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Understanding Transformers

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DC Powered GAS ALARM

You broke up Freddy the firemen's pinochle game. It cost him little, but you saved your car, cabin cruiser, travel trailer...

This is the Solid-State Nose

of our Gas Alarm
See page 31

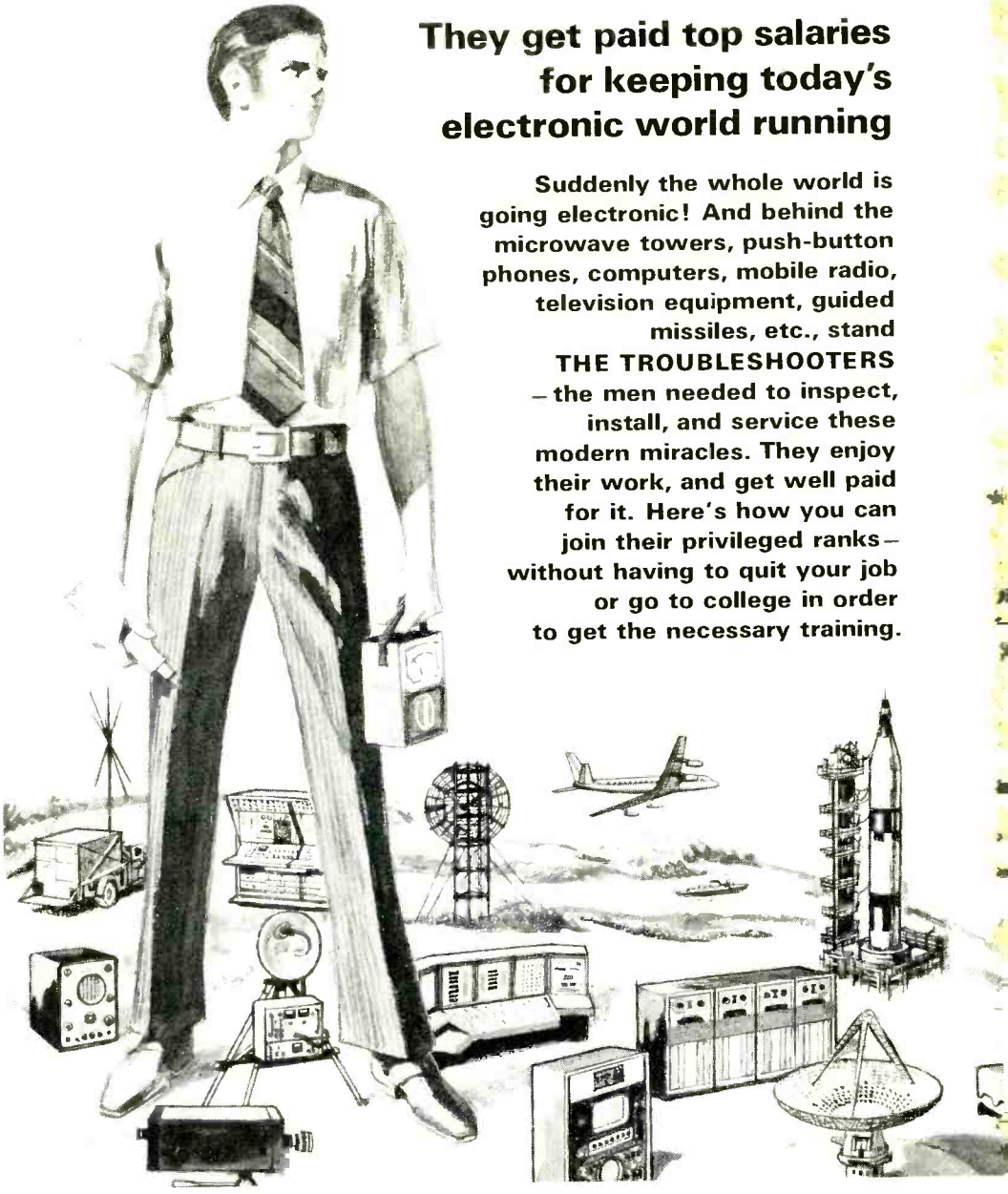
Digital Stop Watch
Low cost kit "throws together" in 2 hours

CB's Modern Circuits
Clever design helps KO rising costs

VT's for Antiques
The care and feeding of old vacuum tubes

A DAVIS PUBLICATION

Join "THE TROUBLESHOOTERS"



They get paid top salaries for keeping today's electronic world running

Suddenly the whole world is going electronic! And behind the microwave towers, push-button phones, computers, mobile radio, television equipment, guided missiles, etc., stand **THE TROUBLESHOOTERS** – the men needed to inspect, install, and service these modern miracles. They enjoy their work, and get well paid for it. Here's how you can join their privileged ranks – without having to quit your job or go to college in order to get the necessary training.

CIRCLE NO. 8 ON PAGE 17 OR 103

ELEMENTARY ELECTRONICS including ELECTRONICS DIGEST (Vol. 14, No. 6) is published bi-monthly by Davis Publications, Inc., at 229 Park Ave., S. New York, N.Y. 10003. One year subscription (six issues)—$3.95. Second class postage paid at New York, N.Y. 10003 and at additional mailing office.

• November/December 1974 • Vol. 14 No. 6

elementary Electronics

Including Electronics Digest®
Dedicated to America's Electronics Hobbyists

☆ Cover Highlights

Cover photograph by Heicklen Studio with fireman John Myles, NYFD

AUTHORS IN THIS ISSUE

Gabe Comlete, James A. Fred, Joe Gronk, George Haymans, Don Jensen, J. R. Laughlin, C. R. Lewart, Kathi Martin, Steve Money, Charles Rakes, Jack Schmidt, Hank Scott, and the ELEMENTARY ELECTRONICS editorial staff.

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Absolutely no previous knowledge of radio or science is required. The "Edu-Kit" is the product of many years of teaching and engineering experience. The "Edu-Kit" will provide you with a basic education in Electronics and Radio, worth many times the low price you pay. The Signal Tracer alone is worth more than the price of the kit.

THE KIT FOR EVERYONE

You do not need the slightest background in radio or science. Whether you are interested in Radio & Electronics because you want an interesting hobby, a well paying business or a job with a future, you will find the "Edu-Kit" a worth-while investment. Many thousands of individuals of all ages and backgrounds have successfully used the "Edu-Kit". In more than 79 countries of the world. The "Edu-Kit" has been carefully designed, step by step, so that you cannot make a mistake. The "Edu-Kit" allows you to teach yourself at your own rate. No instructor is necessary.

PROGRESSIVE TEACHING METHOD

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

You begin by examining the various radio parts of the "Edu-Kit." 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.

