elementary Electronics

MAY-JUNE
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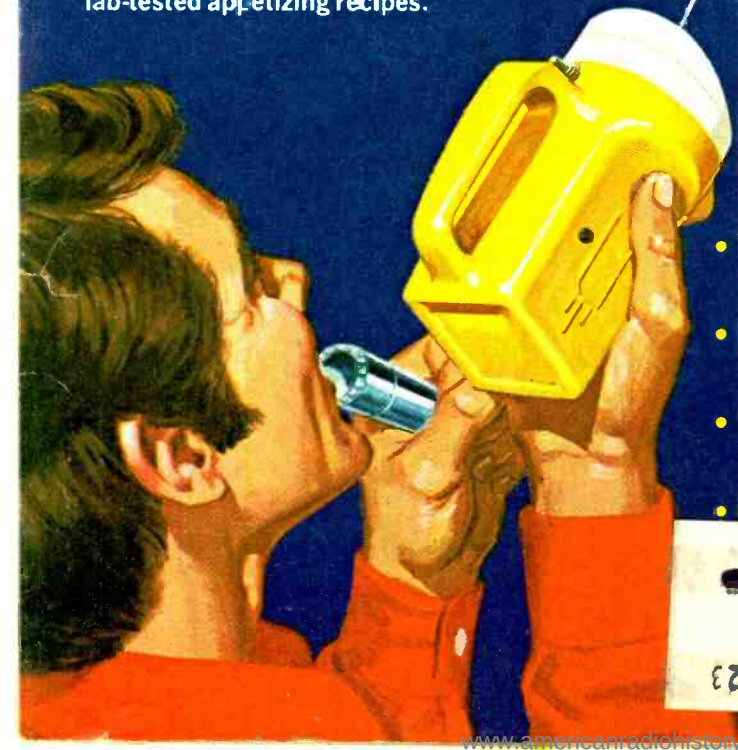
TALK ON A LIGHT BEAM

Faster than a speeding comet your voice travels on an infrared beam across a room, city block or pasture from a light-emitting diode to a space-age solar cell! Complete plans in this issue.

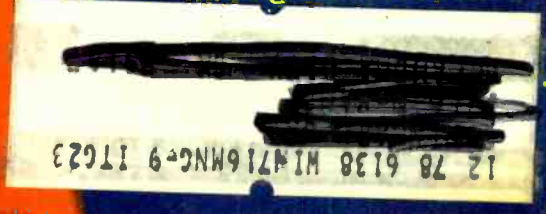
Plus

Now We're Cooking With Microwaves

The greatest discovery since fire! Learn how it works and try our lab-tested appetizing recipes.



- **The War of the Currents** —AC vs. DC
- **Ultra Simple Thermin** —Only 3 Transistors
- **Sounds from the Ground** —A New DX Horizon
- **Understanding Semiconductors**



109.95 buys you a lot of CB!

Midland's new 23-channel mobile compact is quite a CB rig for 109.95 suggested retail! Try to find another unit near this price that gives you all these features: Synthesized 23-channel system —equipped and ready to go. 5 watts audio power, dual conversion receiver. Highly effective automatic noise limiter with front panel switch. Oversized, easy-view transmit/power meter with built-in red TX light. PA switch. Stylish, compact cabinet is just 5½" x 6" x 2". Beautifully styled, hand-fitting mike, coiled cord, and mounting bracket included.

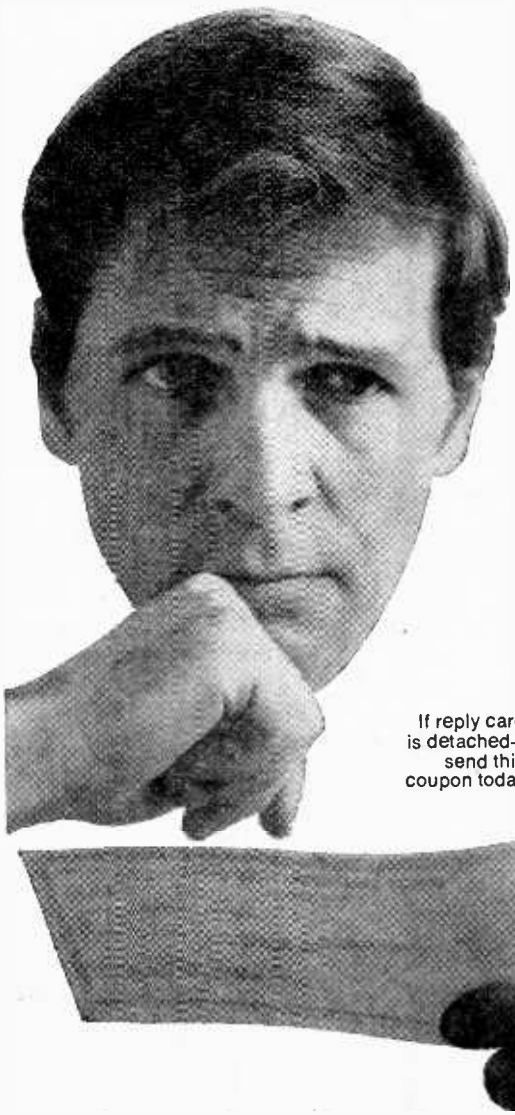
For more on Model 13-869, write for our full-information sheet

MIDLAND
COMMUNICATIONS COMPANY®

P.O. Box 19032, Kansas City, Missouri 64141

CIRCLE NO. 1 ON PAGE 17 OR 103

Your paycheck says a lot about you



It tells you more than how much you make. It tells you how far you've come. And if your paycheck looks very much the same as it did last year, or the year before, it simply means that *you* look very much the same as *you* did last year and the year before.

But times change, and you should be changing with them. Old dull jobs are disappearing. New exciting ones are being created. There are challenging new fields that need electronics technicians... new careers such as computers, automation, television, space electronics where the work is interesting and the earnings are greater.

RCA Institutes has one of the nation's largest and most respected home study schools devoted to electronics. They can get you started even if you've had no previous training or experience. RCA Institutes has developed a faster, easier way for you to gain the skills and the knowledge you need for a fascinating, rewarding electronics career. And you don't have to quit work and go back to school. With RCA Institutes Home Study Plan you can do both. You set your o*wn* pace depending on *your* schedule.

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- You get the widest choice of electronics courses and programs—everything from Electronics Fundamentals right up to Solid State Technology and Communications Electronics.
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• May/June 1972 • Vol. 12 No. 2

e/e elementary Electronics

Dedicated to America's Electronics Hobbyists

☆ Cover Highlights

Cover Illustration by Len Goldberg

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May/June 1972 **Vol. 12/No. 2**
Dedicated to America's Electronics Hobbyists

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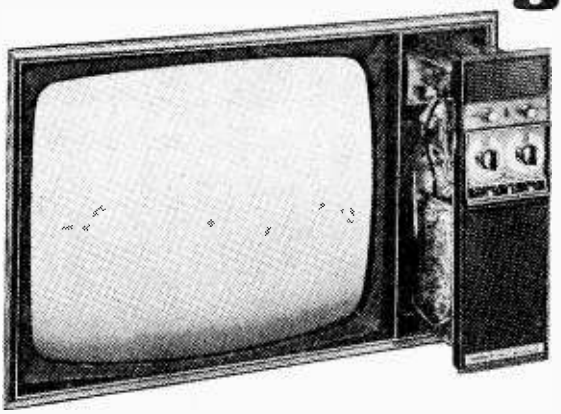

Practice on a new 25" MOTOROLA QUASAR II® chassis.

TV Servicing is a satisfying career . . . and the pay is great. Qualified men are needed now to maintain the 93 million sets in U.S. homes. And prospects for the future are even brighter.

Now . . . here's an opportunity for you to prove to yourself that **you** can learn TV Servicing . . . at home, in your spare time. ICS, the world's most experienced home-study school, will send you a **FREE** Demonstration Lesson (complete with sample questions) if you will merely fill out the coupon below and mail it to us.

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This chassis with automatic fine tuning control is ideal for training purposes because it combines solid state devices with vacuum tubes to give you both kinds of practical experience.

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And we're going to tell you about eight other career opportunities in Electronics and the ICS Career Programs that can help prepare you for them. All you've got to do is mail the coupon. **SEND IT TODAY!**

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- ☐ Computer Maintenance
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- ☐ FCC License
- ☐ Communications/ Broadcasting
- ☐ Hi-Fi Sound Systems
- ☐ Industrial Electronics

Name_____ Age_____

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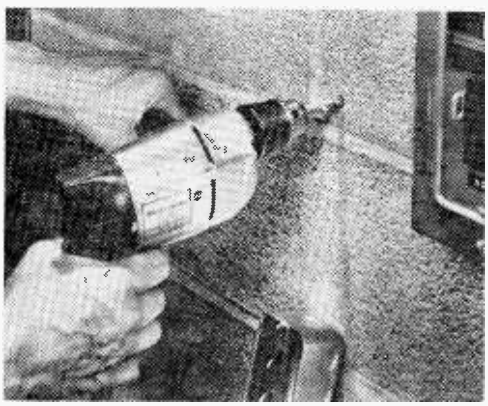
CIRCLE NO. 14 ON PAGE 17 OR 103

Hey, look me over

Showcase of New Products

Variable Speed Drill

A new ½-in. drill with solid state variable speed control and a speed lock switch has been introduced by Black & Decker. With infinitely variable speeds from 0-500 rpm, the unit is especially useful for drilling heavy-duty masonry, hard metal and tile. Just the ideal tool for do-it-yourself elec-



tronics, especially for antenna installations. The speed and torque of this drill increases with the operator's pressure on the trigger. A special lock button permits the right speed to be set for continuous running and greater accuracy. Triple reduction gearing and ¼ HP output burnout protected motor deliver the torque in the compact unit with auxiliary side handle for better control. The unit has a capacity of ½-in. steel, ¾-in. hardwood and 1-in. masonry. It weighs 3¾ pounds. The Black & Decker #7210 ½-in. variable speed drill is available at $29.99 from many retail outlets. For all the facts circle No. 59 on Reader Service Coupon on page 17 or 103.

There's No End

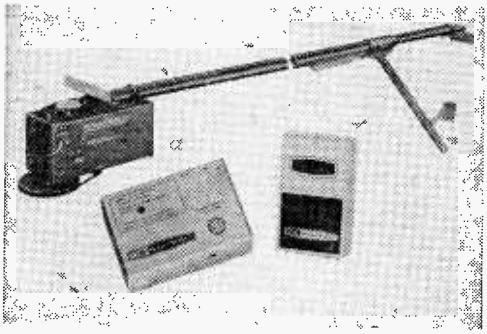
Continuous-play, endless-loop tape cassettes are now available from TDK Electronics Corporation. The wide range of applications for these

HEY, LOOK ME OVER...

repeat-message designs includes continuous background music, telephone answering, control devices, sleep learning and many other educational and industrial applications. EC cassettes are designed to be directly usable in most conventional cassette players and recorders. Like all endless cassettes, the EC series units are designed to play or record in the forward direction only. Forgetful users, however, often accidentally activate the recorder's reverse mode while endless-loop devices are in position, damaging or destroying the cassette. TDK's special construction prevents such damage. An automatic brake is engaged whenever the cassette is out of the recorder, locking the tape supply in position and preventing fouling. Standard EC cassettes are available in three basic message lengths. The EC-1 offers one minute of record/play time ($4.75), the EC-3 runs for three minutes ($5.00), and the EC-6 for six minutes ($5.50). For additional information and specs, circle No. 50 on Readers Service Coupon on page 17 or 103.

Try It, You'll Like It!

Do-it-yourself technology has been applied to remote control garage door openers by the Heath Company thus putting what was once considered a convenience for the wealthy within the grasp of



almost anybody who owns a garage. Costing just $99.95 mail order, complete with one remote transmitter, the new GD-309-A System is actually a "mini-kit" with most electronics (transmitter and in-garage receiver) preassembled. The GD-309-A has a powerful ¼-hp motor with a quiet but strong chaindrive mechanism. It includes receiver, pocket-size transmitter with visor clip, and a push-button that can be permanently installed in the garage. Deluxe features include built-in light that turns on when door is actuated, automatic safety reversing and fuse protected motor. This new Heathkit opener is also available as the GD-309-B with two remote transmitters ($114.95), or individual components—mechanism, transmitter and receiver—can be purchased separately. For further information, circle No. 1 on Reader Service Coupon on page 17 or 103.

Put a Stop On It

Power instruments, Inc. announces a new low price, all purpose, heavy duty, solid-state Master Strobe. This stroboscope stops motion of rotating objects such as shafts, gears, propellers, fans, centrifuges, turbines, printing made on webs, as well as analyze vibration, sprayers, worn gear,

Continued on page 104)

imbalance of wheels, and more. Master Strobe has a range from 400 to 6,000 flashes per minute. Rate of flashes can be controlled manually. A Sync position in the panel allows the unit to be synchronized externally by means of a contactor, voltage source, or Power Instruments photoelectric pickup. For more data, Circle No. 56 on Reader Service Coupon on page 17 or 103.

Show and Tell

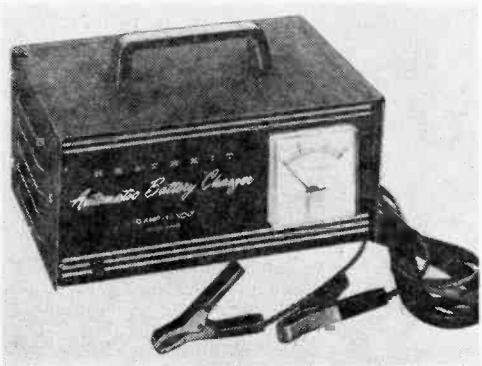
The RAACO Corporation has shown the handyman how to organize his small items with unique utility cabinets fitted with numerous clear plastic drawers. Many handymen find they cannot do without them since RAACO introduced the cabinets 15 years ago. Now RAACO has introduced a new line of plastic utility cabinets in gay colors for use by every member of the family. They are attractive enough to be proudly placed in full sight. Here are some of the small items that are particu-

HEY, LOOK ME OVER . . .

larly suited for storing in the RAACO Color Cabinets: cassettes, tapes, resistors, coils, condensers, coins, shell and rock collections, and of course, the regulars such as hardware small parts and electrical repair items. Three models are made in different colors. The cherry model has nine drawers measuring 9" wide and retails for $2.98. The orange model has nine drawers, is 12" wide and retails for $3.98. The avocado colored model has 12 drawers and is 12" wide retailing for $3.98. Available at hardware stores. For more information circle No. 55 on Reader Service Coupon on page 17 or 103.

Charge It Safely

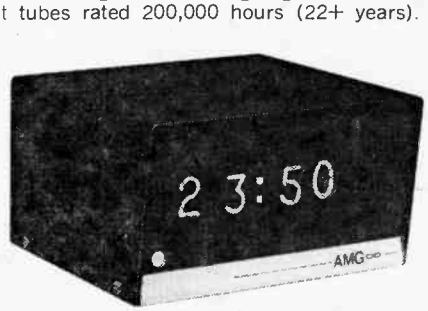
The GP-21 Battery Charger kit by Heath Company is the "lifesaver" for those infrequently used 12-V batteries in automobiles, farm equipment and boats. The GP-21 features a completely auto-



matic, virtually foolproof design. The user simply plugs the line cord into a standard 120 VAC outlet, hooks up the terminal cables and leaves it. The charger brings the battery to 13.4 volts then shuts itself down, maintaining just enough current to compensate for normal leakage. The connections can be left indefinitely, and the GP-21 will not start up unless connected correctly. At $29.95 mail order, the Heathkit GP-21 Battery Charger kit includes a rust-proof aluminum case, stainless steel hardware and cables—assembles in a matter of hours, weighs just 12 lbs. Circle No. 1 on Reader Service Coupon on page 17 or 103 for all the facts.

Digital Clock

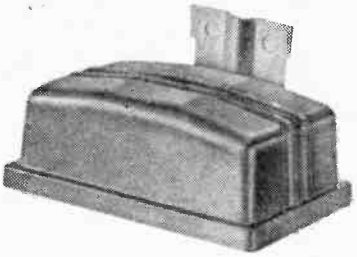
Aero-Metric offers their new 12 and 24-hour solid-state digital clock using bright red neon readout tubes rated 200,000 hours (22+ years). In-



strumentation quality TTL logic includes 15 IC's, 4 transistors, 7 diodes. Accuracy is within 3 seconds per year (60 Hz standard). Built-in, rechargable battery "holds" circuit time during short interval power failures. 24-hour clock has a bright red neon light, flashing for 30 seconds every 10 minutes as a *station-ident* call reminder for Hams. Disable switch provided. Prices: 12-hour, $93.00; 24-hour, $99.00. Standard metal cabinets, black or gold. Optional walnut or maple cabinets $9.00 extra. For more information, circle No. 58 on Reader Service Coupon on page 17 or 103.

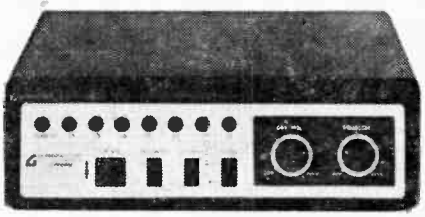
Yagi Couplers

A new YC series of Yagi couplers designed to combine TV antennas has been developed by Jerrold. The new couplers are especially useful in areas where channels are broadcast from different directions. Used with directional antennas, they are very effective in eliminating reflected or "ghost" TV signals. In many cases, the new couplers eliminate the need for an antenna rotator. Multiple single channel antennas can be combined into a single downlead to the TV set, with the new Jerrold Yagi Couplers. They can also be used to combine a single channel antenna with a broadband antenna. 300 and 75-ohm models are available for UHF and VHF. In addition, there is a 75-ohm model for FM. All Yagi Couplers are encased in weatherproof housings. They are complete with straps and thumbscrews for easy mast mounting. For more information, circle No. 47 on Reader Service Coupon on page 17 or 103.



Scan the Hi-Band

Pearce-Simpson has entered the VHF Scanner Field with the Gladding *HiSkan*. This compact and beautifully styled monitor is available at the suggested list of $114.95. The Gladding HiSkan automatically scans eight crystal controlled channels, or the operator may manually switch from channel to channel. HiSkan covers the 144-175MHz band



HEY, LOOK ME OVER . . .

which offers informative listening on police, fire, amateur and marine calls. A priority channel to which the set will automatically revert regardless of reception on other channels, will put you in on the action as soon as it occurs. Other features include a by-pass channel, built in 115VAC/12VDC power supply, "trap door" crystal installation and sensitivity that just won't quit. Get all the facts by circling No. 52 on Reader Service Coupon on page 17 or 103.

Redesigned from Greatness

The Dyna-Com 3B, redesigned by Lafayette from a former bestseller, is a switchable 3-channel, crystal-controlled, 3-watt walkie-talkie with attractive new design and heavy duty die-cast brushed aluminum case. Mike/speaker jack permits use of optional lightweight external microphone while set is shoulder or belt carried. Features 12 transistors and 7 diodes with new combination Battery/RF/"S" Meter and TVI trap. Convenient front mounted variable squelch and volume controls, Range Boost circuitry, pi-network antenna output, and PA switch. Mechanical filter for extra sharp selectivity. Complete with transmit and receive crystals for channel 10, FCC application Form 505, and leather shoulder strap. Price: $59.80. For more information circle No. 48 on Reader Service Coupon on page 17 or 103.

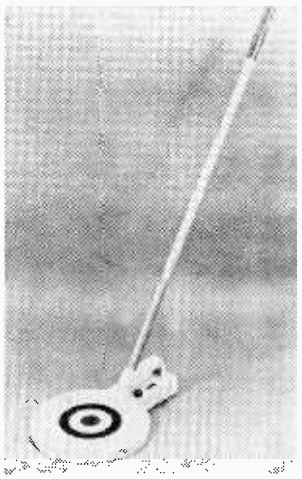
Sky Hook for Super Pros

A massive new mobile antenna, guaranteed not to burn out in CB installations, is now available from The Antenna Specialists Company. The new antenna, Model M-410, is designed around an industrial type loading coil twice the size and weight of the conventional CB type and a stainless steel whip employing an exclusive new copper and nickel coating process known as "Supercon" (for super conductivity). The high capacity design offers increased efficiency, and thus increased effective signal radiation, plus a power handling safety factor of 40 to 1. The antenna is equipped with the company's patented "Quick-Grip" mount for a no holes trunk installation with the cable completely hidden. Installation is exceptionally simple as the 17 foot cable is permanently connected and pre-assembled at the factory. Check with your local CB dealer. Further information may

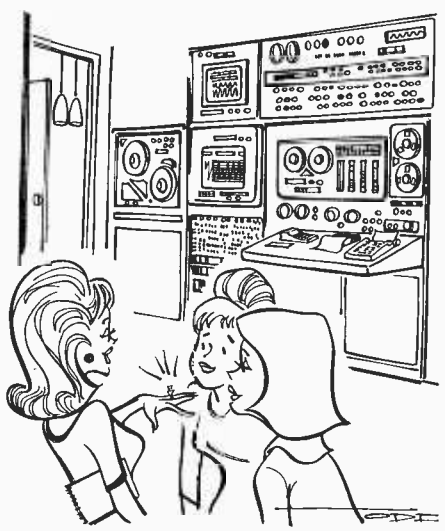
be obtained by circling No. 53 on Reader Service Coupon on page 17 or 103.

Discover Gold

Here's a low-cost self-contained and assembled metal detector which can be used by children and adults. Introduced by Entex Industries, the Discoverer metal detector has the components of much more expensive metal detectors. It utilizes solid-state circuitry to set up a radar-like beam which activates a signal light when it comes in



contact with any type of metal as the detector is moved over a surface. The battery-operated Discoverer is designed to be sold for under $14 retail.



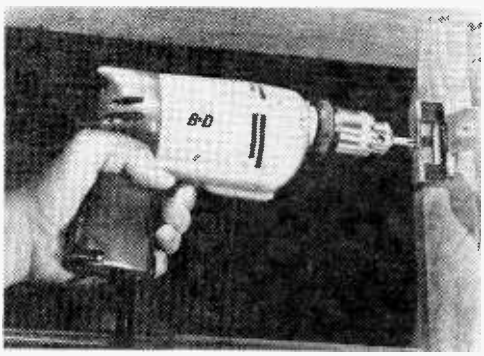
"It was sort of computer dating. He fed in the program for sugar, spice and everything nice and the computer typed out my name!"

HEY, LOOK ME OVER...

The Discoverer will pick up metal buried as much as a foot under earth or sand or covered by construction material. It can also be used as a tool to locate pipes or studs in walls. For additional information, circle No. 57 on Reader Service Coupon on page 17 or 103.

Throw Away Your Screwdriver

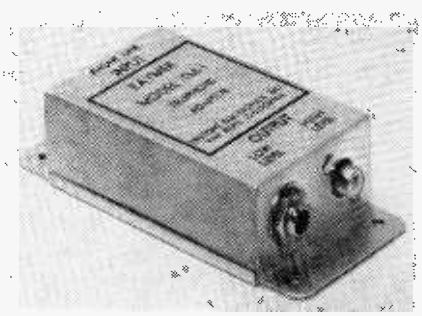
A high torque commercial duty ⅜-in. *Scru-Drill*, which has screwdriving and drilling capacities for the demands of the professional user or the home craftsman, has been introduced by Black & Decker. The Scru-Drill drives up to #10 wood screws or #12 self-tapping screws at full power. A reversing switch permits quick removal of



screws and nuts. The unit delivers 1/6 horsepower output, draws 2.5 amps and weighs four pounds. With a twist of the selector collar the tool instantly converts to a rugged ⅜-in. drill that is capable of handling many heavier duty boring assignments. In the screwdriving operation, the positive clutch of the Scru-Drill allows maximum torque to be applied to the screw head in driving, yet disengages when the screw is fully sealed thereby preventing damage to screwhead or stripping of screw. Scru-Drill is available at $44.99 from all retail outlets handling the Black & Decker commercial duty power tool line. Get more info by circling No. 59 on Reader Service Coupon on page 17 or 103.

Snooper-Dooper

Trutone's Model TM-1 is a telephone matching adaptor to couple a telephone line to either the microphone or auxiliary input (or both) of an amplifier or receiver. The input of the TM-1 Adaptor matches telephone switchboards, dial access tele-



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ELEMENTARY ELECTRONICS

READER SERVICE PAGE

• The Editor of ELEMENTARY ELECTRONICS offers readers an easy way to get additional information about products and services advertised in this issue. Also, if you would like more information about any new product mentioned in our column "Hey, Look Me Over," it's yours for the asking. Just follow the instructions below and the material you requested will be sent to you promptly and at no cost.

• The coupon below is designed for your convenience. Just circle the numbers that appear next to the advertisement or editorial mention that interests you. Then, carefully print your name and address on the coupon. Cut out the coupon and mail to ELEMENTARY ELECTRONICS, Box 886, Ansonia Station, New York N Y 10023. Do it today!

MAY/JUNE 1972 — Void after November 30, 1972

ELEMENTARY ELECTRONICS

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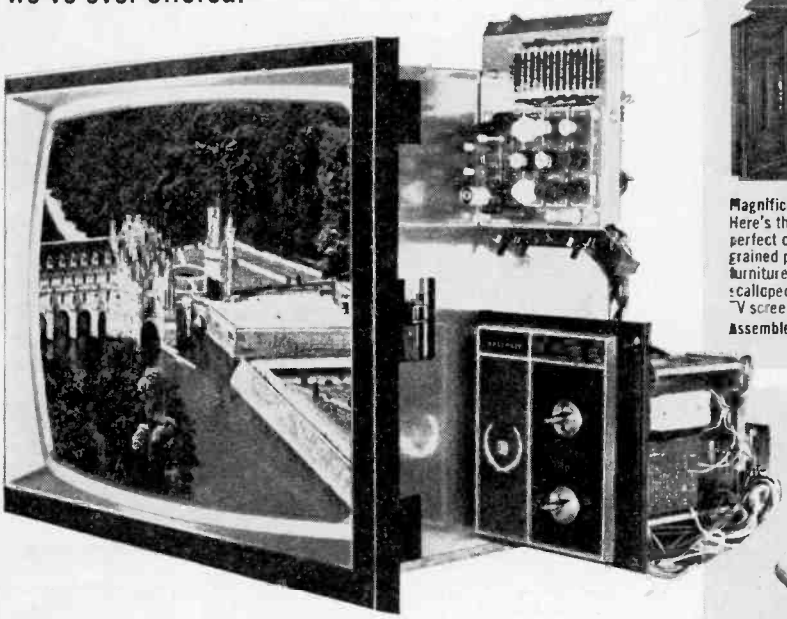
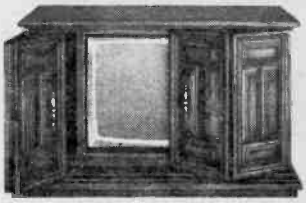
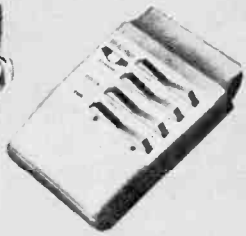




Magnificent Mediterranean Console. Here's the finest TV cabinet we offer, a perfect choice for a GR-900. Has deep-grained pecan veneers on hand-rubbed furniture grade hardwood solids. Two scalloped double-hinged doors hide the TV screen when not in use.

Assembled GRA-405-25, 100 lbs. **179.95***



Wireless Remote for your GR-900. The ultimate in armchair viewing. Gives you eight-function across-the-room control of on/off, three preset volume levels, power tuning (up or down), color, tint, UHF/VHF channel selection. Also activates Custom Wall Mount doors.

Kit GRA-900-6, 6 lbs. **79.95***

The new Heathkit GR-900 25V Color TV has UHF/VHF detent tuning & varactor UHF tuner, angular tint control — more features than any other color TV kit! Better performance than any other set.

UHF/VHF detent power tuning. Push a button and you scan the channels in either direction with detent action locking in on VHF channels 2-13 and any 12 preselected UHF stations. A pushbutton selects either UHF or VHF mode, and a lighted dial indicates tuner position. And you can have full remote-control selection too for just a few dollars more.

New voltage-controlled varactor UHF tuner and specially designed VHF tuner with MOS Field Effect Transistor contribute to better fringe-area reception, increased sensitivity.

New angular tint control. A switch now gives you either "normal" or "wide angle" color demodulation to reduce tint and flesh tone change when changing stations and when programs change. Other deluxe features include "instant on" operation with override for conventional on/off operation; automatic fine tuning; adjustable tone control, and an output for playing TV audio through your stereo hi/fi system.

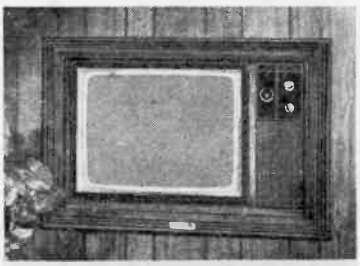
Exclusive Heath MTX-5 ultra-rectangular tube. It's the largest color screen you can buy anywhere, with a full 25 inch meas. diag., 315 sq. in. viewing area. You see virtually everything the station transmits, in the corners and at the sides. The specially etched face plate cuts glare, and reflection, increases contrast without sacrificing brightness, and each dot is projected through a matrix screen to stand out crisply against a solid black background.

Modular solid-state circuitry. Plug-in circuit boards and plug-in transistors make assembly, adjustment and servicing easy. There are 46 transistors, 57 diodes and four ICs — making this one of the most reliable sets we've ever designed.

Other features include automatic chroma control, adjustable video peaking, adjustable noise limiting and gated AGC.

Exclusive Heath self-service built-ins. Your Heathkit GR-900 includes built-in dot generator, tilt-out convergence panel for set-up and periodic adjustments. A handy volt-ohm meter included in the circuitry helps you check your work during assembly, and can be used in conjunction with the manual for any servicing. Like all Heathkit color TVs, the GR-900 gives you complete installation flexibility. There are four beautiful Heath cabinets to choose from plus the new built-in electronic wall mount with hide-away tambour doors. Or you can custom install your GR-900. We think you'll agree, the GR-900 is truly the most impressive color receiver we've ever offered.

Kit GR-900, TV less cabinet, 125 lbs. **599.95***



New Custom Wall Mount. Touch a button on the frame or on your Heathkit Remote Control unit and the folding tambour doors open to reveal your color TV. Kit includes everything needed to build your Heathkit GR-371MX or GR-900 into a wall.

Kit GRA-402-25, walnut finish, 50 lbs. **114.95***

Kit GRA-407-25, unfinished, 50 lbs. **109.95***

FREE '72 HEATHKIT Catalog

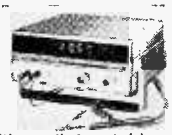
The better-than-ever '72 Heathkit Catalog has the world's largest selection of fun-to-build, money-saving electronic kits...including color TV, stereo/hi-fi, organs, home appliances, engine tune-up tools, radio control, portables, shortwave, marine gear, metal locator, instruments, hundreds more. If you don't have this catalog, you've missed seeing over 50 new kits, introduced since the last edition. Send today for your free copy.

New AR-1500 stereo receiver 379.95*

Successor to the famed Heathkit AR-15, with impressive improvements in every critical area. 180 watts Dynamic Music Power, 90 watts per channel, 8 ohm load. Less than 0.2% IM and 0.25% harmonic distortion. Greater than 90 dB FM selectivity and 1.8 uV sensitivity. Vastly superior AM, too. It's the talk of the audio world. Order yours now.

Kit AR-1500, 42 lbs. (less cabinet)..**379.95***

ARA-1500-1, walnut cabinet, 6 lbs....**24.95***



New digital multimeter 229.95*

Now, a digital multimeter that meets lab specs at a low, low kit price! 3½ digits for 100 uV resolution on 200 mV range; 1V on 1000V; 5 DC ranges (100 uV—1000V, either polarity); 5 AC ranges (100 uV—500V); 10 current ranges (100 nA—2A AC or DC); 6 resistance ranges (0.1 ohm—20 megohms.) DC calibrator supplied for 0.2% accuracy without external equipment. Can be lab calibrated to 0.1%. Don't miss this outstanding instrument value.

Kit IM-102, 9 lbs. **229.95***

New digital frequency display for Heathkit ham gear .. 179.95*

There's nothing else like it on the ham radio market! Actually computes operating frequency. Six bright readout tubes show you exactly (to within 100 Hz) where you are as you dial across the 80-10 meter amateur bands. Designed for all Heathkit SB-Series Receivers and SB- and HW-Series Multiband Transceivers. With transceivers, the SB-650 reads and displays both received and transmitted frequencies. Manual fully describes and illustrates all interconnections for installation with the specific rig you own. Kit assembles approximately 8 hours. All solid-state circuitry — 6 transistors, 35 ICs.

Kit SB-650, 9 lbs. **179.95***

New...Heathkit solid-state 120 MHz counter...just 349.95

Another Heathkit first! The new Heathkit IB-1102 brings you a 120 MHz frequency counter with professional features, accuracy and stability rivaling counters costing far in excess of this modest kit price.

Features include eight cold-cathode display tubes, an overrange lamp, gate lamp, and two range indicator lamps for an easy-to-read display. Overall accuracy is assured by the use of temperature compensated "clock". The high-impedance (FET) input circuit presents minimum loading to the circuit under test. And an automatic triggering level offers simple "hands off" operation.

The Heathkit IB-1102 features a sensitivity of 50 mV to 100 MHz, 125 mV above 100 MHz. It will accept inputs up to 120 V rms from 1 Hz to 150 Hz, 50 V at 4 MHz, and 3 V at 120 MHz without damage to the instrument. The time base crystal is a temperature compensated TCXO offering ±1 ppm stability from +10° to +40° C and an aging rate of less than ±1 ppm/yr. Other features include the latest ECL (Emitter Coupled Logic) circuitry; 1 MHz resolution without switching time base. Plug-in ICs and circuit boards reduce assembly time to an easy 15 hours. And you can wire it for either 120/240 VAC operation. Kit includes handy detachable line cord, portable case with bail handle that converts to stand for best viewing angle.

Kit IB-1102, 12 lbs., mailable **349.95**

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CIRCLE NO. 8 ON PAGE 17 OR 103

DX central reporting

A world of SWL info!

By Don Jensen

☐ The dawning era of Ping Pong Diplomacy and the President's visit has sparked a flury of interest, among DXers, in China. Though it is still true that less is known about the vast Chinese broadcasting operation than any other in the world, increasing numbers of SWLs are prowling the wavelengths hunting these inscrutable oriental signals.

