pueblo, Colo.
Kerry Plantenga (WPE9ITC), Lafayette, Ind.
Gary Ligon (WPE4JAX), Cliffside, N. C.
Mark Connelly (WPE1HGI), Arlington, Mass.
David Conder (WPE9IHV), Centralia, Ill.
Thomas Creery (WPE2PHZ), Conklin, N. Y.

the rally, *Radio Free London* came back on the air and was raided again. The station's operators claimed that they fooled the Government Post Office engineers by letting them take away a transmitter which was, in fact, a useless collection of sockets and tubes. The real transmitter was hidden in the same room.

CURRENT STATION REPORTS

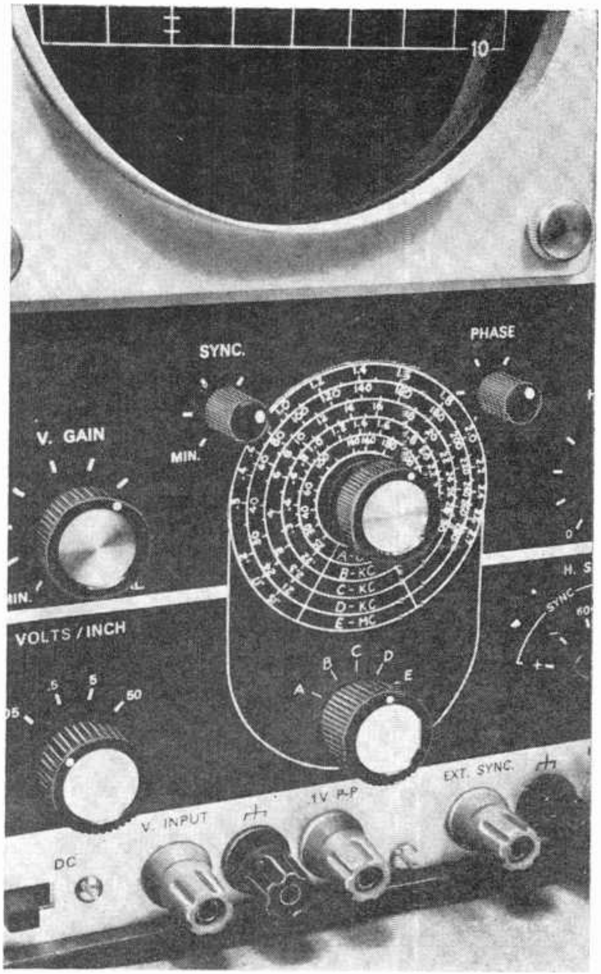
The following is a resume of current reports. At time of compilation all reports were as accurate as possible, but stations do change frequency and/or schedule with little or no advance notice. All times shown are Greenwich Mean Time (GMT) and the 24-hour system is used. Reports should be sent to Short-Wave 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.

Afghanistan—*R. Afghanistan*, Kabul, has English scheduled to Europe at 1800-1830 on 15,265 and 11,775 kHz and to neighboring countries at 1400-1430 on 4775 kHz. German to Europe is aired at 1730-1800 on 15,265 and 11,775 kHz; Russian at 1700-1730 on 7200 kHz and Urdu at 1300-1400 on 4775 kHz, both to nearby areas. All other xmsns are in Pushtu/Dari.

Albania—Tirana was logged in Illinois on the medium wave channel of 1394 kHz at 0035 but with heavy QRM and severe fading.

Algeria—*Idha'at Al Djamhouriati Al Djazariyati Al Demaukrati*, Algiers, 11,810 kHz, is noted from 1950-2145 with announcements and military march fanfares in Arabic except for news in French at 2000. This is beamed to Morocco and the Middle East.

(Continued on page 96)



Add Calibrated Sweep To Your Oscilloscope

Increase the versatility of your scope

BY ROBERT J. BONEBRAKE, W9GCQ

MANY LOW-COST oscilloscopes are equipped with calibrated vertical-gain controls for measuring voltages, but lack calibrated sweep for measuring frequency. If this is a description of your scope, you can probably double the instrument's usefulness by the addition of a calibrated sweep dialplate.

While calibrated sweep may not be needed in some applications, it becomes a necessity when you have to determine the frequency of a signal or the time duration of an unknown cyclic waveform. Adding the calibrated sweep feature to your scope is relatively simple and requires the use of only an accurately calibrated 20-Hz-to-3-MHz sine-wave generator.

The following procedure is worded for the Knight-Kit Model KG-635 oscilloscope, but the appropriate control designations for your scope can be easily substituted. The thing to bear in mind is that the procedure will work for virtually any scope.

First, scribe five concentric circles (about ⅛" apart and the outermost measuring about 2½" in diameter) on a piece of paper. Temporarily tape this piece of paper under the sweep vernier control knob. Connect the output of the signal generator to the vertical input of the scope, and adjust the vertical gain and volts/in controls for a 1" peak-to-peak trace on the CRT. Now, adjust the horizontal gain for a 4"-wide sweep trace (full width of the graticule).

Turn the sweep frequency control to its full counter-clockwise position. (This

(*Continued on page* 114)

AMATEUR RADIO

By HERB S. BRIER, W9EGQ
Amateur Radio Editor

PROTECTING OUR FREQUENCIES

BY INTERNATIONAL law, the amateur bands that are allocated between 3.5 and 29.7 MHz in North America are exclusively amateur. In other parts of the world, all of the 3.5- to 4-MHz band is shared by many services, and the top 200 kHz of the 7-MHz band is assigned to shortwave broadcasters. Of course, we can do nothing about the foreign stations operating legally in our bands. But amateur radio is fighting a constant worldwide battle trying to take over more and more amateur frequencies.

Refusing to vacate a frequency when a commercial intruder moves in is sometimes effective with a low-power intruder, but does nothing against the super-power propaganda broadcasting stations; they don't seem to care whether anybody listens to them or not. The battle against the in-

AMATEUR STATION OF THE MONTH

Bruce John Rogers, WNØUUP, 3043 32 Ave. South, Minneapolis, Minn. 55406, spurred by his interest in radio, is now studying Electrical Engineering at the University of Minnesota. Operating on 40 meters with a National NC-303 receiver, a Heathkit DX-40 transmitter, and a doublet antenna, he has logged 32 states. A 1-year subscription to POPULAR ELECTRONICS goes to WNØUUP for winning this month's Amateur Station Photo Contest. You can enter the contest by sending a clear photograph of yourself at the controls of your station with some details about your amateur career to: Amateur Station Photo Contest, c/o Herb S. Brier, W9EGQ, Amateur Radio Editor, POPULAR ELECTRONICS, Box 678, Gary, Ind. 46401. A good Polaroid shot will do.

truders is being fought by the volunteer "Intruder Watches" sponsored by the American Radio Relay League, Inc. (ARRL), the Radio Society of Great Britain (RSGB), plus other national amateur societies. The ARRL Intruder Watch has been in operation for over four years, and the RSGB group for even longer.

When an Intruder Watch volunteer hears a suspicious signal in an amateur band, he notes its frequency, call letters, and other pertinent data. If the signal is from an illegal intruder, the information is telephoned to the nearest FCC monitoring station (ARRL pays for the phone call). The FCC monitoring network then swings into action to verify the report. If correct, the U.S. State Department requests the government of the illegal station to remove it from the amateur bands.

The Intruder Watch has succeeded in getting many interlopers removed from our bands—often after repeated reports. And even when the protests are apparently ignored, the Intruder Watch is still serving amateur radio. At the next international telecommunications conference, its work will refute any claims that no one was injured by the illegal operations.

Although some Intruder Watch volunteers have very sophisticated equipment, any amateur or shortwave listener with a good, well-calibrated amateur receiver and enough knowledge of international amateur frequency allocations to be able to differentiate between legal and illegal occupants of the bands is capable of becoming a useful member of the Intruder Watch team. If you are interested and are willing to give a few hours a week to the program, write to "Intruder Watch," ARRL, 225 Main St., Newington, Conn. 06111.

Oklahoma City Amateur Classes. An interesting feature of the amateur code and theory classes conducted several times a year by the Aeronautical Center Amateur Radio Club (Postal Station 18, Oklahoma City, Okla. 73169) and the Oklahoma City VHF Amateur Radio Club (821 N.E. 65th St., Oklahoma City 73105) is the fee structure. Each student who completes the course has his $4 returned in the form of a check made out to the Federal Communications Commission to pay his amateur examination fee. Students who drop out of the classes

Proudly displaying the plaque awarded him by the Medical Amateur Radio Council is Dr. Alson E. Braley, WØGET. A dedicated radio amateur, Dr. Braley is head of the Department of Ophthalmology at the University of Iowa. The plaque is in recognition of his founding the Amateur Radio Eye Bank Network.

or who do not take the test forfeit their $4. (It's not clear whether students who take the Novice test—for which there is no fee—get their money back or if it is held in escrow a reasonable time until they are ready for a higher grade test.)

The Oklahoma City amateur classes are designed to prepare students for all classes of amateur licenses from Novice to Extra class. For details on the next series of lessons, contact either club.

Amateur Radio at GOP. Did you work K4GOP in Miami during the Republican convention? The Dade County, Florida amateurs with the help of Charles Colvin, W4LVV, Southeastern ARRL Director (who arranged for financial assistance from ARRL) and Andy, W4IYT, editor of "Florida Skip," set up a special amateur station at the convention for the convenience of the delegates. The Federal Communications Commission cooperated with them by authorizing the use of the special call letters, K4GOP. Eight-hundred-forty-seven messages, including some to Vietnam, from convention delegates and guests were handled through K4GOP during the convention. Equipment used included a Swan 500-C transceiver and a Heathkit HW-12A transceiver. Thanks to "Florida Skip" for this information.

Bill Molnar, WA3JGQ, Mason Town, Pa., worked 24 states in 4½ months as a Novice with his Knight-Kit T-60 transmitter and Heathkit HR-10B receiver.

FCC News. The Federal Communications Commission's proposed modifications of Novice regulations should go into effect shortly. Novice licenses will be issued for two years for code operation only. But under the new setup, any citizen who has not held a valid U.S. amateur license in the

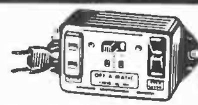
(continued on page 82)

$28.95

Knight-Kit Ignition System Saves Gas, Plug Life!
Capacitive discharge. Easy to assemble and install yourself! For any 12v system. Wt. 2½ lbs.
22 PH 9575X . . . 28.95

7" reel 3 for $7.95

SAVE $1.62 on Allied's Deluxe "265" Recording Tape
1-mil "Mylar": 1875 ft. per reel. Has sensing foils, tape head cleaner. Shpg. wt. 4 lbs.
15 PH 015 . . . 3/7.95

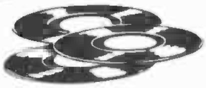


$4.95

Shuts off hi-fi system when last record has played
Quick, easy installation. For any make record changer. 12 oz.
24 PH 9234 . . . . 4.95

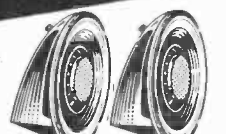
SEE HOW YOU SAVE AT ALLIED

ORDER THESE OUTSTANDING VALUES NOW, RIGHT FROM THIS PAGE!