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- SOLDERING IRON
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- PLIERS-CUTTERS
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- 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."

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.

Progressive "Edu-Kits" Inc., 1189 Broadway, Dept. 570DJ Hewlett, N.Y. 11557

Please rush me free literature describing the Progressive Radio-TV Course with Edu-Kits. No Salesman will call.

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CIRCLE NO. 9 ON PAGE 17 OR 103

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Including Electronics Digest®

Nov./Dec. 1974 Vol. 14/No. 6

Dedicated to America's Electronics Hobbyists

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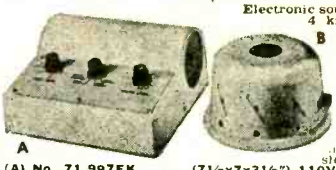

Electronic sound conditioner simulates 4 kinds of soothing sounds of ocean surf and rain. "White sound" helps mask unwanted noise, adds restful, intriguing background sound. Program the solid-state unit to your own need: 2 surf, 2 rain; or "white sound". proven by medical tests to have analgesic effects. Great for meditation, restlessness, sleeplessness psychology.

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AS ABOVE, BUT "WHITE SOUND" ONLY
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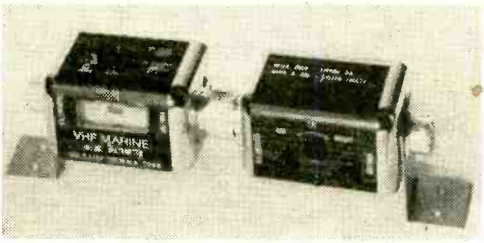
CIRCLE NO. 18 ON PAGE 17 OR 103

Hey, look me over

Showcase of New Products

Boater's VHF Check-Out

Gold Line's VHF Marine Radio Trouble Alert enables you to determine if your radio and antenna system are transmitting. The GLC 1078A alerts you to antenna or transmitter

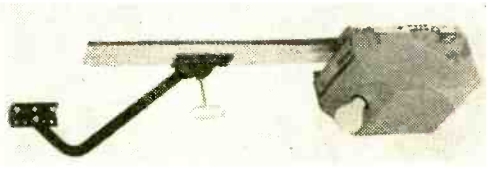


Circle No. **34** on Reader Service Page 17 or 103

problems when an air check is not possible. A green on-the-air light indicates your antenna system is functioning properly. If a *short* or *open* develops in the antenna line, a red light alert comes on. Since antenna lines lose or waste power, a meter indicates this waste or reflected power loss. By tuning a control knob you can minimize the loss. Price for the GLC 1078A is $39.95. Gold Line Connector, Inc., Muller Avenue, Norwalk, CN, designs and manufactures a large variety of accessories and components for the CB and ham radio market.

GDO For Do-It-Yourselfers

A Genie (Model GS-201) radio-controlled automatic garage door opener (GDO) system designed especially for do-it-yourselfers comes completely assembled and ready for installation including AR-30 radio receiver and AT-35A transmitter, all in one portable package. Features include a planetary gear drive system which eliminates belts and pulleys that

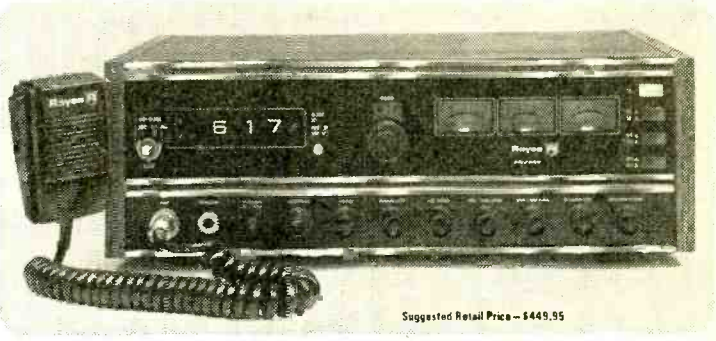


Circle No. **35** on Reader Service Page 17 or 103

Move over, competition! Here comes Royce with 3 Great new SSB/AM CB Transceivers!

Model 1-640
Low Silhouette Styling

Every CB transceiver has some of the features found on this unit. No one else has all of them, at our price. New, low silhouette styling – with smoked plexiglas front, extruded aluminum, walnut-grained wood. 3 large meters monitor S-RF and SWR – let you monitor R.F. output. SWR, simultaneously. Big, big numbers on backlighted digital clock. Greater clarity. **This transceiver has it all! See it soon at your CB dealer!**



Suggested Retail Price – $449.95

Suggested Retail Price – $359.95

Model 1-630 (Mobile)
New Vol-U-Matic Microphone

New dual volume controls. New MOS F.E.T. RF stage. New, larger S-RF meter. All on this great new mobile unit. Plus continuous variable control. Greater clarity. Noise blanker. P.A. Advanced, solid-state circuitry. Choice of upper or lower sideband plus AM. Dual dectectors. **All the extras you'd expect to pay much more for. Don't buy a CB transceiver till you see Royce!**

Model 1-631 (Mobile)
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Same basic mobile transceiver as 1-630. With a big plus – New – built-in combination 117-volt AC and 12-volt DC power supplies – allows unit to be used as a mobile or base.

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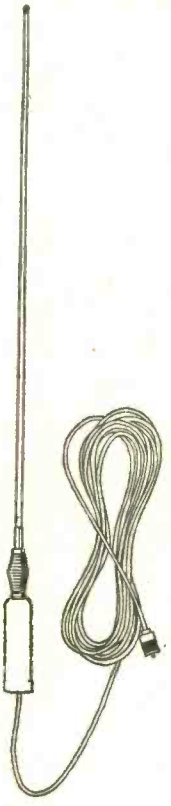
CIRCLE NO. 23 ON PAGE 17 OR 103

HEY, LOOK ME OVER

stretch and wear; an exclusive quick-release handle that disconnects instantly and re-engages easily; and a built-in light that stays on throughout operation. A dual safety adjustment allows the force applied to the door to be adjusted separately for both up and down travel and incorporates a program relay that stops the door and reverses it to full open upon contacting any obstruction. The drive system, proven through years of daily use throughout the U.S., operates both single and double size residential doors up to seven feet high. The new Genie GS-201 package includes completely transistorized AC-30 VHF radio controls that comply with all FCC requirements. The AR-30 radio receiver operates on 24 VAC supplied by the door opener. The AT-35A transmitter which uses a low-cost 9-volt battery, comes in its own case suitable for pocket, purse, and mounting inside the car. Complete details of Alliance's new Genie Model GS-201 (priced at $148.95) automatic garage door opener system and associated radio controls are available from Dept. MJ, The Alliance Manufacturing Company, Inc., Alliance, Ohio, 44601.