For the beginning DXer, Radio Peking's English language service to North America is the easiest target. But even for the more experienced listener, it is the best way to keep tabs on Mao's current version of world events. Expect, naturally, to hear the U.S. government and its policies roundly denounced. But it is true that SWLs who have been following Bamboo Curtain broadcasts for years report the current propaganda line is somewhat less virulent than in the past.

Peking's English transmissions can be found by East Coast listeners around 0030 GMT on 11,945 kHz. For listeners farther west, try 15,050 and 15,095 kHz about 0400 GMT.

The recent easing of relations between the United States and China has apparently resulted in an improved verification policy in Peking. Formerly, QSLs were a sometimes thing and when received, seldom included actual verification data. These days, however, a number of DXers report receiving solid QSLs from the station.

Unfortunately, the QSL policy does not extend to other Chinese radio services. Peking authorities still decline to verify home service broadcasts, foreign language programs to other countries or those transmissions from special service stations.

Among the latter group are those of the New China News Agency. NCNA is, of course, a strictly controlled government operation, but in its own way it serves much the same purpose as our commercial news agencies such as United Press International and Associated Press. NCNA feeds, by shortwave radio, news items used by various domestic broadcasters and local newspapers within China. To allow these editors to handcopy the news items, the reports often are read at very slow dictation speed. Though read in Chinese, these slow-motion newscasts can tip you off that you're tuned to NCNA broadcasts.

These newscasts can often be heard at fairly good strength on 14,416 kHz from around 0000 to after 0100 GMT.

The war of words between China and the Nationalist government on Taiwan continues on shortwave. Torrents of propaganda cross paths over the Formosa Strait daily. On China's part, most of its diatribe is aired by a series of transmitters located along the coast of Fukien Province. The operation is known, in English translation, as the Fukien Front Service and supposedly is run by PLA, the People's Liberation Army.

With good reception conditions, you may hear some of this Chinese language ranting and raving, plus some revolutionary music at times, on 3,200, 3,400 and 3,900 kHz about sunrise.

At the same time of day, keep your ears open for some of the other lesser Chinese stations, home and foreign services of Peking, regional broadcasts and Peking relays from transmitters elsewhere in China. DXers with some listening experiences and more elaborate receivers will have an edge, but occasionally even a newcomer to the SWL game will stumble across these sing-songy Chinese broadcasts on out-of the-way frequencies.

One of the more exotic of these stations transmits on 9,490 kHz. It is believed that this regional station is located at Lhasa, Tibet, a formerly independent country in the Himalayas, now controlled by China.

So far, QSLs from all these non-English-speaking stations are non-existent. But that could change in the future. If you're the lucky one to get the first QSL, let DX Central know . . . pronto!

Tip Topper. Haiti isn't a particularly difficult country to log, but then again, unless you've really been hunting for it, it may have escaped you thus far. The reason is that the voodoo island isn't exactly loaded with shortwave broadcasters, most of the broadcast only in French or the local Creole language and none of them are really high-powered outfits.

But there's one Haitian station you should find with little trouble, if you know when and where to tune. It is Radio 4VEH, a religious missionary station at Cap Haitien.

Its identification surprises some listeners who expect all stations to have purely alphabetical calls. But this isn't always the case. The "4V" prefix has been assigned by the International Telecommunications Union to Haiti in the same way the call prefixes "K" and "W" have been issued to the United States. But 4VEH is the only Haitian broadcaster to announce them on the air. Most other island stations follow the common Latin American practice of announcing identity names, such as Radio Haiti, in place of call letters. *(Continued on page 102)*

COBRA ON GUARD.

**The Cobra 880 Base Station—
Solid State CB Two Way Radio
with Exclusive Channel 9 Scan-Alert**

New Cobra 880 combines a lot of good ideas into one package. It combines Cobra's famous rugged construction with total solid state design to give long life and reliable performance. Adds AC or DC operation to keep working in all power situations. Leaf digital clock with automatic turn-on and turn-off features. And puts you on guard—with Scan-Alert! With Scan-Alert, you'll be able to work your own channels and guard Emergency Channel 9—at the same time.

Scan-Alert is a Cobra exclusive that alternately changes the channel of the receiver from your operating channel to Emergency Channel 9. The Channel Indicator light and the Channel 9 indicator light flash alternately. As Scan-Alert automatically switches between frequencies. When a signal is received on either Channel 9 or the selected channel, the receiver automatically locks on the active channel. The receiver resumes scanning after the transmission is completed. And if you want to respond to a Channel 9 call, just slide one switch, without upsetting your channel selector setting. The Cobra 880 combines normal and emergency guarding—and makes it easy.

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in the Cobra 880:**

23 Channel operation with crystal frequency synthesizer ☐ RF Gated Noise Blanker and Automatic Noise Limiter ☐ Illuminated Channel Selector ☐ Combination Relative Power, SWR and S meter ☐ Dual Conversion Receiver, with FET RF stage ☐ Dynamic microphone, with coiled cord and plug ☐ P.A. and external speaker jacks ☐ Transmitter modulation indicator light ☐ Meets FCC requirements

$229.95

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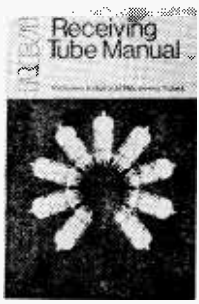
See your local CB Dealer or write us for more information.

CIRCLE NO. 21 ON PAGE 17 OR 103

BOOKMARK
BY BOOKWORM

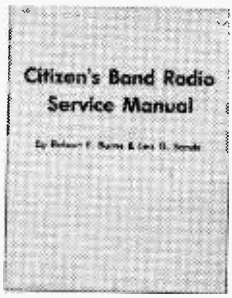
Time Tested & True. A new edition of the *RCA Receiving Tube Manual* that had been completely revised and updated to provide the latest accurate source of technical data on receiving tubes. The new manual, *RCA Technical Series RC-28,* has over 100 pages more than the preceding edition and covers over 1600 tube types. Included for the first time are technical data on over 190 RCA industrial



Soft cover
784 pages
$2.50

receiving tubes. In addition, data for more than 75 new RCA entertainment type receiving tubes are also given. Data for RCA black-and-white and color television picture tubes are presented in chart form. The Application Guide section has been updated to show popular types recommended for use by hobbyists and experimenters. A comprehensive text section and circuit section containing 35 circuit descriptions, parts lists, and schematic diagrams are also included for hobbyists and experimenters.

CB Bible. *Citizen's Band Radio Service Manual* is an all-in-one troubleshooting and maintenance guide for all types of CB Radio transceivers. It's authored by two of e/e's regular contributors—Robert F. Burns and Leo G. Sands. An especially helpful feature is the 36-page foldout section which contains complete schematic diagrams for such late-model transceivers as the Courier CCT4, Cobra 25, Hallicrafters CB-21, Johnson Personal Messenger and Messenger III, Lafayette Dynacom 12A and HB-23A, Midland 13-880, SBE-6CB Sidebander, Sonar T-2, and Telsat 924. The text section contains point-to-point test procedures, trouble charts, and alignment procedures—all the information needed to service CB transceivers. And since they are representative of most transceivers in use, the same information is useful for servicing similar units. Published by Tab Books.



Soft cover
192 pages
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Home Fix-it Special. The service trainee and the home handyman will find thorough, readable coverage of operating principles, diagnosis, and repair in *Basic Appliance Repairs: Dishwashers, Garbage Disposers, Electric Ranges and Ovens,* by Cliff Porter, just published by Hayden Book Company, Inc. Based on the author's experi-

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ence as a Service Training Specialist for a leading manufacturer, the book provides the information needed to diagnose and repair appliance breakdowns as quickly as possible. For each appliance, it discusses and illustrates the individual components in their order of activation in the machine's operating cycle—a method of analysis that rapidly pinpoints the trouble source. The book then goes on to describe trou-

(Continued on page 101)

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Tab Books, Blue Ridge Summit, PA 17214

stamp shack

Philatronics Today!

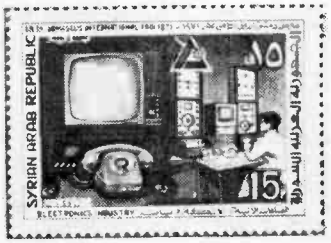
BY ERNEST A. KEHR

●● For many long years, the Damascus International Trade Fair has been show-casing the world's products which the Middle East could import for the improvement of its peoples' lot, or which domestically are made for export to its overseas neighbors.

● To mark the 18th gathering at Damascus between Aug. 25 and Sept. 20, 1971, the Syrian Arab Republic produced a set of four attractive, multi-color stamps intended to advertise the Fair and the locally produced products it hopes to sell on a global scale. Designed by Ziad Zoukari and printed in Damascus Government plant, these include such traditional products as rugs, textiles, fancy glassware and agricultural fertilizers. Also shown are some of the more modern items the Syrians are beginning to manufacture at home.

● Among the latter is a 15-piaster value related to the electronics industry. Featured in the foreground are shown a large-screen, color TV receiver and a telephone handset. To the right, a young Syrian scans the control panels of some instruments which are not identified but symbolize space-age technology.

● Having obtained licenses from European and American electronics firms, the Syrians have gone into the manufacture of such sophisti-



cated products not only to provide employment for the residents, but to export products that serve the Middle East markets. This has resulted in an upsurge of technical industries that is nothing short of phenomenal.

●● Mexico has marked the 50th anniversary of its radio broadcasting facilities with a simply plain 40-centavo stamp that depicts a black

(Continued on page 100)

He Blew It

I have a 21-in. Thomas FP4A picture tube which was in good operating condition until the base became unglued from the glass envelope. In attempting to reglue this base, I broke 2 of the lead-in wires, leaving only about ⅛-in. projecting from the glass envelope. Do you know of any practical means of making connections to these projecting nibs?

—Joe B. Mullins
3607 Central Ave.
Nashville, TN 37205

Heck, I don't know! But I'm sure one of our readers can help you. I do know one thing for sure—you can't solder to these nibs or short wires. The heat of the iron may crack the seal. Also, I never did get the solder to stick.

CBer Traveling North

I am taking a trip to Canada and I have heard various stories about Canadian CB radio rules. Is there some sort of booklet that I can send for that will clear up my questions regarding CB operation in Canada?

—J.S., Dayton, Ohio

Write to the Queen's Printer, Ottawa, Ontario, for a copy of the Tourist Radio Service rules. Also write to the Department of Communications, also in Ottawa, for a Tourist Radio service license application form. Also, the Canadian DOT CB rules and regs are published in our 1972 CB YEARBOOK. Pick up a copy.

This One is Easy

Since you don't offer a circuit design service, can you refer me to someone who does? I need a transistorized current controller rated

(Continued on page 92)

Hank Scott, our Workshop Editor, wants to share his project tips with you. Got a question or a problem with a project you're building—ask Hank! Please remember that Hank's column is limited to answering specific electronic project questions that you send to him. Sorry, he isn't offering a circuit design service. Write to:

Hank Scott, Workshop Editor
101 ELECTRONIC PROJECTS
229 Park Avenue South
New York NY 10003

LITERATURE LIBRARY

61. Kit builder? Like weird products? *EICO's 1972* catalog takes care of both breeds of buyers at prices you will like.

62. Want some groovey PC boards plus parts for communication projects? Then get a hold of *International Crystal's* complete catalog.

63. Now available from *EDI (Electronic Distributors, Inc.):* a catalog containing hundreds of electronic bargains.

64. A pamphlet from *Electra* details the 6 models of the Bearcat III, a scanning monitor receiver.

65. *Dynascan's* new B&K catalog features test equipment for industrial labs, schools, and TV servicing.

66. Before you build from scratch, check the *Fair Radio Sales* latest catalog for surplus gear.

67. *Hallicrafter's* literature features new SR-400A, "Cyclone III", 550 watts P.E.P., SSB/CW, 5 band transceiver for OM or YL amateur.

68. Want a deluxe CB base station? Then get the specs on *Tram's* super CB rigs.

69. Get the scoop on *Versa-Tronics'* Versa-Tenna with instant magnetic mounting.

70. Prepare for tomorrow by studying at home with *Technical Training International.* Get the facts on how to step up in your job.

71. Pep-up your CB rig's performance with *Tuner's* New M+3 mobile microphone.

72. A fully illustrated brochure from *Midland* gives readers a look at their new, complete line of radio monitoring receivers and CB transceivers.

73. The MONitor antennas—keys to superior reception—are available from *Antenna Specialists* in their catalog.

74. Get all the facts on *Progressive Edu-Kits* Home Radio Course. Build 20 radios and electronic circuits; parts, tools, and instructions included.

75. *Olson's* catalog is a multi-colored newspaper that's packed with more bargains than a phone book has names.

76. Custom *Alarms* reveals how inexpensive professional alarms can really be. Install one yourself. Circle 76 for exclusive catalog.

77. Compact is the word for *Xcelite's* 9 sets of midget screwdrivers and nut-drivers with "piggyback" handle to increase length and torque. A "show case" serves as bench stand. Cat. 171.

78. Troubleshooting without test gear? Get with it—let *Accurate Instrument* clue you in on some great buys for your test bench.

79. Keep up-to-date on latest electronics bargains with *Burstein-Applebee's* '72 catalog and supplements.

80. Two leaflets by *R. L. Drake Co.* are available. One is on their SPR-4 communications receiver; the other on the SW-4A international short wave broadcast receiver.

81. *Edmund Scientific's* new catalog contains over 4000 products that embrace many sciences and fields.

82. Pick *Cornell Electronic's* 10th anni. catalog and discover yesterday prices. Tubes go for 36¢ and 33¢. Plus many other goodies.

83. *Allied Radio Shack's* 1972 Electronic Equipment Catalog features all-new 4-channel quadraphonic stereo equipment. The 92-pages include exclusive audio equipment.

84. It's just off the press —*Lafayette's* all-new 1972 illustrated catalog packed with CB gear, hi-fi components, test equipment, tools, ham rigs, and more.

85. *Mosley Electronics, Inc.* is introducing 78 CB Mobile Antenna Systems. They are described and illustrated in a 9-page, 2-color brochure.

86. *RCA* Experimenter's Kits for hobbyists, hams, technicians and students are the answer for successful and enjoyable projects.

87. You can become an electrical engineer only if you take the first step. Let *ICS* send you their free illustrated catalog describing 17 special programs.

88. Radio monitoring enthusiasts, "You're in on the action" with Petersen monitors. Send for catalog having full descriptions of VHF and UHF models.

89. *Avanti's* catalog describes and illustrates their complete line—mobile base CB antennas many others.

90. A new free catalog is available from *McGee Radio.* It contains electronic product bargains.

91. *B&F Enterprises* has an interesting catalog you'd enjoy scanning. Goodies like geiger counters, logic cards, kits, lenses, etc. pack it. Get a copy!

92. *Heath's* new 1972 full-color catalog is a shopper's dream—chockful of gadgets and goodies everyone would want to own.

93. *E. F. Johnson's* 1972 line of CB tranceivers and CB accessory equipment is featured in a new all-line brochure. Send for your free copy today.

94. If you want courses in assembling your own TV kits, *National Schools* has 10 from which to choose. There is a plan for GIs.

95. Free 1972 Catalog describes 100s of *Howard W. Sams* books for the hobbyist and technician. Includes books on projects, basic electronics and many related subjects.

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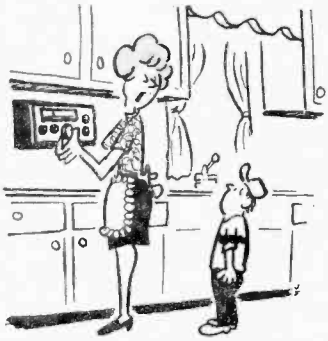
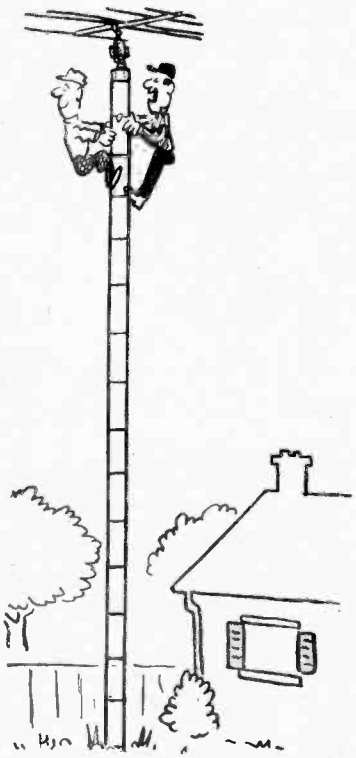
by Jack Schmidt

"Show Aunt Helen some of those little volts you're always making . . ."



"I just heard your father's name on his fire-police monitor. He ran another radar trap!"

". . . then this detector, imbedded in the door frame, senses your body and turns the light on . . ."



". . . and off to the right is that young school teacher . . ."

"Harvard, does your observatory have to be right in the family room?"

elementary MAY-JUNE 1972 Electronics

Light-Comm

All Solid-State Light Beam Communicator Uses Infrared Light Emitting Diode

by Forrest Mims

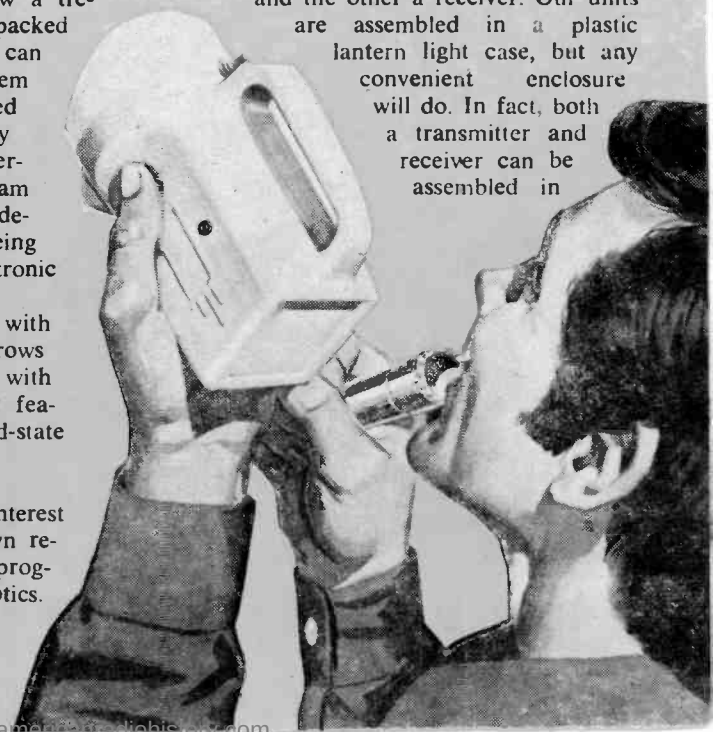
Light beam communications have been around since prehistoric man first used a chunk of shiny mica to signal a buddy. Fortunately for us, electronics has considerably improved things; today all it takes is a handful of components for you to assemble your own sophisticated, invisible light communicator. With our plans, your unit will operate in the infrared portion of the electronic spectrum to transmit voice up to nearly a thousand feet.

Unlike radio, optical communications make use of relatively narrow beams of light, and because the wavelength of light is so high, engineers have shown how a tremendous amount of data can be packed on a single beam. Since the beam can be invisible—like the infrared system used in the communicator described here—transmission is completely private and undetectable. Interestingly enough, the light beam communications idea originally developed by stone age man is being given a real boost with electronic techniques.

Here's your chance to jump in with both feet. Get the feel of tomorrows communication techniques today with Light-Comm—e/e's project that features invisible light from a solid-state lamp.

Get the LED Out. The revived interest in optical communications shown recently is the result of significant progress in the field of electro-optics. Several types of lasers show great promise for optical communication applications, but the light emitting diode (LED) is currently one of the most practical contenders. The LED, usually made of gallium arsenide, is a semiconductor which emits infrared light when forward biased. It was invented more than ten years ago, but only recently has the price of commercial units dropped to the point where they can be purchased by experimenters.

How it Works. The communicators consist of two self-contained units, one a transmitter and the other a receiver. Our units are assembled in a plastic lantern light case, but any convenient enclosure will do. In fact, both a transmitter and receiver can be assembled in



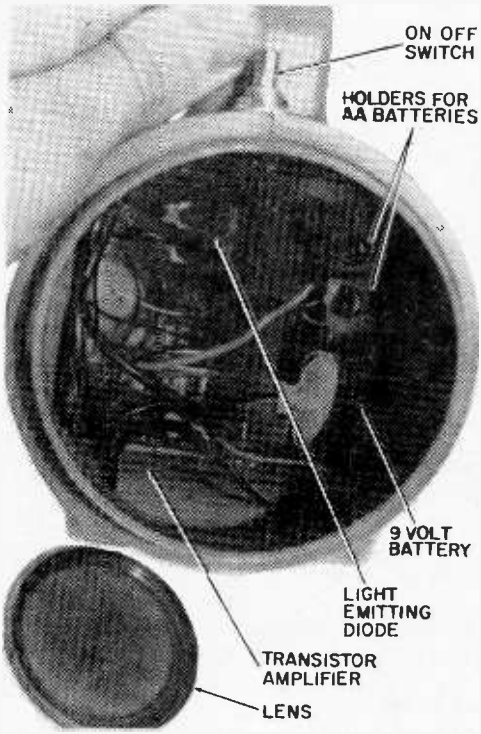
the same enclosure to fabricate a transceiver.

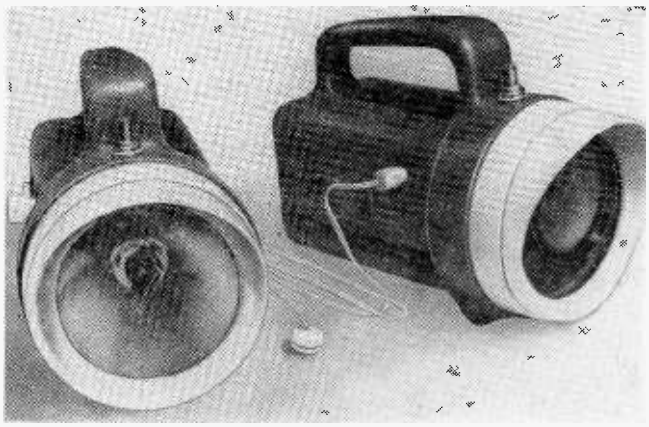
The LED is modulated by means of a pre-assembled miniature transistor amplifier. It is connected to the amplifier's output transformer through a single transistor coupling stage. Two penlight cells provide the LED's driving voltage. Excessive current can degrade or damage a LED, so current limiting is provided by a 100-ohm resistor (R2).

An amplifier similar to the one used in the transmitter is used in the receiver. But a pair of silicon solar cells are connected to the amplifier's input and serve to convert the optical signal to a corresponding audio signal. The amplifiers are available from most mail order electronics distributors, but usable amplifiers can often be salvaged from discarded portable transistorized tape recorders or players.

Transmitter Construction. Begin construction of the transmitter by drilling three 1/32 inch holes in an open space on the output end of the amplifier board. Insert transistor Q1 into the holes and solder its base and emitter leads to the appropriate terminals on the printed circuit board. If necessary, use short lengths of insulated tubing to prevent Q1's leads from shorting against other wiring. Q1 can be practically any general purpose PNP transistor. (Note: the Radio Shack amplifiers used here have a positive ground. If an amplifier with a negative ground is used, Q1 can be any general purpose NPN transistor. See the circuit diagram for additional information.) Q1's collector lead should be left unconnected in preparation for the next step.

Next, cut a 2-in. x 3/4-in. rectangle of perforated board and mount two fahnestock clips on it with appropriate hardware. The board's purpose is to permit you to mount the LED in a position where its light is unobstructed and to mount one or two other components. Drill a 1/8-in. hole in the output end of the amplifier board and mount the perforated board to the amplifier with an aluminum bracket. Place the bracket so that it doesn't short against any of the amplifier's printed wiring. Insert a





Dr. Leakey's illusive rock-in-hand ape man couldn't operate these space age goodies even if he had a pair. But you can build and operate your own if you wish by starting with low cost lantern cases and filling them with transmitter parts shown above. See open receiver and parts location drawings later in article. Finished units, left, show collimating lens in transmitter and solar cells in receiver reflector.

100-ohm resistor in the perforated board below the clips and solder it in place according to the circuit diagram. Where necessary, use lengths of hook-up wiring to reach distant portions of the circuit. Also, solder Q1's collector lead to the appropriate terminal of the LED clips.

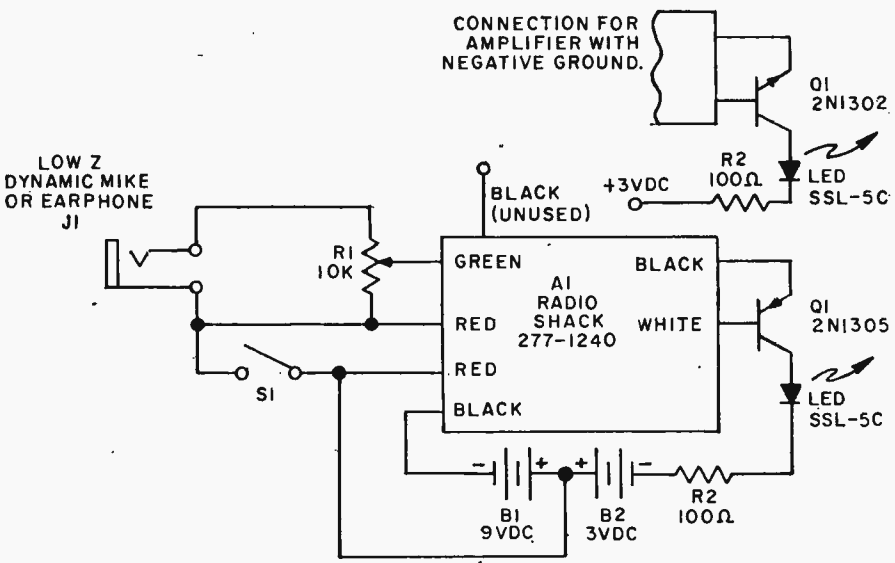
Screwdriver Drift. The 10K gain control potentiometer can be mounted on the inside of the plastic case, or, since adjustment is infrequent, to the perforated board. The latter approach was used in the prototype; a ¼-in. hole drilled into the back of the flashlight case permits the pot to be adjusted with a screwdriver. If the pot is mounted to the perforated board, be sure to drill an appropriately spaced and sized hole in the board before mounting it to the amplifier.

Before mounting the amplifier-LED assembly in the enclosure, install the battery holders. Use AA penlight cell holders for both the penlight cells and the nine volt battery. The latter holder should be modified by sawing the terminal end off and using a standard clip connector to make contact with the battery connectors.

When the battery holders are installed, mount the amplifier-LED assembly inside the enclosure. First, insert the LED into the clips and carefully orient it so that it will face toward the portion of the enclosure where a collimating lens will be installed.

Get it Focused. The amplifier board is mounted to the enclosure with 4-40 hardware. Cut a pair of slits in the bottom of the enclosure so the focus of the LED can be varied by simply moving the entire amplifier-LED assembly in the case. Also at this point, connect leads to the circuitry for the microphone jack and switch. Be sure to leave battery holder, microphone jack, and switch leads long enough to permit the amplifier-LED assembly to be removed for servicing.

Our communicator used a plastic lens with a focal length of about 4½-in. to collimate the infrared light from the LED



PARTS LIST FOR TRANSMITTER

A1—100mW Audio amp. (Radio Shack 277-1240 or equiv.)
B1—9 volt transistor radio battery
B2—3 volts (two AA penlight cells)
J1—Microphone jack
LED—SSL-5C light emitting diode (General Electric Co., Miniature Lamp Dept., Cleveland, OH 44112, $7.15 each)
Q1—Transistor, 2N1305, HEP-629
R1—10,000-ohm potentiometer
R2—100-ohm, ¼ watt resistor
S1—Push button switch, normally open

A partial kit consisting of the following components is available for $10.00 (add $1.00 postage and handling) from MITS, Inc., 2016 San Mateo SE, Albuquerque, NM 87110. Transmitter—LED, Q1, J1, R1, R2, low impedance earphone (for use as microphone), lens, and battery holders. Receiver—J1, P1, R1, and battery holder.

into a narrow beam. An identical lens is available from a source listed in the Parts List. Actually, almost any convex lens can be used to focus the light beam; just be sure the focal length is several inches and the lens diameter is sufficient to intercept the entire beam from the LED. Edmund Scientific Company (see their ad in this issue for address), sells many lenses which work well with the communicator, and most department stores carry a variety of inexpensive magnifiers which can also provide an appropriate lens.

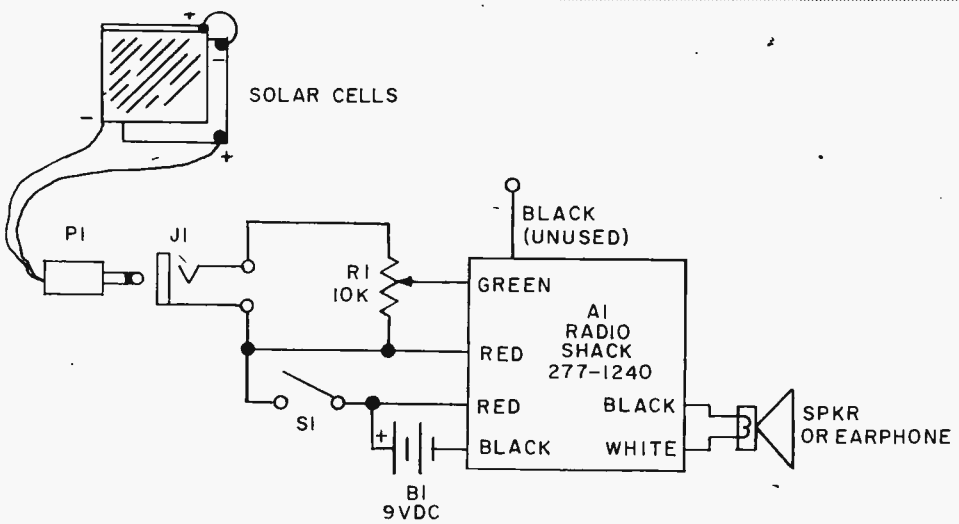
The plastic dust cover which protects the flashlight's parabolic reflector is used to mount the lens. Since it is not required, remove the reflector and set it aside for use in another project. Cut a hole in the clear plastic dust cover for the lens; if the plastic lens available from the source in the parts list is used, the hole should be 2-in. in diameter. A plastic shoulder on this lens permits easy mounting. Insert the lens and glue its edges to the dust cover.

Receiver Construction. Assembly of the receiver is similar to that of the transmitter. The amplifier board can be mounted in a fixed position, however, and there is no need for an additional circuit board. Mount the battery holder and volume control on the inside of the case. A speaker was included on our unit (along with an earphone jack), but it can be eliminated in favor of an earphone if desired.

The infrared light from the transmitter is detected by a pair of back-to-back solar cells in the receiver. The cells, which must be the silicon type, are mounted in the receiver's parabolic reflector by their wire leads. Mount the cells back-to-back by *very* carefully soldering a small wire from the positive terminal (along the front side of one cell) to the negative terminal, which covers the entire back surface of the other cell. Silicon solar cells can be purchased economically in kits that include silicon, cadmium and selenium cells. Or, International Rectifier type S1M cells can be used if the case is opened and the wafer of cells inside is removed.

The remaining positive and negative leads are used to hold the two cells in position: feed them through the reflector's aperture, and wrap them around the protruding neck. A small plug is soldered to the leads, and

(Continued on page 94)



PARTS LIST FOR RECEIVER

A1—100mW Audio Amp. (Radio Sack 277-1240 or equiv.)
B1—9 volt transistor radio battery
J1—Miniature jack
P1—Matching plug for above
R1—10,000-ohm potentiometer
S1—Push button switch, normally open
SO1—Silicon solar cells, unmounted (see text)
SPKR—8-16 ohm speaker
Misc—Hardware, battery holder, flashlight case (Burgess "Dolphin" lantern or equiv.), hook-up wire, optional earphone and jack.

- **Roasts in one half hour**
- **Baked potatoes in 4 minutes**
- **Frankfurters in 30 seconds**
- **Warmed buns in 10 seconds**

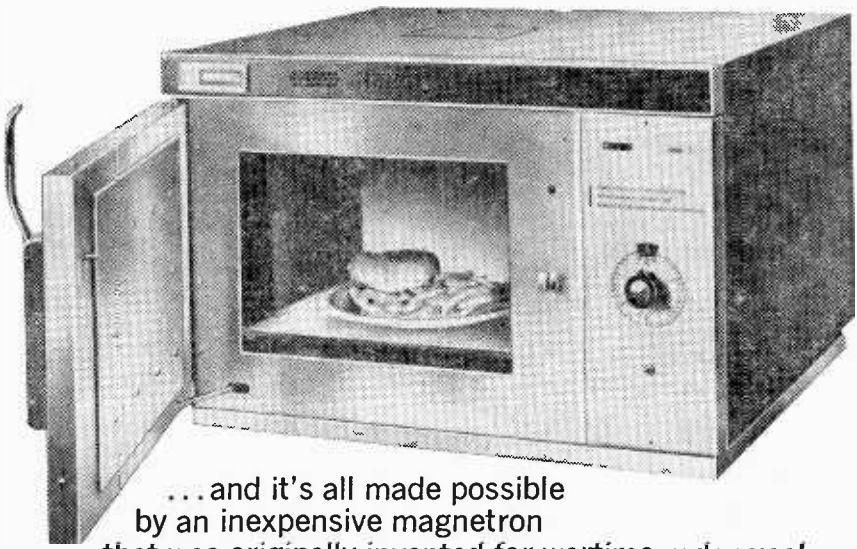


Photo courtesy International Mfg. Co., Inc.

...and it's all made possible
by an inexpensive magnetron
that was originally invented for wartime radar use!

Now We're Cooking with Microwaves

Jackson Kaye

Making waves! That's the best way to describe the coming of the microwave cooking oven into America's homes. And it is a long time coming. Although not recorded in the Army's archives, a World War II tech-sergeant may have been the first person to find "consumer" microwave application when he kept his coffee warm with microwaves from an SCR-584 radar. Or was it a radio station chief engineer in the same era who kept his fried chicken warm near an FM tank circuit while Kate Smith sang *God Bless America*? And there must have been a two-letter-call ham who sizzled a weiner on a 10-meter coil following the departure of his wife to Reno.