3 for $3.29

Set of Three Stereo Demo Records
Tests and demonstrates your stereo system performance. 12-in., 33½ rpm. 2 lbs.
24 PH 9010E 3/3.29

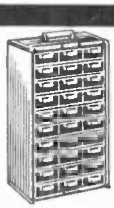


2 for $20.95

Buy 2nd Utah "Celesta" 3-Way Speaker for $1.00 More!
Two 8" three-way speakers for $1 more than the price of one! Full 35-20,000 Hz response. 15 watts capacity. Wt. (2), 22 lbs.
20 PH 8224 .1/19.95 .2/20.95

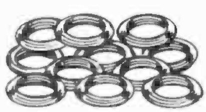
$39.95
SAVE $13.98

Allied 'Mark 26' Antenna Plus Alliance T-45 Rotator
For Color, B&W VHF, UHF and stereo FM. 26-element gold-corodized antenna plus weather-proof rotator, control box. 21 lbs.
11 PH 3081 L2ZW 39.95



$5.49

Parts Cabinet with 30 'See-Thru' Drawers
Steel frame. 9¾ x 17 x 16¼". Wt. 9 lbs.
24 PH 9028X 5.49



10 for 98¢

25-ft. coils Hookup wire
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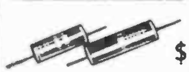

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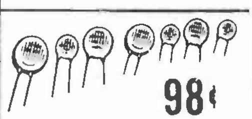

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AMATEUR RADIO

(Continued from page 78)

previous year is eligible to apply for a Novice license, a liberalization of the old rule that prevented anyone who had ever held a U.S. amateur license from obtaining a Novice license. On the other hand, under the new rules, a licensee cannot hold both a Novice and a Technician license simultaneously. The latter seems to negate the Commission's ruling that a Technician who had never held a Novice license was eligible to apply for one.

1968-69 160-Meter DX Tests. At 0500 to 0730, GMT, December 1, 15, 29, January 12, February 2 and 16 are the times of this season's transatlantic tests. Sixteen and a half hours before these early Sunday morning (EST) tests, the transpacific version of the tests is scheduled between 1330 and 1600 GMT.

Donald Demik, WA9BYF, (left) being congratulated by Philip Haller, W9HPG, ARRL Central Division Director, upon being selected Illinois Amateur of the Year for 1968 at the 34th Annual Hamfesters Outing. As CD Communications Officer for Evergreen Park and Oaklawn, Ill., Don spends much time teaching others to handle emergency communications.

Amateur Electrocuted. The Oklahoma City VHF Amateur Radio Club *News* reports that James Roush, WA5MEI, Crescent, Okla., was accidently electrocuted while putting the finishing touches on his new amateur "shack." According to Jim, WA5TXO, his dad was putting his tools away when he came in contact with a 117-volt extension cord and was killed. WA5MEI was Civil Defense Director and Radio Officer for Crescent, Oklahoma, at the time of his death.

NEWS AND VIEWS

Ron Brown, WN2EKW, 260 Ellen Dr., Buffalo, N.Y. 14225, transmits with aid of a homebrew 75 watter and receives on a Heathkit HR-10B. His antenna is a dipole and he has worked 39 states—36 confirmed. Hawaii rates as his best DX. Ron reports that a Worked All States (WAS) net meets each Monday at 1000 GMT (5:00 a.m., EST) on 7170 kHz. Twenty states are represented so far. Get more information from WN2EKW . . . **Darrell "Buck" Buxton, WN8AEZ,** 132 Elk St., Gassaway, W. Va. 26624 also has confirmations from 36 of the states

Walter H. Treftz, KL7GGU, Anchorage, Alaska, has a well-outfitted station with, on the table, left to right, a Heathkit Apache/SB-10 transmitter and Collins 51-J3, Hammarlund SP-600-JX, and Hallicrafters S-36 receivers. Antennas—a 10/15/20-meter beam and 80- and 40-meter dipoles. He didn't identify the unit at lower left—possibly an antenna tuner?

he has worked, mostly on 15 meters. He has five countries worked. A Heathkit DX-100B transmitter cranked down to 75 watts driving a Hy-Gain 18-V vertical antenna, and a Hallicrafters SX-99 receiver completes the WN8AEZ equipment catalogue . . . The Medical Amateur Radio Council, Ltd., (MARCO) *Newsletter* reports that **C. L. Samuelson, M.D., K8WYP,** 1968-69 president of MARCO was awarded the 1968 American Petroleum Certificate of Appreciation for Distinguished Service. The citation covers his work in the fields of Medicine, Toxicology, Health, and atmospheric pollution. Doctor Samuelson is the Medical Director of the Marathon Oil Company, Findlay, Ohio . . . **Scott Gray, WN6EBL,** Inglewood, California, tees off against amateurs who downgrade Technician class licensees, because the instructor of his club's amateur radio course told him not to become a "6-meter lid." Cool it, Scott! Cool it! Neither the class of license or the band operated has anything to do with being a "lid." The recent indictment of three 75-meter operators for allegedly using profane and obscene language on the air proves that. Why be a "lid" on any band?

Kenneth Smyth, WA2WXR/KG6, WN2WXR/WG6, 138 1st Street, N.A.S., FPO, San Francisco, Calif. 96637, has been a forlorn voice on the 21-MHz Novice band. No one has answered his calls from Guam with a 75-watt transmitter feeding an inverted V antenna, although he does ragchew with K7HIX/KG6 on 50 MHz. Things will be different—he hopes—when Ken gets his Vee beam and new equipment in operation. Ken points out that the answer to our recent speculation as to when the first WC6 call will be issued in California is probably never, because WC6 is the Novice prefix for the Caroline Islands. The WD6 prefix is open, however . . . **Thomas C. Clancy, WA3GUI,** 11318 Cherry

Hill Road, Apt. 303, Beltsville, Md. 20705, started his amateur career with a Knight-Kit T-60 transmitter and a Star Roamer receiver, and he worked 15 states with a trap dipole antenna. He still has the same antenna, but the transmitter is now a Heathkit DX-60B, and the receiver a Heathkit HR-10 helped along with an AMECO preamplifier. All states and 64 countries worked, a 25-wpm code certificate, and an Advanced license are his present claims to fame . . . **Alan Brown, WN5VQT,** 2849 Bay Meadow Circle, Dallas, Texas 75234, started out small in the transmitter department. Running seven watts to a homebuilt rig, he worked 12 states and Mexico in three weeks. An inverted-V antenna, 30′ high, and a Knight-Kit R-100A receiver were also involved in this 40-meter work. Probably Alan will have his new 50-watt transmitter completed and on the air by the time you read this.

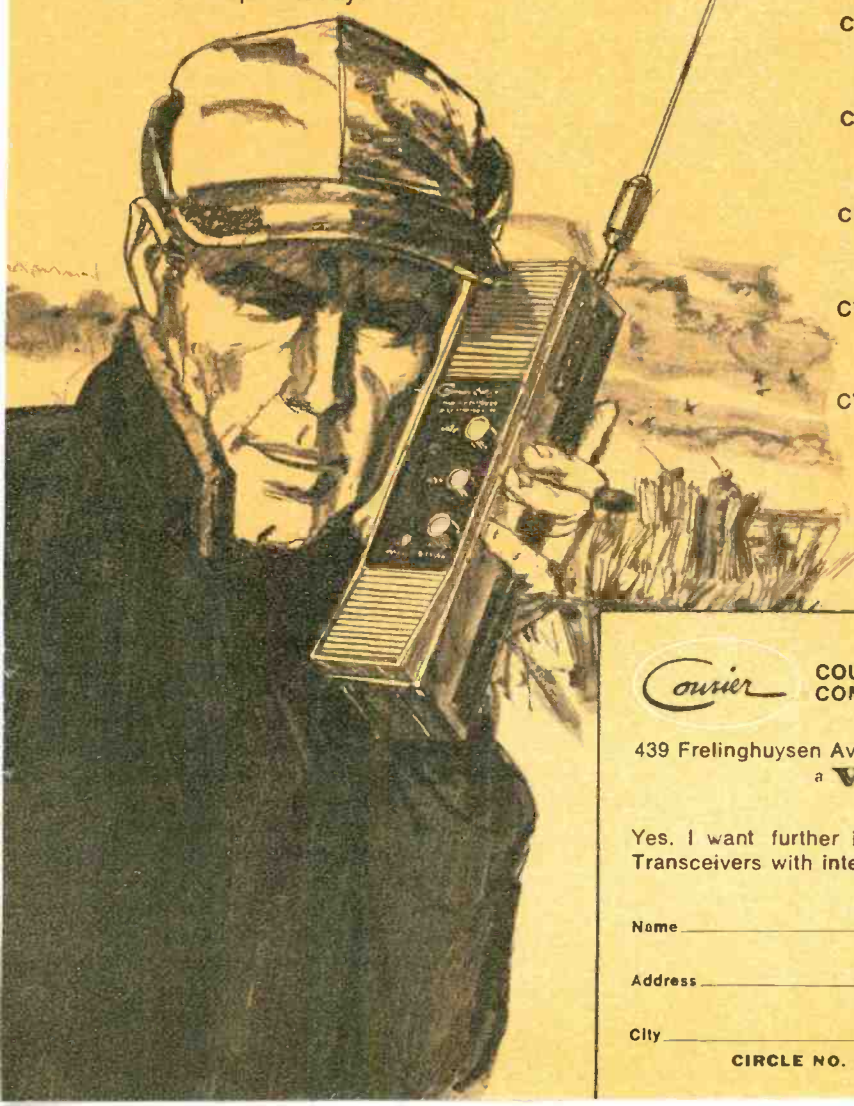
Doug Pongrance, WA3JBN, 316 Donnell Road, Lower Burrell, Pa. 15068, travelled the road of Novice, to Technician to General license but has never been on the VHF's. On 7 and 21 MHz, his Heathkit DX-20 transmitter and Hammarlund HQ-110 receiver have logged 32 states and six countries. Two antennas—a 12′ high dipole and homebrew vertical —do the radiating . . . **Eric Fridman, WA9ZBB,** Versailles, Ind., gets right to the point. He has worked 44 states and 14 countries in about four months with a Drake T-4XB transmitter, R-4A receiver, a Hy-Gain 18AVQ vertical antenna, and an assortment of dipoles. Among his QSL cards is a 15-wpm code certificate . . . In July, an explosion on the Tanker *Mobiloil* 400 miles northeast of Seattle killed a man. **W6SGW/MM** on the tanker reported into the West Coast Amateur Radio Service net on 7255 kHz requesting a phone patch into

Doug Pongrance, WA3JBN, Lower Burrell, Pa., operates his station on 15 and 40 meters with a 12′-foot dipole backed up by a home-built vertical.

San Pedro; so that the captain could talk to the home office. Through the help of K6KZI, W6FXZ, and W7MKW, as well as a multitude of WCARS member who stood by ready to help, the "patch" was completed, and the *Mobiloil* headed for port . . . **William P. Molnar, WA3JGQ,** 214 Cumberland Ave., Masontown, Pa. 15461, went from Novice to General in less than five months. He feeds 60 watts to a Knight-Kit T-60 transmitter to nourish either a 40- or 15-meter dipole; but, as all his 24 states were worked on 40 meters, he apparently doesn't spend much time on "15." Bill receives on a Heathkit HR-10B.

You will probably never see your "News and Views" or picture in *your* column, unless you write that letter you have been planning. Sharp, black and white photos are best. We are also most interested in continuing to receive your club bulletin or being put on your mailing list. Send all material to: Herb S. Brier, W9EGQ, Amateur Radio Editor, POPULAR ELECTRONICS, P. O. Box 678, Gary, Indiana, 46401. Merry Christmas!

73, Herb, W9EGQ.



ON THE CITIZENS BAND

(Continued from page 66)

Pennsylvania's "CB Clean Up" has been credited to the policing job done by clubs.

Hartford's Monitour session was too brief to give a fair analysis, but we found no outlandish violations in two evenings of monitoring. Boston, on the other hand, nosed out Denver with the cleanest operations we have found in the last year. Of the approximately 250 calls monitored in a four-day period, we did not encounter a code name or a linear power boost. There was no vulgarity, profanity or jamming to gain access to a channel.