Good White Knight

The White Knight is a brand new base-loaded spring mounted fiberglass CB whip from Shakespeare, with full power handling capability. Adjustable tip with set screw enables CB-ers to lock-in lowest SWR reading. Helical wound coil is permanently sealed against environment to ensure constant impedance and distributed capacitance. Available in roof top and trunk mount styles. Price: $29.95. For more facts on the White Knight and other CB antennas, write to Shakespeare Company, Dept. PR, P.O. Box 5806, Columbia, SC 29250.

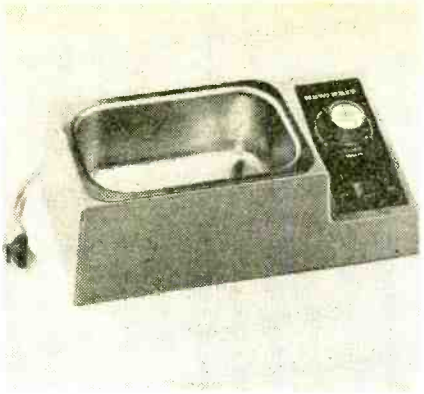


Circle No. **36**
on Reader Service Page 17 and 103

Ultrasonic Cleaner

A kit-form ultrasonic cleaner by Heath uses sound waves to remove dirt from paint brushes, most jewelry, watches, glasses, dentures, etc. To use the GD-1150 Ultrasonic Cleaner, the objects to be cleaned are placed in the

HEY, LOOK ME OVER

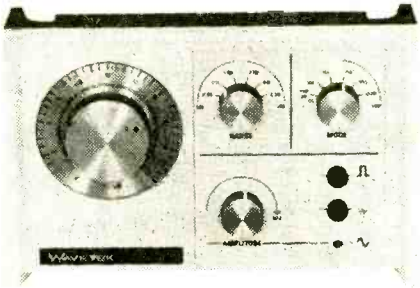


Circle No. 1 on Reader Service Page 17 or 103

stainless steel tank, along with a liquid detergent or solvent. The automatic timer is then set for a cleaning cycle of from 1 to 5 minutes, and the power switch is placed in the on position. When the cycle is completed the unit automatically shuts off. The unit works by producing 41-kHz sound waves that pass through the cleaning solution. This inaudible signal causes a vibrating action in the tank resulting in millions of microscopic bubbles that expand and contract in a process called cavitation. The result is an amazingly effective microscopic non-abrasive scrubbing action. Priced at a low $54.95, mail order, the GD-1150 Ultrasonic Cleaner can be assembled easily in two free evenings. For more information, write Heath Company, Benton Harbor, MI 49022. Tell Heath that ELEMENTARY ELECTRONICS sent you.

Hand-Size Audio Gen

Designed for audio service work, the Model 30 Miniature Audio Sweep/Function Generator is a hand-size, impact-resistant generator that weighs less than 1½ pounds, and with its battery power supply can be operated anywhere with complete line isolation. The Model 30 features 2 Hz to 200 kHz simultaneous sine, square, and triangle waveforms plus sweep. Automatic sweep mode



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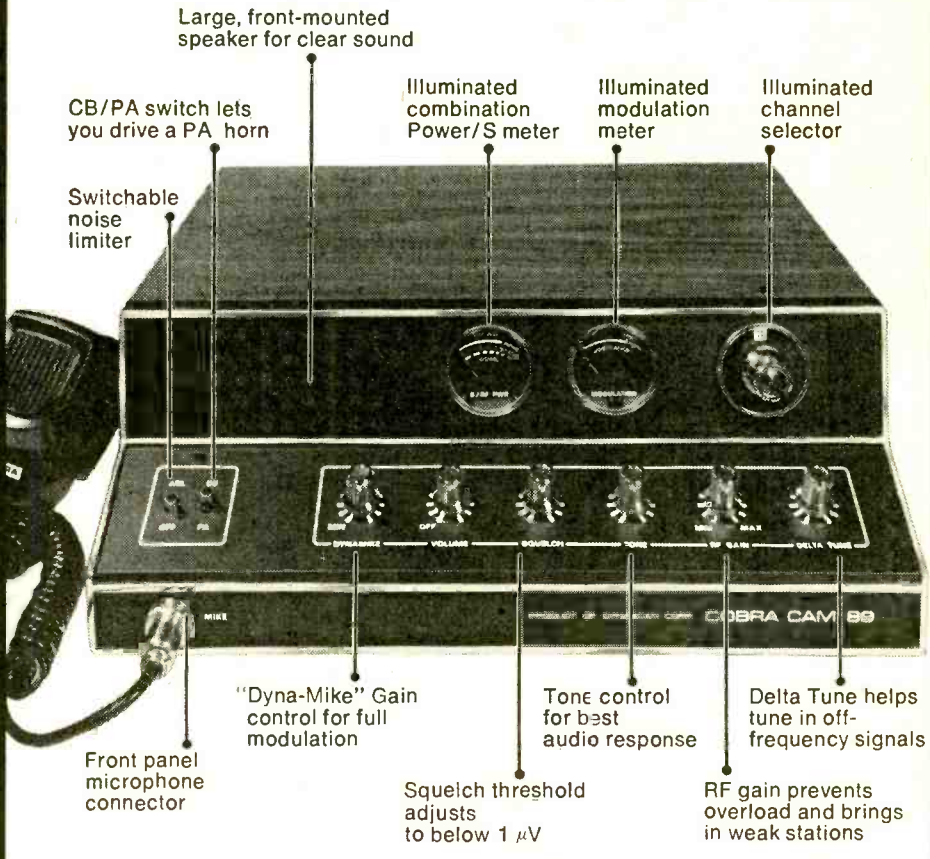
Talkpower you can see and adjust



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COBRA CAM 89

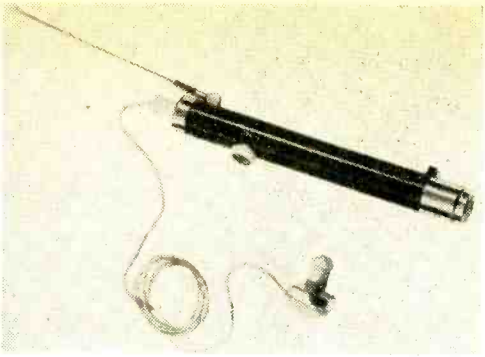
PRODUCT OF DYNASCAN CORPORATION • 1801 W. Belle Plaine • Chicago, Ill. 60613

CIRCLE NO. **16** ON PAGE **17** OR **103**

gives a frequency change of 1000:1, either logarithmically or linearly. Full voltage control of the generator requires only 0 to 1 volt, either DC for programming discrete frequencies or AC for FM operation. The sine wave output is variable up to 1 volt rms. A recharger is available, and can be used for unlimited line operation. Price: $149.95. For further information, write to Wavetek, P.O. Box 651, San Diego, CA 92112. Tell 'em you saw it in ELEMENTARY ELECTRONICS.