Different kind of radiations can be grouped into two sets. First are the *ionizing radiations* such as X-rays, gamma rays, cosmic rays, ultra-violet rays which can cause chemical change to take place in foods with little or no temperature rise. Non-ionizing radiation will not chemically alter food, but will raise its temperature provided the radiation is of sufficient intensity. The non-ionizing radiations are radio wave, microwaves, infrared waves, and visible light, to name a few.

These waves also radiate outward from the center like the waves on the surface of the pond, They travel, however, at the speed of light, 186,282 miles per second, and carry small bundles of energy called photons which vibrate at various frequencies. Radiant waves are characterized by their wavelength and their frequency of vibration (number of complete cycles per second).

Wavelength $\times$ *frequency* $=$ *the speed of light*

Thus, as the frequency increases the wave-length becomes shorter. Microwaves vibrate millions of times per second (that is, they have a very high frequency) and are, therefore, very short waves, hence *(turn to next page)*

the term *microwaves*.

There are two microwave frequencies in general use for microwave ovens: 915 MHz (wavelength is 32 cm or about 12.5″), and 2450 MHz (wavelength is 12 cm or about 5″). These are two of the frequencies allocated by the Federal Communications Commission (FCC) for Industrial, Scientific and Medical Use (sometimes called the ISM frequencies).

Microwave Energy Produces Heat. All matter is made up of atoms and molecules. Some of these molecules are electrically neutral, that is, they have no electrical charge. Carbon tetrachloride, benzene and parafin wax are examples of electrically neutral materials and microwave energy will

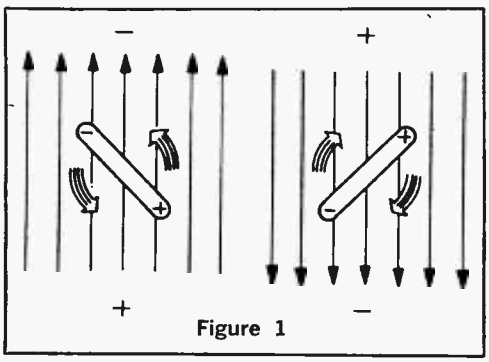
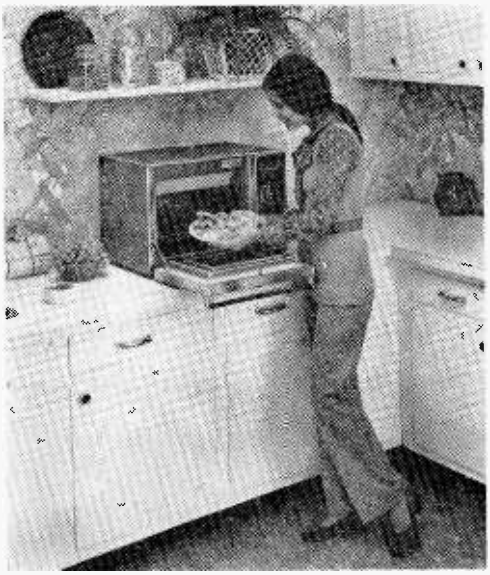


Figure 1

pass through these compounds as if they weren't present.

Most matter *is not* electrically neutral. and when an electrical field is applied the molecules tend to behave like microscopic magnets and attempt to line up with the field. See Fig. 1. When the electric field is reversed millions of times each second, these molecular magnets are unable to keep up because of other forces acting to slow them down. Such forces which restrict their molecular movement may be mechanical such as is the case with ice or solid fats, or viscous as is the case with a syrup like molasses. The energy of the microwaves in trying to overcome these forces is converted to heat. The material converts the energy to heat, or it might be said that the material heats itself. Another way to look at it is, consider billions of molecules rubbing elbows to keep warm.



For people on the go, microwave cooking is the answer. Here's a young Miss putting to "pot" a chicken dinner that'll be done in 30 minutes with the help of General Electric's Jet 80.

Microwave Properties. So far two characteristics of properties of microwave energy have been mentioned: absorbtion and transmission. Like light waves, microwave energy is also reflected. See Fig. 2. Metals reflect microwaves, and since there is no absorbtion, metals *do not heat*. Many materials in addition to glass transmit microwaves, and again, since there is no absorbtion, there is no heating. Paper, china and some plastics transmit microwaves and are therefore likely candidate materials for utensils for use in

SNACKEROONS

1 cup shredded cheddar cheese
¾ cup all-purpose flour
¾ cup coarsely crushed, crisp rice cereal
½ cup chopped walnuts
½ teaspoon garlic salt
⅓ cup softened butter
6 slices crisp bacon, crumbled
4 to 5 teaspoons cold water
Paprika

Mix all ingredients with a fork in a large mixing bowl until a dough forms. Drop by level tablespoonfuls onto greased 8-in. round dish. Sprinkle with paprika. Cook 6 balls at a time in microwave oven 3½ to 4 minutes. Remove immediately from dish. Serve hot or cold. Repeat with remaining mixture. Makes 18 to 20 pieces.

Recipes courtesy General Electric

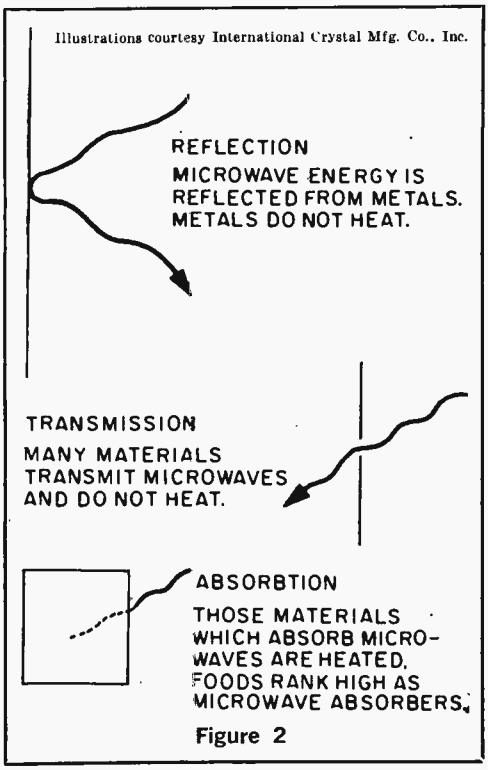


Figure 2

microwave ovens. The overall result is that foods can be cooked or heated in an oven on utensils which are relatively cool to the touch. Hopefully, no more burnt fingers.

Fast Cooking. An additional characteristic of microwave energy is its ability to penetrate deeply into food materials and to produce heat instantaneously as it penetrates. This is in sharp contrast to conventional heating, which depends on the conduction of heat from the food surface to the inside. Conduction heating can be accelerated only by increasing the surface temperature, and obviously there are limits, for who would enjoy a roast beef that is charred on the surface and raw inside?

ASTRODOME DIP

2 cups sour cream (1 pt.)
2 packets (envelope) onion soup mix
2 teaspoons lemon juice
2 tablespoons sherry wine

Combine all ingredients in 1 qt. casserole. Cook in microwave oven 4 to 5 minutes, stirring once during cooking period. Remove from oven, stir and serve with wheat crackers. This dip may be made ahead of time and refrigerated. Heat in microwave oven 5 to 6 minutes.

Measurement of the temperature distribution in an item heated in a microwave oven reveals another difference. The surface will be usually cooler than an inch or so below the surface. This is caused by radiation of heat from the food surface to the cooler surroundings of the microwave oven. It does not happen in a conventional oven because the oven heat is outside the food and must slowly conduct through the food to the cooler interiors.

Power Is Heat. To properly develop a sense of timing in microwave cooking, it is first necessary to know how much power is available in the oven. A microwave oven is not like a conventional hot oven. There is no excess of heat available. All of the microwave energy is absorbed by the food. There is no wasted energy.

You can measure the power by converting microwave energy into heat and measuring it in a simple calorimeter. The tools needed are a Pyrex measuring cup, a thermometer, a clock and some cold water. See Fig. 3.

Pour two measured cups of cold tap water into a Pyrex dish or cup. Note the

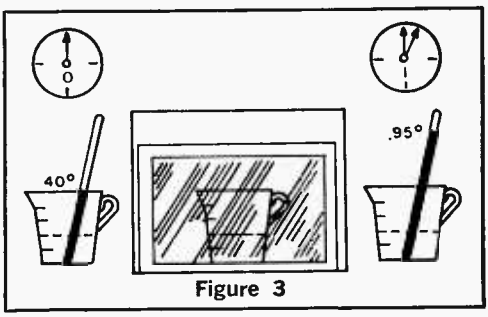
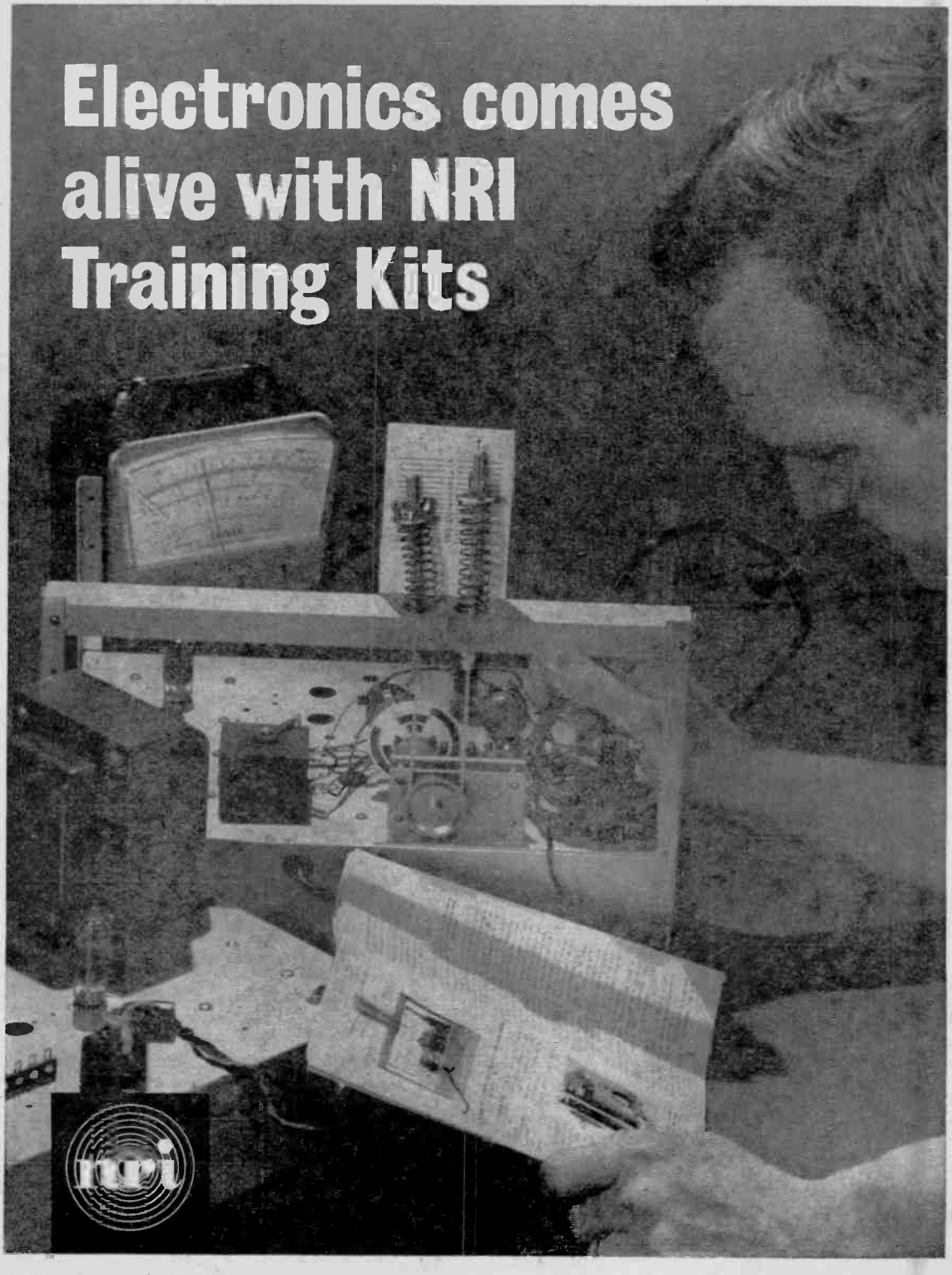


Figure 3

temperature. Heat the water in the microwave oven for exactly one minute and measure the temperature again. The difference in temperature times 17.5 is the power in watts. This is the amount of power generated in the oven in one hour. One-sixtieth (1/60th) of this power is available every minute.

A British thermal unit (Btu) is the amount of heat which will raise the temperature of one pound of water one degree Fahrenheit. In terms of Btu then, a one kilowatt oven puts out 57 Btu each minute, and if one pound of water were placed in the oven it should increase in temperature 57°F. in one minute.

Most foods contain moisture in varying amounts with the exception of pure fats like salad oils, shortening and lard. Another



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exception is dehydrated foods which do not depend on moisture to convert microwave energy into heat. The amount of moisture in a food has a direct bearing on its heating rate in a microwave oven.

One pound of food with 50% moisture will take less time to heat to a specific temperature than one pound of food with 75% moisture. Or if both are heated for the same length of time, the food with less water will reach a higher temperature than the food consisting largely of water. One pound of water, however, will heat

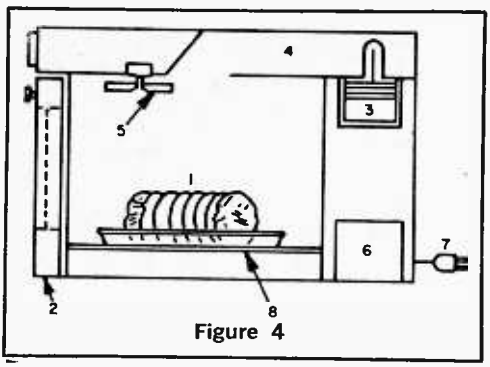


Figure 4

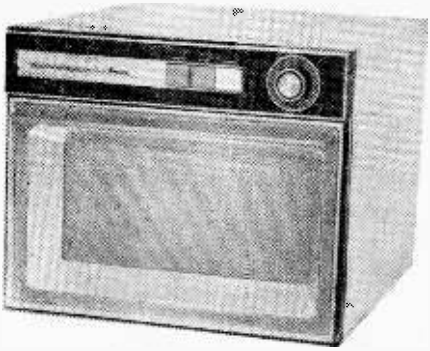
only half as fast as one pound of fat. The reason for this requires an explanation of the term *specific heat*. This is a measure of a material's ability to hold heat as compared to water. Water has a value of one (1.0). Fats are about 0.5. Thus water takes twice as much heat as fat to increase its temperature by one degree. Therefore in our one kilowatt oven one pound of fat will increase in temperature by 114°F. while the same amount of water will only increase 57°F. (It should be noted that this does not apply at high temperatures where some of the water may be changed to steam. This change uses up much more energy.)

A simple formula shows the relationship between the heat required and these other factors:

"Heat required in Btu's (Q) equals weight in pounds (W) times specific heat (s) times temperature difference in degree Fahrenheit (F), or

$$Q = W \times s \times t$$

With this simple equation, you can compute how long it would take to heat 12



Here's the Radarange R-2 by Amana that operates off an 117-volt, 15-ampere circuit and can do a good job on roasts and franks—it's your choice!

ounces of canned green beans to 160°F. in one kilowatt microwave oven. The specific heat of most vegetables, because of their high moisture content, is around 0.9. Let us assume that the beans would be at an initial temperature of about 70°F. (off the shelf).

$Q = 0.75$ lbs. $\times 0.9 \times (160°F. - 70°F.)$

$Q = 0.75 \times 0.9 \times 90$

$Q = 60.75$ Btu

Since our oven (1 kW) provided 57 Btu per minute, then the heat required (Q) divided by 57 Btu/minute would give the time, or

$$T = \frac{Q}{57} = 63 \text{ seconds}$$

How long would it take if the green beans were just removed from a 40°F. refrigerator?

When two foods at different starting temperatures are heated simultaneously in a microwave oven the colder food takes longer than the warmer food. An interesting example is that of apple pie and ice cream.

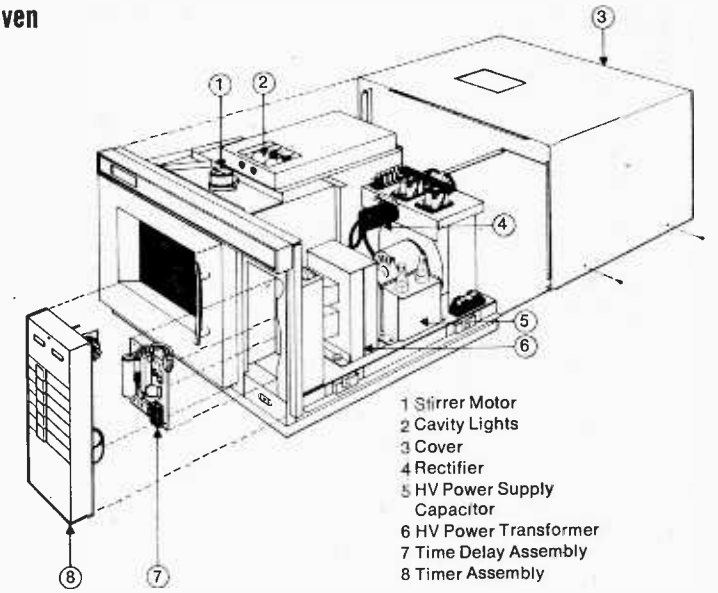
HOT ANTIPASTO

1 can (6-oz.) cocktail meatballs
1 can (4-oz.) vienna sausage, drained, each cut into 3 pieces
8 whole canned mushroom crowns
8 large pitted ripe olives
8 stuffed green olives
½ cup Italian salad dressing

Combine ingredients in 1-qt. casserole. Toss lightly and marinate in refrigerator several hours or overnight. Toss lightly again. Cover casserole. Cook in microwave oven 5 to 7 minutes until all items are hot. Makes 8 to 10 servings.

Inside a Microwave Oven

If you have seen the inside of one microwave oven you've seen them all. Basically, tracing from the line cord in, there's the rectifier, high-voltage transformer, and magnetron (hidden behind the oven's cavity). Necessary extras are stirrer assembly, oven lights and timer.

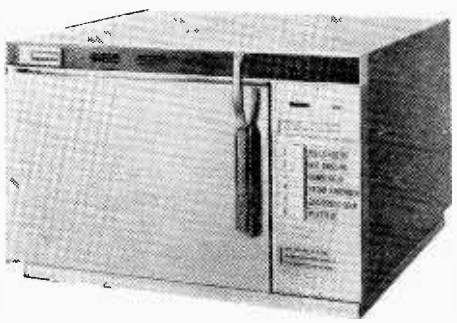


With the pie at room temperature and a scoop of hard frozen ice cream on top, the pie can be warmed without melting the ice cream. About 15 seconds in a 1 kilowatt oven will do the trick.

Inside the Microwave Oven. Unlike most cooking appliances in which the food to be cooked is overwhelmed with heat, a microwave oven operates essentially at room temerature. In fact, if anything, the food heats the oven.

The basic parts of a microwave oven are shown in Fig. 4: the cavity (1) the door (2) the magnetron (3) waveguide (4) the mode stirrer (5) the power supply (6) and the power cord (7). The main function of the power supply is to convert low voltage line power to the high voltages required by the microwave energy generator, the magnetron. When the magnetron is energized it generates high-frequency energy which then passes down the wave-guide to the cavity. The mode stirrer as it turns interrupts the energy as it enters the cavity and causes it to be distributed more uniformly about the cavity before it is absorbed by the food load. Without the mode stirrer, standing waves would occur in the cavity and there would be regions that would receive more energy than others, causing *hot spots* and *cold spots*.

The food load is shown positioned off



International Model 1000-001 is designed for fast food counters. Pushbutton controls are programmed for special menu items for restaurant use.

CREAM BEEF AND CHEESE DIP

1 package (8-oz.) cream cheese
1 jar (2½-oz.) sliced dried beef, finely chopped.
¼ cup coarsely chopped walnuts
¼ cup dairy sour cream
2 tablespoons each finely chopped onion and green pepper
2 tablespoons milk
1 to 1½ teaspoons pepper

Unwrap and place block of cream cheese in 1-qt. casserole. Cook in microwave oven ¾ to 1 minute, or until cheese is softened. Add all other ingredients and stir until well blended, cover. Cook in microwave oven 3 to 5 minutes, stirring once during cooking. Serve with melba toast rounds, crisp toast points or unsalted crisp crackers. Makes 1½ to 2 cups.

the floor of the oven on a glass shelf (8) for a reason. This position permits some of the energy to be reflected from the oven floor into the food from below. If this were not done the bottom of the food would lag behind in cooking giving uneven doneness.

The purpose of the oven door is to provide an access to the cavity and also to confine the microwave energy. A proper fitting door is essential to completely confine the energy and, it, as well as the door flange, should be wiped clean regularly to insure good contact of the door and the door flange. Considerable ingenuity has gone into microwave oven door design because it is such a critical feature of the oven. Good metal to metal contact is only one means whereby microwave tightness of the oven is assured. Another approach utilizes a quarter wave slot or "choke" seal around the perimeter of the door which acts to choke off or cancel out microwave emissions at this point. On ovens in which tightness is effected by a metal to metal contact, food spatters and spills on or between the door and the flange provide a pathway for microwave energy leakage from the oven. Food buildup should not be permitted to accumulate on the door seals.

Oven controls consist mainly of a timer, indicating lights, a start or cook button and a master switch. Timers vary from one manufacturer to the next, but are usually marked so that short heating cycles can be set with some degree of accuracy. The timer is important because all microwave cooking is gauged by time, not temperature and time.

A few seconds excess time in some cases can mean the difference between success and failure. An audio signal such as a buzzer bell usually indicates when the set time has elapsed and the oven has turned itself off. The oven may also be turned off simply by opening the door. To protect the user from unnecessary exposure to microwave energy is a requirement of all microwave ovens. Two or more interlocks operate when the door is opened any one of which could turn off the oven.

The oven can also be turned off by turning the timer back to zero time or by turning off the master switch. In some oven designs the cook button is omitted and cooking action initiated simply by closing the door.

Browning. The brown surface color of foods is due to a chemical reaction between food sugars and amino acids, the building blocks of protein foods. This reaction proceeds slowly at low temperatures and is accelerated by increasing the temperature. In microwave cooking the surface temperature of foods rarely exceeds 212°F., the boiling point of water, and is usually much lower. Because of this, most foods cooked in microwave ovens lack the surface coloration expected of certain foods. A steak or a meat pattie, for example, would have a gray, unappetizing surface appearance. Baked goods would not have a brown crust. The appearance of such foods can be enhanced by placing them in a hot oven for a few minutes, or in the case of the steak and meat pattie, on a grill or under a broiler. Restaurants which do a sizable steak business presear a quantity of steaks in advance and finish them in seconds in the microwave oven when ordered. Some foods which because of their size take longer to cook in a microwave oven do take on an acceptable surface appearance. This is aided by the presence of surface fats as in beef

(Continued on page 95)

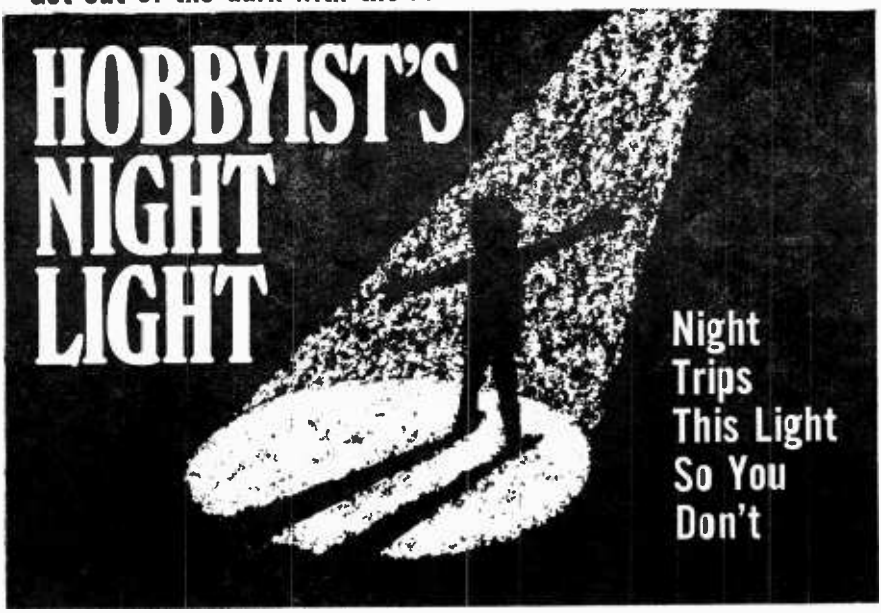
Heath's entry into the microwave oven marketplace is with their kit that anyone can put together.

NACHOS

Use large plain or taco-flavored tortilla corn chips, canned Jalapeno bean dip or refried beans, and hot pepper cheese. Spread about 1 teaspoon bean dip or refried bean mixture on each tortilla corn chip. Top with ⅛-in. thick slice of cheese, to cover bean dip. Place 8 to 12 pieces on paper plate or small pottery plate. Heat in microwave oven ½ to ¾ minutes, until cheese just melts. Serve hot.

Get out of the dark with the . . .

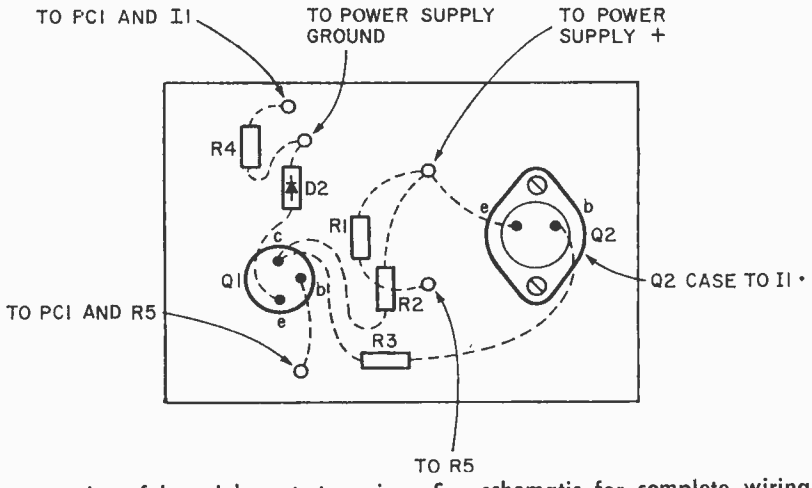
HOBBYIST'S NIGHT LIGHT



by Steve Daniels, WB2GIF

A bedside light is always a nice thing to have around. It keeps you from falling over wastebaskets, shoes, and other obstacles that might be scattered around. It's even nicer when you build it yourself. The Hobbyist's Night Light is a lamp that responds to large changes in ambient light and switches itself on whenever the light level goes below a point that you select.

A Light Response. In this circuit, light is detected by a cadmium-sulphide photocell which varies its resistance in *inverse* proportion to the light striking it. This simply means that, in the evening when the light gets dimmer and dimmer, the photocell resistance slowly increases. When the resistance of the photocell becomes greater than the total resistance of R1 and R5,



Suggested perf board layout, top view. See schematic for complete wiring.

transistor Q1 will turn-on. Recalling basic transistor theory, an NPN transistor conducts (turns on) whenever the base is positive with respect to the emitter.

Whenever Q1 conducts, it makes Q2 conduct and turn on a small pilot lamp that serves as the night light. A night light need not be bright. We've chosen a common, inexpensive #47 pilot lamp for ours because a wide selection of sockets is available.

Quick Pick-up. By connecting the lamp to the junction of PC1 and R4, the circuit is made to switch rapidly from off to on because lamp current flowing through R4 develops a small positive bias voltage to help Q1 turn on and remain on.

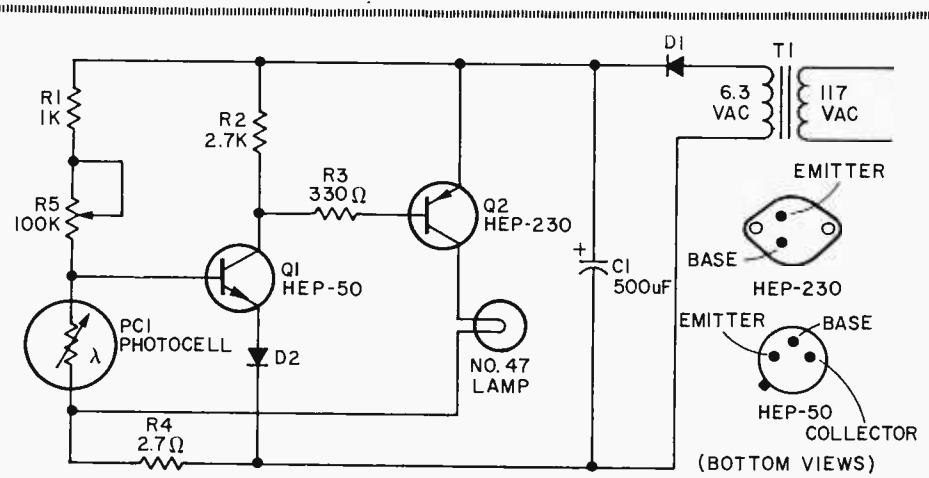
Most of the circuitry for this project can be wired on a small piece of perforated board about 2-in. x 3-in. in size. A suggested layout is shown; notice that connections are required for power, sensitivity control, photocell and lamp.

Night Light Construction. Mount the transformer and the rest of the power supply components in the box you are using and wire the power supply leaving 6-in. terminations for connection to the board. Wire the board. A heat sink for the power transistor is only necessary if you use a lamp rated over 300 milliamps. Mount the sensitivity pot on the box in a convenient location, secure the photocell in a hole with Duco cement where it will be exposed to room light, and screw the circuit board down on a couple of spacers. How you mount the lamp is up to you. A plastic reflector on the author's model came from his junk box; everything was just glued in place.

In any case, just make sure that light from the pilot lamp doesn't get back to the photocell; it would lower your unit's light sensitivity. Finish wiring the unit by connecting the photocell, power supply, sensitivity pot, and the lamp to the board. Screw the cover on and your night light is ready for use.

Adjustment is simple. Turn the unit on and set sensitivity pot R5 somewhat past the point at which the lamp goes out with the room lights on. It may be necessary to readjust things to account for ambient light conditions, but once set you'll be able to count on a light when you need it.

If you want to control an outside or porch light, substitute a 6-volt relay (Potter & Brumfield MR5D or equiv.) for the lamp and control the new lamp through its contacts. ■

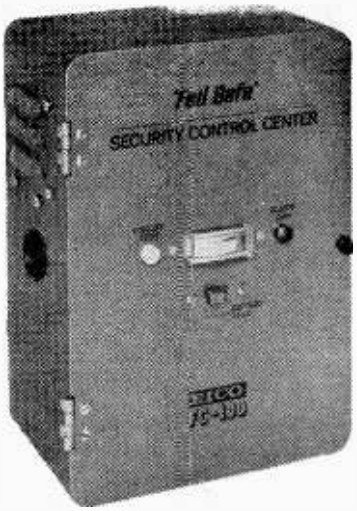


PARTS LIST FOR HOBBYIST'S NIGHTLIGHT

C1—500 uF, 15-VDC electrolytic capacitor
D1—Silicon rectifier diode, 2-amp, 50-V
D2—Diode, IN34 or any general purpose germanium (Lafayette 19-49015 or equiv.)
I1—Pilot lamp, #47
PC1—Photocell, Clairex CL703L
Q1—NPN transistor, Motorola HEP-50
Q2—PNP transistor, Motorola HEP-230
R1—1000-ohm, ½-watt resistor, 10%
R2—2,700-ohm, ½-watt resistor, 10%
R3—330-ohm, ½-watt resistor, 10%
R4—2.7-ohm, ½-watt resistor, 10%
R5—100,000-ohm, linear taper potentiometer
T1—Filament transformer, primary 117 VAC, secondary 6.3 VAC @ 1.2 amps (Stancor P-8190 or equiv.)

e/e checks out the first do-it-yourself

Burglar/Fire Alarm System

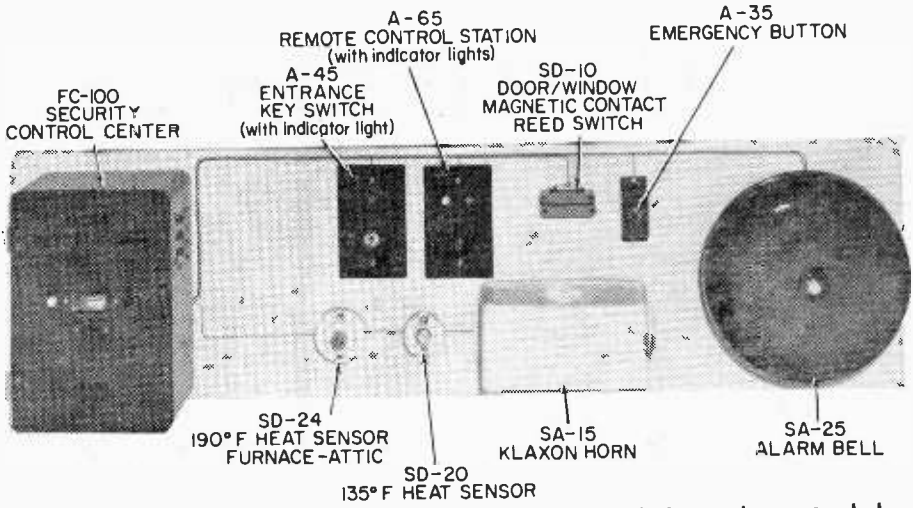


Truly a new consumer approach to professional protection EICO's system can be purchased completely or in parts!

Depending on the size of your apartment or home, a burglar alarm system professionally installed will set you back between $600 and $1000 (or more) and there's no guarantee you won't be stuck with a monthly service charge of about $10 "to make certain the alarm will work when needed." But if you're handy with a screwdriver and hammer, EICO's $99.95 SS-500 Home Protection System will give you *burglar, fire* and *emergency* protection that is "fail safe"; you won't have to shell out ten bucks a month just to make certain it's working.