One emergency call brought a mechanic to the rescue at about 1:00 a.m. one morning in Boston. A woman driving home from work experienced fuel-pump problems in her car. A mobile CB'er spotted the car, relayed the information to a courteous base station female, and stayed with the stranded woman until help arrived.

From a year of monitoring, your CB editor has finalized the results for 1968. Judging only those areas visited in person, the locations with the cleanest CB operation were (in descending order): Boston, Denver, Philadelphia, Aspen, Fontana.

In the final analysis, comments received through the mail indicate that Monitour 68 has aroused enough interest to warrant continuing the project in 1969. Readers have been more detailed and factual in their reporting since the publishing of Monitour reports, and dozens of readers have invited POPULAR ELECTRONICS to visit their areas to compile in-person statistics through Monitour procedures.

If your CB organization would be interested in having us make a "live" Monitour appearance in your area, have a club officer send us a request telling us why you would like to have your active CB channels monitored. Send the request to Matt P. Spinello, CB Editor, POPULAR ELECTRONICS, One Park Ave., New York, N. Y. 10016.

In the meantime, the Federal Communications Commission has some serious thoughts on what CB clubs in all areas can do about local problems. As in the past, the FCC looks upon CB clubs and organizations as the best way of policing the CB channels in their own areas. The Commission would like to see organized groups continue to constructively reprimand and educate area violators, either on an individual basis as problems occur, or by planned programs conducted by veteran users.

I'll CB'ing you. —Matt, KHC2060

SOLID STATE

(Continued from page 71)

subminiature single-layer toroidal ferrite-core transformers, the new inductive components can be adjusted to exact values by using airbrasive techniques to remove core material. Although the first units have been developed primarily for use at high frequencies, as in video i.f. amplifiers, future units may be suitable for the entire upper audio through VHF spectrum.

● Motorola has introduced a new line of low-cost plastic encapsulated transistors designed for medium-power applications. In a new case, called the *Uniwatt,* (Fig. 3) the units have excellent thermal characteristics, whether used alone or attached to heat sinks by means of the copper tabs. Although only

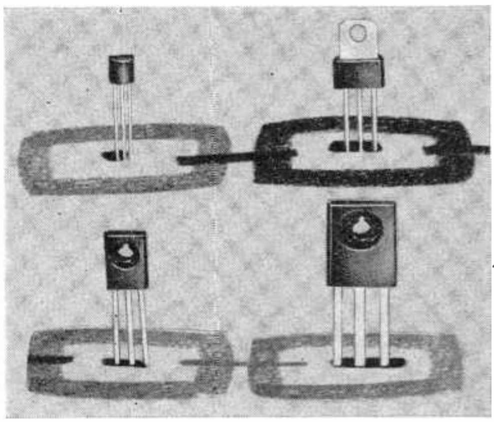


Fig. 3 "Uniwatt" plastic encapsulated transistors are either npn or pnp and dissipate 1 to 8 watts.

about the size of a TO-5, the new units can dissipate from 1 watt to 8 watts, depending on the specific device heat sinking. These are silicon annular transistors, at voltage ratings from 30 to 180 volts. Types MPSU01, MPSU02, MPSU03, and MPSU04, are *npn* devices, while types MPSU51 and MPSU52 are complementary *pnp* units.

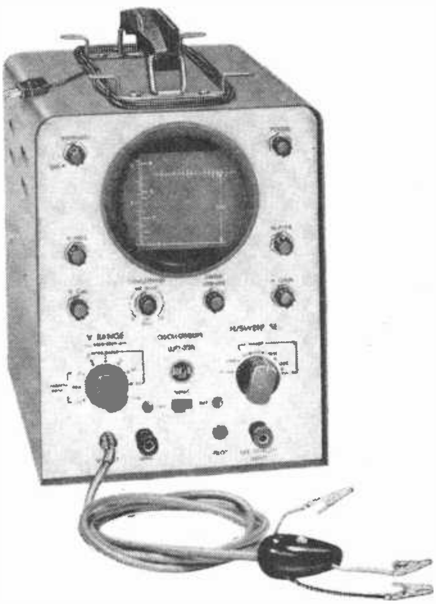
● A new monolithic integrated circuit designed primarily for the speed control of induction motors and lamp dimming applications has been introduced by GE's Semiconductor Products Dept. (Electronics Park, Syracuse, N. Y. 13201). Identified as type PA436, the new IC delivers trigger signals suitable for the phase control of power triacs. Suitable for direct line operation, the PA436 features internal zener voltage regu-

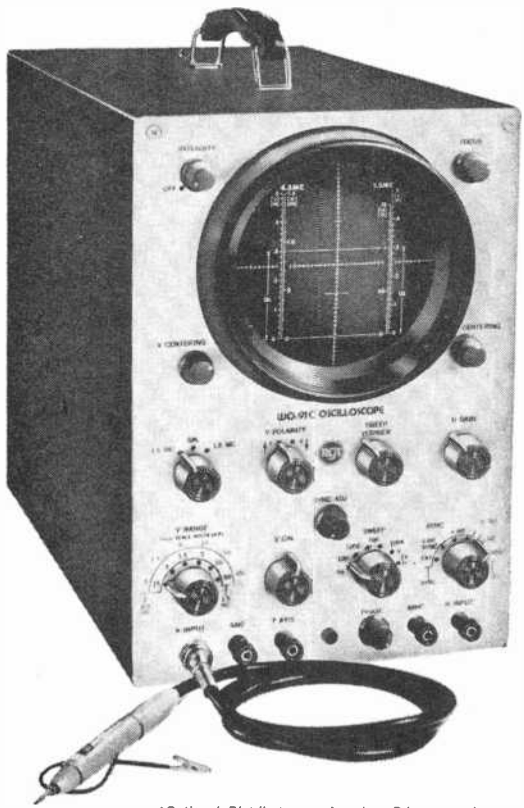
(Continued on page 96)

view

The RCA WO-33A Super-Portable 3-Inch Oscilloscope helps solve virtually any electronics servicing problem, inside or outside the shop. Its combination of exceptionally low cost and high performance have already made it popular as a monitoring and trouble shooting 'scope in black and white and color TV broadcasting studios, and in professional service. And why not? Here's a 3-inch 'scope that meets your requirements for gain, bandwidth, transient response, accuracy, versatility, and portability. AND IT'S ONLY $139.00.* Also available in an easy to assemble kit, WO-33A (K).

The RCA WO-91C 5-inch Dual Band Oscilloscope is a reliable, heavy-duty, precision 'scope in use in thousands of installations from classrooms to TV distribution systems...from service benches to broadcast stations. You probably can't find a better value. Applications include waveform analysis, peak-to-peak voltage measurement, square-wave testing, and observation of circuit characteristics. A front-panel switch gives you an easy choice of wide-band or narrow-band (high sensitivity) operation. It's easily portable, AND IT'S ONLY $269.00.* The WO-91C-V1 is available for 240V operation, no increase in price.





*Optional Distributor resale price. Prices may be slightly higher in Alaska, Hawaii, and the West.

Write for a catalog with complete descriptions and specifications for all RCA test equipment: RCA Electronic Components, Commercial Engineering, Department No. L133W, Harrison, N. J. 07029

LOOK TO RCA FOR INSTRUMENTS TO TEST/MEASURE/VIEW/MONITOR/GENERATE

RCA

CIRCLE NO. 45 ON READER SERVICE PAGE

There's A Heathkit® Gift

NEW kit GT-18
$189^{95}
(less ski)

The HEATHKIT "Boonie-Bike"... The All-Season Trail Bike

Introducing the new Heathkit GT-18 Trail Bike . . . it lets you go places other people can't . . . remote backwoods and forest areas . . . rugged mountain regions . . . isolated lakes & streams . . . rough country roads and long forgotten paths . . . even in the snow . . . places inaccessible by usual means. With the GT-18 you no longer have to depend on paved or dirt roads, or even trails. The GT-18 is only 24½" wide — if there's room to walk, you can ride with this one. But don't let the small size give you the wrong impression. The GT-18 is full of surprises. It's larger and huskier than a mini-bike, smaller, lighter and substantially more powerful than a motorcycle-type trail bike . . . and it has the agility, stability, traction and sheer guts of a mountain goat. Here's why: Pre-mounted on the welded ⅞" tubular steel frame is the easy-starting Briggs & Stratton 5 horsepower, 4 cycle engine, and it gives the 116 pound GT-18 extraordinary power. Performance? You can't touch it for any price. The tubeless front tire is big by trail bike standards (5.30 x 4.50"), but the tubeless rear tire is nothing short of huge — 18 x 8.50"!! And that's what's behind the amazing all-surface performance . . . that 8½" tread coupled with the two speed shift and 5 horse engine will power you thru mud, sand, snow, gravel, tall weeds and rough underbrush . . . up steep hills & rocky paths that would put other bikes totally out of it. And when the going gets snowy, just snap on the optional ski accessory (GTA-18-1 at $16.95). Heath's unique "grip-lock" mounting eliminates any need for tools too!

And stopping is easy and safe with the big hand-operated Bendix drum type rear brake. Loaded with other features too . . . welded steel skid pan, spring shock front suspension . . . big, comfortable seat . . . safety spring-loaded throttle . . . 400 pound load capacity and much more. The Heathkit All Season Trail Bike is so much fun you'll be looking for reasons to ride it. It's the only way to go when the going gets rough. Order yours today. 125 lbs.

NEW kit GR-58
$47^{95}

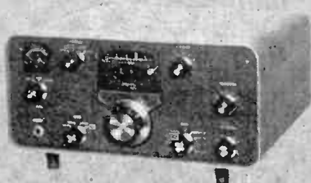
HEATHKIT GR-58 Solid-State AM/FM Clock Radio

The easy way to get up in the morning. Choose the morning news & weather on AM or the bright sound of FM music. AFC makes FM tuning easy. The "Auto" position on the Telechron® clock turns only the radio on, or use the "Alarm" setting for both the radio and the alarm. You can even enjoy fresh coffee when you awake in the morning, thanks to the clock-controlled accessory AC socket on the back of the new GR-58. The handy "snooze" alarm feature lets you wake up gradually for ten minutes to the sound of the radio, then the alarm goes on . . . push the "snooze" button to silence the alarm for ten minutes more of music or news — the alarm sounds automatically every ten minutes and the "snooze" button turns it off, cycling continuously until the selector switch is moved to another position. Fast, easy circuit board construction, smart blue hi-impact plastic cabinet and top reliability make this GR-58 the clock radio for you. 8 lbs.

NEW kit TA-38
$225^{00}

HEATHKIT TA-38 Solid-State Bass Amplifier

The new Heathkit TA-38 is the hottest performing bass amp on the market, for quite a few reasons. First, there's all solid-state circuitry for reliability. Then there's the tremendous power — the TA-38 puts out 120 watts of EIA music power, 240 watts peak, or 100 watts continuous. Extremely low harmonic & IM distortion too. Many amps suffer from "blow-out" problems, but not the new TA-38 — *YOU CAN'T BLOW IT* . . . it boasts two 12" heavy duty special design speakers with giant 3 pound 6 ounce magnet assemblies mounted in a completely sealed, heavily damped ¾" pressed wood cabinet — those speakers will take every watt the amp will put out, and still not blow. Sound? The TA-38 is tailored to reproduce the full range of bass frequencies delivered by bass guitars and its sound with combo organs and other instruments is remarkable. Easy 15 hour assembly to the wildest bass amp on the market. Order one now and surprise the guys with the high-priced gear. 130 lbs.



kit SB-310
$249^{00}

HEATHKIT SB-310 Professional SW Receiver

The finest shortwave receiver you can buy. Covers six shortwave broadcast bands (49, 41, 31, 25, 19 & 16 meters), 80, 40 & 20 meter amateur bands and 11 meter CB. And the new optional SBA-310-3 kit converts the 11 meter band to 15 meters for additional amateur coverage. Has many of the same features that have made Heathkit amateur gear the world's best selling . . . pre-built & pre-aligned Linear Master Oscillator . . . crystal-controlled "front end" for same-rate tuning on all bands . . . linear tuning with 1 kHz dial calibrations . . . separate RF and AF gain controls . . . 5 kHz crystal filter included for clear AM, CW & SSB reception . . . switch-selected upper and lower sideband coverage . . . built-in 100 kHz calibrator . . . headphone jack . . . calibrated "S" meter . . . famous Heathkit SB-Series styling and much more. For the finest shortwave listening, order your SB-310 today. 24 lbs. SBA-310-3, 15 Meter Conversion Kit, 1 lb., $9.95.