Snoop on Jet Pilots

There is no greater thrill than to eavesdrop on the conversations between a jet pilot and an air traffic controller. And this is easily accomplished with a remarkable solid state pocket size receiver that picks up, with amazing clarity, tower transmissions within a five-mile radius and aircraft up to 25 miles away (anywhere in the 110-140 MHz aircraft band). Saxton's Sky Spy receiver is no toy. It's a highly engineered miniature radio/receiver that is used professionally by flying schools, ground crews, and pilots as a portable emergency receiver. The Sky Spy VHF aircraft receiver is battery powered, no larger than a marking pencil, weighs a mere 1½ ounces, and is packaged in a clear plastic



Circle No. **39** on Reader Service Page 17 and 103

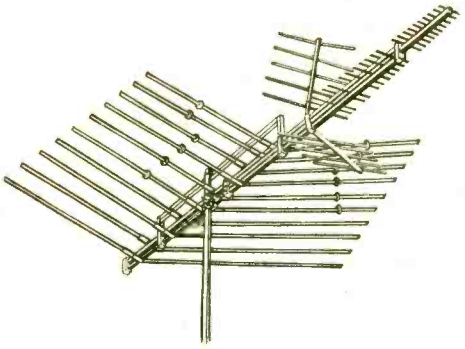
container. Supplied complete with batteries, pre-tuned telescopic antenna, and high quality magnetic earphone. FCC approved. This Saxton unit (Model A-982), retails for $20.95. Get info on Sky Spy and other products direct from Saxton Products, Inc., 215 North Route 303, Congers, NY 10920.

Fringe Fixer

JFD has begun production of a new series of VHF/UHF/FM antennas known as the LPV-UC Color Best, combining the JFD patented log periodic design with a new ultra-sensitive corner reflector and UHF driver for sharply detailed reception in color or black and white

HEY, LOOK ME OVER

on all channels. Capacitor-coupled dipoles provide synergistic response for crisper picture detail, richer color on all (not just some) of the VHF channels. An electronically integrated high gain corner reflector captures more signal, provides higher front-to-back and front-to-side signal ratios for clearer, stronger reception on channels 14 to 83. A staggered multi-element phased driver minimizes ghosts and snow on VHF and UHF bands. Super-

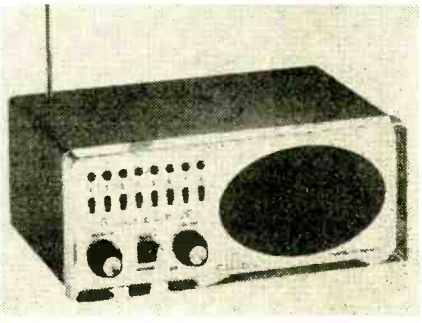


rugged triple square crossarm construction maintains solid rigidity, improves signal transfer. The use of lustrous gold colored anodized aluminum protects and beautifies the antenna. An all-band VHF/UHF/FM splitter is included with each of the seven area-engineered Color Best models: model LPV-UC180 (far fringe), LPV-UC150 (fringe), LPV-UC120 (near fringe), LPV-UC90 (suburban-fringe), LPV-UC60 (suburban), LPV-UC40 (local suburban), LPV-UC30 (local). Descriptive literature and prices are available on request to JFD Electronics Corp., 1462 62nd Street, Brooklyn, NY 11219.

New VHF Bander

The Bearcat IV may well be the first receiver to cover the full 470 MHz to 512 MHz band, in addition to the 30-50 MHz, 146-174 MHz, and 450-470 MHz bands. This unique

(Continued on page 22)



Circle No. 30 on Reader Service Page 17 or 103

ELEMENTARY ELECTRONICS

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• The Editor of ELEMENTARY ELECTRONICS offers readers an easy way to get additional information about products and services advertised in this issue. 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 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! Coupon torn out? Then turn to page 103 for more!

NOV./DEC. 1974

Void after APRIL 17, 1975

ELEMENTARY ELECTRONICS
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New York, N.Y. 10023

1	2	3	4	5	6	7	8
9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24
25	26	27	28	29	30	31	32
33	34	35	36	37	38	39	40
41	42	43					

Please send literature for the numbers I have circled. I understand this is a free service. Allow 6-8 weeks for delivery.

We would like to know something about you. Please help us by placing an "X" in the appropriate boxes. Do you own a Class D CB transceiver? 44 ☐ Yes 45 ☐ No If your answer is Yes, please check appropriate boxes below if you have one or more of the types indicated. 46 ☐ Base Station 47 ☐ Mobile Unit 48 ☐ Portable Do you use CB in your work? 49 ☐ Yes 50 ☐ No

51 ☐ Enter my subscription for 9 issues at $3.97 and bill me.

Name (print clearly) _____

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Compare what you get training and you'll

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Only NRI offers complete TV/Audio Servicing Courses from $312 to $955 . . . with terms as low as $10 down and $22 monthly. In the Master Course in color TV servicing, with a 25" diagonal solid state color TV, you save $800 or more over other comparable courses. And NRI provides you with a handsome TV cabinet and other equipment at no extra charge.

NRI saves you money because our costs are lower. We pay no salesmen, and we design our own kits and equipment. We don't buy "hobby kits" from others. Nor do we penalize you with big interest charges for time payments. We pass the savings on to you.

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NRI is one of the few home study schools that maintains its own full-time staff of technical writers, editors, illustrators, development engineers and publications experts. The people who design the kits also design the lessons . . . so that theory and practice go hand in hand. The lessons aren't "retro-fitted" to an outside-source "hobby kit". The NRI set is designed exclusively for training. The fact that it is also a superb receiver for your personal use is an added plus.

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Most schools offer one course in color TV servicing, period. Only NRI offers you five different courses to match your needs and budget. The 65-lesson basic course, complete with 7 kits, costs as little as $312. Or you can step up to a $425 course that includes a 12" diagonal black & white portable TV for hands-on experience. Then there's the 19" diagonal solid-state color TV course for $695; the advanced color TV course for trained technicians with the same 19" TV for $535; and finally, the magnificent 25" diagonal solid-state color TV course, complete with console cabinet, oscilloscope, TV pattern generator, and digital multimeter, for $995. Other schools charge you up to $800 more for an equivalent course.

in TV/Audio home choose NRI.

Compare equipment

NRI has engineered the widest variety of professional electronic lab equipment ever designed entirely for training at home. When you enroll in the master course in TV/Audio Servicing, for instance, you receive kits to build a wide band, solid-state, triggered sweep, service type 5" Oscilloscope; color pattern generator; solid-state radio; and a digital multimeter.