The EICO SS-500 system consists of EICO's FC-100 Control Center and an assortment of security hardware such as an 8 in. alarm bell, magnetic switches, push switches, heat sensors, remote control panel, entrance key switch, door cords, etc.

The heart of the system is the fail safe FC-100 Control Center which is AC powered and can be powered by a standby lantern battery. In the event of a power failure, or if an intruder cuts the power lines to the house, the FC-100 automatically switches to the standby battery; it automatically switches back to AC operation



EICO's do-it-yourself home protection system for fire, theft can be expanded to the requirements of your home. Fail-safe battery supply maintains protection.

when power is restored.

The control center provides for both indoor and outdoor alarm bells and horns, has individual circuits for the intruder/burglar, fire and emergency sensors and switches, has a built in battery test meter and test lamps for checking out the installation; and most important, it is *impulse controlled*—meaning the alarm can be turned on and off from any desired entrance or inside switch. An important feature is that the intruder sensors can be either the open or closed circuit type—anything from window foil to mat (undercarpet) sensors or switches.

The control center also has outputs for signal lights that show all intruder/burglar circuits are "closed," or *ready*, and an *alarm on* lamp. The remote (indoor) control supplied in the SS-500 kit has both lamps, the outdoor (entrance) key switch control plate has an *alarm on* lamp. Any reasonable number of remotes, key switches and indicator lamps can be used; the limit is about 10 lamp circuits. While the AC power supply can handle much more than 10 lamp circuits, in the event the standby battery switches in you don't want too many lamps exhausting the battery before AC power is restored.

Three in One. The SS-500's three protection circuits work slightly different from each other. The intruder/burglar detector has a "lock up"; once tripped the alarm can only be silenced by turning off the system. Even if an intruder restores the protective circuit the alarm bell(s) keep ringing until the system is turned off.

The fire circuit is turned on when heat causes the heat detector(s) to close. The detector automatically resets itself (turning off the alarm bell or horn) several minutes after the excess heat is removed. The emergency circuit is switch controlled. Once turned on, say by a bedside switch, it can only be turned off by the same switch.

Additional protection is easily added by simply connecting the appropriate sensor to the correct terminals in the control center. For example, you can connect a smoke detector to the fire circuit, connect a freeze or water-flooding alarm to the intruder circuit (to summon a neighbor if you're on vacation), or even connect a telephone dialer in place of, or in addition to, the alarm bells.

Ring Them Bells. Since one of our staff was in the process of installing a burglar alarm we decided the best test of the EICO SS-500 was to have the staff member actually install the system.

Everything worked out as claimed. Two really outstanding features that everyone liked were the impulse control and signal lights. The user found it very convenient to check that all circuits were closed by simply looking at a light, rather than going from door to door to see if each "shunt switch" was set properly. (The SS-500 does not use shunt or bypass switches.) It was also convenient to come home late at night and not have to worry whether the entrance key switch index, when facing up, meant the alarm was on—or was it off? If the red light

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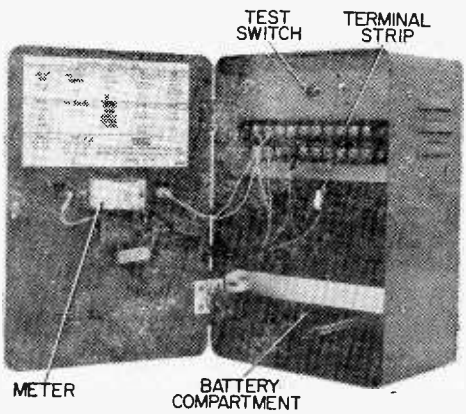
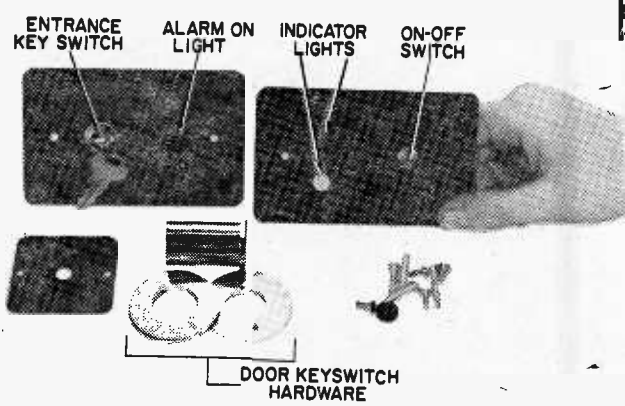
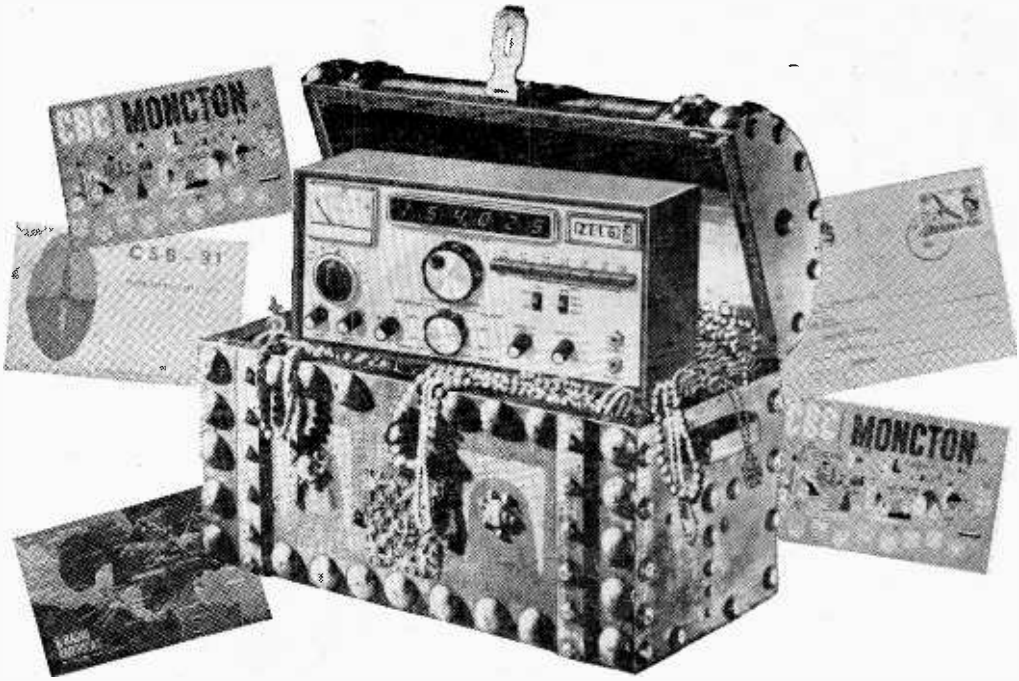


FC-100 has terminal strip for all external connections. Simplified installation means sure, full protection for you and your home.



External key switch plus inside unit allows you to disable system before entry or exit. Lamp shows others house is protected.



Stamp Collector's DX Guide to Atlantic Treasure

See how the QSL card can become a philatelic gem

by C. M. Stanbury II

THE ART OF DXING (distant radio listening) might best be described as a multi-hobby rather than a mini-hobby as some would have us believe: it ties in with many interests in addition to radio itself. For many, the collection of stamps and post marks from exotic parts of the globe is a rewarding addition to DXing. For example, the philatelist with a short wave receiver would have little trouble locating R. Santa Isabela on, say their off-band 6250 kHz frequency, after which a reception report and a description of the program heard could be sent. Barring political complications he should, in turn, receive the station's QSL card or letter accompanied by some rare (especially for the beginner) Ecuatorial Guinean stamps. Ecuatorial Guinea, a new independent nation, was formerly Spanish Guinea.

However DXing for stamps from these tropical, semi-Atlantic islands presents certain problems not generally encountered with more publicized Pacific counterparts. First, none of the Portuguese held islands (Sao Tome, Cape Verde and the Azores) have their own stamps. This is due to strictly political considerations; the Lisbon government wants each of its colonies to be an integral part of Portugal itself. On the other hand, considering the uncertain future faced by old-style colonial empires today, Portuguese stamps bearing these postmarks might at some not to distant future date become exceedingly valuable. If you're willing to gamble on this then your DX work is cut out for you.

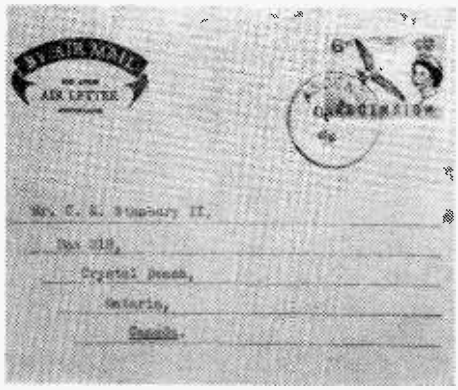
From the Islands. Each of these islands have short wave broadcast stations operating on either the 60 Meter tropical band or, of all places, 75 Meters. These stations are R. Clube de Cabo Verde (3886 kHz at Praia, the administrative capitol), R. Barlavento (operated by the Portuguese government itself from the nearby island of Sao Vincente on 3930

kHz), R. Clube de Sao Tome (nominally a privately owned station on 4807 kHz but has been associated with R. Portugal's somewhat nebulous plans for a "Voice of the West" relay in Africa), and Emisoras Regional dos Acores (another Portuguese government station at Ponta Delgada on 4865 kHz). All are good verifiers and all four sign-off at 1800 EST. This means that, with patience, DXers and stamp collectors East of the Mississippi should eventually bag them but reception further West would probably be rare.

Those who find themselves in the latter position can nail down the Azores at least via the widely heard Santa Maria Aeradio. A good bet for this is 8947 kHz during daylight hours. But in the evening

(Continued on page 99)

Some stamp hunting grounds for DX hounds.



Virtually unreplaceable, this Ascension Island letter from BBC is prized by author.

e/e's Guide to Atlantic DX

kHz	Station	Time (EST) & Notes
960	ZFB1, Hamilton, Bermuda	Early AM
1235	ZBM1, Hamilton Bermuda	Night
2868	Santa Maria Aeradio, Azores	Evenings
	Kindley Aeradio, Bermuda	Evenings
3886	R.Clube de Cabo Verde, Praia, Cape Verde Islands	1800 S/Off
3930	R.Barlavento, Sao Vincente, C.V.I.	1800 S/Off
4807	R.Clube de Sao Tome	1800 S/Off
4865	Emisora Regional dos Acores Ponta Delgada, Azores	1800 S/Off
6005	BBC Ascension	1700-1930, see text
6250	R.Santa Isabela,	1800 S/Off, 0000 S/On
8871	Kindley Aeradio, Bermuda	Days
8882	Canarias Aeradio, Las Palmas, Canary Islands	
8947½	Santa Maria Aeradios, Azores	Days
9510	BBC Ascension	Evenings, see text
11092	Cable & Wireless Ltd., Ascension	0600-0800, see text
	Cable & Wireless Ltd., St. Helena Island	0600-0800, see text
11228	Ascension Aeradio	See text
11800	RNE Canarias, Santa Cruz de Tenerife, Canary Islands	Evenings, see text
15360	RNE Canarias	Evenings, see text

SOUNDS from the GROUND

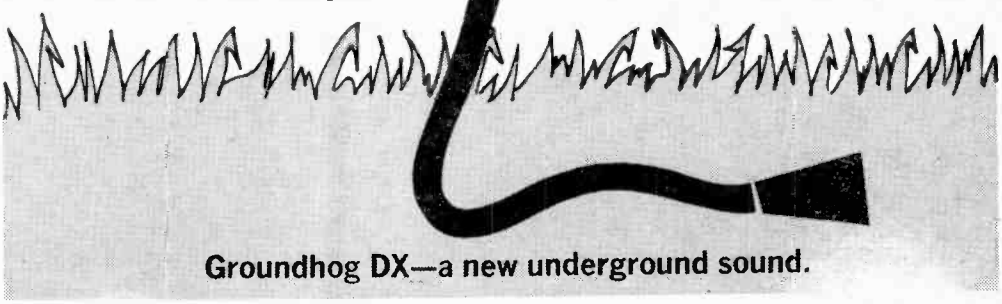
by Mike Centore III

No matter how long you've been a radio listener, no matter how sophisticated your receiver may be, chances are you're missing out on an entire spectrum of communications and broadcasting stations. Where are the signals from these unheard stations? They circulate in the earth beneath your feet!

It all started more than two-hundred years ago when Ben Franklin and others found that electrical impulses could be sent from one place to another by using the earth itself as the conductor. Later, Samuel Morse succeeded in sending code through the ground. Early in the 1900's, Nathan Stubblefield devised a method of sending audio many miles through the earth's water table. This sparked the interest of many and was the principle behind the first wireless field phones.

The use of underground *radio* dates back to World War II. Our Army, Navy, and Air Force used it in situations where conventional radio was useless (because of enemy jamming, etc.). Ham operators, forced off the air because of the war, tried underground radio as a secondary system of communications. While the system was found to be less efficient than above-ground radio, some surprising contacts were made.

Backyard Propagation. To get a basic idea of how an underground communications systems works, look at Fig. 1. As you can see, the signal to be transmitted (be it radio or otherwise) is fed directly into the earth by way of an underground antenna. Since the earth is a mixture of water and minerals, the soil is a



Groundhog DX—a new underground sound.

a highly conductive medium known as a chemical *electrolyte*. The signal propagates through the ground just as it would travel in a large, low value resistor. But, unlike a resistor, the resistance of the earth is not the same in all places. This is due to variations in chemical make-up, water content, and temperature. Because of this, the signal is distributed unevenly, with maximum signal in the areas of lowest resistance. Fig. 1 shows the high concentration of signal in the wet earth surrounding a body of water. Also shown in Fig. 1 is the all-important *water table*. This is the upper extreme of the earth's *zone of saturation*, where the space between each grain of soil is completely filled with water. At this point, usually eight feet below the surface, the resistance of the soil is at its lowest, making signal conditions excellent. In fact, the water table is just as important to underground communications as the ionosphere is to above-ground radio. The major requirement for the underground transmitting antenna is that it be buried deep enough to make good contact with the water table.

Putting Your Ear to Ground. It's just as easy to receive underground radio signals as it is to hear the normal variety. In fact, all you need to do is bury your present above-ground antenna! This is absurd, but in theory it would work fine. A more practical approach is to use an "antenna" like the one illustrated in Fig. 2. Here, a metal pipe (or rod) is driven into the ground as deep as possible. While the pipe should be long enough to reach the water table, I have had satisfactory results using pipes as short as three feet. The pipe can be of copper, bronze, galvanized steel, or any relatively non-corrosive metal. The surface of the pipe should be bare metal—free from paint or grease. The diameter is not of great importance. On top of the pipe, some type of wire clamp should be mounted. This may be a regular ground clamp or a large self-tapping metal screw.

The success of your underground reception depends a great deal on the location of your underground antenna. To be effective, the antenna should be driven into an area of high signal concentration. As you know, the mud around a pond or other moist area is an excellent antenna site. But even if there is no such condition around your yard, there are other factors to consider. For example, it has been found that certain types of soil make better electrolytes than others. Soil containing large amounts of refuse material (ashes, cinders, etc.) is the most conductive type. Next best is soil containing adobe, clay, shale, or loam. The least conductive soils are composed mainly of sand and gravel. One final note about the location of your antenna: do *not* drive your underground antenna into an area which is closer than ten feet from any other ground rod or water pipe. Read on and you'll see why.

Dirt Cheap Receivers. Well, now that you have your underground antenna set up, it's time to start thinking about the receiver. The first thing that comes to mind is to use a standard shortwave radio. But unless your receiver tunes down to around ten or twelve kHz (that's *kilo*hertz), you will be missing out on most of the underground action.

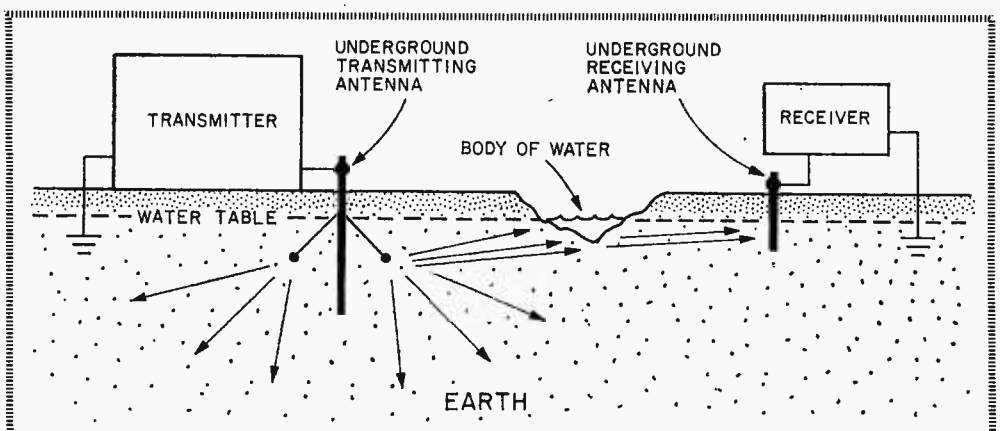


Fig. 1. Transmitter is either radio or audio type. Practical receiver is shown right.

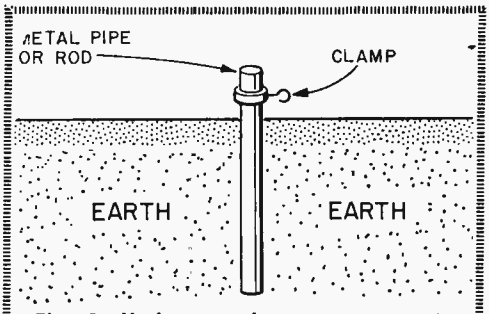


Fig. 2. Underground antenna extends into water table for best results.

Also, the input impedance of most receivers can't be varied enough to stay matched to widely changing ground conditions.

For the past few years, I have been using the simple "receiver" shown in Fig. 3 with very good results. When connected to the underground antenna and a good earth ground, the circuit is capable of receiving signals on *any* frequency, including audio. As shown pictorially, the entire receiver can be built around the connecting lugs on the potentiometer. The sensitivity of the circuit is surprisingly good. Best results have been obtained using a high impedance crystal earphone (Lafayette 99—25512 or equivalent), although a headset with an impedance of 20,000 ohms or more may be used.

Double-Ground Hookup. For proper operation, the circuit must be connected to a good earth ground (cold water pipe, ground rod, etc.) as well as the clamp on the undreground antenna. Any signal which is received has developed a voltage between the receiving antenna and the electrode used as earth ground. This explains why the underground antenna must be separated by at least ten feet from the grounding electrode—otherwise, the incoming signal would be short-circuited by the low resistance of a small patch of earth between them.

If it is desired to have the receiver located far from the underground antenna or grounding electrode, you may run long interconnecting wires. However, if the wires are made longer than fifty feet or so, they will begin to act as above-ground antennas, causing you to pick up local broadcast station interference.

What You Will Hear. With everything connected properly, while listening to the earphone, "tune" R1 through its range until you hear something. Fig. 3 shows which direction to rotate the shaft on the potentiometer to select either radio or audio signals. If you hear two stations at once, the potentiometer may be adjusted to bring in one over the other to some degree.

Most of the stations you hear will be operating on the Very Low Frequency range and below. All modes of operation are used ranging from CW (code) to AM (voice), including many types of "radiolocation" beacons. Some of what you hear, including most of the beacons, are not intentionally transmitted underground. The extensive antenna grounding methods employed at these low frequencies set up a strong underground signal that travels many miles. One such station to listen for is the Navy's two-million watter operating from Cutler, Maine. The station sends CW on 14.8 kHz. The CW is received as a loud low-pitched hum.

Through the years, I have heard everything from CW and beacons to hard rock on my underground receiver. You must understand that some of what is transmitted under ground was sent this way to obtain some degree of privacy. I found this out one hot summer day (when conditions are best) as

(Continued on page 98)

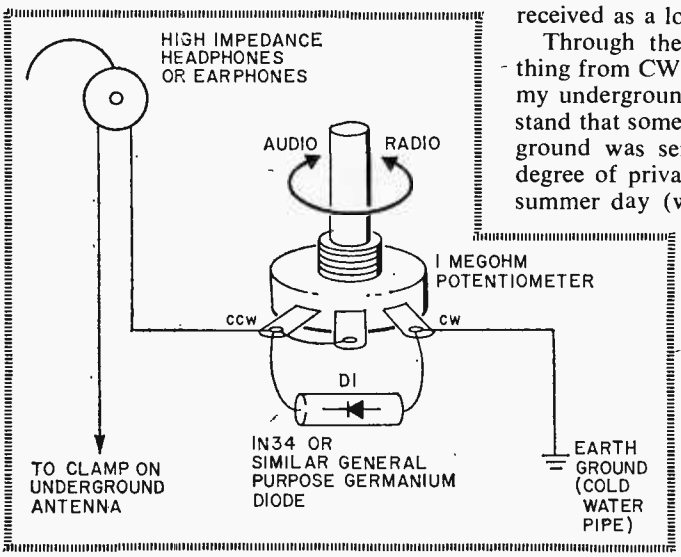
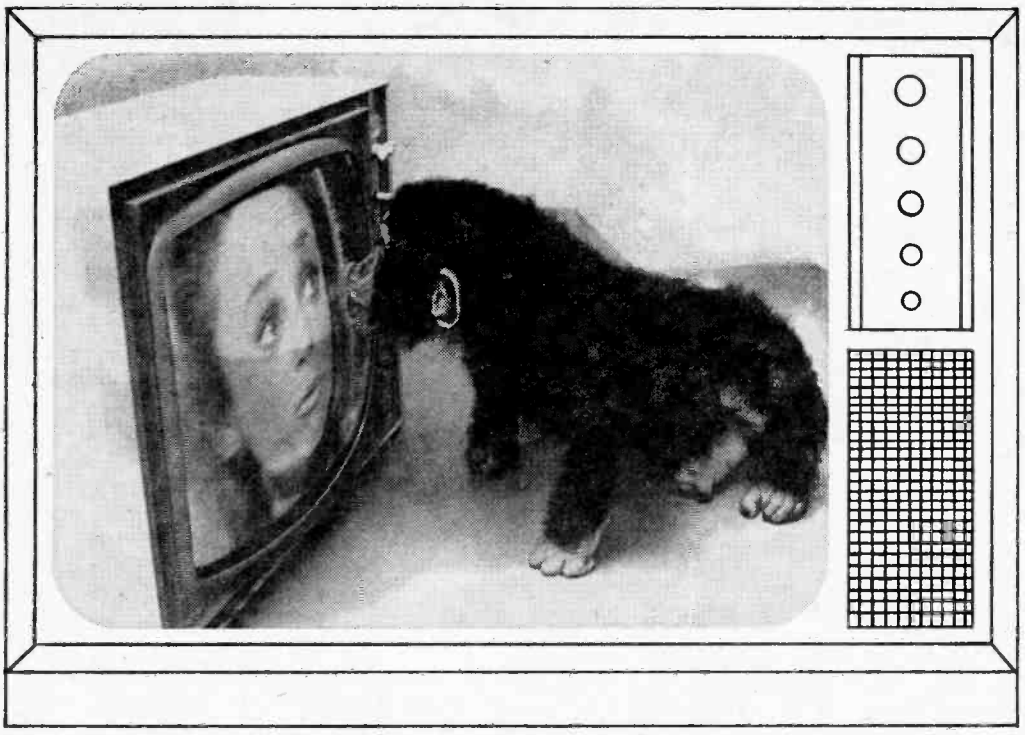


Fig. 3. Circuit uses 3 parts. Use this simple circuit to pick up both AF and RF signals from the ground.



PRIMATES PICK

TV is no monkey business at Emory U. where simians

These chimps go wild over westerns, and can even predict much of the action!

TV is the favorite pastime at Emery U. —at the monkey house that is. Here primates watch TV all day while their human brothers are busy conducting studies. It all started with an idea that TV might relieve the monkeys' boredom—and it did! Now, this is the basis of a new study, and it seems that you and the ape have the same video taste.

Dr. Bourne, director of the Primate Research Center, sent out requests for old sets, and set these up along the corridors of the monkey house, and in various TV rooms where the monkeys can be more carefully studied. As time passed, differences appeared among the primates. The chimps preferred westerns—the more action the better! They prance around with excitement and can tell the bad guys from the good. But the orangutans and gorillas shied away from violence; their preference seems to be soap operas and quiz shows. And don't think

These young chimps are spellbound while the ape would rather have their friend's attention.

This orangutan gets his kicks from changing channels. Programs don't excite him.

PRIME TIME

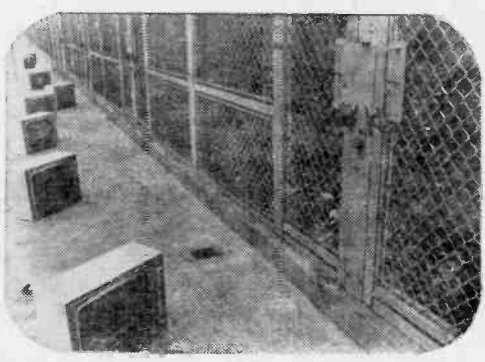
choose the same video programs you do!

they'll allow a show they dislike to stay on. They are quick to change the channel!

This behavior is not so startling if you consider monkeys have keen eyesight and are able to discern figures on a screen. The unusual part is their intense involvement. Moreover, the primates do not even seem to mind commercial interruptions. Some interesting observations were: there's the chimp who tries to kiss all the pretty girls on the screen, and then there's the ape who was spellbound for 120 minutes watching a rerun—King Kong, of course.

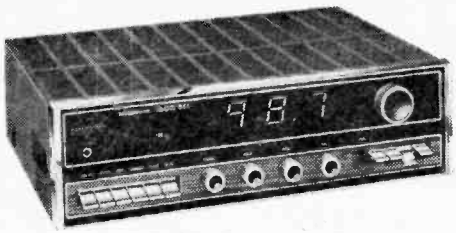
—Myrtle Gronk

This chimp's involvement is very similar to a human's. Like us, he's puzzled.

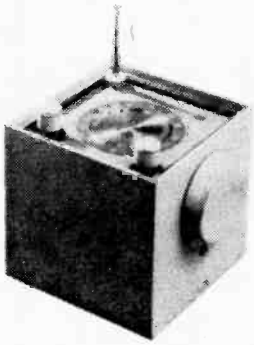


The corridors are lined with television sets so the monks can watch all day long.

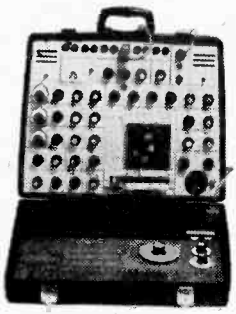
E/E looks at new...



The first receiver featuring digital tuning for both FM and AM, the Magnavox IK8898 is rated at 150 watts and priced at $579.95. Precise tuning for FM is achieved when the digital readout "locks" into a steady glow; for AM, the tuning is adjusted for a readout of frequency. Circle No. 33 on Reader Service Page.

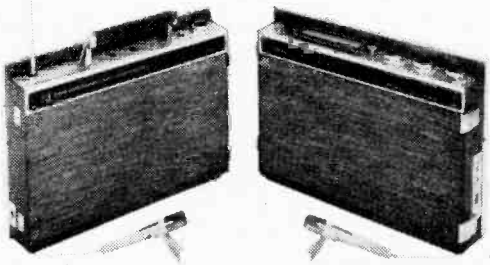


When you want to listen to a favorite TV program but can't watch the screen, try the Video Voice by Concept Plus. Featuring both VHF television sound and FM broadcast sound on dual bands, the $24.95 Video Voice is battery powered and has a collapsible antenna, earphone and jack, and loudspeaker. Circle No. 34 on Reader Service Page.



Synthi, an electronic music synthesizer from England's EMS, has its own internal speakers and can set up almost any single sound effect. All outputs can act either as signals or controls. The basic Synthi is $995; with keyboard, $1,095. Circle No. 36 on Reader Service Page.

For your compact or foreign car, Panasonic's RS-248, "The Joplin," is a removable stereo cassette player with a console that bolts to the transmission hump. Priced at $109.95, "The Joplin" has a sliding door that locks securely. The top surface is recessed for cassette storage. Circle No. 37 on Reader Service Page.



Take-it-with-you entertainment from Toyo: the 404 portable 8-track stereo cartridge tape player and recorder features fast forward, and contains an AM/FM-stereo radio, for $159.95. Record your own tapes live, or directly from the radio. Circle No. 35 on Reader Service Page.

HI-FI COMPONENTS

KATHI'S CB CAROUSEL

By Kathi Martin, KAIO614

WHAT'S A GIRL TO DO? With hemlines in New York changing faster than Spring weather, it's hard to keep my office wardrobe up to snuff. Skirt lengths change, pants suits become popular (and believe me, *very* functional on cold, windy winter days) while hot-pants are definitely out! With bikini weather just a warm breeze away, my solution is a half-way compromise.

It's back to mini's with lengths halfway between micro-mini and my knee—leaving pants suits and an *occasional* midi for next winter. What does all this have to do with this issue's column? Well, with CB transceiver design, a compromise is usually necessary when a manufacturer packs a full 5 watts into an itty-bitty package not much larger than an eye shadow kit. Sure, the mini's are fun to tuck away in the glove compartment or beach blanket, but until I had a chance to work the Regency *Formula 23*, I'd forgotten just how a little extra size can make a big difference in convenience features and performance.

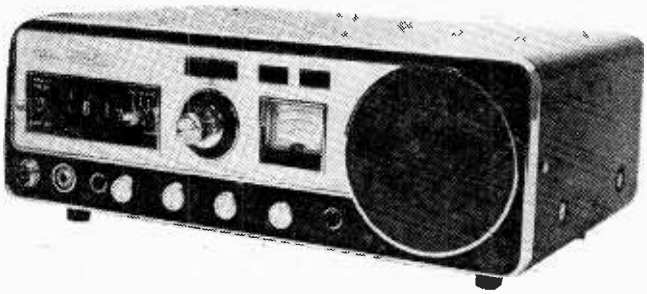
Instant Performer. By modern standards the Formula 23's 5¼-in. x 14½-in. x 9-in. cabinet is large, but the extra space allows Regency to include a power control digital clock that turns on the instant-warmup rig at a preset time. You also get a front panel microphone jack, SWR meter, full size phone jacks for headphones, remote speaker and PA speaker and a 117 VAC/12 VDC power supply with positive and negative ground. And just so you know for certain your signal is really getting out, there's a transmit light and a modulation light that glows only if the rig is being modulated.

The Formula 23 is supplied with all crystals for 23 channels. There is a 3-position delta tune switch that changes the receive tuning approximately ±1.5 kHz. Across the bottom of the front panel are the microphone and headphone jacks, volume and squelch controls, ANL, the SWR meter calibrate, and the meter selector that converts the single meter from an S-meter to a relative power output meter to an SWR meter. The rear apron has the remote speaker and PA speaker jacks, antenna input, power supply connector and antenna loading adjustment (factory preset).

Though easily overlooked, the loudspeaker is an important part of the Formula 23 because it is relatively large and faces forward —not down or sidewise as many do; it's the best combination for no-strain monitoring.

Full Circuit Line-up. The innards start off with a FET (field effect transistor) front end and double conversion; the second IF has a mechanical filter and IC amplifier. This feeds a switchable noise limiter and the audio amplifiers. The transmitter uses frequency synthesis for full 23 channel coverage; its modulator has 100% modulation limiting on both positive and negative peaks.

On the test bench, the Formula 23 puts it all together with some first rate performance. The sensitivity is a real signal-grabber —0.8 μV for 10 db S+N/N while selectivity



Certainly a swell looking rig, but our real concern is communications. Well that's what this Regency rig is built for—from the speaker grill all the way back to the antenna terminal. Get more facts direct from Regency by circling No. 45 on Reader Service Coupon on page 17 or 103.

is a razor sharp 60 dB on the adjacent channel. Image rejection is 80 dB. And if you want even more, wait till you try out the front end on a powerhouse signal; the FET crushes strong signal overload and cross-modulation. Even with signal levels above 10,000 μV which often cause many rigs to break into squeals and whistles, the *Formula 23* comes through and takes it all in stride.

The only thing not up to snuff is the AGC action. Between 10 and 10,000 μV the AGC action is about 6 dB (average), but if you tune from a weak signal below 10 μV to a strong signal there will be moderate speaker blasting.

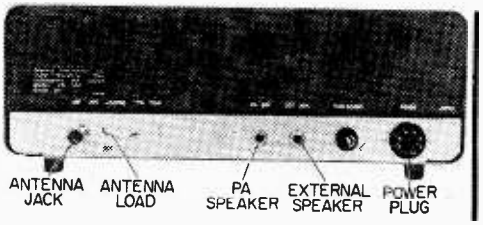
The S-meter takes 100 μV input for S9; the rest of the readings are relative.

The transmitter put out 2.8 watts RF from a 117 VAC power source and 3.4 watts from a DC supply. The relative microphone sensitivity for 100% modulation was −29 dB—more sensitive than the average −23 dB microphone sensitivity. The modulation is limited to 100%, so even if you scream into the mike you're not going to splatter your message over several channels.

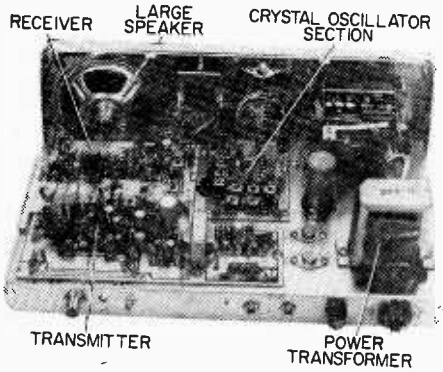
Listening's Good Too. Using the Formula 23 was a real pleasure. The sound quality is terrific, and I can listen to that large speaker for hours without getting an earache. The receiver did a first rate job, and with that FET front end even locals a couple of channels away didn't give me any problems.

Summing Up. It's hard to sum up a transceiver that just works well all the time. After all, how can I single out something special when the *Formula 23* does a terrific overall job. The price is $189.00 plus $6.74 surtax.