Idea For Every Budget

HEATHKIT AD-27 FM Stereo Compact

The new Heathkit "27" Component Compact was designed to change your mind about stereo compact performance. How? By sounding as if it were made of top quality stereo components . . . which in fact it is. Heath engineers took their highly rated AR-14 solid-state Stereo Receiver, modified it physically to fit the cabinet, and matched it with the precision BSR McDonald 500A Automatic Turntable. Performance? Here's the AD-27 in detail. The amplifier delivers 30 watts music power . . . 15 honest watts per channel — enough to drive any reasonably efficient speaker system. Response is virtually flat from 12 Hz to 60 kHz, and Harmonic & IM distortion are both less than 1% at full output. Tandem Volume, Balance, Bass & Treble controls give you full range command of all the sound. Select the FM stereo mode with a flick of the rocker-type switch and tune smoothly across the dial, thanks to inertia flywheel tuning. You'll hear stations you didn't know existed in your area, and the clarity and separation of the sound will amaze you. The adjustable phasing control insures best stereo separation at all times. And the automatic stereo indicator light tells you if the program is in stereo. AFC puts an end to drift too. The BSR Automatic Turntable has features normally found only in very expensive units, like cueing and pause control, variable anti-skating device, stylus pressure adjustment and automatic system power too. Comes complete with a famous Shure diamond stylus magnetic cartridge. The handsome walnut cabinet with sliding tambour door will look sharp in any surroundings, and the AD-27 performs as well as it looks. For the finest stereo compact you can buy, order your "27" Component Compact now. 41 lbs.

HEATHKIT AD-17 Stereo Compact

Using the component approach of the AD-27, Heath engineers took the solid-state stereo amplifier section of the AD-27, matched it with the high quality BSR-400 Automatic Turntable and put both of these fine components in a handsomely styled walnut finish cabinet. The result is the "17" — featuring 30 watts music power, 12 Hz to 60 kHz response, auxiliary & tuner inputs, less than 1% Harmonic & IM distortion, adjustable stylus pressure & anti-skate control and much more. Order your "17" now. 27 lbs.

HEATHKIT Miniature Speaker System

Miniature in size, but not in performance. This new Heathkit acoustic suspension system features two Electro-Voice speakers . . . a 6" woofer and a 2½" tweeter for 60 Hz to 20 kHz response. Handles 25 watts of program material. Adjustable high frequency balance control lets you adjust the sound to what you like. The 8¼" H x 15¼" W x 6½" D walnut cabinet is protected by clear vinyl for lasting good looks. Pick a pair of these performers for stereo compacts. 16 lbs.

HEATHKIT Solid-State Tachometer

The new Heathkit MI-18 has advanced performance features like unique inductive pickup for connection to any spark-type engine and any ignition system, 0-6000 & 0-9000 RPM ranges, temperature compensated ±4% accuracy, stainless steel hardware, splashproof black & chrome case. Pick the MI-18-1 for panel mounting, or the MI-18-2 with case and hardware. Send for yours now. 4 lbs.

HEATHKIT GR-17 Solid-State AM-FM Portable

Everything you want in AM/FM portable. The all solid-state circuit delivers clear, stable AM from distances the mini-portables can't match, and the FM section, with it's 34" whip antenna, three IF stages and 5 uV sensitivity performs like a high priced table model receiver. AFC for drift-free listening and easy tuning too. All critical circuits preassembled and prealigned, and the circuit board wiring harness assembly makes construction even easier. For the greatest sound around, get your GR-17 today. 5 lbs.

HEATHKIT Low Cost Solid-State Organ

Put the sound of live music in your home now with this low cost, all solid-state Heathkit/Thomas Organ. It features all genuine Thomas factory-fabricated parts and 5-year warranty on the plug-in tone generators. Ten true organ voices . . . variable repeat percussion . . . 13 note heel and toe bass pedals for C_1 to C_2 range . . . two overhanging 37-note keyboards, range C_2 thru C_5 each . . . Color-Glo keylights . . . 75 watt peak music power amplifier . . . 12" speaker . . . vibrato . . . manual balance control. Thousands of people have already experienced the thrill and unique personal satisfaction of building this sophisticated, beautiful sounding musical instrument, and you can too. It takes no special skills or knowledge — the famous Heathkit manual with it's easy to follow instructions and giant fold-out pictorials make the 50 hour assembly enjoyably simple. Comes with finished walnut cabinet and 40-lesson self-teacher course. Put the sound of music in your home this Christmas with the GD-325C from Heathkit. 172 lbs.

CIRCLE NO. 22 ON READER SERVICE PAGE

Heathkit® Christmas Gifts

Now There Are 4 Heathkit Color TV's . . . All With 2-Year Picture Tube Warranty

kit GR-681

kit GR-295

kit GR-227

kit GR-180

New Wireless TV Remote Control
For GR-295, GR-227 & GR-180
69^{95}

New Wireless TV Remote Control
For GR-681
59^{95}

Wish Your Family Merry Christmas This Year With A New Heathkit Color TV . . . A Better Buy Than Ever With New Lower Prices

New GR-681 Deluxe Color TV With Automatic Fine Tuning

kit GR-681 **$499^{95}** (less cabinet)

The new Heathkit GR-681 is the most advanced color TV on the market. A strong claim, but easy to prove. Compare the "681" against every other TV — there isn't one available for any price that has all these features. Automatic Fine Tuning on all 83 channels . . . just push a button and the factory assembled solid-state circuit takes over to automatically tune the best color picture in the industry. Push another front-panel button and the VHF channel selector rotates until you reach the desired station, automatically. Built-in cable-type remote control that allows you to turn the "681" on and off and change VHF channels without moving from your chair. Or add the optional GRA-681-6 Wireless Remote Control described below. A bridge-type low voltage power supply for superior regulation; high & low AC taps are provided to insure that the picture transmitted exactly fits the "681" screen. Automatic degaussing, 2-speed transistor UHF tuner, hi-fi sound output, two VHF antenna inputs . . . plus the built-in self-servicing aids that are standard on all Heathkit color TV's but can't be bought on any other set for any price . . . plus all the features of the famous "295" below. Compare the "681" against the others.

GRA-295-4, Mediterranean cabinet shown **$119.50**
Other cabinets from $62.95

Deluxe "295" Color TV...Model GR-295

now only **$449^{95}** (less cabinet)

Big, Bold, Beautiful . . . and packed with features. Top quality American brand color tube with 295 sq. in. viewing area . . . new improved phosphors and low voltage supply with boosted B+ for brighter, livelier color . . . automatic degaussing . . . exclusive Heath Magna-Shield . . . Automatic Color Control & Automatic Gain Control for color purity, and flutter-free pictures under all conditions . . . preassembled IF strip with 3 stages instead of the usual two . . . deluxe VHF tuner with "memory" fine tuning . . . three-way installation — wall, custom or any of the beautiful Heath factory assembled cabinets. Add to that the unique Heathkit self-servicing features like the built-in dot generator and full color photos in the comprehensive manual that let you set-up, converge and maintain the best color picture at all times, and can save you up to $200 over life of set in service calls.

GRA-295-1, Walnut cabinet shown **$62.95**
Other cabinets from $99.95

Deluxe "227" Color TV...Model GR-227

now only **$399^{95}** (less cabinet)

Has same high performance features and built-in servicing facilities as the GR-295, except for 227 sq. inch viewing area. The vertical swing-out chassis makes for fast, easy servicing and installation. The dynamic convergence control board can be placed so that it is easily accessible anytime you wish to "touch-up" the picture.

GRA-227-1, Walnut cabinet shown **$59.95**
Mediterranean style also available at $99.50

Deluxe "180" Color TV...Model GR-180

now only **$349^{95}** (less cabinet)

Same high performance features and exclusive self-servicing facilities as the GR-295 except for 180 sq. inch viewing area. Feature for feature the Heathkit "180" is your best buy in deluxe color TV viewing . . . tubes alone list for over $245. For extra savings, extra beauty and convenience, add the table model cabinet and mobile cart.

GRS-180-5, table model cabinet and cart **$39.95**
Other cabinets from $24.95

Now, Wireless Remote Control For Heathkit Color TV's

Control your Heathkit Color TV from your easy chair, turn it on and off, change VHF channels, volume, color and tint, all by sonic remote control. No cables cluttering the room . . . the handheld transmitter is all electronic, powered by a small 9 v. battery, housed in a small, smartly styled beige plastic case. The receiver contains an integrated circuit and a meter for adjustment ease. Installation is easy even in older Heathkit color TV's thanks to circuit board-wiring harness construction. For greater TV enjoyment, order yours now.

kit GRA-681-6, 7 lbs., for Heathkit GR-681 Color TV's **$59.95**
kit GRA-295-6, 9 lbs., for Heathkit GR-295 and GR-25 Color TV's **$69.59**
kit GRA-227-6, 9 lbs., for Heathkit GR-227 and GR-180 Color TV's **$69.95**

Keep On Giving

HEATHKIT AR-15 Deluxe Solid-State Receiver

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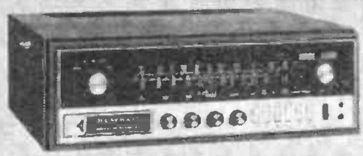

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The remarkable solid-state FM stereo tuner section from the famous Heathkit AR-15. If you already own a fine stereo amplifier, the AJ-15 is the stereo FM tuner for you. It has the exclusive design Heathkit FET FM tuner with two FET RF amplifiers and an FET mixer for 1.8 uV sensitivity and excellent cross modulation. The tuner section is completely factory assembled and aligned for easier construction too. Other features include the exclusive Heathkit Crystal filters in the IF section for perfect bandpass shape, noise-operated squelch, stereo threshold control, "Black Magic" panel lights and more. Put the world's best FM stereo tuner in your system now . . . the AJ-15. 18 lbs. **Optional walnut cabinet AE-18, 8 lbs. . . $19.95**

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kit AA-15 **$169^95** (less cabinet)

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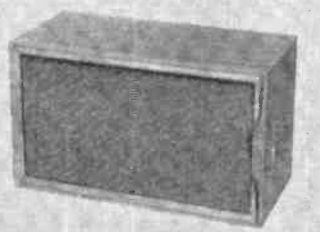
The Heathkit AS-10 system features the extended bass response, smooth high frequency response and low distortion that has made acoustic suspension systems a favorite of audio enthusiasts the world over. The 10" woofer with ceramic magnet delivers rich, full bodied bass down to 30 Hz, and the two 3½" cone tweeters in dispersed array produce clear, lifelike highs to 15,000 Hz. Handles from 10 to 40 watts of program material. The high frequency level control lets you adjust the high frequency response. The AS-10 can be installed either vertically or horizontally and comes in both handsome walnut finish or unfinished wood. You'll need two for superb stereo. 43 lbs.