Before you settle on any home training course, compare the over-all program. See if you are getting kits engineered for experimentation and training . . . or merely "hobby kits". Count the experiments . . . compare the components. Don't just count kits. (Some schools even call a slide rule a kit.)

Compare schools

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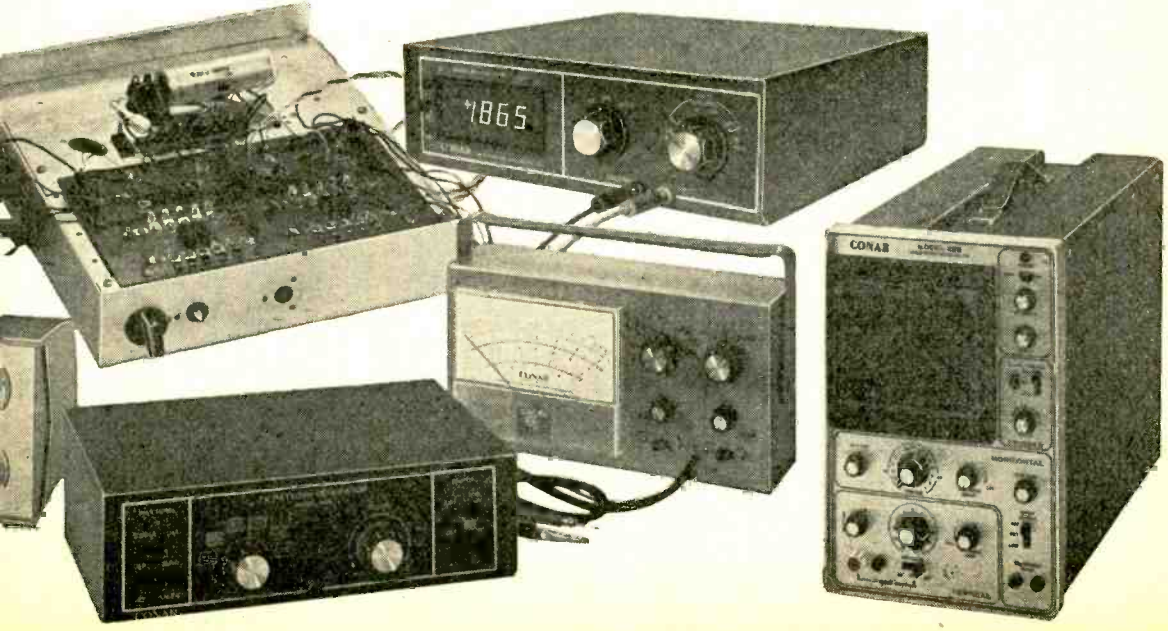


HEY, LOOK ME OVER

(Continued from page 16)

development allows users to monitor the new frequencies recently authorized by the FCC and currently being used by many metropolitan police departments. The Bearcat IV, a product of the Electra Corporation, will offer its own features as well as the features of its forerunner, the Bearcat III, which will continue to be the mainstay of the Bearcat line. The Bearcat IV is now available at $179.95 less crystals. Additional information can be obtained from the Electra Company, 300 E. County Line Road, Cumberland, IN 46229.

Two For The Money

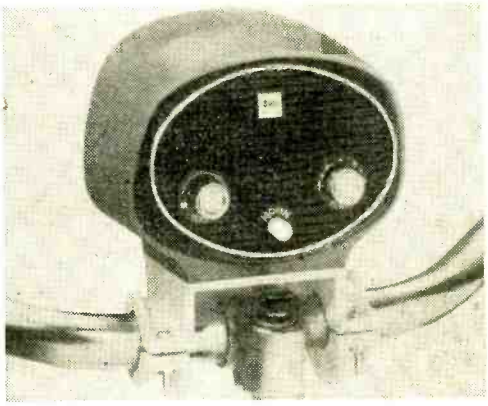
Shakespeare's Thundertwins (Style 4038) offer CBers a bumper mounted co-phased whip combo with 3-section assembly. The fiberglass antennas are end-fed, half-wave and center-loaded. Exclusive Shakespeare Diplexer harness makes 76-in. antenna act like it's 18 feet tall. Complete with dual mounts and harness—$74.50. For all the facts, write to Shakespeare Company, Dept. PR, P.O. Box 5806, Columbia, SC 29250.

Circle No. **36** on Reader Service Page 17 or 103

AM Bike Radio

No need to miss the morning news while riding your bicycle to work now that Radio Shack has introduced their new Archer "Road Patrol" AM Bike Radio. The radio comes complete with a universal mounting bracket which attaches securely to the handlebars of any bike. A flip-lever on the mount-

(Continued on page 98)



Circle No. **4** on Reader Service Page 17 or 103

TROUBLE? TIME TO CALL ON SILTRONIX

When trouble is riding high on the wind, it's time to avert disaster. SILTRONIX suggests you can cool an emergency situation with advanced preparedness: install an SSB-23 CB transceiver and learn 10-Code signals!

Reliability starts with quality equipment. SILTRONIX' SSB-23 "Tiny T-N-T" includes the extra "talk-power" of single-sideband. SSB increases useful range, cuts through hash, limits channel clutter, effectively doubles channel availability, and above all, has greater reliability than AM units.

Assurance of quality in design and workmanship is upheld when you invest in CB equipment bearing the SILTRONIX label. Investigate our "Tiny T-N-T" . . . it's worth the $329.00 price tag!

In 1940 the Associated Public Safety Communications Officers, Inc. (APCO) adopted their, now universally accepted, Ten Signals. Ten Signals help achieve communications reliability and speed. For instance, a 10-73 call, followed by location data, is immediately recognized by the Forestry Service. In a matter of seconds, it tells them where to investigate a smoke report which may lead to protection of life and property.

WHEN TROUBLE'S IN THE WIND,
IT'S TIME TO CALL ON SILTRONIX!

As an aid to promoting the use of accepted APCO standards, SILTRONIX offers CB'ers a free copy of the revised official APCO Ten Signals. This handy pocket reference card is available from your SILTRONIX dealer. He also has those beautifully embroidered SILTRONIX SIDEBANDERS emblems for just $1.95 — wear one as your elite label of distinction among single-sideband CB operators. For convenience, you may send your name, address and $2 to SILTRONIX — you'll receive an emblem, CB equipment catalog and your free copy of the Ten-Code reference card.

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ENJOY SILTRONIX SIDEBANDERS RELIABILITY

Whatever your CB needs may be, place your confidence in authorized SILTRONIX dealers — they know the meaning of service.