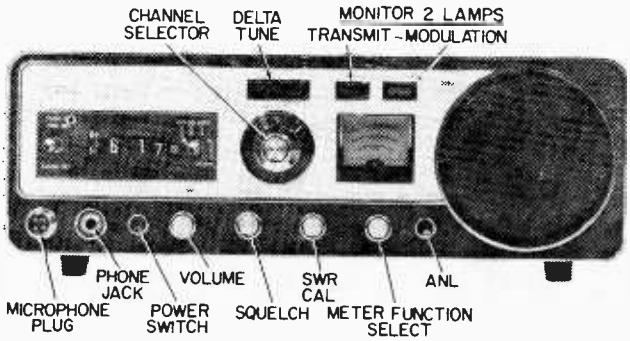
For more information circle No. 45 on Reader Service Coupon on Page 17 or 103.■



Now there's something rare; standard size phone jacks for the PA and external speakers. Base or mobile power is applied to a dual power supply via single power plug. Rig also includes an effective TVI filter.



One reason for the Formula 23's good performance is the heavy duty power transformer and unusually large speaker. Note clock is part of transceiver; this rig is more than just a mini squeezed into a large case. It's one clock radio that'll go well on any CBers night table!



The front panel is packed with goodie features. Digital clock can turn rig on or function as an alarm clock. A single meter serves as an S-meter, relative power RF output meter and as an SWR meter for monitoring.

e/e checks out the...

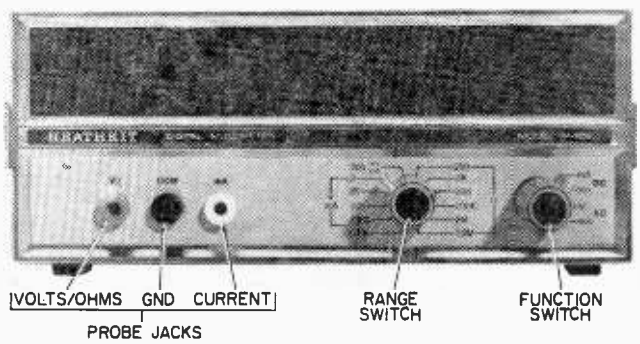
First Digital Multimeter Kit

Count on Heathkit IM-102 to bring accuracy to your test measurements

Do you have these day-to-day problems with your VOM? Is it reading 105 volts when it should be 120 volts, or is the resistance really 180 Ohms and not 160, or is the VOM reliable since it dropped on the floor? Has it worked at all since you dropped it on the floor! Consider how much easier it would be to read out the measurements from digital numerical display tubes having almost "lab standard" accuracy.

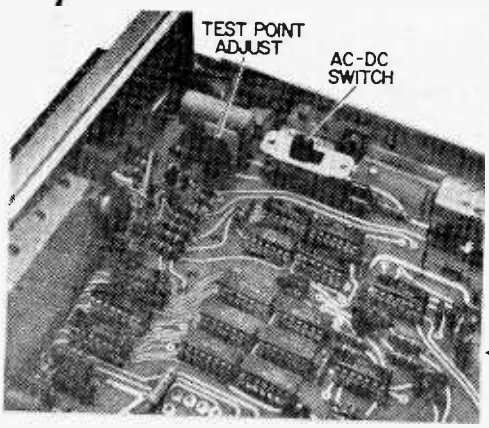
Fact is, with a digital multimeter such as the Heathkit IM-102 you can read AC voltages down to 100 uV, or resistance values as low as 0.1 Ohm. (with 0.1 Ohm accuracy). And with the Heathkit digital multimeter, even assuming you botch the calibration procedure, the worst-case accuracy will be about 1% ± 1 digit. If you're real careful about the calibration or have access to laboratory calibration equipment the IM-102 will have a nominal accuracy of 0.5% (or less) ±1 digit. In short, the Heathkit IM-102 is so accurate it can serve as the calibration standard for all the other instruments in your shop. You've come a long way, baby.

Priced at $229.95 in kit form the IM-102 provides five AC and DC voltage and current ranges, and six resistance ranges. The full scale voltage ranges are 200 mV to 1000 V (500 V maximum for AC) and the current ranges are 200 uA to 2 amperes. The resistance ranges are from 200 ohms to 20 megohms. The polarity of the DC



Reader Service Coupon. Heath by circling No. 1 on Get more information from than the usual shop VOM's. minimum of three times better Don't forget accuracy, it's a than many analog VOM's. makes the IM-102 easier to use for volt and ohm measurements match. Just one set of jacks accuracy no ordinary meter can operates coupled with an convenient way the meter Why a DMM? It's the

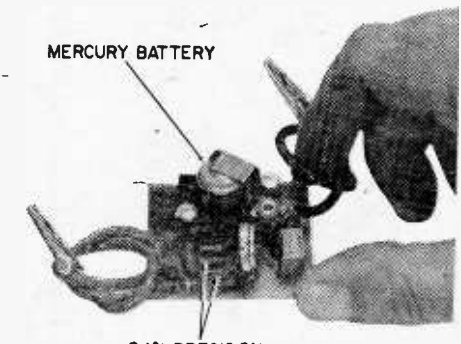
e/e FIRST DMM KIT



◄ **Heath's IM-102 includes special DC and AC procedures for calibration at home to 1.0 per cent ± 1 digit accuracy on AC.**

voltage and current is automatically indicated, and the decimal point is automatically located for each range. All ranges are overload protected by a fuse and/or a diode clamp. An overrange indicator shows if the applied voltage or current exceeds the range capability.

Digits Do It. The IM-102 is what is termed a 3½ digit meter; meaning there are three display tubes (cold cathode type) with 0 to 9 digits and a neon lamp to provide a "1" (the half digit). It works this way: assume you apply 9.98 volts to the meter; three tubes will light showing 9.98. If you raise the voltage to 19.98 volts the half digit neon lamp illuminates and the display is 19.98. Obviously the display cannot indicate higher than 19.99. If you apply 20 volts the display shows 00.0—one digit higher than 19.99. Since the range switch is set to 20 volts a ±0.00 reading equals 20 volts. (This takes about 1 minute to get used to.)



◄ **Here is a prewired calibrator used to set meter's DC calibration. Mercury reference battery is user replaceable if required.**

Now should you apply 20.01 volts or higher the *overrange* lamp goes on, indicating you must switch to a higher range—this is the equivalent of pinning a conventional meter, except the digital multimeter won't be damaged by "pinning." Depending on the range in use and the amount of overvoltage, the digits might run or scramble in addition to turning on the overrange lamp.

Typical of digital meters, the IM-102 takes one to two seconds for settling, that is, after the test probes are applied the display will run until it locks onto the voltage. Only the 20 megohm range takes longer, nominally 20 seconds because of the very high resistances involved.

Calibration. One of the questions you are sure to ask is how can you calibrate a lab-grade DMM such as the Heathkit IM-102 if you don't have any other lab grade equipment. The answer is simple. Heathkit provides a precision (factory wired and calibrated) calibrator with the DMM kit.

The calibrator serves as a precision voltage reference and as a precision resistance reference. Two supplied precision resistors serve as the reference for the calibration of the 20 megohm and AC current ranges. The DC current ranges automatically calibrate with the DC voltage adjustments; the supplied calibrator is used to simply check the DC current calibration.

Building the kit. Most of the circuitry is on one large printed circuit board, providing a basic DC digital meter. A small PC board that mounts under the main board is an *AC convertor* that converts an AC input into a DC source for the basic meter. Both boards have wide-spaced component mounting and there is no parts jam. The only hassle you'll have is soldering the IC pins to the rather fine foils. We strongly suggest you obtain a very fine conical tipped soldering iron (such as an Ungar). If you use a large (standard) soldering tip there is a strong chance you will bridge several foils with solder. Total construction time runs about 10 hours plus

(Continued on page 98)

See what four technicians and a black box do to...

The Language Of Gain

by Norman Crawford

WHEN YOU GLIDE the old heap into a gas station and ask the attendant for "two bucks worth of hi-test," he's sure to know you want high octane gas and can part with two dollars.

But just try to ask for "two liters of Ethyl" and you just might end up with an empty gas tank and seven or eight kittens!

In this article we want to discuss gain—the kind electronics is made of. But instead of explaining gain in textbook style (to help avoid something akin to our two liters of Ethyl misunderstanding), we think we've found a sort of black box dialect that'll help you understand electronic terms associated with gain.

Mu, beta, and gm. We know that each term describes gain. Why, then, such a variety of terms?

Can a triode have its gain described by mu, or can a FET have a beta? Exactly what do all these terms mean?

Read on . . . To answer these questions let us suppose that we concealed some type of amplifying device in a black box, and sent it to

e/e THE LANGUAGE OF GAIN

an electronics lab with a request that its gain be measured. The input and output leads are brought out and identified, but the lab is not told whether the box contains a vacuum tube, an ordinary bipolar transistor, or a FET. We also supply the lab with a 2-volt signal source for the input, and give them a load resistor to be connected across the output leads.

The lab, to enhance its reputation, decides to make four independent measurements and compare the results. The entire set-up is therefore handed to the first of four lab technicians with the only instruction, "measure the gain of this box."

The first tech takes the straightforward approach and measures input signal voltage and output signal voltage as shown.

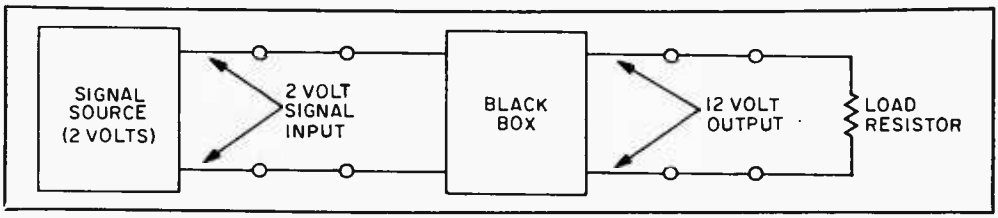
his lab bench, finds that he does not have at hand any convenient way to measure voltages, but has some excellent current-measuring devices all ready to use. He therefore measures the input and output *currents* as shown.

A signal current of 3 microamperes flows into the box, he discovers, causing an output signal current of 360 microamperes. Taking the ratio of these two currents, he obtains the *current gain*.

$$\text{Gain} = \frac{\text{i } (out)}{\text{i } (in)} = \frac{360 \text{ microamps}}{3 \text{ microamps}} = 120$$

Since current gain is usually expressed by the term beta, the tech reports to his boss that the black box has a beta of 120.

Now, remember that these two numbers, a mu (voltage gain) of 6 and a beta (current gain) of 120, are measurements made on the same amplifier, with the same signal



Black box (slang for an unknown circuit) test set-up for input/output voltage measurements.

Finding that the black box has a 2-volt input and a 12-volt output, he takes the ratio of these two voltages, and obtains the gain.

$$\text{Gain} = \frac{\text{e } (out)}{\text{e } (in)} = \frac{12 \text{ volts}}{2 \text{ volts}} = 6$$

Since this result is the ratio of two voltages, it is the *voltage gain*, and is usually expressed by the term mu. This tech therefore reports the black box has a mu of 6.

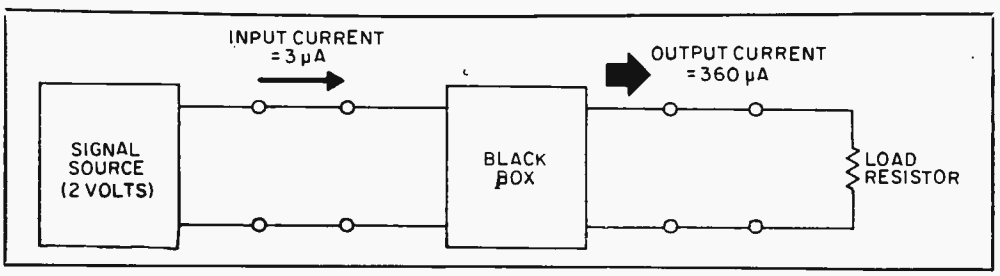
Joe trys. The entire set-up is then taken to a second technician, who, looking around

source and the same load. The only difference between the two measurements is that voltages were measured in one case, and currents in the other.

This same set-up now is passed to a third technician, who, with a mischievous glint in his eye, proceeds to measure the output *voltage* and the input *current*. He gets yet another figure for gain.

$$\text{Gain} = \frac{\text{e } (out)}{\text{i } (in)} = \frac{12 \text{ volts}}{3 \text{ microamps}} = 4 \text{ megohms}$$

Fred's Folly? Hold on there! Gain, in meg-



The second tech, Joe, who measures currents must describe his gain in beta.

ohms? Yes, indeed! Ohm's law states very clearly that when volts are divided by amperes, the result is in ohms. It's perfectly legitimate to express the gain of an amplifier in ohms, or kilohms, or megohms; whatever the ratio of its output voltage to its input current yields.

Does this mean that the amplifier can be replaced by a 4-megohm resistor? No, for the 4 megohms defined by the ratio is a special kind of resistance, called a transfer resistance, meaning that it indicates the voltage transferred to the output when a certain current is applied to the input. It is sometimes shortened to transresistance and is also called *mutual resistance* (RM).

This way of expressing gain is a bit unusual, which accounts for the mischievous glint in the third tech's eye. It is not found among the more common gain expressions given in the first paragraphs. Nonetheless, it is a perfectly valid way to describe an amplifier's gain.

Sam's System. The fourth technician, who now inherits the black box for the final measurement, has seen the stir created by his colleague's mixed measurement of current and voltage, so he decides to try for another flurry, only this time by reversing the measurements, getting readings for *output* current and *input* voltage. He obtains yet another gain measurement.

$$\text{Gain} = \frac{\text{i}\,(out)}{\text{e}\,(in)} = \frac{360 \text{ microamps}}{2 \text{ volts}}$$

Gain = 180 micromhos.

This is another variation on Ohm's law. Just as volts divided by amperes gives resistance (ohms), so the inverse (amperes divided by volts) gives conductance—the inverse (reciprocal) of resistance. The unit of conductance is the mho, which is ohm spelled backwards.

The special conductance used to describe an amplifier's gain is called transfer conductance, for the same type of reason given above for transfer resistance. Similarly, shortened forms include *transconductance* and *mutual conductance*, symbolized as GM.

So the fourth and final measurement on the black box yields an answer of 180 micromhos for the gain. In summary then, four different measurements on the same amplifier gave the following differing figures for gain.

mu (voltage gain) = 6
beta (current gain) = 120
rM (mutual resistance) = 4 megohms
gM (mutual conductance) = 180 micromhos

Whatever device is in the box, it certainly can use any of the familiar gain expressions—mu, beta, or gM—to characterize its gain and, moreover, can even have its gain stated by the less familiar rM.

What's relevant. In general, any device—triode, pentode, transistor, or FET—could theoretically use any of these four terms to state its ability to provide gain. But in practice, the technique chosen to measure gain depends on how relevant one method may be over another.

For example, a triode's negative-biased grid, sticking into a stream of electrons in a vacuum, draws almost no current, and even that tiny current it does draw doesn't mean much in determining the triode's output. Since the input current is so tiny, and the output current so much larger, a triode vacuum tube's beta (current gain) is extremely large, but it is difficult to measure, it would vary widely from tube to tube, and doesn't mean much anyway when it comes to practical gain calculations.

On the other hand, the voltage on the grid is very easy to measure and is very meaningful in controlling the output. So, the triode's input signal is always stated in terms of voltage.

Similarly, the pentode's grid and the FETs gate draw so little current that their betas would be astronomical but meaningless, while like the triode, their grid or gate voltages are easily measured and relate closely to the output.

Something different. The ordinary bipolar transistor, however, is a quite different animal. Instead of having a grid in a vacuum or an insulated gate, it has an input consisting of a turned-on PN junction—the base-to-emitter diode. (See e/e's Basic Course for March-April, 1972 and May-June, 1972 —Understanding Semiconductors).
This diode is almost a short circuit for signals; input voltages are therefore, very hard to measure, never go above approximately 0.6 volt, and bear a very unwieldly relationship to the transistor's output. However, this turned-on diode draws an appreciable current which also happens to be the parameter that controls the transistor's output. Therefore, the quantity most conveniently measured at the bipolar transistor's input is *current*.

Check our box score on the next page.

The output circuits of these devices are the other half of the story. All of them

e/e THE LANGUAGE OF GAIN

DEVICE	INPUT PARAMETER
Triode	Voltage
Pentode	Voltage
Transistor	Current
FET	Voltage

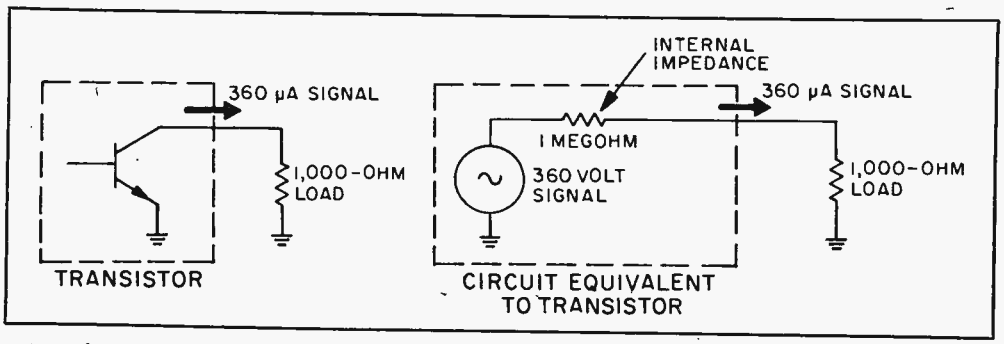
certainly produce current, but three of them —the pentode, transistor, and FET—produce it in a most unusual way—the same way a very high voltage and a very large resistor combine to produce current in the following example.

gard for the value of the external load, as long as the load is much smaller than the internal resistance.

Such devices are called constant-current sources, and pentodes, transistors, and FETs behave in just this manner to provide an output signal current which is not influenced by typical load resistors. The current from these devices is, therefore, the logical parameter to be measured.

The triode, on the other hand, is not quite so single-minded about producing current as are FETs, pentodes, and transistors. Instead of some 1,000,000 or more ohms of internal impedance, triodes run from as low as 5,000-ohms equivalent resistance to approximately 50,000-ohms.

Since the triode is not a constant-current



Text shows why pentodes, transistors and FET devices are called constant current sources.

Notice that it would make almost no difference in the 360-microampere output signal current if we dropped the 1,000-ohm load down to 10-ohms, because the total resistance (internal + load) would drop from 1,001,000-ohms to 1,000,010-ohms—an imperceptible change. An upward change of load from 1,000-ohms to, say, 10,000-ohms also has very little effect on the 360-microampere output current, because the huge resistance inside the device overwhelms the relatively small change contributed by the load. So a device that has a large internal resistance will pump out the same unvarying current, almost without regard for the value of the external load, as long as the load is much smaller than the internal resistance.

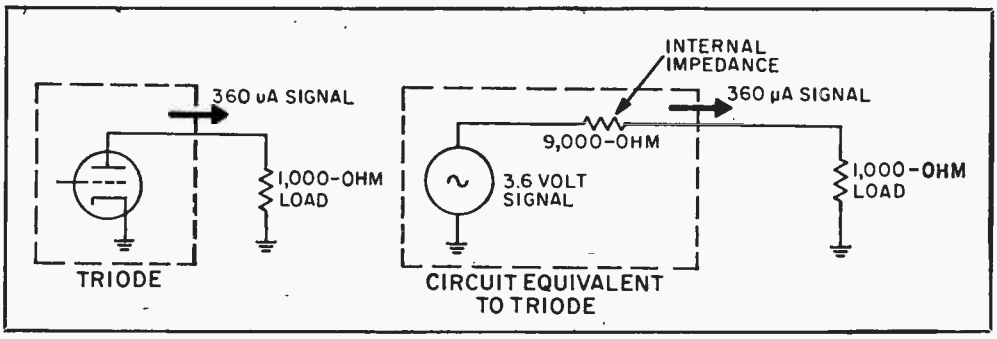
device (note that it makes quite a difference in the total resistance if the load is changed from 1000-ohms to 10,000-ohms), we normally try to measure both current and voltage in characterizing triode gains.

The box score now reads as shown below.

DEVICE	INPUT	OUTPUT	OUT/IN	WHICH IS
Triode	Voltage	Voltage	Volts/Volts	mu
Triode	Voltage	Current	Current/Volts	gm
Pentode	Voltage	Current	Current/Volts	gm
Transistor	Current	Current	Current/Current	beta
FET	Voltage	Current	Current/Volts	gm

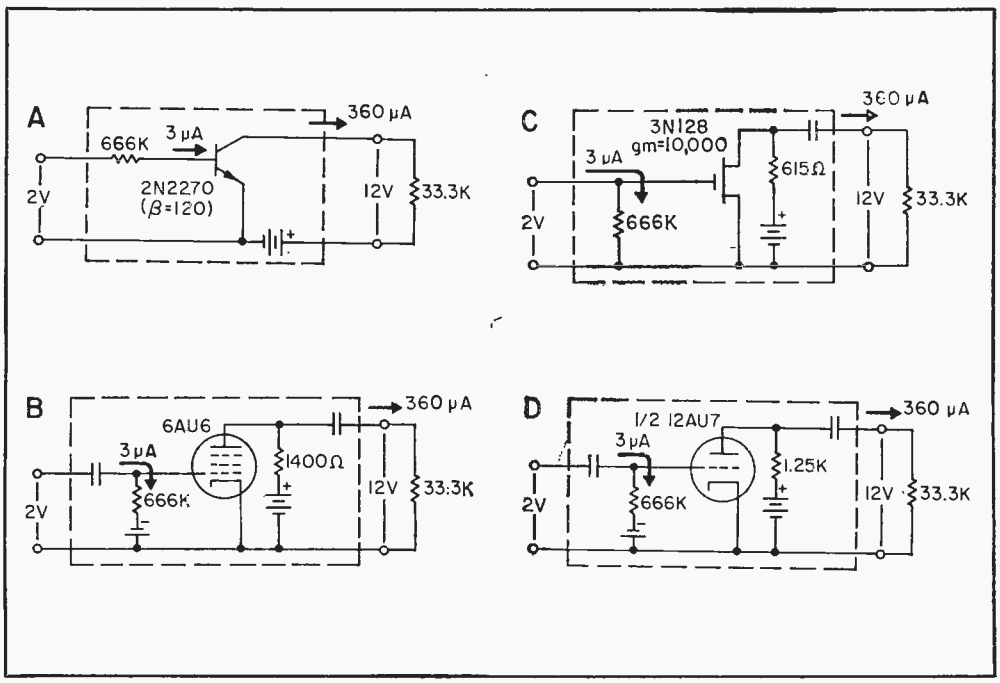
This accounts for the association of beta with transistors, g_M with pentodes, triodes, and FETs, and mu with triodes alone. Note that there is no device available which is best characterized as producing an output voltage in response to an input current; hence r_M does not appear as a relevant item in the list.

The Unanswered Question. So, what was in



Characteristic low internal impedance makes triode gain measurable in mu.

the black box? Actually, no present-day device, by itself, could respond to the four tests as described above. For example, a vacuum tube would not draw in its grid will work with both AC and DC inputs. Coupling capacitors are used in the remaining three circuits, so only AC measurements are possible with these.



Bet those techs flipped out when they saw how all four circuits could give the same results. Note identical input and output parameters for each circuit.

circuit the 3 microamperes measured by the second and third techs, while a transistor would be destroyed if we attempted to impress 2 volts directly across its input, as measured by the first and fourth techs. Therefore, the box's contents must have included some other components. In fact, any of the following circuits would give the four techs the measurements they reported. However, only the transistor circuit

So we can conclude that mu, beta, and gm (and the unfamiliar rM as well) all describe gain in their own way and can, in general, describe any amplifier's gain. The individual peculiarities of tubes and transistors cause us to prefer certain terms for certain devices, and understanding what these terms are trying to tell us is very important as we learn to speak the language of gain. ■

CB coffee break

THIS ISSUE'S COLUMNIST—HERB FRIEDMAN, KBI9457

Myths take a long time dying. At some time or other early in life, just about every student learns or studies how modern radio and television broadcasting is built on the work of early radio amateurs—how the Hams got the high frequencies to work, how they made the earliest phone broadcasts, etc. And just as early in life the young electronic student hears the old, tired cliches about the "appliance CB operators," the CB "lids," the "Country Bumpkins" and "Chicken Band" of radio.

You can still tune in the Ham bands and hear endless lectures on how the FCC ought to kick the CB'ers off the air. Yet, unknowingly, these very same Hams who berate all CB'ers in general, are using store-bought equipment with technical performance, features and hardware originally intended for the CB market. And many of these appliance Ham operators know far less about their equipment than the average CB'er.

Get the Facts Straight. First, let's look at antennas. Early CB'ers shared a 108-in. mobile whip with just about every other communications service using approximately the same frequency. And while you will still see Hams, police, fire, ambulance and newscasters driving around with a flagpole on the back of the vehicle, CB'ers are using mini-whips such as the Antenna Specialists *M-168* and *M-175*, Hy-Gain *Hellcat* and Lafayette *Auto-Top*. Because these mini-whips can mount in a more optimum location—the top of a car—their performance generally equals or exceeds the full length whip swinging from the rear bumper or fender. Of course, if you like the looks of a full length whip, they're still available.

And how about fully portable antennas. While other services are still playing around with SWR meters for tune-up, we CB'ers have the Elenex *Tiger Tail* with *built-in* antenna tuner and SWR meter. In the same time it takes a commercial operator just to connect the SWR meter, the CB'er has a *Tiger Tail* tuned and on the air.

The picture concerning base-station antennas is even better. CB'ers started on a par with most other services—a ground plane got you on the air cheap and fast. But while other services had to go to the directional beam—usually with a rotator—to pick up some power gain, CB'ers were getting low-angle rock-crushing signals on the ground with the *stretched* ground planes such as the Avanti *Astro Plane*, Cushcraft *Ringo*, Antenna Specialists *Mighty Magnum* and Hy-Gain *CLR*, just to name a few.

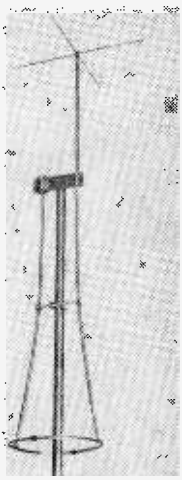
Where It All Starts. Moving on to the rig itself, CB gear started out with the same carbon mikes and cheapie crystal/ceramics. But who was it who put the first speech compressors directly into consumer gear? Right, the CB manufacturer. And who was the first to scrap the garbage mikes and get some decent sound quality. Right again, the CB'er. And though other services have several add-on speech processors, is there anything to compare with Turner's *M+3* talk power or new *Sidekick 100* microphones—the latter is designed especially for SSB and AM.

While other services were peddling mechanical filters at $20 a unit (with *you* doing the installation), CB rigs were already using mechanical filters as a matter of course—even in the low-cost models.

(Continued on page 93)

Turner Sidekick 100 Station Mike (Circle 43 on Reader Service Page)

Avanti Astro Plane Base Station Antenna (Circle 42 on Reader Service Page)



THE WAR OF THE CURRENTS

Whether to use AC or DC power in your home was decided over 80 years ago in a small room at the end of Auburn Prison's death row.

by Gary Webster

One of America's most furious and important technological struggles, "the war of the currents," ended just eighty years ago. It started when alternating current marketed by George Westinghouse took the field against Thomas Edison's direct current.

Their contest lasted more than a decade—then, incredibly, erupted on death row and led to a switch in public opinion.

Willie Kemmler, a nondescript hatchet-killer, was no more than a pawn in the industrial war. Still, his name appears in every comprehensive biography of Edison and of Westinghouse. For it was the life—or rather, the death—of Kemmler that turned the tide in favor of everyday use of alternating current.

Edison Got the Jump. Michael Faraday developed a crude but workable dynamo on October 17, 1831. Problems connected with commercial production and distribution of electricity were so great that it took thirty years to perfect a practical dynamo for use in arc lighting.

Big-name European scientists devoted a great deal of time to improvement of the dynamo. But self-taught Thomas Edison, who never pretended to be a scientist, was the man who first put it to work on a large scale.

Edison startled the western world in 1879 by developing a constant-voltage dynamo with an efficiency in the range of 90%. His "Long-waisted Mary Ann," devel-

oped in the machine shop at Menlo Park, had potential to turn enough steam power into electricity to light the world. At least, that's the exuberant claim the inventor made.

Edison put the first commercial central generating station into business on Monday, September 4, 1882. Six dynamos of approximately 125 hp were located at the plant on Pearl Street, New York City. At first only fifty-nine customers contracted to buy current, so just one dynamo was actually used.

Edison's DC generator used a commutator that functioned best at a low constant voltage—110 to 220. Above 220 volts the commutator tended to heat quickly.

"The potential demand for electric current is practically limitless," the inventor declared a few weeks after his Pearl Street station began operation. "In the end, production and sale of power will prove more important than all of my inventions."

Backing that judgment, he put everything he had into the Edison Electric Illuminating Company. Business grew slowly at first. By 1884 there were 508 consumers—and the number of incandescent lamps fed by the system had grown from 400 to 10,164.

Edison had a bear by the tail, and he knew it. "I'm going to be a business man," he confided to a friend in 1883. "I'm going to take a long vacation in the matter of inventions and devote my time and energy to work as a contractor for electric lighting plants."

Westinghouse Enters Field. George Westinghouse, just one year older than Edison, hit the big time with his steam-power brake device for railroad use. From 1869 to the mid 1880's he devoted most of his enormous energy to railroads and auxiliary equipment for them.

In the spring of 1885 he became interested in methods of generating and transmitting electric power. By this time Edison was firmly entrenched, determined to hold his monopoly, and rather contemptuous of competing alternating current systems that were in the infancy of their development.

French electrician Lucien Gaulard and English engineer John Dixon Gibbs perfected a device that they called a transformer. With it, they claimed, alternating current could be generated and delivered at high voltages and corresponding efficiency. At the point of use, a transformer would step down current to the desired level.

Edison had an opportunity to buy U.S. rights to the new patent, but decided to stick with his direct current system. Westinghouse, a brash newcomer to the electrical field, paid $50,000 for the Gaulard-Gibbs patent and set out to challenge Edison.

He made several improvements in the European design, pushed forward with development of essential accessories needed in an alternating current system. Two of them, the meter and the AC motor, made him a serious challenger.

By 1886 the newly organized Westinghouse Electric Company was manufacturing transformers in quantity. A test program was arranged in Great Barrington, Mass. Using a power line that carried 500 volts, Westinghouse and his men employed transformers to reduce voltage to about 100 volts at point of use. Several stores in the village were lighted satisfactorily.

Transmission at high voltage meant that the Westinghouse system was not limited by distance. He proved that by establishing a system in Buffalo and putting it into service on the night before Thanksgiving, 1886.

Public Became Involved. Westinghouse and his backers had not completed their first New York installation before the general public became involved. Ex-governor Cornell wrote an urgent letter to New York's mayor in 1888. "High-tension circuits must be absolutely prohibited within the city limits," he insisted.

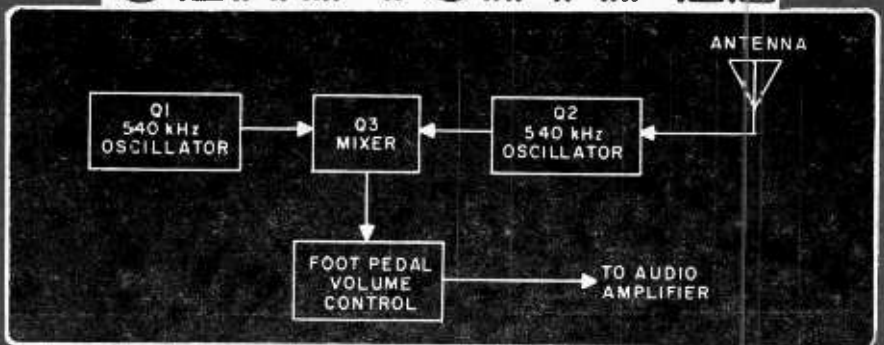
Cornell simply reflected views expressed in lurid newspaper stories, many of which are now known to be of doubtful authenticity. Headlines screamed such tidings as:

WIRE CLAIMS ANOTHER VICTIM
HORRIBLE DEATH OF A LINEMAN
HIGH-TENSION SLAUGHTER
ANOTHER CORPSE IN THE WIRES

At least one repairemen was killed while mending an insulator at the top of a pole and a boy peddler dies from contact with a wire that hung too low. Some New York papers set up special departments to collect and distribute gifts to "adults crippled, children orphaned in consequence of public indifference to the arch destroyer running

(Continued on page 92)

ULTRA SIMPLE THERMIN



Here's a real Now Sound from the past!

by Steve Daniels

WHENEVER THE MAD SCIENTIST IN THE movies bends over a console that looks like something from ELEMENTARY ELECTRONICS, you can bet that any weird background music heard is played in part by an electronic curiousity called a Theremin. The Theremin is an old device whose circuits have been around for years but were often too unstable or too complex for an experimenter. We now present the Ultra Simple *Thermin*—a stable, solid-state musical instrument with a live and most extraordinary sound. We'll also show you how to make a swell-to-great expression pedal for controlling the volume with your foot.

Leon Theremin, a Russian, invented the first Theremin and planned to display it at the 1939 New York World's Fair. A ballerina was to dance between two columns, her body capacitance to generate music. Unfortunately, when the dance was graceful, the music wasn't and contrarywise. Thus, the ultimate Theremin never appeared but the smaller versions have ever since. Our *Thermin*, so simple and so small, took an abbreviated form of Leon's surname, Theremin.

With practice it's possible to play any kind of tune on the UST, making it a natural for Rock Combos. Another plus in this application is its ability to work through a standard Hi-Fi amplifier or musical instrument amplifier. Adding effects to home recordings or school plays or just jamming with friends are some of the ways UST can prove its worth. Cost is all of ten bills if you'll settle for a cigar box or similar case.