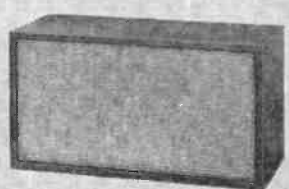
kit AS-10U **$59^95**

kit AS-10W **$64^95**



HEATHKIT AS-16 2-Way System

The AS-16 is an outstanding performer with any equipment and in any surroundings. It features an 8" Electro-Voice® woofer for complete bass response to 45 Hz and two 3½" tweeters that give clear, open highs up to 20,000 Hz. The high frequency level control on the back of the handsome walnut veneer cabinet lets you adjust the high frequency to suit your taste. Handles from 10 to 25 watts of program material. Speakers are already cabinet-mounted . . . just wire the crossover network and enjoy the sound. Buy two for stereo. 22 lbs.



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CIRCLE NO. 22 ON READER SERVICE PAGE

SOLID STATE

(Continued from page 90)

lation, ambient temperature compensation, and adjustable gain. It will accept d.c. control signals from a potentiometer, a thermistor network, or other types of sensors and transducers.

Transitips. Transistor circuit troubleshooting with a voltmeter can be frustrating unless you know not only *what* voltages to expect but *how* to interpret the measurements. Generally, all tests should be made with a sensitive voltmeter having a full-scale low-voltage range of 0-1 volts, or better.

As far as a single stage is concerned, the most significant measurements are the emitter-to-base and emitter-to-collector voltages. Although the actual circuit voltages will vary some measurements are predictable. If measurements are far from the expected values, one can often make a good guess as to the general type of defect to expect, whether in the device itself or in the circuit.

The base-emitter voltage of a conducting transistor depends primarily on its junction characteristics . . . *not* on the supply voltage or bias current. In the case of a germanium transistor, this value is about 0.2 volts, while that of a silicon transistor is about 0.6 volts. If the measured values are far less than these figures, it indicates either that the device is shorted or that there is an open or short in the bias supply circuit (an opened bias resistor or shorted bypass capacitor, for example). On the other hand, if excess voltage is measured, it indicates that the device may be open internally.

If the transistor is operated in a saturated condition, its collector-emitter voltage should be about 0.2 volts, with the balance of the supply voltage dropped across the load device. A lower value indicates a shorted device or an open in the load, while a higher value indicates either that the unit is open or that it is operating class A or class B.

As a general rule, a transistor operated as a class-A stage will have somewhat less than half the supply voltage appearing between its collector and emitter electrodes. This is not an inflexible rule, however, for the class of operation is determined primarily by circuit currents rather than voltages. Similarly, nearly full supply voltage should appear between the collector and emitter electrodes under zero-signal conditions if the transistor is operated at cut-off (class B).

In either case, if the emitter-collector voltage *exactly* equals the supply voltage, there is an open either in the device itself or in its base bias supply, for such a measurement indicates zero collector current. By the same token, a zero emitter-collector voltage measurement indicates either an internal short or an open in one of the supply paths (an open collector load, for example).

With care, then, and a knowledge of circuit behavior, you can track down many device and circuit defects with voltmeter measurements alone. —*Lou.*

SHORT-WAVE LISTENING

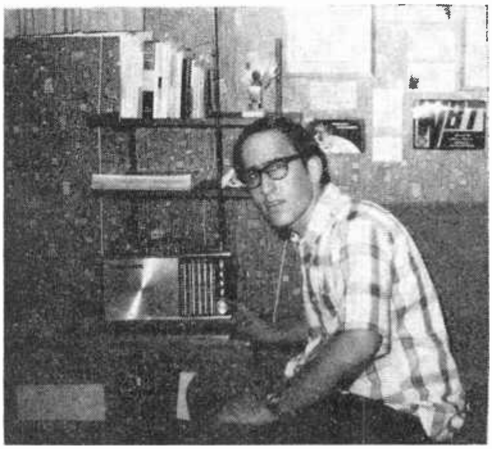
(Continued from page 74)

Angola—*Emisora Oficial,* Luanda, has this new schedule: weekdays 0745-1655 on 11,925 kHz, 0500-1655 on 9535 kHz, 0500-0000 on 7235 kHz, 0500-0745 and 1855-0000 on 4820 kHz and 1655-0000 on 3375 kHz. On Saturdays 7235 and 3375 kHz close at 0200. Sundays 0630-1655 on 11,925 and 9535 kHz, 0620-0000 on 7235 kHz, 1855-0000 on 4820 kHz and 1655-0000 on 3375 kHz. Late listening also indicates two new frequencies in use: 6175 and 9660 kHz from 0500 s/on. The latter channel, at least, has pop music to 0600, then news, in Portuguese. There are two chimes every half hour.

Bolivia—A letter from Hazen C. Parent, General Director of CP75, *La Cruz Del Sur,* La Paz, reads in part "We have been encountering many difficulties in trying to find a new frequency. Our main purpose is to reach Bolivia and surrounding countries . . . . We had tried 5025 kHz and this seemed ideal. However, some local stations claimed interference . . . . we tried 5055 kHz . . . . it is very poor for Bolivia . . . . as a result we have felt obliged to return to 4985 kHz until we can get some clarification or better assignation from the government".

Brazil—ZYA1, *R. Roraima,* Boa Vista, 4835 kHz, has Brazilian pop tunes at 0150 and an ID at 0204. This is an all-Portuguese xmsn. ZYM22, *R. Cultura Sergipe,* Aracaju, 3295 kHz, s/on at 0930 with a prayer, in Portuguese. A new station is *R. Educadora Sao Jose,* Macapa, operating on 2400 kHz with 1 kW power at 0945-0300.

Cameroon—*R. Buea,* Buea, listed for 5984 kHz, has been found on 3970 kHz at 2020 with African pop tunes and anmts in French.



Using a Grundig TR1000 receiver, Harvey Straus, WPE2QJB, Great Neck, N. Y., has logged 60 countries of which 35 are verified. On the medium waves, he has 18 states verified out of a total 28 heard.

Canary Islands—*R. Nacional de Espana,* Santa Cruz de Tenerife, 11,800 kHz, is good in Spanish to L.A., relaying Madrid, from 2200-2315; news bulletins are given on the hour followed by variety music.

Ceylon—*R. Ceylon,* Colombo, observed opening at 0130 on a new frequency of 15,120 kHz with gongs, some pop music some native music, poor level and no English.

China—Two unlisted channels for *R. Peking* are 15,325 and 12,080 kHz, together with listed 11,860 kHz, noted at 2300-2345 in Spanish to South America; news, commentary, native Chinese and march music.

Colombia—*R. Nacional de Colombia,* Bogota, was heard on its generally inactive frequency of 17,865 kHz (may vary to 17,870 kHz) from 0225-0335 s/off with classical music and infrequent IDs.

Congo—Brazzaville's relay has been heard on the rather unusual frequency of 5970 kHz which has a power rating of 4 kW. Dual to stronger signals on 11,725 and 15,445 kHz, the broadcast opens at 0500 with French news.

Cyprus—Tests from Nicosia have been extended and now read: 1900-2100 Monday on 15,245 kHz, Tuesday on 17,760 kHz, Wednesday 15,260 kHz, Thursday 17,875 kHz and at 1300-1505 Friday on 15,270 kHz, Saturday on 17,760 kHz and Sunday on 17,785 kHz. Your Editor thus corrects his own listing of last month; red-faced, we admit having mis-read our own calibration chart!

Ecuador—HCOS4, *La Voz del Rio Carrical,* Calceta, was logged on 3570 kHz at 0215 with listeners re-

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quest music and very few ID's. There is heavy RTTY QRM at times.

Egypt—*R. Cairo* is good on 9475 kHz at 0215 with news. An Arabic speaker on 7215 kHz from 0300 s/on (with a clock striking six) is believed to be Cairo.

England—The latest World Service schedule from the *BBC*, London, reads: to U. S., Canada and Mexico at 2115-2245 on 17,790 kHz, 2115-0030 on 15,140 kHz, 2115-0245 on 11,780 kHz, 2300-0330 on 9580 kHz and 2245-0330 on 6110 kHz. To West Indies, Central and South America (north of the Amazon and including Peru) at 1030-1315 on 21,740 and 17,790 kHz, 2000-2315 on 21,590 and 17,740 kHz, 2000-2300 on 15,200 kHz, 2245-0215 on 15,070 kHz, 2300-0330 on 11,750 and 9580 kHz, and, from the Ascension Island relay, at 2200-0330 on 11,865 kHz and 2200-0415 on 15,260 kHz.

Ethiopia—A new frequency for *R. Voice of the Gospel*, Addis Ababa, is 15,180 kHz, excellent at 0445 with multi-lingual annts, including English, then into music. The station has also scheduled tests in Mandarin to China on 17,830 kHz. (Sunday through Wednesday) and 17,735 kHz (Thursday through Saturday).

Formosa—BED7, Taipei, 7130 kHz, carries Indonesian from 1100-1130, Vietnamese to 1200, Thai to 1230, Chaochow to 1300, Amoy to 1330, Hakka to 1400 and Cantonese to 1500.

Del Hirst, WPE5CFU, Snyder, Texas, has a Hammarlund HQ-100 receiver. Atop it is a homemade W6SAI preselector and at left is an Airline monaural, dual-track tape recorder. Del has 99 states verified.

Germany (East)—*R. Berlin International* is now scheduled to East Coast N. A. at 0100 on 9730 kHz and 0230 on 9500 kHz and to West Coast N. A. at 0330 on 9560, 9650 and 9710 kHz. Additionally, 15,170 kHz is noted along with 9730, 15,190, 15,225 and 15,315 kHz at 0300 and 21,475 kHz at 1645 in English.

Greece—The only foreign language programs (i.e., non-Greek) from *R. Athens* are on 9605 and 9710 kHz in English at 1115 and French at 1118-1121 and on 7295 and 9605 kHz in English at 1410 and French at 1413-1416, then eight minutes duration of each of the following: Turkish at 1420, Serbian at 1430, Albanian at 1440, Rumanian at 1450, and Bulgarian at 1500. The Greek Prime Minister has just ordered the establishment of a short-wave center at Thessaloniki, with two 100 kW xmtrs.

Indonesia—An outlet on 5047 kHz is noted daily from 1145 with the Perkutut bird IS and English news to 1155; a short period of light music follows. The ID is usually for *R. Indonesia*, Djakarta but at 1159 there is a hard copy ID for Djogjakarta. From 1200 the station has Programa Nasional news in Indonesian.

Iraq—Baghdad was logged from 2130-2211 s/off with news at 2200; otherwise live music and chanting in an all-Arabic xmsn. Another xmsn noted from 0227 with the nightingale IS, anthem, and s/on at 0230; both xmsns are on 11,785 kHz.

Israel—The "D Program" of the Home Service of *Kol Israel* is now in English at 0500, 1130 and 1830 and in French at 0515, 1200 and 1845 kHz on 7189 kHz.

Kuwait—The new xmtr of *R. Kuwait* has been found testing at 1745-1815 on 11,900 kHz. Music and anmts in English. Reports to Box 397, Kuwait.

Lebanon—The latest schedule received from Beirut reads: to Africa on 15,370 kHz at 1830-2030 (English 1830-1900); to South America on 17,750 kHz at 2300-0100 and to N.A., the Antilles and Europe on 15,440 kHz at 0130-0400 (Arabic 0200-0230 and 0300-0330; French 0130-0200; English 0230-0300 and Spanish 0330-0400). Omnidirectional broadcasts are at 0430-0730 and 1625-1820 on 5980 kHz and 0925-1600 on 9545 kHz.