CIRCLE NO. 11 ON PAGE 17 OR 103

X Me a Question

Where can I find a 1-MHz crystal for a frequency standard? I need a 1-MHz crystal (PR Type Z-9 HC6/U Holder or similar). I intend to use the standard to calibrate and find subfrequencies on my SW receiver.

—A.M., Malvern, PA

Write to International Crystal at 10 North Lee, Oklahoma City, OK 73102 and tell them what you need. That's their business!

Snap, Crackle, Pop and Hiss

I heard on TV how radios were made from oat-meal boxes. I didn't catch the whole thing on how to make them. That's the reason I am asking you how they did it.

—M.M., Wilmington, Del.

First, eat a lot of hot cereal for breakfast. Next, buy ELEMENTARY ELECTRONICS every issue because the editor promised to run an article on the subject. And save the box top, maybe Quaker Oats will offer a signet code decipher ring, or something.

Talented Finger

I have a Realistic DX-150B receiver, and when tuned to certain frequencies, you can tap on the outside of the receiver and hear the tapping through the speaker or phones. This only happens when an antenna is hooked up to it. What gives?

—G.T., Montoursville, PA

It was Vlasov Merezhkovsky, who in 1908 first discovered this phenomenon and postulated the cure—keep your hands in your pockets whenever you get the urge to do the Castle Walk with your pinky.

(Continued on page 98)

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
ELEMENTARY ELECTRONICS
229 Park Avenue South
New York, NY 10003

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Realistic SA-101 Stereo Amplifier. Inside the handsome walnut-grain wood case is an ITL/OTL amplifier with plenty of power for compact speakers. It's versatile too, with inputs for a magnetic or ceramic phono, tuner and tape. And there are separate volume, balance and tone controls, a speaker in/out switch, and a stereo headphone jack for private listening. U.L. listed. #31-1983.

Realistic TM-101 Stereo Tuner. Our lowest priced tuner, but it pulls in FM stereo and AM the way you like it. You'll hear more stations and less noise thanks to three-ganged FM tuning, ceramic filter, advanced multiplex IC and external FM antenna terminals. Other features include a slide-rule dial, stereo beacon and walnut-grain wood case. It's a perfect "system mate" for the SA-101. U.L. listed. There's only one place you can find it . . . Radio Shack! #31-1984.

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CIRCLE NO. 32 ON PAGE 17 OR 103

DX central reporting

A world of SWL info!

BY DON JENSEN

☐ At the "word factory" where I work, the resident wit at the next typewriter, who also happens to be a top DXer, was talking about selectivity in a communications receiver the other day. "When I bought my first quality receiver," he recalled, "a non-DXing member of my family asked, 'Will you be able to hear more stations with it?' 'Nope,' I replied, 'the same stations . . . but I'll be able to hear 'em one at a time.' "

And he was right on target. Even a simple, inexpensive receiver will bring in plenty of shortwave stations. But unless the radio can separate the jumble of a crowded SW band into individual listenable signals your DXing activities won't go very far.

That's selectivity, the ability of your receiver to separate signals from stations operating in the same range of frequencies, eliminate or decrease "spill-over" and heterodynes and allow you to "hear 'em one at a time."

Some radio historians trace the birth of SW DXing to the appearance of the first honest-to-goodness communications receivers 40 years ago. There were several important developments in receiver design in the Thirties. The superheterodyne radio is perhaps the most heralded of these; but it was, in fact, the incorporation of the crystal IF filter into receiver design that created the first true communications set. The crystal filter was an important step toward receiver selectivity. And the magazine ads of that era ballyhooed it as the "single signal" factor.

One of the first selective communications receivers was the AGSX, made by the National Radio Co. According to advertisements, the AGSX, which accompanied Adm. Richard E. Byrd to Little America on his second Antarctic expedition, was "fitted with a crystal filter circuit with an adjustment by which the degree of selectivity can be regulated." About the same time, Hammarlund offered the Comet Pro with a "quartz crystal filter" which provided a "single signal peak or elimination notch."

"Single signal" selectivity was still a key phrase seven years later at the outset of WW

Be amazed!

21.95

Add Realistic® 4-channel sound to any stereo system this low-cost, easy Radio Shack way

Quatravox® uncovers a new world of reflected sound hidden in stereo recordings. It's the "magic" that creates the atmosphere of a live show . . . but it goes unheard unless you add Quatravox QV-3 to your system. Try it and be amazed . . . experience all the music on records, tapes and FM! The QV-3 beats the competition with two synthesizer circuits, blend and rear-level controls, plus all hookup cables. Just add two speakers. And there's just one place you can find it—Radio Shack! #40-2011

Save 7.90—Complete Quatravox Add-On System

Reg. Separate Items Price 47.85

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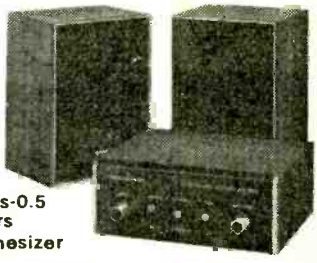
- **Two Realistic Minimus-0.5 Walnut Grain Speakers**
- **QV-3 4-Channel Synthesizer**



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CIRCLE NO. 32 ON PAGE 17 OR 103

DX Central Reporting

II, when National boasted of its NC200's "wide range crystal filter with selectivity in six steps from 200 to 7,600 cycles bandwidths."

Its contemporaries, the RME43, made by the well-known but now defunct Radio Manufacturing Engineers, Inc., of Peoria, Ill., and the Hallicrafters SX-24, featured crystal filter selectivity. The former, by the way, a top rig in its day, sold for $109 in 1941!

Receiver designers have found many ways of building in selectivity since the advent of the first simple crystal IF filters. But other things have changed greatly too over the years. While there may have been several hundred SW stations on the air in 1934, there are probably well over 5,000 SWBCers today. Transmitter powers are measured in kilo and even megawatts now and there is much greater competition for a limited number of available shortwave channels. All of this means more bedlam on the dial. With it becoming harder and harder to "hear 'em one at a time," selectivity is, more than ever, the name of the game in choosing a communications receiver.