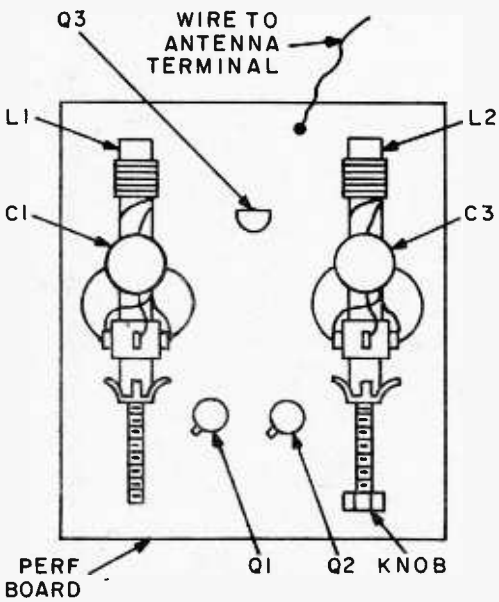
Some Thumbnail Thermin Theory. Everybody knows that a superhetrodyne receiver works by mixing too high frequency signals and amplifying one of the resulting (sum or difference) frequencies. That is exactly what happens in the UST. As two signals are mixed, the resultant difference frequency falls within the audio spectrum. Look at the schematic and you'll see two oscillator circuits similar to those found in wireless mikes. Each oscillator generates a signal at approximately 540 kHz depending on the setting of the loopstick slugs. Each RF signal is then coupled through C5 or C6 to the gate of Q3 where mixing occures. Initially, the oscillators are adjusted to generate signals of the same frequency; therefore, no audio note is heard. But if someone were to approach an antenna connected to the tuned circuit of one of the oscillators, his or her natural capacitance would *load* the circuit and lower the frequency of oscillation. A beat note, whose frequency is in proportion to the amount of body loading, i. e., distance from the antenna, would be heard.

ULTRA SIMPLE THERMIN

What makes this circuit stable is the use of a FET as the mixer. It provides a very high-Z load to the oscillators to prevent the external amplifier and cable from affecting frequency.

Construction. First, locate and drill holes for the output and antenna jacks. A hole larger than the diameter of the cable for the pedal goes in the back, and a grommet is inserted to prevent damage to the insulation. A hole on the front panel for the slide switch is made with a nibbling tool, while a clamp for the battery can be just a strip of sheet metal bent to shape and screwed to the side wall. Mount and tighten all components.

The author used a 3½-in. x 4½-in. punched phenolic terminal board and push-in terminals to construct the circuit. You'll probably find it convenient to wire an oscillator on either side of the board with the mixer in the middle. Don't wire in C5 until the rest of the oscillator section is complete; this way you can decide where Q5 will go and make the gate connections with no trouble. Start by bending the coil mounting brackets at right angles. Mount one on either side of the circuit board. Snap the coils in place and put a knob on the coil which will be connected to the antenna. Finish the tuned circuits by soldering 3-in. leads to each coil terminal and by soldering the 270pf capacitors across opposite lugs (1 and 3). Wire one oscillator at a time; orient Q1 and Q2 so both emitters point toward the front of the case.



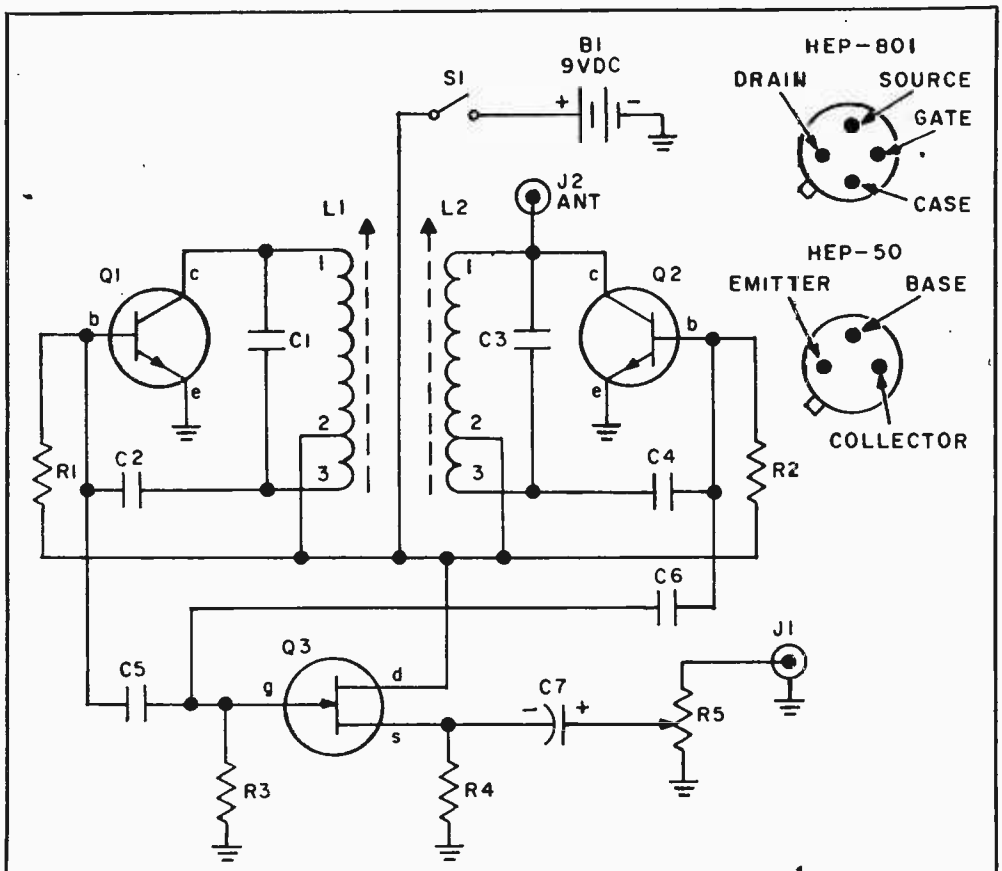
Basic parts layout involves angle brackets for mounting loopsticks. Suggested transistor orientation aids assembly; position Q1 and Q2 emitter leads toward front of board.

When the board is ready, mount it in the box. Thread the 3-conductor pedal cable through the grommet in back and wire it to the circuit. One lead goes to the hot side of J1, one to the circuit board output terminal, and one to ground. Make the antenna by soldering a 1-foot length of busbar to the center contact of an RCA phono plug. Connect the antenna to the antenna jack and begin work on the swell-to-great pedal.

No Cake Baking Here. Make the pedal by screwing together a 6 x 3½-in. piece of thin sheetmetal and a piece of slightly smaller masonite. It must be hinged at the bottom with a butt hinge available from a hardware store. Fasten it to the masonite side of the pedal with short screws and nuts so that it won't restrict pedal movement. The base is a metal cake pan. Ours measured 9¼ x 5¾ x 2¾-in. Screw the pedal assembly to the inverted pan about a half-inch from the edge. Uncoil one turn of a small, firm spring and re-wrap it under the head of a 6-32 screw. Fasten the spring to the center of the pan in a position that raises the pedal about two inches above its base (include a solder lug under the nut for later use).

An angle bracket is used to mount the potentiometer shaft about 1½-in. from the bottom of the pan. Turn the shaft to its maximum counter-clockwise position, and file or sandpaper a small area on the top of the shaft to make it rough. Tin the area with solder using a very hot, clean iron. At this point, solder a 1½-in. length of No. 18 Busbar to the tinned area on the shaft. Bore a hole in the pan directly under the center of the pedal top and run a second piece of bus bar through this hole and solder to the upper end of the pedal. Use trial and error fitting to loop the two busbar ends together until the pedal moves freely up and down. When all is well, connect the 3-conductor cable from the UST. Ground the pedal with a wire from the solder lug to the cable ground.

Tuneup and Testing. Temporarily break the lead from the emitter of Q2 to ground; turn the UST on and place it near an AM



PARTS LIST FOR ULTRA SIMPLE THERMIN

B1—2U6 or equal 9-volt battery
C1, C3—270pF disc capacitor
C2,C4—300pF disc capacitor
C5,C6—100pF disc capacitor
C7—10uF, 15 volt electroytic capacitor
L1,L2—Loopstick (Lafayette 32—41080)
Q1,Q2—HEP-50 or 2N706 transistor (Motorola)
Q3—HEP-801 N-channel junction field-effect transistor (Motorola)
R1,R2—100,000-ohm, ½-watt resistor
R3—3.9-Megohm, ½-watt resistor
R4—5,600-ohm, ½-watt resistor
R5—10-Megohm potentiometer modified as per text.
Misc.—4 x 6 x 3-in. box, perforated board, push-in clips, No. 18 bus wire, phone jack, RCA phono jack, hook-up wire, knob, solder lug, approx. 5½-feet of 3-conductor cable.

radio tuned to 540 kHz. Adjust the slug in L1 with a screwdriver for a strong carrier signal. Reconnect the Q2 emitter. With the antenna plugged-in, connect an amplifier to the output jack. Turn on the UST, depress the foot pedal and turn the L2 slug slowly until you hear a squeal. As you keep turning, the squeal should get lower and lower in pitch until it disappears. This will occur at two settings very close to each other. You will want the setting which allows you to change the pitch by moving your hand toward the antenna. If you have a problem with stability, lack of range, or sensitivity (your hand has to be too close to the antenna to get a tone), just play with the adjustment of L2 to get the best compromise. It's critical but should be stable once properly set.

Now start to practice by learning where various notes are located. Any special effects on your amplifier, particularly reverb, can be used to advantage for modifying the basic sound of the instrument. When people want to know how you get the squeals without touching anything, say there's a girl inside and when you bring your hand too close. . . . ■

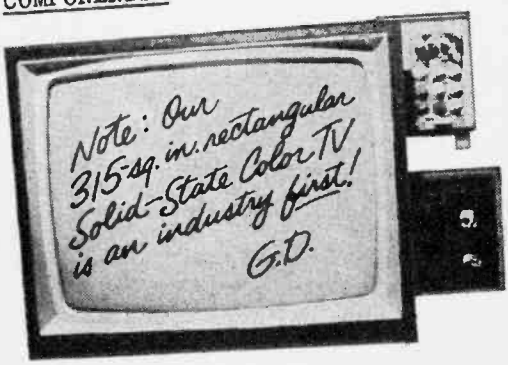
BELL & HOWELL TECHNICAL REPORT

Subject: New Home Entertainment Electronics Systems Program

Competitive Advantages:

- Features first Solid-State Color TV (315-square inch, rectangular screen) Kit for at-home training to build, keep.
- Helps prepare recipient for Color TV Service Business of his own. Covers solid-state circuitry in depth--also other Home Entertainment equipment. Fully updated.
- Provides three additional professional quality kits to assemble, keep, use.

COMPONENTS:



Specifications:

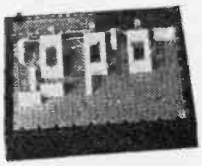
New 25" diagonal, ultra rectangular screen. 315-sq. inch viewing area. 25,000 volt, solid-state design, w/ 45 transistors, 55 diodes, 2 silicon rectifiers. 4 advanced IC's w/46 transistors, 21 diodes. 2 tubes: picture and high voltage rectifier. Solid-State VHF and UHF tuners. 3-stage solid-state IF. AFT standard. VHF power tuning. Also: "Instant On" circuit, automatic color control, noise limiter.

Descriptive analysis:

Modular plug-in circuit board design provides for more than 100 advanced solid-state devices. Insures premium color, sound control, exceptional reliability, easy access. Includes Hi-Fi amplifier for sound output, built-in dot generator, tilt-out convergence panel. Handy Volt-Ohm meter permits initial set-up and adjustment plus detailed trouble-shooting. 315-sq. inch picture tube face transmits entire image. Push button channel advance. AFT module brings in perfect picture, sound automatically. Easier to service than older, non solid-state sets. Quality components throughout.

Electro-Lab-at-Home: Components included:

The Electro-Lab® consists of three units, arriving in 16 shipments which recipient assembles, keeps. All components are professional quality. The circuit DESIGN CONSOLE contains built-in power supply, test light, speaker. Patented Modular Connectors permit plug-in to console to rapidly "bread-board" many different circuits. No soldering or messy un-soldering necessary.



The portable 5-inch, wide-band OSCILLOSCOPE is calibrated for peak-to-peak voltage and time measurements... offers 3-way jacks to handle test leads, wires, plugs. Images on screen are bright, sharp.

The lightweight TRANSISTORIZED METER combines most desired features of a vacuum-tube voltmeter and a high-quality multimeter. Features a highly sensitive, 4-inch, jewel-bearing d'Arsonval meter movement. Registers current, voltage and resistance on large, easily read dial. CONSENSUS: first class gear.

Program is designed to give:

- Understanding of electronic circuits in most home entertainment electronic systems
- Ability to analyze and trouble-shoot a wide variety of advanced solid-state and other TV circuits
- Capability to understand and use test equipment and procedures with special emphasis on TV testing
- Ability to assemble, test and adjust the solid-state TV kit included with the program

MAIL CARD TODAY FOR ALL THE FACTS
No Postage Needed

Color TV is going Solid-State—here's how to help yourself get ready for it:

There's nothing else like this exciting new program that offers the *first* 315-sq. inch Solid-State Color TV available for at-home training.

As you follow the simple, step-by-step assembly and testing procedures, you will soon become thoroughly familiar with the most advanced solid-state TV circuitry. And you'll help prepare yourself for a profitable Color TV service business of your own—either full or part time.

Why Color TV pays better.

Today, Color TV is the big seller. And tomorrow, when it goes all solid-state, the man who has mastered this circuitry, will be in demand. This, of course, is where the money is going to be made.

But, this new Bell & Howell Schools program will also give you the in-depth knowledge of the basics as well as TV circuit analysis. You'll get the theory and practical experience you need to handle radios, Hi-Fi's, stereos, tape recorders, B & W television as well as most other home entertainment electronic devices.

Build, keep your own 25" diagonal Solid-State Color TV Set

Whether you are a beginner, an experienced hobbyist, or a pro working in the field, you are going to be delighted with the performance you get from this new solid-state kit. So proud, you'll want to show it off to your relatives and friends.

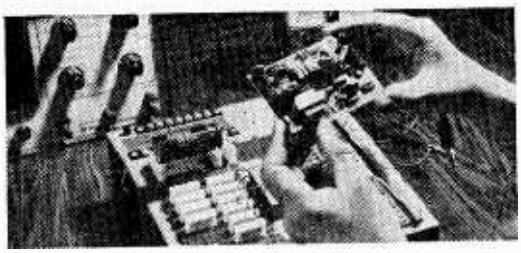
The "specs" at left give a few of the facts. But there are many, many features besides these which you will not find in any set on the market today. Send for all the facts and this is the one you'll want.

You're ready for many kinds of Home Entertainment Equipment

This is a thorough-going program, put together by professionals, with completely up-dated components and materials. When you have completed it, you'll have a new kind of confidence in your ability to tackle almost anything related to electronics in the home. And I can assure that these devices are definitely on the increase!

In addition, you'll have the kind of sound technical background you need for either a career as a technician in the Electronics industry or a business of your own—either full or part time.

Note: TV picture is simulated.



CONSIDER THESE ADVANTAGES:

Bell & Howell Schools' Electro-Lab-at-Home Plan gives you the most thorough background possible in solid-state Color TV. Everything comes to you by mail. No traveling. You go at your own speed and never miss a paycheck!

When you have completed your program our **Lifetime National Placement Service** will help you locate in an area that interests you. This service is available at any time—now or in the future.

Approved for G.I. Benefits.

Our programs are approved for Veterans' Benefits. If you're a Vet, check the space in the card for full details.

Student Loans now available

If you are a non-veteran and need financial assistance, you may qualify for Student Loans, which are also available.

Special Help Sessions.

These are scheduled regularly (Saturdays) at seven Bell & Howell Schools and in many other cities. Here you can get expert guidance by top instructors to help you over any rough spots.

Bell & Howell Schools offer you even more. Once you have finished your program at home, you may decide you want more advanced preparation. In this case, you can **earn transfer credits** to any one of our seven schools which are located all across the country.

Mail the postage-free card today for all the facts. There is no cost or obligation of any kind.

DeVRY INSTITUTE OF TECHNOLOGY

ONE OF THE

BELL & HOWELL SCHOOLS

(TV kit is not available in Canada)

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No Postage Needed

322

e/e etymology

How about a word with us?

STAR

▲ In the current edition of *Webster's International Dictionary,* "star" rates ten entries. Most of 'em have two, three, or more subheads. But there's nary a word about STAR.

Scientists at Caltech's Jet Propulsion Laboratory perfected an electronic whiz kid and put it into operation in 1968. Unlike most computers, this one has capacity (within limits) to diagnose its own flaws and to figure out ways to master those flaws—without human help.

A prototype of the kind of computer that will be needed to guide unmanned expeditions to Jupiter and the outer planets, it was natural to call the Caltech electronic brain a "Self-Testing and Repairing" computer.

But in everyday use, no one—not even the persons who are proudest of it—are going to use such a title. Initial letters of the label describing the computer that will (hopefully) pave the way to the stars form a cluster of symbols that reads: STAR.

Obviously, this combination of letters was not formed by chance. Builders of STAR, casting about for a name, chose one from which the acronym could be formed.

So many thousands of devices, techniques, procedures, and substances have tongue-twisting names that abbreviation is practically demanded. Result: a special dictionary of acronyms. To distinguish these artificial words, they're commonly written in capital letters.

Increasing numbers of them are going lowercase, however, by entering the common vocabulary in the fashion of *radar* (*ra*dio *d*etecting *a*nd *r*anging).

NAL

▲ Unless an acronym is the result of deliberate manipulation of words, its unlikely to resemble any term in common speech. Until it becomes so widely used that great numbers of persons recognize it instantly, the coinage continues to be written or printed in capitals—and does not win space in ordinary dictionaries.

It's anybody's guess as to what the future of NAL will be.

Until it was chosen as the site for the *N*ational *A*ccelerator *L*aboratory, Batavia, Illinois, was merely another obscure mid-western community. Today, scientists everywhere speak of Batavia because of its most famous son.

NAL was initially planned to operate with maximum energy of 500 billion electron-volts. Competition from other big accelerators on the drawing board, plus desirability of yet more energy, has caused keepers of NAL to do some re-thinking.

A ring of super-conducting magnets laid on top of the present main ring of conventional electromagnets offers theoretical hope of boosting power to 1,000 or even to 2,000 GeV. Regardless of whether that peak is ever reached, work at Batavia offers such exciting possibilities in proton acceleration that NAL has a good chance of becoming *nal* during this century.

LIDAR

▲ A casual glance suggests that LIDAR is at least distantly related to *radar*. In the family of words, this relative newcomer is a grandson of the old-timer that is in the working vocabulary of practically all air travelers, weather report watchers, and traffic officer lookers.

Using light from a laser in lieu of sound, *l*ight *d*etection *a*nd *r*anging is proving more versatile and efficient than pioneers in the field conceived possible. LIDAR has already demonstrated its capacity to scan the face of the moon with uncanny accuracy; now it is being adapted for pursuit of the elusive CAT (*c*lear *a*ir *t*urbulence) that is a major hazard in aircraft operation here on earth.

FRAT

▲ Put to its first practical use in Viet Nam, FRAT is a highly-sophisticated device with which many GI's prefer not to fraternize.

Research workers have known for years that heroin affects body chemistry. But it was not until this decade that the drug was found to leave its "signature" on certain free radicals (clusters of atoms that do not form molecules, but which retain their identity).

Once this effect of heroin was known, it was comparatively simple to devise an electronic machine for Free Radical Analysis Technique. A FRAT costs only $26,000 and for about $1 gives a decisive verdict about whether or not a person is on heroin. ■

e/e's all NEW BASIC COURSE in ELECTRICITY & ELECTRONICS *

PART 2
UNDERSTANDING SEMICONDUCTORS

What You Will Learn. In this part you will learn about how transistors are biased for use as amplifiers and why different polarity voltages are required for PNP and NPN transistors. You learned what a hole was in Part 1, now you will see where hole flow is found in transistors. How a transistor amplifies is discussed, and a look at the three basic types of transistor amplifiers shows you why each has special uses. You will also be introduced to transistor specification sheets.

* This series is based on **Basic Electricity/Electronics**, Vol. 2, published by **Howard W. Sams & Co., Inc.**

TRANSISTOR OPERATION

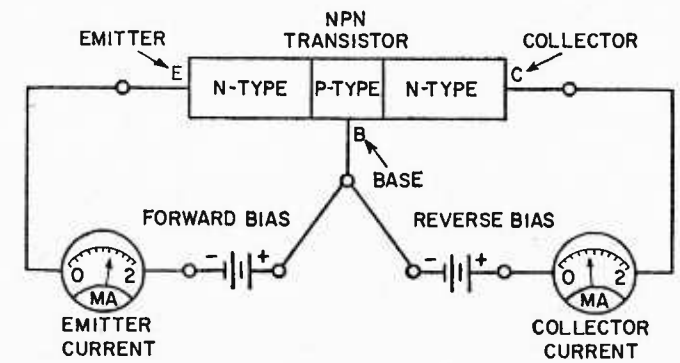
Several questions have probably come to mind by now if you have read and digested Part 1. How can a solid-state material amplify? Is there a difference between a junction and point-contact transistor or between a PNP and an NPN transistor? One of these questions can be answered immediately. Junction and point-contact transistors are almost identical in operation for our purposes. Therefore, all discussion will be directed to junction transistors, but it is understood that it applies to both types.

Biasing

In the junction transistor, two PN junctions are established. If these PN junctions are properly biased, the transistor can be made to operate as an amplifier. The proper method for biasing an NPN transistor is discussed next.

The figure shows an NPN transistor biased properly to operate as an amplifier.

BIAS FOR NPN TRANSISTOR AMPLIFIER



Q1. A transistor is a single semiconductor crystal with - - - PN junctions.

Q2. A transistor can perform the same function as a - - - - - - - - - - - - - - - . (From part 1)

Q3. P-type semiconductor material sandwiched between two pieces of N-type material forms an - - - transistor.

Your Answers Should Be:

A1. A transistor is a single semiconductor crystal with **two PN junctions.**

A2. A transistor may perform the same function as a **vacuum-tube triode.**

A3. P-type semiconductor material sandwiched between two pieces of N-type material forms an **NPN** transistor.

In the arrangement shown, a forward bias is applied between the base and the

emitter. This results in emitter current. A reverse bias is applied between the collector and the base. This results in a flow of collector current that is nearly equal to the emitter current. The reason for this seeming contradiction, as we will see, is that the base is very thin—less than one-thousandth of an inch.

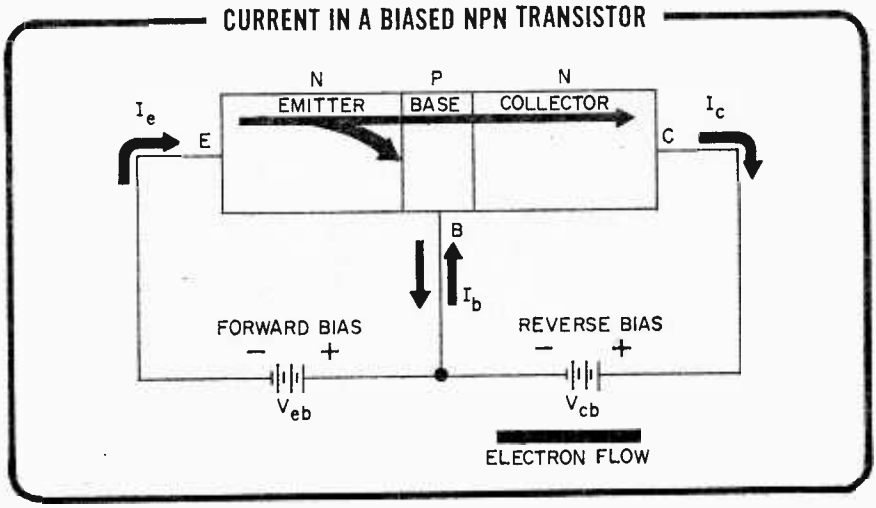
Before continuing, it is time to learn a few more short-hand notations used when referring to transistors:

B—Base
E—Emitter
C—Collector
I_B—Base current
I_E—Emitter current
I_C—Collector current
V_{EB}—Voltage from emitter to base
V_{CB}—Voltage from collector to base

Note: these are all average values

Current Flow in a Biased Transistor

The figure shows the electron flow in a biased NPN transistor. With the emitter-base junction forward biased, electrons in the emitter drift into the base to combine with the holes in the base. Each time an electron enters the emitter from V_{EB}, an electron leaves the base and returns to V_{EB}. Thus there is electron flow from emitter to base.



Since the base-collector junction is reverse-biased, very little current should flow through it. This current is produced by leakage due to V_{CB}.

Why is I_C almost equal to I_E? Since the base is very thin, there is not a sufficient barrier in the base region to stop the large number of electrons coming from the emitter. These excess electrons pass through the base and on to the collector due to the presence of V_{CB}. The reason why these electrons are not stopped by the collector-base barrier is that there is a strong positive voltage attracting them. This voltage is due to the series combination of V_{EB} and V_{CB}. **The major portion of I_C is due to the electron flow from emitter to collector.** Notice that current flow in the base is due to both the forward and reverse bias voltages. Thus, there are current flows indicated in both directions. I_B is the difference between these two currents.

Q4. The emitter-base junction of a transistor amplifier must be - - - - - - - biased and the collector-base junction must be - - - - - - - biased.

Q5. Under these conditions collector current is (equal to, slightly less than, more than) emitter current.

Q6. This is explained by the fact that not a large enough electrical - - - - - - - exists in the base to stop all the - - - - - - - - - coming from the - - - - - - -.

Q7. Identify the following shorthand notations: I_B, I_C, I_E, V_{EB}, and V_{CB}.

Your Answers Should Be:

A4. The emitter-base junction must be forward-biased and the collector-base junction reverse-biased.

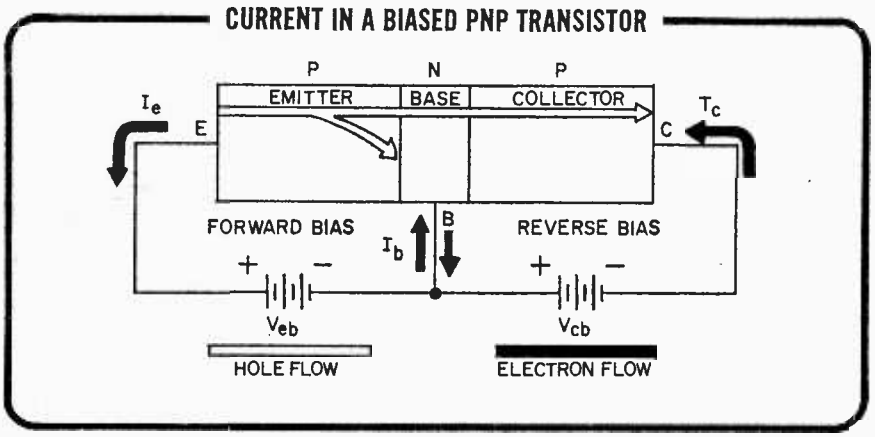
A5. Under these conditions collector current is slightly less than emitter current.

A6. This is explained by the fact that not a large enough electrical barrier exists in the base to stop all the electrons coming from the emitter.

A7. I_B—Base current
I_C—Collector current
I_E—Emitter current
V_{EB}—Voltage from emitter to base
V_{CB}—Voltage from collector to base
} All average values

Biasing PNP Transistors

The difference in operation between PNP and NPN transistors is that the movement or flow of electricity in PNP transistors is accomplished not by electron flow but by hole flow. Also, proper bias for a PNP unit is achieved by using negative voltage polarities—just the opposite of those used for an NPN transistor. However, the bias between emitter and base is still forward bias and the bias between collector and base is still reverse bias. Since the emitter is P-type and the base is N-type germanium, a battery with its positive terminal connected to the emitter



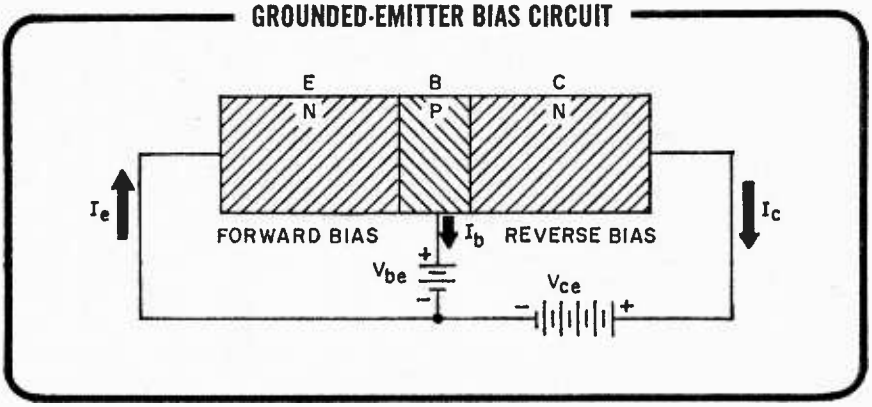
will forward-bias the emitter-base junction. In a similar fashion, a battery whose negative terminal is connected to the P-type collector will reverse-bias the collector-base junction.

When so biased, the transistor conducts. The emitter, being a P-type semiconductor, passes a positive charge to the base. Whenever an electron from the emitter enters the positive terminal of the forward bias battery, it leaves what is called a hole. At the same time, an electron from the negative terminal of the battery enters the emitter via the base to fill a hole. This is the technique employed to describe the passage of electrons in P-type semiconductor material.

Because the base is thin, nearly all the holes from the emitter are drawn to the negative terminal of the battery connected to the collector. Of course, only electrons, and not holes, flow in the external circuit.

HOW A TRANSISTOR AMPLIFIES

Recall in basic theory how the control grid in a vacuum-tube triode has a great control over plate current. A transistor is capable of amplification because of a similar arrangement. The base in the transistor acts to control current through the transistor in much the same fashion as the grid controls current in the triode.



Consider another arrangement of the transistor. This arrangement is similar to the one showing a properly biased NPN transistor. The only difference is that the reverse bias between collector and base is provided by V_{CE} in series with but opposing V_{BE} (V_{CE} is large compared to V_{BE}). This is called a **grounded-emitter** circuit.

Q8. Bias polarities for a PNP transistor are the - - - - - - - - of those for an NPN transistor.

Q9. The base in a transistor has an action similar to the - - - - in a triode.

Your Answers Should Be:

A8. Bias polarities for a PNP transistor are the **opposite** of those for an NPN transistor.

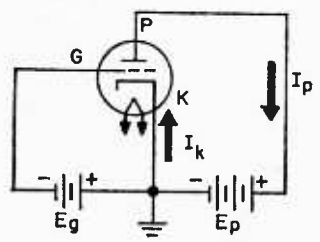
A9. The base in a transistor has an action similar to the **grid** in a triode.

Triode Amplifier Versus Transistor Amplifier

The grounded-emitter circuit mentioned is the most common arrangement for a transistor amplifier. Let's compare it with the most common triode circuit, the grounded-cathode amplifier. You can see from the figure where this amplifier gets its name.

Compare the two circuits shown in the figure. The triode is composed of a cathode (K) that emits electrons; a plate, or anode, (P) that collects the electrons; and a grid (G) that controls the flow of electrons to the plate. The transistor is composed of an emitter (E) that supplies electrons, a collector (C) that collects the electrons, and a base (B) that controls the flow of electrons. The transistor base is very thin, and the vacuum-tube grid has a fine-wire construction. Each of these elements, therefore, allows accelerated electrons to pass through. However, each has great control over the number of electrons that actually reach the collector of electrons (the plate or collector).

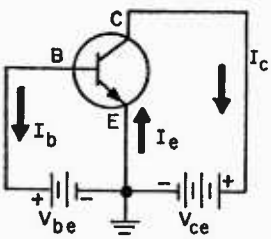
BASIC TUBE AND TRANSISTOR AMPLIFIERS



VOLTAGE GAIN FORMULA

$$\text{VOLTAGE GAIN} = \frac{\Delta E_p}{\Delta E_g}$$

CURRENT GAIN FORMULA



$$\text{CURRENT GAIN} = \frac{\Delta I_c}{\Delta I_b}$$

In the transistor, the forward bias (V_{BE}) serves the same function as the negative bias in the triode. Instead of a voltage gain, however, a current gain will be measured. The symbol for current gain is the Greek letter β. To obtain this current gain, I_C and I_B are recorded for a particular V_{BE}. V_{BE} is changed and the new I_C and I_B recorded (V_{CE} is held constant). Current gain is then calculated by dividing the change in I_C by the change in I_B. β is often called h_{FE}.

Another parameter of the transistor (beta is a parameter like mu in the triode tube) is alpha (α). Alpha is the ratio of the change in collector current to the corresponding change in emitter current, when the collector voltage is constant. Another symbol for α is h_{FB}. It has been shown that under most biasing methods the collector current is slightly less than the emitter current (due to the base drawing some of the current from the emitter). Therefore, the ratio of $\triangle I_C$ and $\triangle I_E$ must be less than one. For example, if the collector current changes 4.8 ma and the emitter current changes 5 ma, then the base current must change 0.2 ma. Calculate alpha as follows:

$$\alpha = \frac{\Delta I_C}{\Delta I_E} = \frac{4.8 \text{ ma}}{5.0 \text{ ma}} = 0.96$$

Q10. A - - - - - - - - - - - - - - - - transistor configuration corresponds to a grounded-cathode triode amplifier.

Q11. The numerical value of alpha is - - - - - - - - - - - - - -.

Q12. If I_B is 100 μa when I_C is 1.0 ma, and I_B is 50 μa when I_C is 0.5 ma, what is β?

Your Answers Should Be:

A10. A **grounded-emitter** transistor configuration corresponds to a grounded-cathode triode amplifier.