SHORT-WAVE ABBREVIATIONS

anmt—Announcement	L.A.—Latin America
BBC—British Broadcasting Corp.	N.A.—North America
B/C—Broadcasting	QRM—Station interference
GMT—Greenwich Mean Time	R—Radio
ID—Identification	RTTY—Radio teletype
IS—Interval Signal	s/off—Sign-off
kHz—Kilohertz	s/on—Sign-on
kW—Kilowatts	xmsn—Transmission
	xmtr—Transmitter

Malaysia—*R. Malaysia's*, schedule includes the following frequencies as being in service: From Penang on 4790, 4985, 7200, 7300 and 9515 kHz, Kuala Lumpur on 4845, 6025, 6135, 7110, 9000 and 9750 kHz, Kuching, Sarawak, on 4835, 4950, 5037.5, 7145, 7160, 7270, 9535 and 9565 kHz, and Jesselton, Sabah, on 4970 kHz. *The Voice of Malaysia* is on 6175, 11,900 and 15,280 kHz.

Papua and New Guinea—Two new stations are in operation: *R. Bougainville*, VL9BA, Kieta, Bougainville, 3332.5 kHz, 2 kW, in pidgin English at 0700-1105, and *R. Samarai* or *R. Milne Bay*, P. O. Box 6, Samarai, New Guinea, VL8AS, 3125 kHz, 250 watts, in pidgin English at 0730-1130.

According to a recent schedule, *R. Australia's* outlet in Papua has a new xmtr on 5985 kHz at 2230-0530. The 4890 kHz outlet, VLT4, Port Moresby, scheduled 0730-1400, is being very well heard in the midwest around 1000-1030 in English and pidgin English.

Peru—A new station is *R. Santa Rosa*, Lima, on 6045 kHz, and heard 0300-0320 with a normal Spanish format. OBX4Q, *R. El Sol*, Lima, 5970 kHz, is very strong on the West Coast around 0430 to a very abrupt s/off at 0455 with Spanish language and U. S. pop music.

Seychelles—*Far East B/C Corp.*, Manila, is constructing a 50 kW relay station for programs to India, Pakistan and Ceylon. Target date is early in 1969. When other antennas are completed in about one year, a new service will also begin to South Africa.

Singapore—*British Forces B/C Service* is now on the air in English on Monday through Friday 2230-0030, 0500-0630 and 0900-1230, Saturdays 2230-0030 and 0500-1230 and Sundays 0030-1230. Gurkha is aired daily at 1230-1430, all on 5010 kHz. Tests are being conducted on 6040 kHz which may become the frequency for the Gurkha broadcasts in the future.

South Africa—*R. RSA*, Johannesburg, has been tuned in English to Europe at 1900-1950 on 5990 kHz in dual to 17,790 kHz. English is also found on 11,775 kHz at 2335; a new frequency.

Switzerland—Berne, 15,180 and 17,845 kHz, has Arabic at 1715, French at 1745 and English at 1815, all to Africa. English to the United Kingdom at 1930-2030 is generally good on the West Coast on 11,865 kHz.

Tunisia—In the September column a station was listed as being in Saudi Arabia on 11,900 kHz. Further checks now reveal that it is most likely Tunis, based on the Arabic ID of *Huna Al-Idha-A Att-Tounoussia*. Noted at 0410-0430 with IS, then s/on, and again just prior to s/off at 2330 (varies), a dual channel seems to be in operation 5985 kHz. We're still working on this one!

Venezuela—YVLC, *R. Valencia*, Valencia, 3355 kHz, was logged with a football game from 0100 with frequent IDs. This remains unverified after five attempts.

SHORT-WAVE CONTRIBUTORS

Bill Smith *(WPE1FZ)*, Uxbridge, Mass.
Chris Lobdell *(WPE1GCI)*, Reading, Mass.
Peter Malvasi *(WPE2NWH)*, Paramus, N. J.
Peter Macinta *(WPE2ORB)*, Kearny, N. J.
Gary Kromer *(WPE2PIH)*, Auburn, N. Y.
Robert Gormley *(WPE2PPV)*, Yonkers, N. Y.
Thomas Henry *(WPE2PSZ)*, Staten Island, N. Y.
Michael Feinstein *(WPE2QAV)*, Bridgeton, N. J.
Rowland Archer *(WPE2QFG)*, Ossining, N. Y.
Carl Rosell *(WPE2QHH)*, Kearny, N. J.
Harold Ort *(WPE2QHN)*, Gloversville, N. Y.
Richard Wells, Jr. *(WPE2QHY)*, Wayne, N. J.
Jack Lyons *(WPE2QHZ)*, Plainview, N. Y.
Michael Gouthro, Jr. *(WPE2QJC)*, Buffalo, N. Y.
Tom Shultz *(WPE2QJJ)*, Cherry Hill, N. J.
Paul Kilroy *(WPE3FOB)*, Washington, D. C.
Clark Turner *(WPE3HKC)*, Wyoming, Pa.
Grady Ferguson *(WPE4BC)*, Charlotte, N. C.
Baine Keel *(WPE4JGL)*, College Park, Ga.
Edward Henley *(WPE4JHC)*, Mobile, Ala.
Richard Allen *(WPE5BZO)*, Braintree, England
Del Hirst *(WPE5CFU)*, Snyder, Texas
David King *(WPE5EWJ)*, Monroe, La.
Trevor Clegg *(WPE6FAF)*, Fresno, Calif.
Steve Higgins *(WPE6HAS)*, Covina, Calif.
Jeff Utter *(WPE6HDJ)*, Carlsbad, Calif.
James Preston *(WPE8JQV)*, Reedsville, W. Va.
Gerry Dexter *(WPE9HDB)*, Lake Geneva, Wis.
Richard Pistek *(WPE9HOA)*, Chicago, Ill.
Gary Bullinger *(WPE9JCZ)*, Aurora, Ill.
Jack Widner *(WPE9JDT)*, Indianapolis, Ind.
Fred Lynch *(WPE9JHD)*, Girard, Ill.
Joe Brown *(WPE9JTO)*, Chicago Heights, Ill.
A. R. Niblack *(WPE9KM)*, Vincennes, Ind.
John Beaver *(WPEØAE)*, Pueblo, Colo.
Bud Whitlock *(WPEØCQS)*, Augusta, Kansas
Jim Randles *(WPEØCWK)*, Cunningham, Kansas
Jack Perolo *(PY2PE1C)*, Sao Paulo, Brazil
Cpl. G. A. Hebron *(VE3PE2LC)*, Chibougamau, Que.
Kenneth Ford *(VE7PE1DR)*, W. Vancouver, B. C.
Craig Anderson, Pasadena, Calif.
William Bailey, Loudonville, N. Y.
Rev. David Clark, Sand Point, Alaska
John Code III, Saratoga Springs, N. Y.
Erik Corey, Sepulveda, Calif.
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Doug Hedges, Pittsburgh, Pa.
John Patterson, Oswego, Ill.
Terry Petrarca, Derry, Pa.
Jeff Pollakoff, San Dimas, Calif.
Jose Rabat, Liege, Belgium
Dean Roche, Houston, Texas
Vincent Spataro, Fairview, N. J.
Kim Stenson, Wilmington, Va.
Tim Sullivan, Minneapolis, Minn.
ETLF, Addis Ababa, Ethiopia
Sweden Calling DX'ers Bulletin, Stockholm, Sweden

Clandestine—*R. Concorde* is aboard a Hondurian ship that is anchored off Knokke, Belgium. Xmsns are said to have begun on 39 and 1754 meters (exact frequencies unknown: 39 meters is in the area of 7500-7700 kHz and 1754 meters is long wave, around 170 kHz—Editor) at 0500-0200 in French and English with perhaps a little Dutch. The power is said to be 50 kW. Has anyone been able to hear it and pinpoint the frequency?

Gia Phu-ong Radio ("Viet Cong") was heard in the midwest on 10,015 kHz at 1228-1301 with anmts in Vietnamese and periods of Viet folk music. News is given at 1231. Location may be Tay Ninh.

73, Hank. WPE2FT/W2PNA

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 and model number of the unit. If you don't know both the maker's name and the model number, give 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. Do not send an individual postcard for each request; list all requests on one postcard. 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.*

Hallicrafters Model S-27 AM/FM receiver, before 1942. Schematic, parts list, and manual needed. (William R. Waddell, Rising Sun, Md.)

Zenith Model 26-298. Schematic and tube placement chart needed. (Karl Geier, 145 E. Grandview Ave., Sierra Madre, Calif. 91024)

National Model SW-54. Operating manual, schematic, and alignment data needed. (Randy Foth, 314 Crescent Dr., Neenah, Wisc. 54956)

Precision Radiation Instruments Model 107B Professional Geiger Counter A.E.C. #SGM-49B. Schematic and batteries needed. (Tim McCormick, 2104 E. Lemon St., Tempe, Ariz. 85281)

Philco Model 38-89. Schematic needed. (Michael Conley, 2331 Chatham Rd., Springfield, Ill. 62704)

Wire Recording Corp. Model WP wire recorder wanted. Operating manual, service information, wire, spools, parts, wire storage cans needed. (LaMar C. Mertz, Jr., 2141 Grove Rd., Bethlehem, Penna. 18018)

Stromberg-Carlson Model 1025-H radio. Schematic and transformer needed. (Mildred V. Smith, 750 O'Farrell St., #111, San Francisco, Calif. 94109)

Heathkit Model VF-1 VFO. Schematic and instruction manual needed. (Jaime E. Vega, Cambronal 8, Santo Domingo, Republica Dominicana)

Clough-Brengle Model 185 Unimeter, line #115-60. Schematic, specs, and probe information needed. (Stephen L. Amrhein, P.O. Box 493, Van Wert, Ohio 45891)

Electrical Research Model S-11 receiver, ser. no. 59221. Schematic or details of tube characteristics needed. (David Parkinson, Saroni Tumor Institute, Mt. Zion Hospital & Medical Center, 1600 Divisadero St., San Francisco, Calif. 94115)

Telefunken 882 WK superheterodyne radio. Tubes needed. (Clarence Wirtz, 1332 W. Commercial St., Appleton, Wisc. 54911)

(*Continued on page* 103)

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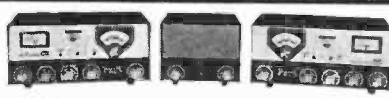

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CIRCLE NO. 16 ON READER SERVICE PAGE

ASSIST

(*Continued from page* 101)

Bell RT-360 tape recorder. Motor operating switches or source and service information needed. (Allan B. Bell, 5712 Princeton Ave., N.E., Seattle, Wn. 98105)

RCA Model 27S63-17 (8M19C, R5386R), circa 1936. Schematic and/or instruction book needed. (John N. Ramsey, 22 Waterside Ln., West Hartford, Conn. 06107)

Fisher radio navigator; tunes 280 to 320 kHz. Schematic and/or instruction manual needed. (Robert F. Malone, 21 Joysan Terr., RFD #1, Freehold, N.J. 07728)

Lear Inc. "Dynatrobe" wire recorder AM/FM tuner, turn table, and amplifier. Schematics, manuals, and source for parts ESP 7F7 and 14F7 tubes. (Jim Courter, 24051 Long Valley Rd., Hidden Hills, Calif. 91302)

Heathkit Model OM-3 oscilloscope. Schematic needed. (Norman Tyson, RD 1, Box 240, Laurel, Md. 20810)

Pilot WASP regen short-wave receiver. Uses RCA UX-201A tubes. Tube list, schematic, and operating instructions needed. (Harry W. Prendergast, 9 Almar Ln., Katonah, N.Y. 10536)

Webster-Chicago Model 180-1 wire recorder. Schematic needed. (Larry Klug, 9211 Army Dr., Baroda, Mich. 49101)

Eico Model 320 signal generator. Schematic and instruction manual needed. (John Oesterling, RR #6, Rushville, Ind. 46173)

Grundig-Majestic Model 2069 receiver. Schematic and parts source needed. **Westinghouse** Model H-563P4A portable 4-tube receiver. Schematic and parts source needed. (Kirby McElhearn, 87-46 Chelsea St., Jamaica Estates, N.Y. 11432).