Bandsweep. (Frequencies in kHz, times in GMT) **3290**—Not the most widely heard South American station by a long shot. *Action Radio,* at Georgetown, Guyana, can be heard if you're willing to lose some sleep. You may hear programs in English and Hindi, an East Indian language, around 0830 . . . **4850**—A fairly recent newcomer to the 60 meter band is *Radio Clarin* in Santo Domingo, Dominican Republic. It has been widely reported with solid signals in Spanish during evening hours . . . **4900**—*Radio CORDAC,* a missionary station in the African country of Burundi, recently has become a real DX target of many North American DXers since reception has been reported around 0500 on this side of the Atlantic . . . **5042**—A Peruvian station, *Radio Libertad de Junin* has been operating around this frequency in recent months and can be heard on occasions about 0600, with programs of Andean music. If you're familiar with the "sound" of Simon and Garfunkel's record, "El Condor Pasa" you'll quickly recognize Andean-type music . . . **6055**—Because of an abbreviated English schedule, Belgium is not among the first dozen European stations a DXer logs. But you should have no difficulty if you tune in at 0040 for the English commentary . . . **7170**—The newest of the *Voice of America* overseas relay stations is located at Kavala, Greece. Listen for English programming around 2330, with identification at 0100 . . . **9725**—The English language Merry-go-Round program is one of the most popular offerings of the *Swiss Broadcasting Corporation* at Berne. Tune for this at

(Continued on page 99)

When You Go Mobile... Fill'er up WITH PREMIUM at Radio Shack

Realistic® SSB/AM transceiver— the "talk power" you need **249.95**

The TRC-47 isn't gimmicked or souped-up just to be pretty. This husky brute is a powerful performer. 69-channel operation—23 AM, and when it's tough to get through, you've got 46 more on SSB. 12 watts PEP output—works where AM-only sets won't. With all crystals. Negative ground. #21-147.

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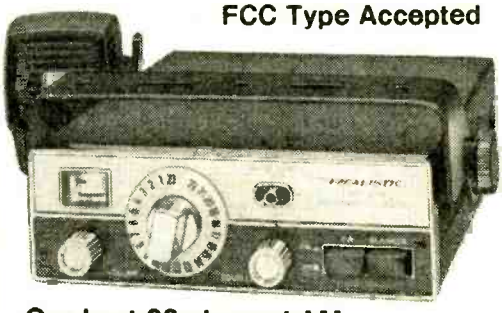

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Our best 23-channel AM transceiver—real "heavyweight"

The TRC-24B is a no-frills, no-nonsense rig that packs a mighty CB wallop. It's got full-power 4-watt output for long-range "sock" and a dual conversion receiver that rejects adjacent-channel interference in high-CB-usage areas. Rugged, compact, reliable. With all crystals. Negative ground. #21-145. **159.95**

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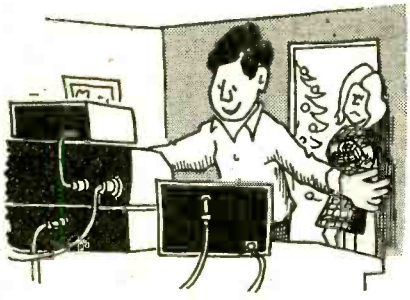
CIRCLE NO. 32 ON PAGE 17 OR 103

'TIS THE SEASON

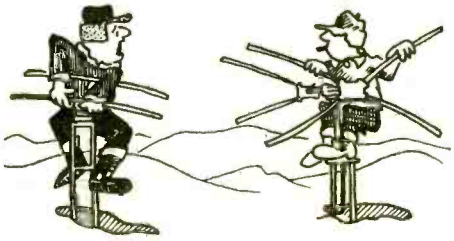
By Jack Schmidt

"Do you gift wrap?"

"The store had this marvelous sale on outdated tapes."



"My, my . . . look what Santa brought us!"



"This is our whitest Christmas since the blizzard of '69."

"Don't worry . . . I have the homing beacon on and a strobe light on the mast . . . he'll find you."

". . . the cabinet is on sale . . . the guts are extra."

elementary Electronics NOV/DEC 1974

WARNING!

DANGEROUS GAS PRESENT

BUILD OUR

MOBILE GAS ALARM

by C. R. Lewart

Now—our mobile gas alarm means safety on the road; it stands silently by—sniffing with an electronic nose for dangerous combustible gases. When just a small concentration accumulates around its solid-state nostrils . . . *WHAMMO!* The area is shattered. Not by a tragic explosion, but by a loud screaming alarm that keeps on sounding until *you* turn it off!

Best of all, this alarm can be conveniently powered by electrical systems found in cars, campers, trucks, travel trailers, motorhomes, houseboats, speedboats, electric-start outboard boats, airplanes, all-terrain vehicles, even your electric-start lawn mower—virtually everywhere 12 volt DC power is available.

(Turn Page)

e/e MOBILE GAS ALARM

Although we don't always like to think of it, there is a danger associated with de-oxidizing (combustible) gas such as pro-pane-fired camper stoves, gasoline fumes in the bilge of a boat, exhaust fumes released by everything from diesel trucks to lawn mowers. There's even the possibility of flame-out and gas leakage with a plumber's soldering torch.

All these situations and many more can mean danger if gas is allowed to accumulate in confined areas. Though the special semi-conductor gas sensor used in this project has been the basis for kits and construction

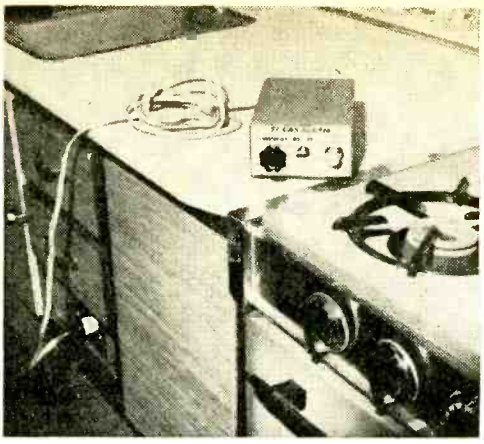
Author's model for portable use. A remote location for both the semiconductor "nose" and Sonalert alarm is an option to consider.

articles in magazines in the past, none, to our knowledge, made such efficient use of the power required to operate its sensor. OK. No problem when you're powered by your local electric company. It's when your power system is based on a storage battery that even ½-watt* becomes important.

But with this project e/e efficiently snips the AC power cord and moves the solid-state gas sensor anywhere 12-volt DC pow-er is available.

You can have this modern gas sensor for use away from power lines that draws hard-ly more than one tenth of an amp at 12 volts—an average power of 1.2 watts. We've used the handy 555-type timer to *power-pulse* the detector at the 12-volt level, so the *average* power is similar to that provided by 1.2 volts DC.

*With a series dropping resistor lowering 12 volts to the required 1.2, you can waste 9 times the power actually used by the gas detector element. This is pure power waste you can't afford when operating from battery power—even high power auto batteries. Multiply that power loss by the number of hours the unit is in operation (say, overnight) on a camping trip, and you come up with a hefty amount of wasted watt-hours.



Typical temporary installation in a pick-up camper. Recreational vehicles often have an electrical outlet supplying 12 volt power.

How Does It Work? Three basic parts of the circuit are a power-saving filament volt-age supply for the sensor, the gas sensor device itself, and the alarm tripping circuit. Let us look at them one at a time.