A11. The numerical value of alpha is **less than one.**

A12.

$$\beta = \frac{\Delta I_C}{\Delta I_B} = \frac{1.0 \text{ ma} - 0.5 \text{ ma}}{100\mu\text{a} - 50\mu\text{a}} = \frac{0.5 \text{ ma}}{50\mu\text{a}} = 10$$

Transistor Amplification

How can a current gain of less than one result in amplification? The answer is that a power gain is realized. The reason for this can be found in the values of the input and output impedances (resistances) of the transistor. The input resistance of the forward-biased, emitter-base junction is low. The output impedance of the reverse-biased, collector-base junction is very high. Consider the formula for power.

$$P = I^2R$$

If you compare the input and output circuits of the transistor in terms of their power consumption, you will see that there is a power gain. Consider a transistor with an emitter-base resistance of 100 ohms and a collector-base resistance of about 1 megohm. Since the collector and emitter currents are very nearly the same, the difference in the power produced by each will depend largely on the resistance. Thus, the power in the collector circuit will be much larger than that in the emitter circuit. The transistor is capable of matching low-resistance circuits to high-resistance circuits and of providing a power gain. It is this transfer of resistance that gives the transistor its name. Contracting **trans**fer and re**sistor** gives **transistor.**

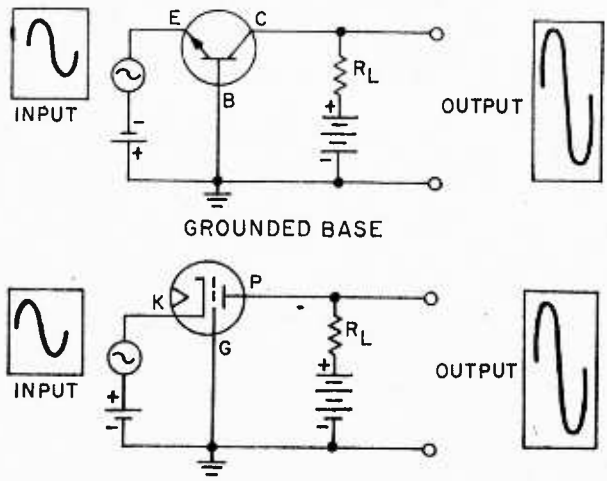
BASIC TRANSISTOR AMPLIFIERS

NPN or PNP transistors can also be used as grounded-collector and grounded-base amplifiers. The three basic transistor amplifiers can be compared with the three basic vacuum-tube amplifiers—the grounded-cathode, grounded-grid, and grounded-plate.

Common-, or Grounded-, Base Amplifier

Shown below are an NPN **common-base amplifier** and its vacuum-tube equivalent, the **grounded-grid amplifier.** The base and grid are grounded. The input signal is applied to the emitter in the common-base circuit, and to the cathode in the grounded-grid circuit. The output signal is taken from the collector and the plate. The input and output signals of these amplifiers have the same polarity; that is, they are in phase. The common-base circuit is used mostly as a voltage amplifier. It has these characteristics:

TUBE-TRANSISTOR AMPLIFIER COMPARISON



1. The input impedance is low, about 60 to 100 ohms.
2. The output impedance is high, about 0.5 to 1.0 megohm.
3. Current gain is less than one.
4. Voltage gain is medium, about 150.
5. Power gain is medium, about 450.
6. No phase reversal occurs.

Q13. Phase shift in a grounded-base amplifier is - - - -.

Q14. The voltage gain in a grounded-base amplifier is - - - - - -.

Q15. In a grounded-base amplifier, the input impedance is - - -, and the output impedance is - - - -.

Your Answers Should Be:

A13. Phase shift in a grounded-base amplifier is **zero.**

A14. The voltage gain in a grounded-base amplifier is **medium.**

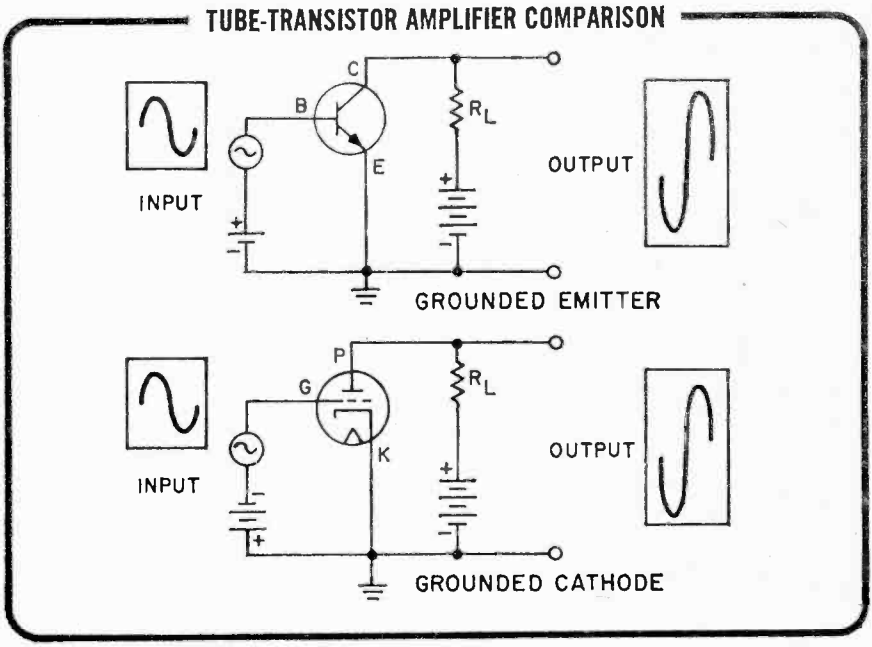
A15. In a grounded-base amplifier, the input impedance is **low,** and the output impedance is **high.**

Common-, or Grounded-, Emitter Amplifier

The figure below shows a **common-emitter amplifier** and its vacuum-tube equivalent, **the grounded-cathode amplifier.** The emitter and cathode are grounded. The input signal is applied to the base and the grid, respectively, and the amplified output is taken from the collector and the plate, respectively. A phase reversal of 180° occurs between the input and the output. The common-emitter amplifier had these characteristics:

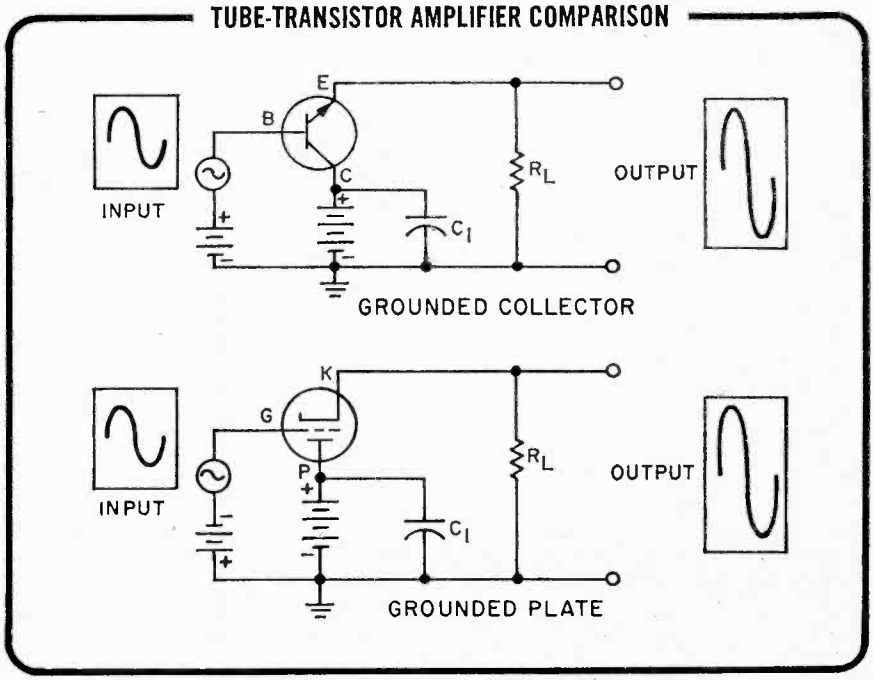
1. Input impedance is low, about 700 to 1,000 ohms.
2. Output impedance is high, about 50,000 ohms.

3. Current gain is about 50.
4. Voltage gain is high, about 500.
5. Power gain is very high, about 800.
6. Phase reversal occurs.



Common-, or Grounded-, Collector Amplifier

The figure shows a **common-collector amplifier** and its vacuum-tube equiv-



alent, the **grounded-plate amplifier.** Notice that the collector and plate are not at DC ground, but at AC ground, due to the large capacitor bypassing the battery. The input signal is applied to the base and grid, respectively.
The output signal is taken from the emitter and cathode, respectively. This circuit is also called an **emitter follower,** and its equivalent is called a **cathode follower.** The characteristics of the emitter-follower amplifier will follow.

Q16. A common-emitter amplifier produces a phase shift of ——.
Q17. The voltage gain of a common-emitter amplifier is - - - -.

Your Answers Should Be:
A16. A common-emitter amplifier produces a phase shift of **180°.**
A17. The voltage gain of a common-emitter amplifier is **high.**

Emitter-Follower Characteristics

The gain of an emitter-follower and a cathode-follower circuit is always less than one. These circuits are usually used to match impedances between two circuits. The common-collector amplifier has these characteristics:

1. Input impedance is very high, about 300K to 600K.
2. Output impedance is low, about 100 ohms.
3. Current gain is about 50.
4. Voltage gain is less than 1.
5. Power gain is low, about −250. (The negative sign means that power is consumed by R_L.)
6. No phase reversal occurs.

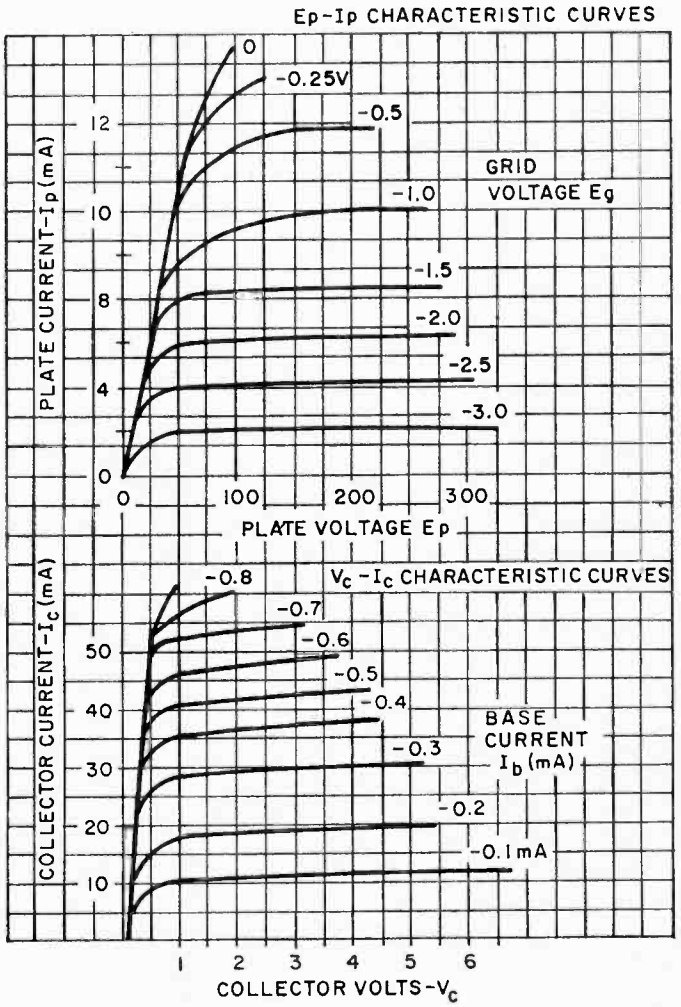
TRANSISTOR CHARACTERISTICS

The performance of transistors, like solid-state diodes, is affected by temperature. A change in temperature varies the junction resistance. From the study of diodes you learned that the PN junction has a negative temperature coefficient. This changes the junction bias and the current flow across the junction and therefore affects transistor performance. For this reason, manufacturers list operating temperatures for their transistors.

TRANSISTOR CHARACTERISTIC CURVES

Do you remember how to obtain information from a family of curves associated with vacuum-tube amplifiers? Transistors have similar curves. The figure shows the family of curves for both a pentode amplifier and an NPN-type transistor connected as a common-emitter amplifier. Notice the correspondence between I_P and I_C, E_P and V_C, and E_G and I_B.

TUBE-TRANSISTOR CHARACTERISTIC CURVES



Q18. The emitter follower is best used for what purpose?

Q19. The common-base circuit is most used as a - - - - - - - - - - - - - - - -.

Q20. The - - - - - - - - - - - - - - - circuit may best be used as a power amplifier.

Q21. Use the V_c-I_c curves to obtain beta.

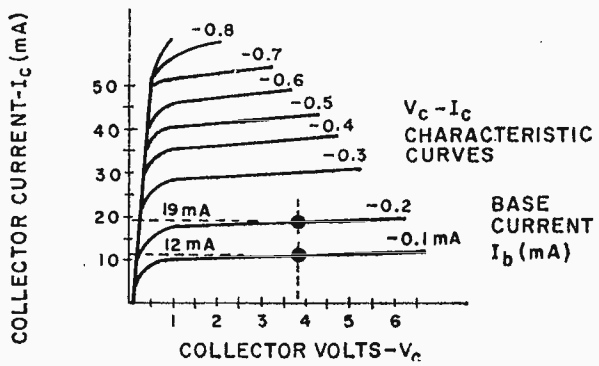
Your Answers Should Be:

A18. The emitter follower is best used to **match high-empedance circuits to low impedance circuits.**

A19. The common-base circuit is most used as a **voltage amplifier.**

A20. The **common-emitter** circuit may be used as a power amplifier.

A21.



$$\beta = \frac{\Delta I_C}{\Delta I_B} = \frac{19 - 12 \text{ ma}}{0.2 - 0.1 \text{ ma}} = \frac{7 \text{ ma}}{0.1 \text{ ma}} = 70$$

Notice that this method is almost identical to the method used to obtain parameters from vacuum-tube curves.

TRANSISTOR SPECIFICATION SHEETS

Most transistor manufacturers present transistor information on specification sheets. These sheets are the equivalent of a tube manual. The figure shows some of the typical data supplied.

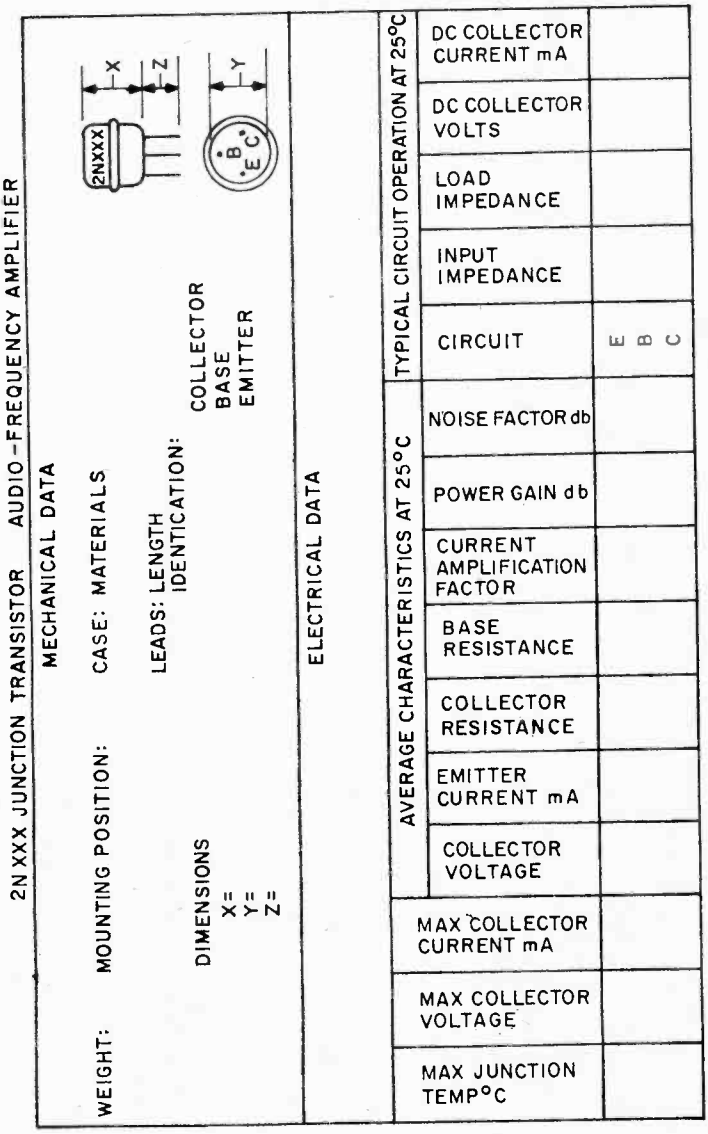
Each manufacturer selects some of his own special electrical specifications for presentation on these data sheets. However, many of them are alike for various manufacturers. Notice that the temperature at which these specifications were obtained is mentioned. Many of these specifications differ at other temperatures. The maximum values listed are limiting values. Above these values transistor life and performance are impaired.

Q22. Transistor data sheets give - - - - - - - - - - and - - - - - - - - - - specifications.

Your Answer Should Be:

A22. Transistor data sheets give **electrical** and **mechanical** specifications.

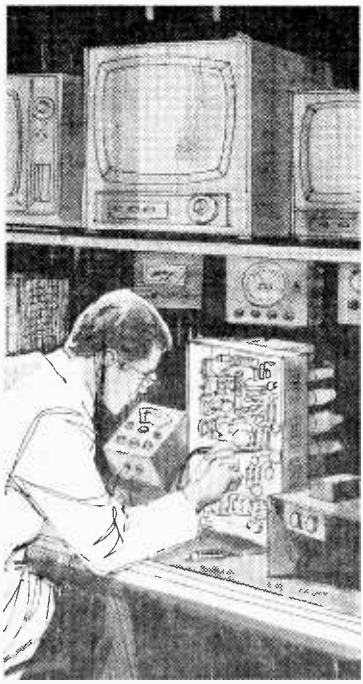
TYPICAL TRANSISTOR DATA SHEET

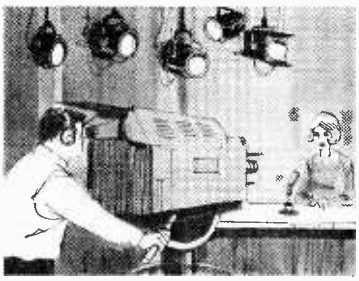


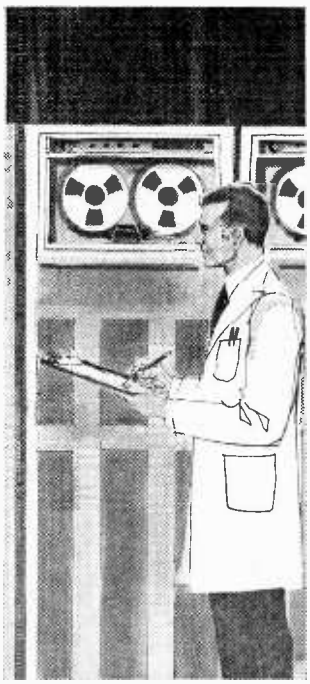
WHAT YOU HAVE LEARNED

1. The collector-base junction must be reverse-biased.
2. Transistor current gain (measured from collector to base) is called beta (β) and may be quite large. Another current gain (measured from emitter to collector) is called alpha (α) and is usually less than one.
3. The base of the transistor is very thin.
4. Holes in a PNP and electrons in an NPN transistor are drawn to the collector by the voltage connected to the collector terminal.

Great careers







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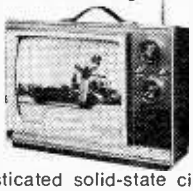

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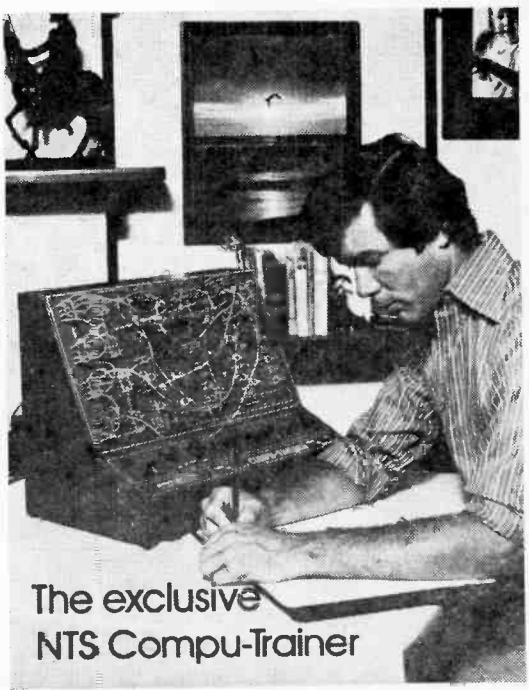

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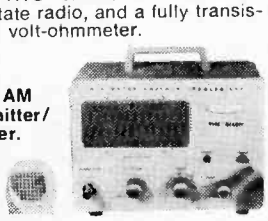

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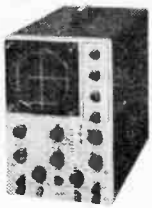

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CIRCLE NO. 10 ON PAGE 17 OR 103

Ask Hank, He Knows . . .

Continued from page 26

at 40 amp capacity at 12 volts. Output to be used to control a DC motor.

—R.L.W., Calif. Hot Springs CA

Forty amps is a lot of juice at any voltage. Your best bet is a surplus or inexpensive battery charger that can deliver 40 amps continuously. This purchase will be a heck of a lot cheaper than trying to buy parts for the powerhouse you need.

It's Where You Look!

I have a Lear Radio and need a tube that so far we can't find. It's a 6SF7. What do I do?

—J. L., Hoopeston, IL

I didn't believe your address was real till I checked the postmark. Nice to know we have friend(s) in Hoopeston. As for the 6SF7, gad —they should be all over like *umgowha*! Find the oldest TV or radio repairshop in your neck of the woods and I'll bet you they have a basement full. If the owner has trouble finding some, tell him they're under the pile of 6SN7's.

DXing Ice Cubes

My DX-150A Realistic SW receiver equipped with a Hy-Gain window-mount antenna experiences extremely strong interference from the refrigerator compressor in our home. Is there an inexpensive way to cure this?

—C. S. E., Poultney, VT

If your refrigerator does not have a three prong plug, ground the unit to the outlet plate with a #12 copper wire. By the way, your radio is trying to tell you your refrig's motor may go anyday. Start saving for a new unit.

Receiver Hot Line

What type of aerial would pull in the most DX possible? Is it a doublet, a long-wire antenna, a loop, a directional loop or what?

—F. B., Montreal, Quebec

A long wire antenna because the longer and higher the wire, the greater its capture effect. However, in a metropolitan area, such as Montreal, there are so many strong radio signals on the air that selectivity will suffer and even receiver overloading can occur. Better, use a tuned antenna in such an area, but this will require retuning the antenna system when you retune the receiver. ■

War of Currents

Continued from page 66

from telegraph pole to telegraph pole."

Edison wrote an article on *The Dangers of Electric Lightning* for the influential *North American Review*. He virtually converted his big West Orange laboratory into a propaganda factory where stray dogs and cats purchased for 25¢ each were killed in the presence of reporters and dignitaries.

A New Use for Electricity. Propaganda plus demonstrations plus occasional fatal accidents convinced the masses that the new alternating current actually was deadly.

Ordinary folk paid no attention to the Westinghouse emphasis upon use of transformers, by which current was customarily reduced to 50 volts before it entered a shop or residence. They only knew that alternating current will kill.

In this climate, it took just one vivid incident to suggest a new use for electricity.

Several members of the New York state legislature were among witnesses to a particularly gruesome hanging. Since the rope was not adjusted properly, the condemned woman slowly strangled before their eyes.

Why not do away with ropes? Why not bring "instant and painless death" by means of the dreadful alternating current?

This proposal made so much sense that the legislature of 1886 created by statute a commission of three investigators. Headed by Elbridge T. Gerry, they reported in favor of adopting capital punishment by electricity—and were careful to specify that alternating current be used.

Westinghouse took out advertisements protesting that direct current can be lethal, too. He pointed to the example of Benjamin Franklin, who had killed a number of small animals with direct current of low voltage.

Widely revered, more firmly established, and perhaps more aggressive in his propaganda campaign, Edison won easily. On June 4, 1888, Governor David B. Hill signed a bill stipulating that in New York condemned felons would, after January 1, 1890, be executed by means of "alternating currents of electricity applied to the body."

Contracts were drawn up for electrical death apparatus at Sing Sing, Auburn, Buffalo, and Clinton prisons. Significantly, it was the one-time Edison employee Harold P. Brown who got the jobs.

At Clinton he used a dynamo capable of supplying alternating current for 650 incandescent lamps of sixteen candle power each.

Three commissioners appointed by the New York State Prison Superintendent

made elaborate tests at each prison. To be sure that apparatus was lethal and painless, at Auburn they tested current on a calf and a horse. "Death was instantaneous," they reported.

One member of the commission, Dr. Alphonso D. Rockwell, devised but did not patent a special wooden chair fitted with electrodes. Hailed as "a marvel of humane progress," the new electric chair and its deadly alternating current would "forever end shame and indignities of barbarous dispatchment of those condemned by society."

Equipment was ready; the only thing needed was an occupant for the chair.

Declared guilty of having killed his commonlaw wife, timing of Willie Kemmler's trial was such that he seemed to be the logical condidate upon which to test the new and humane method of execution.

Long-drawn Legal Contest. Sentenced in Buffalo early in June, 1889, Kemmler was sent to death row in Auburn Prison.

While his case was being appealed, a number of prominent persons began challenging the Electrical Death Law. Kemmler, who had no money, suddenly announced that he was being represented by a big-name and high-fee law firm headed by the nationally famous W. Burke Cochran.

Legal maneuvers, public protests, paid advertisements, and secret lobbying failed. Electrocuted by means of alternating current shortly after dawn on August 6, 1890, Kemmler's death was seen by two dozen notables. Reporters were barred, so mingled with thousands of curious outside the prison.

Instead of producing a quick and tidy death, the electric chair virtually cooked its victim during several minutes when current was applied and then re-applied.

Strange Denouement. More than any other single factor, the slow and tortured death of Willie Kemmler convinced the man on the street that Thomas Edison was wrong. Alternating current couldn't possibly be so lethal as the great inventor had said.

A surge of popular support for Westinghouse came in the aftermath of one of the most highly publicized executions in American history. Efficiency and low cost of the alternating current system gave it ever-increasing advantages over the direct current system.

Edison eventually capitulated and joined forces with Westinghouse. They pooled their patents and resources to expand alternating current and make it standard in most U.S. operations. Twenty years afterward Edison made one of his rare confessions: "I was wrong," he told George Stanley. "If I had followed your father's advice and given alternating current a fair trial, this country never would have been subjected to the war of the currents." ■

CB COFFEE BREAK

Continued from page 64

Frequency synthesis? Cut crystal costs in half? While electronic magazines were still printing articles on what it was, CB'ers were using it!

How about noise blankers to crush mobile noise interference? Now there's a nice expensive item for other services, if you can get one. Yet for several years one of the best blankers ever made has been a standard feature in several Lafayette transceivers.

Lafayette HB-625 has high quality noise blanker. (Circle 41 on Reader Service Page)

Samaritan Syndrome. Let's take a look at the CB'ers public service operation. While other services use duplicate equipment to monitor emergency frequencies, the CB'er has dual receive capability in such units as the Johnson 124-M (whose monitor receiver has 2-channels).

There are many other firsts for the CB'er which have been copied in equipment for other services. The built-in SWR meter, the first really low-cost accurate modulation meter you didn't have to build yourself, the first low-cost in-line RF wattmeter, perhaps the first fully reliable non-military solid-state transceiver and the first 5 watt rig to work from flashlight batteries.

And let's not forget price. Who else but a CB'er can get a full-feature rig such as the Pace *P100-S* for $79.95, or a glove compartment size rig such as Lafayette's *Micro 12* for the same $79.95. Of course, if you want to

Full feature Pace 100-S rig (Circle 39 on Reader Service Page).

spring for more bread you can go sideband with SBE, Tram and Lafayette, whose sideband signal sounds a lot better than a lot of commercial stuff.

The time will come when someone will strike a medal in honor of creativity and performance brought to modern communications by CB. But until that happens, you'll just have to grin and bear it the next time you hear someone say, "CB is just a plaything for kids." ■

LIGHT-COMM

Continued from page 32

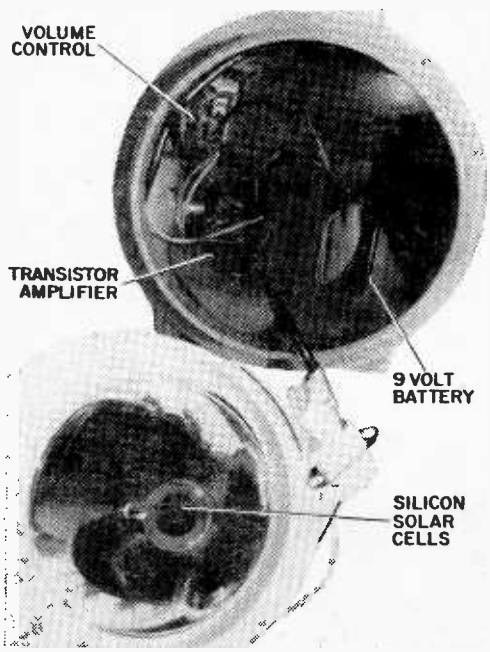
a jack is soldered to the amplifier input so that the detector-reflector assembly can be quickly disassembled if necessary.

Note. When soldering to the solar cells, use a 30 watt soldering pencil. Do not use a soldering gun. With reasonable care, the experimenter with average soldering ability should have no trouble soldering the leads to the cells. If it is preferred not to solder to the cells, make use of the wire leads already soldered to the cells. Also, it is not absolutely necessary to use two cells since the cells are mounted in a reflector to capture a fairly large quantity of signal. It is more efficient to use two of them, but just one cell may be used.

Getting On The Air. When the receiver is assembled, insert a nine volt battery in its holder, clip on the terminal snaps, and place the detector-reflector assembly back on the unit. With the reflector pointed toward a standard room lamp (incandescent or fluorescent) a 60 Hz tone should be heard from the speaker or earphone. If the tone is heard, the receiver is operating properly and the transmitter can be checked out. If not, carefully check the circuit for wiring errors. Also, make sure the battery is fresh.

To check the transmitter for proper operation, insert the batteries, turn the unit on, and point it at the receiver. Speak into the microphone and listen for the received signal in the receiver. If the signal is heard and the voice is reasonably good audio quality, the units are both operational and ready for field testing. If the voice is not heard or is of poor quality, turn the transmitter off and check for possible wiring errors. Pay particular attention to possible shorts and polarity reversal. Also, make sure the batteries are fresh.

The Long Reach. Range test the completed communicators for maximum DX with the help of a friend. First, align the optical elements of both transmitter and receiver. For the transmitter, adjust the position of the amplifier board until the LED fills the



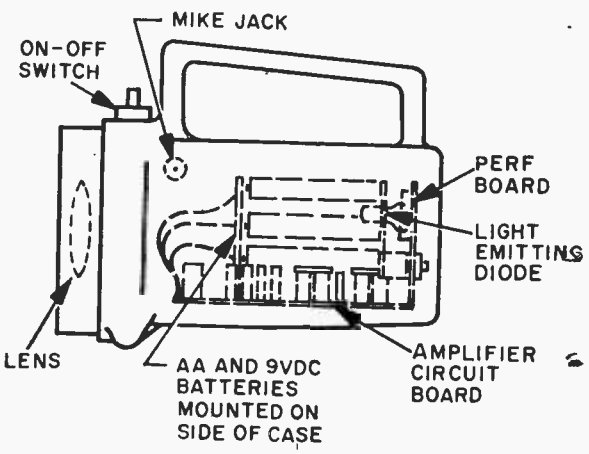
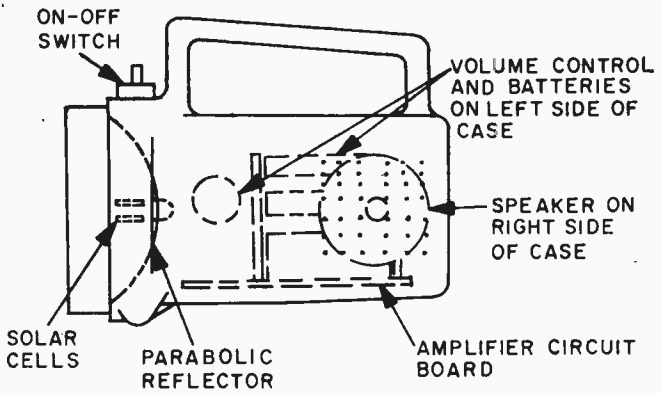


Photo on page 94 shows inside view of receiver with quick disconnect plug for solar cell separation. X-ray views show suggested parts location in detail AA batteries in transmitter power LED. 9-volt battery in each unit provides amplifier power.



aperture of the lens when the lens is observed several feet distant. Adjust the receiver's solar cells so that the entire reflector takes on the dark color of the cells when observed straight-on. This means that all light striking the reflector will be reflected to the cells.

When the units are aligned, leave the transmitter and its operator at a fixed location, and slowly walk away while directing the receiver toward the point of maximum signal. Instruct the transmitter operator to count into the microphone. As the range is increased, reception will be more difficult (because of alignment), but the signal from the transmitter should be receivable at about 1.000 feet at night. Range will be dependent on the size of the receiver's reflector. Daylight operation will result in considerably reduced range due to saturation of the detector solar cells. The problem can be partially alleviated by placing a cardboard tube over the front of the receiver to shield the detector from stray sunlight. Reception can be further improved by placing an infrared filter over the receiver detector. Edmund Scientific Co. sells several inexpensive filters. These optical shielding techniques will also reduce effects of buzz and hum from artificial light sources. ■

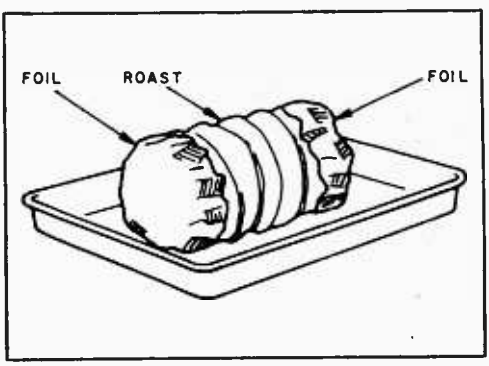
MICROWAVE OVENS

Continued from page 42

roasts or roasting chickens and turkeys. These fats reach temperatures above 212°F. and act to accelerate the browning reaction on the meat surface.

Some Cooking Tips. Since small items cook faster than large items, it is good practice to do all of one size at a time. In baking potatoes, for example, if they are nearly alike in size they will all be finished at the same time. The alternative to size grading is to remove the smaller items as they are done and continue to cook the larger items. This requires considerably more attention.