Nova Tech Model 4B Air O Ear receiver. Alignment instructions needed (also parts replacement list). Walter E. Niemiec, 227 Fairway Dr., New Hartford, N.Y. 13413)

RCA AR88 LF receiver. Schematic and alignment data needed. (Norman Yeager, 7529 Bailey Rd., Montreal 29, Que., Canada) (Can supply manual for Hallicrafters S-40.)

Hallicrafters Model HT-17 transmitter. Schematic and operating manual needed. (Richard Strobele, Box 203, Oakfield, N.Y. 14125)

Hallicrafters Model S-38 short-wave receiver. Schematic, instruction, and operating manuals needed. (J. A. Mazza, 96 Smithfield Ave., Meriden, Conn. 06950)

Stephens Mfg. Corp. Model 500 D trusonic audio amplifier. Schematic and instruction manual needed. (M. Otalora, Los Mochis Sugar Factory, Los Mochis, Sin., Mexico)

Arkay Model 012 vacuum tube voltmeter. Schematic needed. (Frank Orzechowski, 313 Mayock St., Wilkes-Barre, Pa. 18705)

Farnsworth Model AT-50 3-band radio. Schematic needed. (F. R. Giannatti, 3138 W. Glenrosa, Phoenix, Ariz. 85017)

Deforest Crosley Model DC-5 radio. Tube complement and placement and/or tube source (preferably Canadian). (Vic Henderson, 17 Bradfield Ave., Tornot 18, Ont., Canada)

E. H. Scott Model SLR-F receiver. Schematic, operating manual, parts source, and any information needed. (Dennis Bell, 1172 Citrus Ave., Concord, Calif. 91520)

Majestic Model 460 receiver. IF transformer part #10253 needed. (Gerald Hodges, 422 Lincolnia Rd., #103, Alexandria, Va. 22304)

Superior Instruments Model TD-55 tube tester. Schematic and test chart needed. (Ben E. Klein, 614½ S. Ohio, Sedalia, Mo. 65301)

TEC Model S15 transistor stereo amplifier. Audio output transformer P-43 A.T.C. 133 needed. (Joseph Gagliardo, 128 Clinton Ave., Brooklyn, N.Y. 11205)

B&K Model 160 dynamic transistor tester. Operating manual needed. (Thomas R. Haskett, 416 Lafayette St., New York, N.Y. 10003)

Truetone Model DC3880 personal portable. Schematic and source for parts needed. (A. T. Chapulis, P.O. Box 9515, Baltimore, Md. 21237)

Western Television Corp. mechanical-scanning TV receiver, circa early 1930's. Schematics, kino lamp, source for parts, technical and historical data needed. (Ed Bukstein, 3800 Minnehaha Ave., Minneapolis, Minn. 55406)

DeWald Model R1050 CB transceiver. Schematic and operating manual needed. (Alan Stanoszek, 110 Circle Dr., McKeesport, Pa. 15131)

Crosley Model 148 BCB receiver. Schematic, parts list, source for parts, and any information needed. (N. Young, 133 W. Walnut Park Dr., Philadelphia, Pa. 19120)

Atwater-Kent Model 33 radio receiver. Schematic and source for parts needed. (Mike Clouse, P.O. Box 243, Rainier, Ore. 97048)

Hallicrafters Model S-85 receiver. Operating manual, alignment instructions, and schematic needed. (Gary Whitmore, 1037 Bonnie St., Memphis, Tenn. 38122)

DeVry Model S4F power supply. Schematic needed. (David Ostrander, 901 Talbot St., St. Thomas, Ont., Canada)

Grunow all-wave, short-wave, and AM receiver, 1935. Operation manual and any information on how to read dial needed. (Jim Moon, 108 Tenby Rd., Havertown, Pa. 19083)

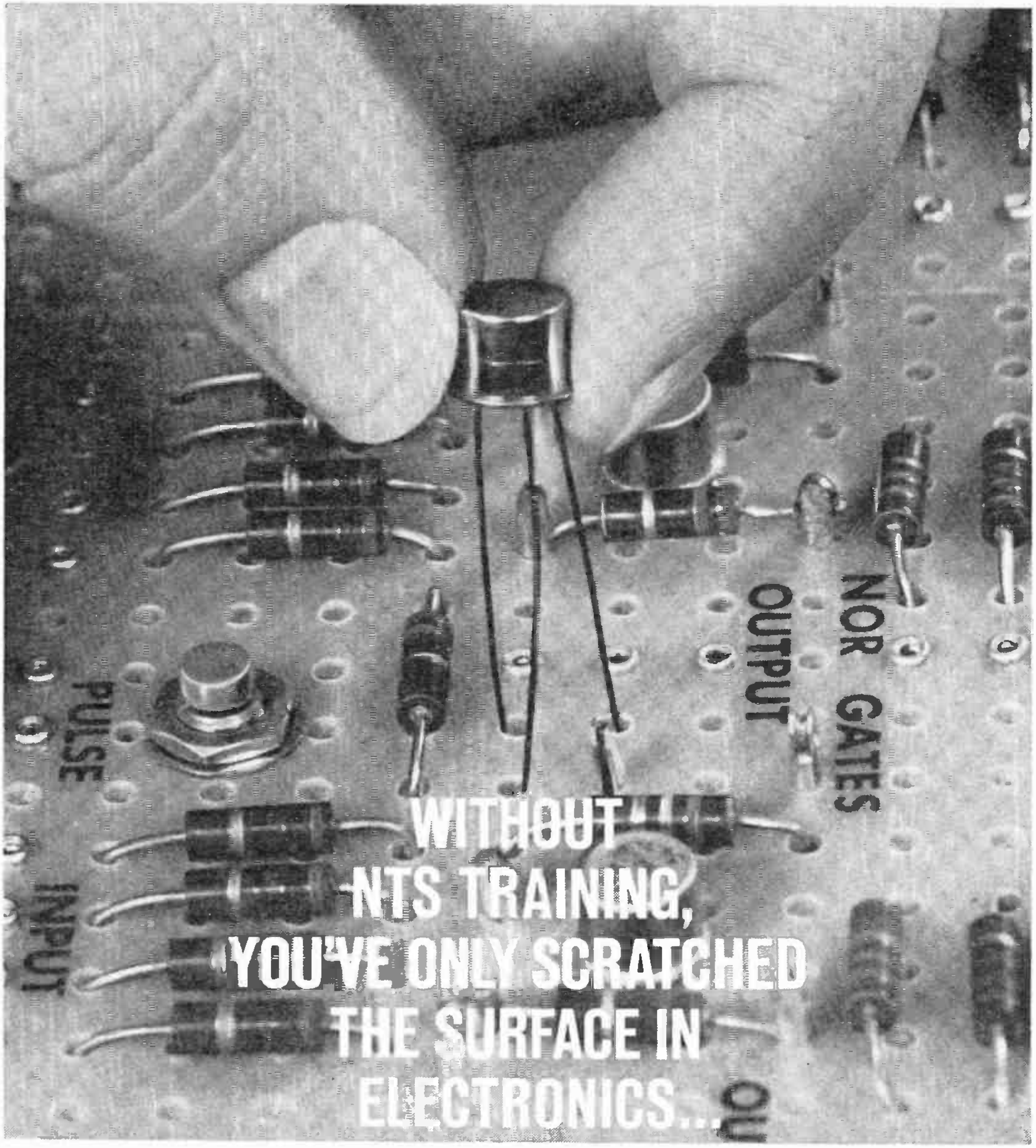
Heathkit Model 08 oscilloscope. Construction manual needed. (Reid Larson, 215 S. Grant, Westmont, Ill. 60559)

Hallicrafters Model S-38C receiver. Cabinet needed (Part # 66 C 722). John Crosby, SUPO Box 9821, Tucson, Ariz. 85720)

OUT OF TUNE

BUILD THE SPORTS TIMER (October, 1968, Parts List, page 32) transistor Q4 should be an MPS2923 or 2N5129. Schematic diagram at top of page is correct.

—30—



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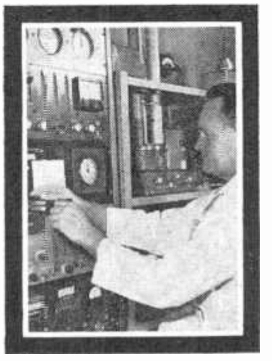

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VOLT-OHMMETER

(Continued from page 40)

changes, adjust *R2* on the V/F module to get an identical 001 reading with the input test leads either open or shorted. Center the adjustment on the 001 reading and then adjust it slightly lower, favoring the 000 reading.

DIGITAL VOLTMETER SPECIFICATIONS

Ranges: D.c. volts: 0-2, 0-20, 0-200. Ohms: 0-200, 0-2000, 0-20,000, 0-200,000. Range extendable to anything that can be represented by a variable 0-2-volt d.c. signal.

Input Impedance (Voltmeter): 0-2, 1 megohm; 0-20, I megohm; 0-200, 10 megohms.

Maximum Ohmmeter Current: 0-200,000 ohms, 10 μA; 0-20,000 ohms, 100 μA; 0-2000, 1 mA; 0-200, 10 mA.

Resolution: One part in 200, any range. ±5 millivolts on 0-2-volt range, ±0.5 ohms on 0-200-ohm range.

Accuracy: Better than ±1% of full scale, ±1 count over most portions of most ranges. Internal calibration with 1.35-volt secondary mercury standard.

Stability: Less than 1 count drift per 20 minutes after 15-minute warmup.

Noise Rejection: Instrument is a fully integrating, multiple slope type and is essentially "blind" to any 60-Hz line-borne hum or noise and has a high degree of rejection to all other high-frequency noise.

Update Time: 15 measurements per second; instrument integrates input for 16.7 milliseconds and displays for 50 milliseconds.

Miscellaneous: Automatic overrange indicator, floating decimal points for "actual value" indication; zener input protection; polarity reversal switch; internally self-calibrating; useful accuracy to 200% of full scale.

To calibrate the ohmmeter portion, ZERO and CALibrate the DVM as described above. Then place the test leads across a precision 1% resistor between 1300 and 1500 ohms (do not use higher or lower values) and switch to the 0-2K resistance range. If the DVM does not read exactly the resistance being measured, adjust *R13* on the V/F module till it does. The instrument is now fully calibrated on all scales.

Readjust the ZERO and CALibrate 1.35 front-panel controls any time you like. This gives you an instant check on how the DVM is doing. The internal trimmers will rarely if ever need readjustment. —30—

LIBRARY (*Continued from page* 14)

provided where necessary. The book is arranged alphabetically in 100 chapters, covering circuits for everything from alarms to welding equipment. Both tube-type and semiconductor designs are provided, along with component values and types. If you need a circuit schematic in any branch of electronics, you can probably find it in this book.

Published by McGraw-Hill Book Co., 330 West 42 St., New York, N. Y. 10036. Hard cover. 864 pages. $18.50.

GADGET BOX

(*Continued from page* 65)

for the interconnections. You can anchor the 9-volt battery to the perf board with a length of wire as shown in the photo on page 65.

All of the components will mount inside a common cigar box, but if you want a more durable housing, you can use a Bakelite box of an appropriate size. Also, you can substitute a 3.2-ohm speaker, but performance will not be as good as with the recommended 8-ohm speaker.

As far as controls are concerned, you can select almost any type that suits your fancy. The d.p.s.t. push-button switch designated for *S2* in the Parts List requires some preparation before installation. First decide which set of contacts you will use as the power switch for the siren assembly. Then, bend these contacts so that they are the first to close and the last to open when *S2* is depressed.

For the ticker circuit, two controls were used—the on/off switch, *S1*, is a switched potentiometer, but the potentiometer section is not used; and a separate pot was used for *R3*. If you wish, you can use just one switched pot to control the tick rate and power. Almost any general-purpose unijunction transistor can be used for *Q1*.