Since metals, including aluminum foil, reflect microwave energy you can use this phenomenon to advantage in certain cooking operations to restrict heating in certain areas. A good example to illustrate this effect is in the cooking of a large beef roast. See Fig. 5. First, wrap aluminum foil over the outer two inches at each end of the roast and cook for 2 to 3 minutes per pound (in a 1 kW oven 20 to 30 minutes for a 10 lb. roast). The roast should be turned at least once during this time. Remove the foil and cook for an equal period of time, again turning at least once. Remove the roast from the microwave oven, cover and let stand an additional 30 to 45 minutes or until a meat thermometer inserted into the center of the roast reads 140-150°F. Shielding the roast in this way dur-



ing cooking will insure a more uniform degree of doneness from one end of the roast to the other. If a more well done roast is desired, it can be returned to the oven for an additional 5 to 10 minutes.

A circle of foil placed in the center of a slice of left over roast will keep it from becoming too well done while warming it for service. When heating a casserole, the use of a strip of foil around the edge will slow down the heating effect in this area and insure a hotter center. There are many other possibilities using foil and metal forms to control microwave heating.

Regular shapes heat more uniformly in a microwave oven. When the shape is irregular the thin, narrow parts tend to overcook and may be dried out by the time the thicker parts are done. This of course, happens in conventional cooking but is less pronounced because cooking is slower. Where it is possible to control the shape, as for example with a meat loaf or by tying a beef roast into a more cylindrical form, much more uniform results are obtained. Where this is not possible, thin parts may be covered with aluminum foil for a part of the cooking cycle. The same technique can be applied in protecting the wing tips and legs of roasting chickens and turkeys.

Dinner is in the Bag. One of the principle advantages of microwave cooking is that it often can be accomplished in the serving dish or in the package in which the food was purchased. With the exception of metals, all packaging materials are transparent to microwave energy. The list includes ovenproof glass, ceramics, chinaware, plastic ware, paper containers of all types and plastic films.

It is not entirely true that in microwave cooking only the food is heated. Some plastics must be used with caution. Melamine plastic ware, for example, absorbs enough energy to cause charring in places. Such plastic ware quickly becomes too hot to handle. Styrenes give off a strong odor and deform if heated too long.

The amount of energy containers absorb can be determined by making an oven power measurement with and without the container in the oven. The difference is the amount of energy aborbed by the container.

Some ceramic dinnerware may absorb several watts of power for each ounce of weight. Considering the weight of such containers, the total power absorbed can be considerable. In some cases this is a desirable feature since foods in these dishes tend to remain warm longer after serving.

Care should be taken not to use chinaware with metallic trim designs, as the thin metal trim will tend to arc and pit, thereby damaging the appearance of the chinaware. The container is also likely to be quite hot in these regions and care should be taken in handling such dishes. It should be pointed out that no harm will come to the oven if such dishes are inadvertently used.

Save the Nutritive Value. The effect of microwave energy on vitamins in foods is negligible with a slight edge in favor of the microwave oven. Generally the effect is about the same as for conventional heating methods.

In many instances more of the natural vitamins are retained when vegetables are cooked in a microwave oven because in most cases this is done without the addition of water, thus there is no leaching out of vitamins. When vegetables are cooked in water usually only the vegetable is served, not the liquid, though studies have shown that a good percentage of the vitamin is in the liquid. ■

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EICO Alarm System

Continued from page 46

above the switch was *on* the alarm was *on*, and a flick of the key turned it off. The SS-500 entrance key switches are spring-return, so it always resets to the operating position.

It is important to note that the basic intruder/burglar protection uses series connected ("closed circuit) sensors, and only they operate the "circuit test" or "ready" light. Though the intruder/burglar circuit can also accommodate "open circuit" sensors they cannot signal through the "circuit test" light. Of course, if an open circuit sensor is tripped the alarm will instantly sound the bell when the system is turned on. Open circuit sensors are generally used for a backup, such as a matswitch placed under the carpet at the foot of the stairs, or next to patio doors; a closed circuit sensor would normally protect the door itself.

It Gets Larger. Another feature we liked is that of *expandability*. You can start with basic protection—such as the entrance doors, with fire detection in the bedroom areas, and then easily expand the system as the budget or your time allows to other rooms in your house.

And just to make sure you get the installation and any possible expansion done correctly, the SS-500 is supplied with a thorough, well illustrated installation manual.

Summing up. The EICO SS-500 Home Protection System works as well as, if not better, than many so-called "professional" or industrial systems—at a lot less cost. Fact is, the SS-500 has more features than much "professional" equipment. And it certainly works a lot better than many do-it-yourself systems presently on the market that are supposedly intended for the average home owner.

We should point out that if you live in an apartment or very small house and have no need for all the security hardware in the SS-500 kit, you can obtain just the FC-100 Control Center and the necessary bell, horn and/or sensors. EICO sells all parts on a peg board rack at your local independent electronics dealer. For additional information write, circle No. 44 on Reader Service Coupon on page 17 or 103. ■

Sounds from the Ground

Continued from page 51

I casually tuned across a weak signal that seemed to be a three-way telephone call! Well, you'll just have to listen for yourself. . .

Audio? Why Audio? You may be wondering why the underground receiver was designed to receive audio signals. It seems that there's a new fad among electronics minded Hippies. Recently, they have been feeding their high-power guitar amplifiers into the earth! They tell their local friends to drive a pole into the ground, connect it to the input of their own guitar amplifier (along with a good earth ground), and listen to the speaker! ■

Healthkit DVMM

Continued from page 58

an additional hour or so for calibration. Since the overall accuracy is totally dependent on *the user's* calibration efforts, the more time you spend on calibration the greater the accuracy.

How it works. The Heathkit DVMM uses what is called "dual slope" integration, which in non-fancy words means that it is really, a frequency counter with a readout expressed in volts, ohms or milliamperes. The basic DC voltmeter simply measures how long it takes for a capacitor to discharge. The DC input voltage is applied to an integrator; the integrator's capacitor charges and discharges in accordance with the applied voltage. The greater the voltage the longer the discharge time. The discharge time is measured and the readout is calibrated in DC volts. The readout is maintained until the input voltage changes, at which time the readout locks onto the new voltage input.

For AC measurements the input voltage is simply converted to DC through a half-wave rectifier. For resistance measurements the meter applies a current between 1 mA and 100 nA through the unknown resistance and the meter measures the voltage drop across the unknown resistor (which is in series with a known resistance). For current measurements the meter again measures voltage drop, this time across calibrated resistors built into the IM-102.

Goof proof. You would have to try hard to damage the IM-102 because the inputs are protected both by fuses and diode clamps. Even if the meter were set to say, the 200 mV range, it is protected against overload up to 250 AC volts, 350 DC volts. On the higher ranges the overload protection extends to 500 AC volts, 1000 DC volts.

Easy to use. One of the nicest features of the Heathkit IM-102, which is not even found on many higher priced lab models, is the single set of input jacks (with standard ¾" spacing) for all voltage and resistance measurements. You do not have to move the test leads when going from AC to DC volts or volts to ohms. You need move only the positive test lead when measuring current.

Performance. Since this is supposed to be a lab grade meter we tested it for long term stability. After initial calibration we turned it on and let it run continuously for *two weeks.* There was absolutely no change in performance, calibration or accuracy at the end of the test period. Since we do not have a voltmeter calibrator we checked the IM-102 against a lab grade DVMM (priced well over $500) with a 0.1% accuracy. Under worst-case conditions our IM-102 had a 0.5% accuracy except on the AC current ranges where it was nominally 1%. (All accuracy is of course ± 1 digit.)

Most important, the IM-102 has a nominal accuracy of 1% from 20 to 20,000 Hz on the lower ranges and a worst-case. 2% 20-20k accuracy on the higher ranges. This makes one heck of a good, sensitive AC meter and is superior to many so-called lab grade DVMMs whose accuracy poops out above 10 kHz. And bear in mind that this accuracy is with a preset adjustment of the high frequency input divider trimmers. If you can latch onto a voltage calibrator (or have an alignment lab or Heath do a full instrument calibration) the 20-20k accuracy improves to a nominal 0.5%. And that is top performance in any language.

Summing up. Because the Heathkit IM-102 is so accurate you'll find it's a natural for calibrating your other test equipment such as VOMs and signal generators. Fact is, we'll bet this is one instrument you'll never loan a friend, because you'll suddenly find you cannot do without a DVMM. Why don't you get more facts and figures direct from the Heath Company by circling No. 1 on the Reader Service Coupon found on page 17 or 103. ■

DX Guide

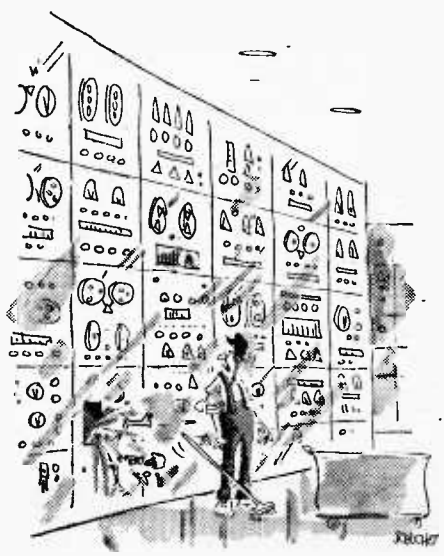
Continued from page 48

they have been logged in North America on frequencies as low as 2868 kHz. All reports should contain two International Reply Coupons available from any post office for 15-cents each. This is of course less than you would pay a dealer for the equivalent stamps, and in most cases he couldn't provide the rare postmarks.

Stamp collectors turned DXers will encounter a completely different kind of problem if they tackle the Spanish held Canary Islands and British owned Ascension. These are the sites of widely heard international relays operated by R. Nacional Espana and the British Broadcasting Corporation. It is official policy of both these organizations to issue all QSLs from their headquarters in Madrid and London respectively. However some reports addressed to Sr. J. de Rojas Mora, Director, RNE Canarias, Santa Cruz de Tenerifi have been answered directly from the islands. RNE Canarias is easily heard evenings in North America with Spanish transmissions beamed to Latin America on 11,800 and 15,360 kHz.

(Continued on next page)

It just may happen!



"Burp..."

Electronic QSL's? When the BBC'S S. Atlantic Relay Station first appeared on the scene in 1966, the staff planned to issue special QSL cards directly from Ascension island at their own expense. However the quantity of mail, among other factors, soon became so overwhelming that the project had to be abandoned. As giant interelated networks of SWBC relays, of which BBC Ascension is a part, become ever more all-encompasing and politically intricate, DXers will find it increasingly difficult to obtain QSLs representing any individual transmitter site. This same "transmitter explosion" is part of an overall technological trend which, ironically, may eliminate the postal system entirely as we know it. If that happens collectors will have to abandon stamps, except as high priced historical artifacts of an antique communications system, and concentrate entirely upon the QSL which by then would reach the DXer electronically via a myriad of completely interchangeable facilities.

In other words, the very problems posed for stamp collectors by RNE Canarias and BBC Ascension suggest yet another reason why all philatelists should also now become QSL connoisseurs. On the other hand, if you are unable to receive a reply directly from RNE Canarias, you can always try for Canarias Aeradio working South Atlantic traffic on 8882 kHz. Unfortunately, Ascension Aeradio won't do you a bit of good as it is operated by the USAF and would use U.S. stamps.

Early Morning Goodies. With the exception of ultra-rare St. Helena, Bermuda is least involved in political/technological issues of all the islands covered in this article and therefore, once you log it, it will be the easiest from which to receive a QSL with the island's own individual stamps affixed. But even here, ZFB1, a MW Broadcast Band station (960 kHz) at Hamilton, sometimes acts as an unofficial Voice of America relay. Early in 1971 they were reported by members of the International Radio Club of America with VOA English language transmissions during the wee hours of the morning; QSLs for these can be obtained directly from ZFB1. If you live East of the Mississippi and don't have an all night local on 960, you should eventually bag this one.

Meanwhile, during the evening hours Eastern collectors, depending upon the selectivity of their receivers and local QRM situation, might also be able to hear ZBM1 on 1235 kHz, half way between two graveyard channels. Or, if you can hear neither ZFB1 nor ZBM1, Kindley Aeradio is widely heard days on 8871 kHz and 2868 kHz at night. ■

Stamp Shack

Continued from page 25

speaker against blue and green concentric circles to suggest radio waves.

● Shortly after the United States developed the Marconi invention and began broadcasting, our southern neighbor's technicians decided to adapt this then-newest of communications

methods for the enlightenment and entertainment pleasure of its people. A small studio was erected in Mexico City and on Oct. 9, 1921, the first transmission was effected. In the intervening five decades, radio broadcasting has become a major enterprise, not only in the capital, but all over the Mexican landscape from the Rio Grande to Yucatan. Having added TV to its facilities, Mexico City's broadcasting operations (including network programs) are housed in an immense skyscraper whose many floors are filled with studios of every size and with equipment that rivals that to be found in Radio City or Hollywood. *(See top of next page)*

"He claims the flesh tones improve!"

●●When Carl Zeiss began business at Jena in 1846, he concerned himself solely with the careful grinding of small optical lenses. He possibly never anticipated that his name one day would become world famous, nor that it would be honored by postage stamps —after all, the first ones had been introduced only six years earlier; Jena itself would not have postage stamps until four years later. Yet that is what happened on Nov. 9, 1971.

● The Postal Administration of East Germany released an interesting triptych stamp as a tribute to the 125-year old firm. At the left to a small 10-pfennig value which depicts a model Dahlta 010A theodolite in the firm's GEOmat series, the first of which was developed by Zeiss in 1908. In the center is a multi-lens projector with a circle of astronomical phenomena as the subject of the 25pf value. It was Zeiss' invention of this instrument that enabled him to create the world's first planetarium for the reproduction and study of the heavens and outer Space, under artificial conditions.

● At the right is another small design, a 20pf stamp which shows a modern medical microscope in the MIKroval series which developed over the decades since Zeiss made his and Europe's first high-power magnifier only a year after he opened his shop.

● All three of the stamps, which may be used individually or as an unservered triptych for a total face value of 55pf, include the internationally recognized "Carl Zeiss/Jena" trademark to be found on all of the firm's optical products.

● Following WWII and the Soviet occupation of East Germany, the firm's plants in Jena were appropriated by the Communist regime, and because of the exceptionally high standards of excellence and precision of Zeiss products it became a vital part of East German economy. It still is the foremost of that land's industries.

● **What's New?** Sensing that some collectors do not like printed albums but prefer to make up their own individual ones, the Vidiforms Company, of New York, N.Y. 10956, has turned out a handy spiral-bound binder containing 20 heavy pages that have only a thin black frame and pale gray quadrilles. Owners, then, can mount their stamps to satisfy personal tastes with as much or as little descriptive matter and decoration as may be desired. The album costs $2, and may be ordered from the publisher.

The H. E. Harris Co., Boston, Mass. 02117, has come up with its newest edition of its annual "US-UNBNA Catalogue." This latest in a long series of price guides for those who do not want to spend much more for the more elaborate, standard ones, costs $1 as usual. It describes, illustrates and gives current market values of United States and UN stamps in mint and used singles and mint blocks of four, and also includes a section for British North American issues. ■

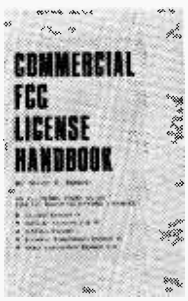
Bookmark

Continued from page 24

bleshooting techniques—how to check for wear, breakdown, and alignment—and how to make repairs once the problem has been located. Comprehensive troubleshooting charts for each appliance help locate malfunctions quickly. Throughout the text, specially prepared line drawings underscore key topics and give a clear picture of the components discussed in relation to the overall unit.

Ticket Trainer. Here's a new and unique study guide and reference manual which combines theory and applications with up-to-date questions and answers for all commercial FCC classes—1st, 2nd, and 3rd class radio-telephone license exams, as well as for broadcast and radar endorsements. Naturally, the title is *Commercial FCC License Handbook* and it's by Harvey L. Swearer.

Everything a license applicant needs to know is included—complete detailed answers to questions on any subject he may be asked when taking an exam, plus complete sets of ques-



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tions on each element (with answers in the back of the book) as a double-check on what has been learned and what needs further study. Numerous practical examples are used to describe the various principles covered in the exam questions. Published by Tab Books.

(Continued on next page)

A Freebee. One of the first booklets ever to clearly and simply explain the use of optical flats is *Optical Techniques For Measuring Flatness* which is published by Edmund Scientific Co. The text familiarizes readers with the effects of the interference of light and the necessary techniques for measuring flatness using optical standards. To use an optical flat (Edmund carries a complete line *in stock*), it is necessary to understand the theory on which it is based. This instructive booklet is practical not only for quality control and machine shops but also for educators . . . because it clearly explains the theory so you will be able to devise your own techniques when faced with an unusual problem, or a situation differing slightly from those described. The 16-page booklet covers: light waves and interference; contact method for testing flatness; typical interference patterns and their interpretation; non-contact methods of measurements (Twyman & Green and Fizeau Interferometers); and applications. To get your free copy of the Optical Techniques . . . Booklet, No. 9883, by return mail, just write to Edmund Scientific Co., 555 Edscorp. Bldg., Barrington , New Jersey 08007. Tell 'em you saw it in ELEMENTARY ELECTRONICS. ■

DX Central Reporting

Continued from page 22

In a land where pagan voodooism is still widely believed and practiced, it's understandable that Christian missionaries would turn their attention to Haiti. It was in 1950 that a missionary group, the East and West Indies Bible Mission, began Radio 4VEH. Its work was taken over by the Oriental Missionary Society in 1958, and since then the station's operations have expanded greatly.

On both medium and shortwaves, Radio 4VEH operated with dual programs in Spanish, French, Creole and English, some 150 hours a week. Co-directors, the Rev. Mardy Picazo and Gaudin Charles, a Haitian citizen, co-ordinate the efforts of some 17 Haitian missionaries who produce religious and informational programs in the local languages. Seven foreign missionaries handle the technical aspects of broadcasting and produce the English and Spanish programs.

In the U.S., Radio 4VEH can be heard broadcasting in English during the morning hours, around 1230 to 1400 GMT, on 9.770 kHz.

The station is very friendly to SWLS and appreciates letters. Over 22,000 were received by 4VEH in 1970 alone. Correct reports, sent to *Radio 4VEH, Box 1, Cap Haitien, Haiti*, will bring a QSL card. Return postage, in the form of unused Haitian stamps, or two (2) International Reply Coupons, available at your post office for 22 cents, are appreciated by this station which operates on a limited budget.

Bandsweep. Frequencies in kHz, tunes in GMT. **3,223**—Remember a few months back when we mentioned the proposed new African station, Swazi Radio? Though this commercial outlet in Swaziland is not on the air as this is written, look for them on this frequency during the late afternoons. . . . **4,965**—Consistently one of the best bets for those looking for South American stations is Radio Santa Fe in Colombia. Its Spanish broadcasts can be heard nearly every night on this spot. . . . **5,047**—And for those looking for African signals, the powerful transmitter at Lome, Togo is the ticket. On the East Coast you might catch it before 2300 sign off. Otherwise, try around 0600 GMT. . . . **6,090**—Radio Australia's foreign service is often heard by SWL's. For something a tad more difficult, try the domestic broadcaster of the Australian Broadcasting Commission at Sydney around dawn. . . . **7,300**—One of the more audible clandestine stations is the so-called Voice of Truth, operated from East Germany by the Greek Communist Party. A tuning signal, played on a flute, preceeds its sign on at 1900. . . . **9,516**—Many DXers need Uruguay in their countries logged list. Radio Sarandi, Montevideo with Spanish broadcasts until 0100 s/off may do the trick for you. . . . **10,040**—The English-speaking "lady" who broadcasts to American troops in Indochina has been dubbed "Hanoi Hattie." You can hear her over North Vietnam's Voice of Vietnam 2320. . . . **11,850**—Another African outlet worth tuning is Radio Ghana, which has an English transmission to North America from 2000 to 2100. . . . **15,520**—The conflict between India and Pakistan resulted in the creation of a new country. You can find Radio Bangladesh in an English foreign service from 0230 to 0300.

(Credits: Harold Sellers, Ontario; Jim Roberts, Manatoba; Art Glover, Washington; A. R. Niblack, Indiana; Larry Magne, Pennsylvania; Danny Jamison, Kentucky; James Ronda, Ohio; Gladys Martin, Brooklyn, N.Y.; North American SW Association, Box 989, Altoona, Pennsylvania)

Backtalk. "I enjoy your column and look forward to each issue of ELEMENTARY ELECTRONICS for the information in the Bandsweep section," writes Edward Parker of Hoffman Estates, Illinois. "But I have a question. I read somewhere that the BBC does not accept reception reports and I'd like to have the situation clarified."

The British Broadcasting Corporation (BBC) is happy to receive reception reports, Ed. And SWLs reporting correctly will receive an attractive card in return. However, the card's text says only that the report was in agreement with BBC's scheduled programs; obviously

ELEMENTARY ELECTRONICS

READER SERVICE PAGE

• The Editor of ELEMENTARY ELECTRONICS offers readers an easy way to get additional information about products and services advertised in this issue. Also, if you would like more information about any new product mentioned in our column "Hey, Look Me Over," it's yours for the asking. Just follow the instructions below and the material you requested will be sent to you promptly and at no cost.

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MAY/JUNE 1972 — Void after November 30, 1972

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something less than a definite verification statement. The BBC's rational for this policy is that their programs are aired not only from transmitters in England, but also relay stations on Ascension Island, Cyprus and Malaysia, to say nothing of off-the-air pickups and relays by non-BBC stations in various parts of the world. Since many of these stations broadcast within the same range of frequencies, sometimes at the same hour, the BBC apparently feels it can't be sure which transmitter a listener has logged.

One of the top medium wave listeners on the West Coast, Father Jack Pejza of San Diego, passes along the word that California BCB monitors are hearing a new Russian station on 1529 kHz from 1000 to 1200 GMT.

Clyde Burdette, Jr., describes himself in his letter as "an Army GI stationed in Germany whose spare time hobby is SWL'ing." Clyde has nabbed a station that many Stateside DXers would love to tune. The station is FEBA, a religious missionary outlet on 11,950 kHz, operating from the island of Seychelles in the Indian Ocean. He logged them at 1700 to 1900 GMT, asking for reception reports to Box 234, Seychelles. This one has been heard in the U.S., so the rest of you, go to it!

Letters have been received also from Robert Vance, Kansas City, Mo., who sends a nice list of DX loggings, from 15-year-old Tim Fisher of Columbus, Ohio, who has logged 51 countries in a year and a half of SWLing.

Both Bob and Tim list among their loggings the powerful Radio Nacional de Nicaragua, a solid catch on 11,875 kHz, during the evening hours in North America.

Be a Joiner. Our parade of DX clubs continues this month with the Worldwide TV-FM DX Association. It is particularly appropriate that we tell you about this fine club now, as the annual late spring summer TV and FM DXing season is almost upon us.

Maybe you didn't know that really long range TV and FM DXing was possible. If you didn't know that reception of FM and television stations hundreds and thousands of miles away was possible, then a glimpse of WTFDA's information packed monthly bulletin will be a real eyeopener!

If you are a newcomer to this special field of DXing—or if you'd like to become one and don't know where to start—WTFDA will help you become familiar with the equipment and techniques of other members and offer plenty of useful information. Some members have been in FM-TV DXing for 20 years and are willing to pass along tips learned by long experience. A basic packet of material for the new DXer is also available through the club.

Curious? Then use the handy form on this page to join up or request a sample bulletin. Remember to send it directly to the club, not to DX Central Reporting. ■

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☐ Please send me more information about WTFDA and a sample bulletin. I am enclosing 50 cents.

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Hey, Look Me Over

Continued from page 16

phones, or internal telephone systems as a paging source. The TM-1 has two outputs: (1) a high level output for matching the auxiliary (phone-line) input of an amplifier or receiver; (2) a low level output that matches either a Lo-Z or Hi-Z microphone input of an amplifier or receiver. Supplied in a sturdy metal case with mounting flanges. List price: $13.50. For more information circle No. 49 on Reader Service Coupon on page 17 or 103.

Plum Snakey Stereo

Heathkit has given portable stereo a whole new dimension with its new GD-111 "Plum Snakey" kit that puts an automatic recorder player and an AM radio in a turned-on primal purple package. There's an acoustically matched stereo system—4-speed automatic turntable, powerful 18-watt amplifier and two detachable 4½ in. high-compliance speakers. Turn the mode switch and the

GD-111 is turned on to the solid-state AM receiver. To stash it all and go, the speakers swing closed, the turntable tilts in and a handle flips up, resulting in a durable rough-and-ready carrying case. The GD-111 goes together in a few hours. The changer and cabinet are preassembled. The kit builder simply constructs the AM and amplifier circuits boards, installs the changer, speakers in the cabinet. The "Plum Snakey" sells for $109.95 mail order direct from Heath Company. For further information, circle No. 1 on Reader Service Coupon on page 17 or 103. ■

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Classified Ads 65¢ per word, each insertion, minimum 10 words, payable in advance. To be included in the next available issue of ELEMENTARY ELECTRONICS, copy must be in our New York Office by April 1st. Address orders to R. S. Wayner, Manager, Classified Advertising. ELEMENTARY ELECTRONICS, 229 Park Avenue South, New York, N. Y. 10003.

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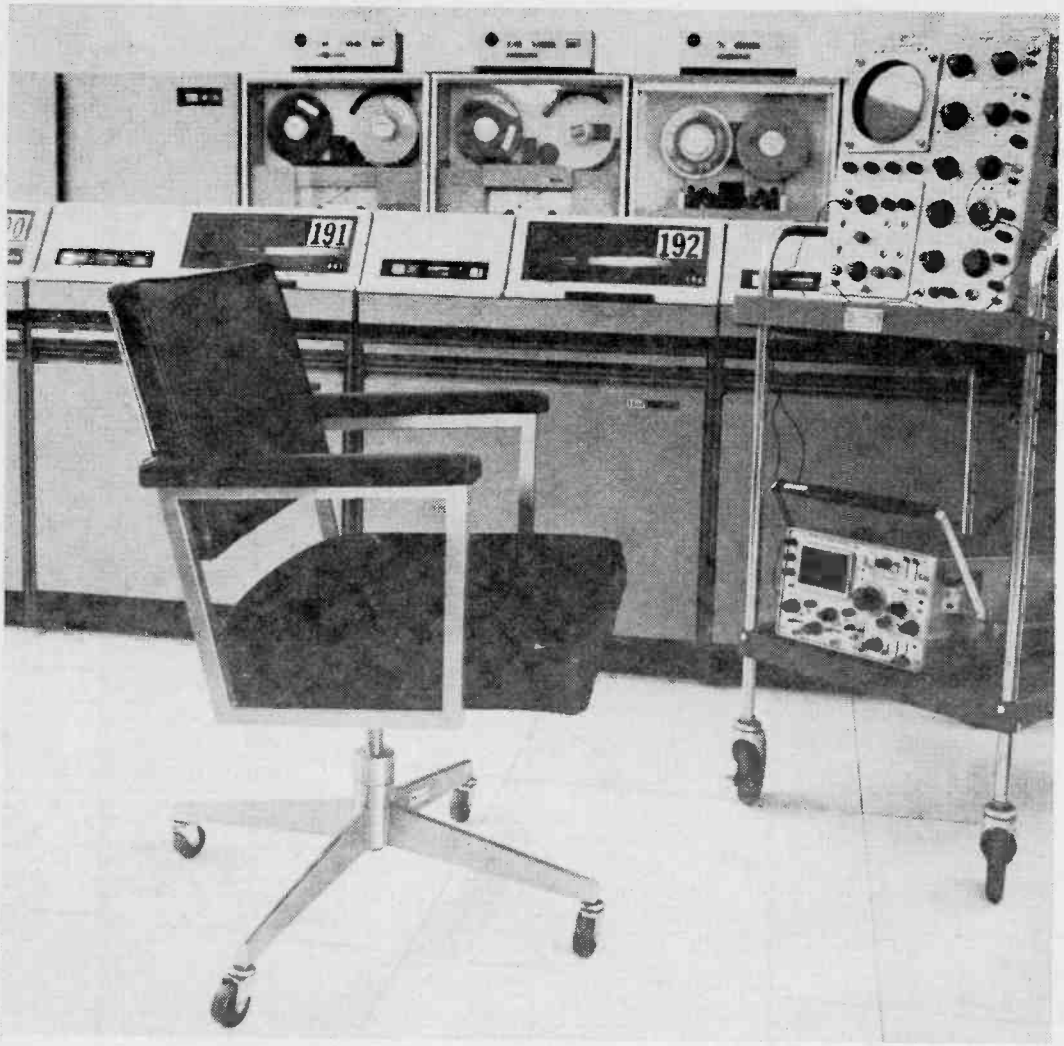

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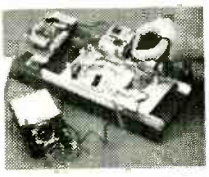

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The Progressive Radio "Edu-Kit" is the foremost educational radio kit in the world, and is universally accepted as the standard in the field of electronics training. The "Edu-Kit" uses the modern educational principle of "Learn by Doing." Therefore you construct, learn schematics, study theory, practice trouble shooting—all in a closely integrated program designed to provide an easily-learned, thorough and interesting background in radio.

You begin by examining the various radio parts of the "Edu-Kit." You then learn the function, theory and wiring of these parts. Then you build a simple radio. With this first set you will enjoy listening to regular broadcast stations, learn theory, practice testing and trouble-shooting. Then you build a more advanced radio, learn more advanced theory and techniques. Gradually, in a progressive manner, and at your own rate, you will find yourself constructing more advanced multi-tube radio circuits, and doing work like a professional Radio Technician.

Included in the "Edu-Kit" course are Receiver, Transmitter, Code Oscillator, Signal Tracer, Square Wave Generator and Signal Injector Circuits. These are not unprofessional "breadboard" experiments, but genuine radio circuits, constructed by means of professional wiring and soldering on metal chassis, plus the new method of radio construction known as "Printed Circuitry." These circuits operate on your regular AC or DC house current.

THE "EDU-KIT" IS COMPLETE

You will receive all parts and instructions necessary to build twenty different radio and electronics circuits, each guaranteed to operate. Our Kits contain tubes, tube sockets, variable, electrolytic, mica, ceramic and paper dielectric condensers, resistors, tie strips, hardware, tubing, punched metal chassis, Instruction Manuals, hook-up wire, solder, selenium rectifiers, coils, volume controls and switches, etc.

In addition, you receive Printed Circuit materials, including Printed Circuit chassis, special tube sockets, hardware and instructions. You also receive a useful set of tools, a professional electric soldering iron, and a self-powered Dynamic Radio and Electronics Tester. The "Edu-Kit" also includes Code Instructions and the Progressive Code Oscillator, in addition to F.C.C. Radio Amateur License training. You will also receive lessons for servicing with the Progressive Signal Tracer and the Progressive Signal Injector, a High Fidelity Guide and a Quiz Book. You receive Membership in Radio-TV Club, Free Consultation Service, Certificate of Merit and Discount Privileges. You receive all parts, tools, instructions, etc. Everything is yours to keep.

Progressive "Edu-Kits" Inc., 1189 Broadway, Dept. 555DJ, Hewlett, N.Y. 11557

FREE EXTRAS
• SET OF TOOLS

- SOLDERING IRON
- ELECTRONICS TESTER
- PLIERS-CUTTERS
- VALUABLE DISCOUNT CARD
- CERTIFICATE OF MERIT
- TESTER INSTRUCTION MANUAL
- HIGH FIDELITY GUIDE • QUIZZES
- TELEVISION BOOK • RADIO TROUBLE-SHOOTING BOOK
- MEMBERSHIP IN RADIO-TV CLUB: CONSULTATION SERVICE • FCC AMATEUR LICENSE TRAINING
- PRINTED CIRCUITRY

SERVICING LESSONS

You will learn trouble-shooting and servicing in a progressive manner. You will practice repairs on the sets that you construct. You will learn symptoms and causes of trouble in home, portable and car radios. You will learn how to use the professional Signal Tracer, the unique Signal Injector and the dynamic Radio & Electronics Tester. While you are learning in this practical way, you will be able to do many a repair job for your friends and neighbors, and charge fees which will far exceed the price of the "Edu-Kit." Our Consultation Service will help you with any technical problems you may have.

FROM OUR MAIL BAG

J. Stataitis, of 25 Poplar Pl., Waterbury, Conn., writes: "I have repaired several sets for my friends, and made money. The "Edu-Kit" paid for itself. I was ready to spend $240 for a Course, but I found your ad and sent for your Kit."

Ben Valerio, P. O. Box 21, Magna, Utah: "The Edu-Kits are wonderful. Here I am sending you the questions and also the answers for them. I have been in Radio for the last seven years, but like to work with Radio Kits, and like to build Radio Testing Equipment. I enjoyed every minute I worked with the different kits; the Signal Tracer works fine. Also like to let you know that I feel proud of becoming a member of your Radio-TV Club."

Robert L. Shuff, 1534 Monroe Ave., Huntington, W. Va.: "Thought I would drop you a few lines to say that I received my Edu-Kit, and was really amazed that such a bargain can be had at such a low price. I have already started repairing radios and phonographs. My friends were really surprised to see me get into the swing of it so quickly. The Trouble-shooting Tester that comes with the Kit is really swell, and finds the trouble, if there is any to be found."

UNCONDITIONAL MONEY-BACK GUARANTEE

Please rush my expanded "Edu-Kit" to me, as indicated below:
Check one box to indicate choice of model

- ☐ Deluxe Model $31.95
- ☐ New Expanded Model $34.95 (Same as Deluxe Model Plus Television Servicing Course and valuable Radio & TV Tube Checker).

Check one box to indicate manner of payment

- ☐ I enclose full payment. Ship "Edu-Kit" post paid.
- ☐ I enclose $5 deposit. Ship "Edu-Kit" C.O.D. for balance plus postage.
- ☐ Send me FREE additional information describing "Edu-Kit."

Name .....

Address .....

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

PROGRESSIVE "EDU-KITS" INC.
1189 Broadway, Dept. 555DJ, Hewlett, N. Y. 11557

PRINTED CIRCUITRY

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

A Printed Circuit is a special insulated chassis on which has been deposited a conducting material which takes the place of wiring. The various parts are merely plugged in and soldered to terminals.

Printed Circuitry is the basis of modern Automation Electronics. A knowledge of this subject is a necessity today for anyone interested in Electronics.

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