If you're going to paint the cigar box or decorate it with adhesive-backed vinyl, do so after drilling but before mounting any of the parts. Then, when you're finished with construction, show your child once or twice how the controls work and the functions of the Gadget Box. Then, leave him to his own devices. –30–

POWER METER

(Continued from page 69)

power at 10 volts is $10^2/500$ or ⅕ watt. As a result, if the voltmeter were calibrated in watts, it would give the proper indication only with one particular value of load resistor.

The solution to the problem is to forget about voltage measurements and concentrate on the amount of current required to produce a full-scale meter deflection. With a 1-mA meter movement, all we have to do is arrange for 1 mA to flow through the meter whenever we want the meter to indicate full scale (1 watt, 3 watts, etc.). A simplified circuit for doing this is shown in Fig. 2(b).

For a full-scale meter deflection of 3 watts and with a load resistor of 100 ohms, the voltage across R_L would be $\sqrt{W \times R}$ or 17.32 volts. To make a 1-mA meter indicate full scale, the total resistance in the meter circuit (R_M plus meter movement resistance) will have to be 17,320 ohms. Similarly, if the load resistor is 500 ohms, the voltage across it is 38.73 volts and the meter-circuit resistance must be 38,730 ohms.

TABLE II—METER RESISTOR VALUES

R_L (ohms)	E (volts)	R_M (calculated) (kohms)	R_M (used) (kohms)
4.7	3.742	3.7	3.9
10	5.48	5.5	5.6
22	8.12	8.1	8.2
37	11.87	11.8	12
100	17.32	17.3	18
220	26.67	25.7	27
470	37.42	37.4	39
1000	54.8	54.8	56
2200	81.2	81.2	82
4700	118.7	118.7	120
10 k	173.2	173.2	180

The values used to determine R_M for the Power and Impedance Meter are given in Table II. Note that in every case, the calculated value of R_M is close enough to a standard resistance value that it is not necessary to use special resistors. The use of 3 watts as the full-scale deflection makes possible this happy circumstance. Since the meter, in this case, had an internal resistance of only 100 ohms, its resistance was ignored. —30—

ELECTRONIC KITS

(*Continued from page* 46)

two-transistor phono amplifier, and a tone generator. Four projects were chosen for evaluation because of the rather high cost of this kit in addition to the fact that assembly time for even the most elaborate project required less than 10 minutes.

This is a most impressive kit and working it is a breeze. The user simply selects the proper blocks containing the components required for a given project and places them on the plated steel project assembly board. The individual blocks are held in place by magnets that are molded in the bottoms of the blocks.

Aside from the ease with which projects go together, this kit deserves a gold star for another very unique feature: Wiring and component symbols and values are embossed on top of the blocks so that, when the project is finished, its schematic diagram is in clear view, complete with component values. You simply copy the circuit as it appears on the blocks.

In summary, all of the educational electronic kits discussed are designed for the beginner. Every kit has intermediate (and some a few advanced) projects to take the beginner beyond the initial learning stage. Scope of the kits is not limited to a single area; basic control, audio, and radio circuit projects are all represented.

Going a step further, the individual kits are by no means rigidly structured to just the projects described in the instruction manuals. For example, you might put together a crystal-detector radio receiver in one project; an audio amplifier stage would be added in the next project; and so on, always building on the original project (or changing it). Obviously, such repetitions instill a certain amount of inquisitiveness in the youngster working with the kit. Soon, he will be substituting or adding parts either through logically conceived ideas based on what he has learned, or through simple curiosity. In either case, he will be learning by doing. -30-

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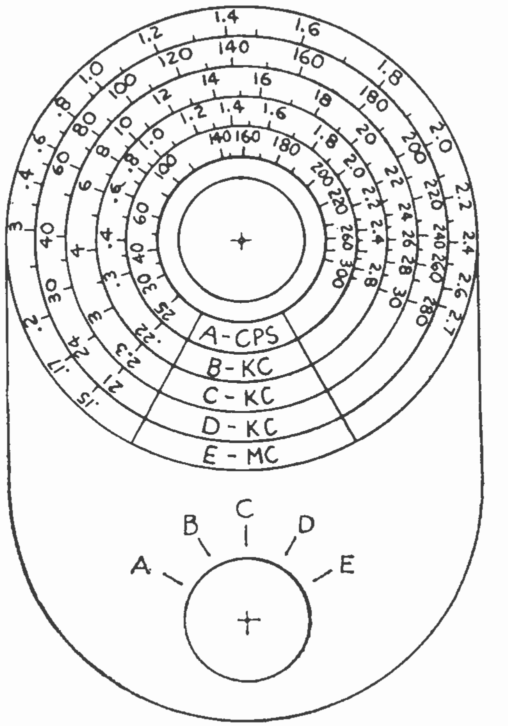

Sweep template should look similar to this. Here, sweep vernier and range switch are close together.

is range "A" on the KG-635.) Set the sweep vernier full counterclockwise and adjust the signal generator's frequency control for a display of one cycle per inch on the CRT. Make a mark (on the innermost circle) and enter the frequency indicated by the generator's dial. Set the generator's frequency to the next higher calibration point, and adjust the sweep vernier control clockwise for a one-cycle/inch display. Mark the position and enter the frequency as before. Proceed in this manner to the fully clockwise position of the vernier control, marking the positions and entering the frequency as you go.

Now set the sweep frequency control to each of its successive positions, and repeat the above steps for the vernier control for each of the positions. Use successive concentric circles to mark the positions and enter the frequencies for each position of the sweep frequency control. When the calibrated sweep dialplate is completed, it should look similar to the one shown in the drawing.

Be sure that, when you skip from position to position and range to range, you touch up the horizontal gain control as needed to maintain a constant 4" trace width. The same applies when you use the scope to measure frequency.

When the calibrated dial is completed, clean it up, or transfer the markings and frequency designations to a more durable medium (such as sheet Mylar, acetate, or a thin sheet of plastic), and use a permanent marker to enter the positions and frequencies. Finally, glue the cleaned up dial to the front of the oscilloscope, being extremely careful to orient it properly. The photo shows the dial mounted and ready for use. —30—

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(Quiz appears on page 54)

1 **TRUE** Although ambient light level plays an important part in seeing any TV picture, sunlight temporarily desensitizes many phosphor luminescent materials.

2 **TRUE** A piezoelectric bar about six inches long can be excited by the flyback pulse and has about 6 kV output. By adding voltage doublers, it can be employed in receivers with small- and medium-size screens.

3 **TRUE** Disconnect the yoke from the receiver and apply 50 to 75 volts from a variable transformer. Use for about 10 seconds and the heat generated will free the yoke.

4 **FALSE** Pincussion correction circuits correct a tendency for the picture to be compressed in the middle as compared to the sides.

5 **FALSE** All else being equal, the phase of the 3.58-MHz signal would still be shifted in frequency by the distance over which it travels.

6 **TRUE** Film frames are alternately exposed two and three times, or five times for each two frames. This "exposes" the camera 60 times for every 24 frames.

7 **TRUE** Mesa is one of the few semiconductor type names which is not an acronym.

8 **FALSE** "Plastic transistor" refers to the encapsulating material. They are growing in favor because they are less expensive to manufacture. They may be either silicon or germanium.

9 **TRUE** Around a.c. power lines, the body acts as a capacitive divider, thus displaying the familiar 60-Hz signal. (Raise one foot from the floor, reducing capacitance, and the signal will be reduced.

10 **FALSE** MOS is an acronym that stands for Metal Oxide Semiconductor.

11 **FALSE** The triac is equivalent to only two SCR's.

12 **FALSE** E_{eff} and E_{rms} are the same. E_{av} is only .9 of E_{eff} or E_{rms}.

13 **FALSE** Ceramic cartridges have been marketed which rival many excellent magnetic types.

14 **FALSE** An anechoic chamber absorbs sound and eliminates reverberation.

15 **TRUE** A small speaker must have greater "travel" and Doppler distortion is therefore greater.

16 **TRUE** A wobbulator may be referred to as the entire sweep generator or the device which drives a frequency-sensitive element in a tank circuit, thus sweeping a band of frequencies.

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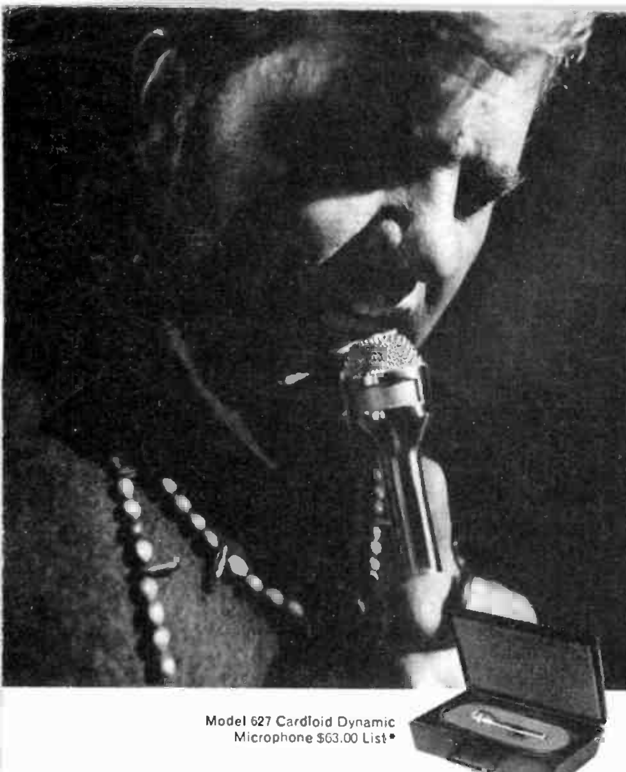
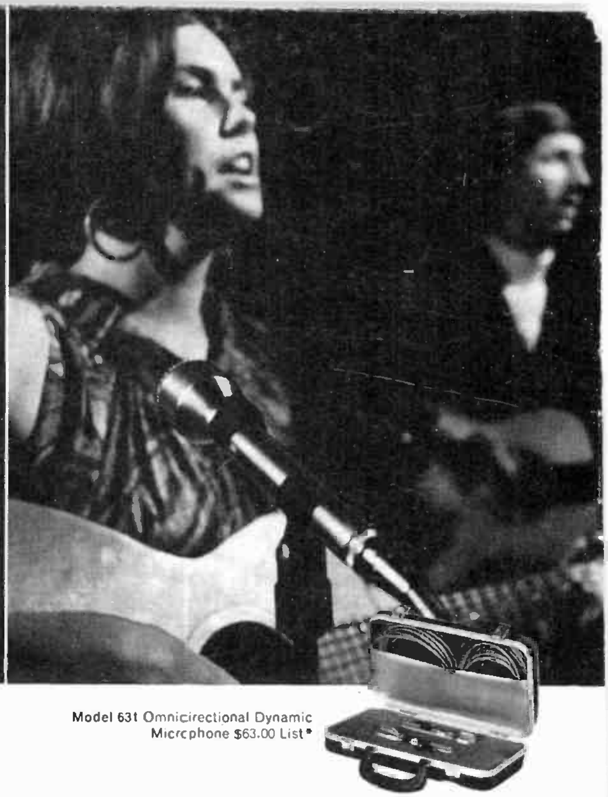


Model 627 Cardioid Dynamic Microphone $63.00 List*



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Both models offer an on-off switch, but the switch on the Model 631 deserves special attention. The unique E-V Uniseal switch is a magnetically operated reed relay buried inside the sealed case. Snap off the magnetic actuator, and the 631 is set permanently "on". Snap it back on and the actuator returns the 631 to normal "on-off" operation. Unusually reliable and exclusively Electro-Voice.

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