• The power supply for the gas sensor consists of pulse-generating integrated cir-cuit IC1 and a PNP power transistor Q1. The integrated circuit sends periodic pulses which turn the power transistor on and off and thus gate the battery power. This ap-proach saves approximately 80 percent of the battery power as compared to the con-ventional voltage dropping resistor or power transistor with heat sink methods. Zener diode D1 assures a constant filament supply for the sensor independent of changes in the battery voltage.

• The gas sensor element (Fig. 1) is com-posed of bulk semiconductor material

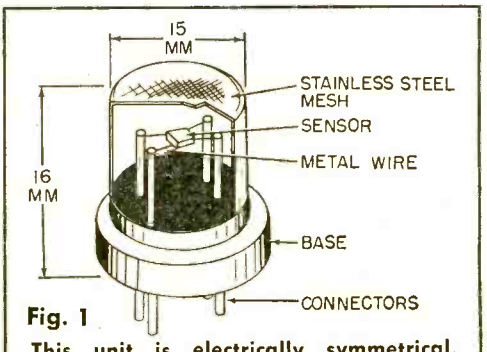
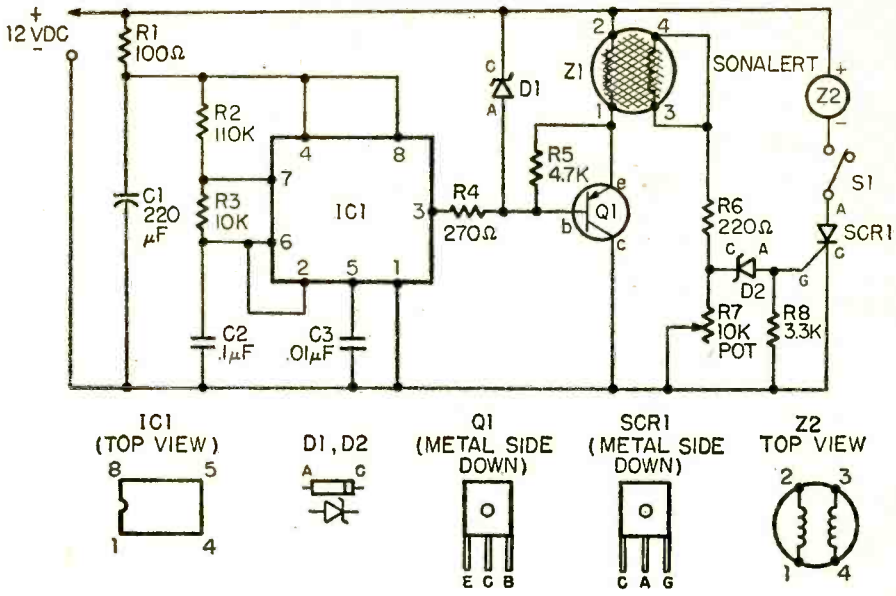


Fig. 1

This unit is electrically symmetrical. Either element can serve as the input or the output of this rugged detector.

(mainly tin oxide) heated by a thin filament coil. The semiconductor material lowers its resistance when exposed to a variety of deoxidizing gases. The sensor reacts to hydrogen, carbon monoxide, propane, and organic solvent vapors in the alcohol, ketone, and benzol families. For example, the sensor can easily detect concentrations of only 100 ppm of carbon monoxide. The sensor restores itself to high resistance a few minutes after the gas source has been removed, and it has a life span of several years.

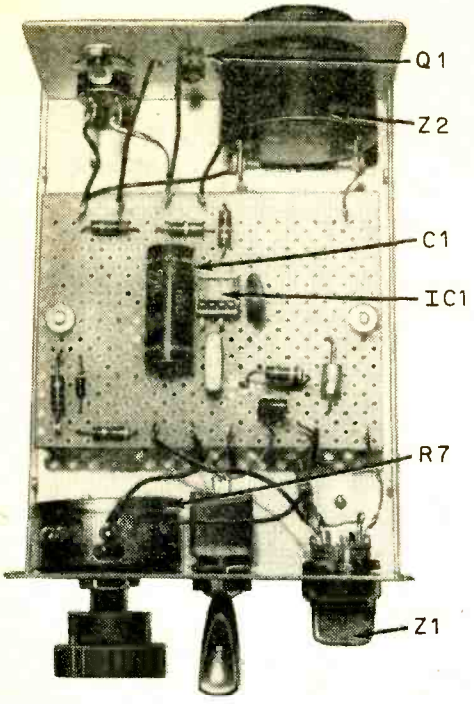
• The alarm tripping circuit turns the buzzer on when the sensor resistance decreases so that the voltage at the gate of the SCR exceeds a value preset by R7, the sensitivity adjustment potentiometer. Once the SCR is triggered, the buzzer starts to operate. Then, switch S1 must be used to reset the SCR to stop the buzzer. Zener diode D2 prevents the circuit from sounding

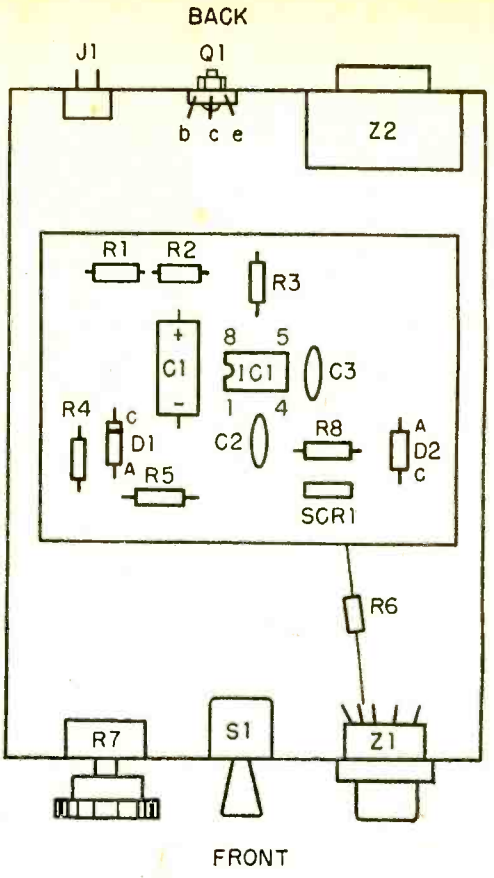


PARTS LIST FOR GAS ALARM

C1—220 uF electrolytic capacitor, 35 to 50 VDC (Radio Shack 272-1017 or equiv.)
C2—0.1 uF capacitor, 25 VDC or better (Radio Shack 272-1069 or equiv.)
C3—0.01 uF capacitor, 25 VDC or better (Radio Shack 272-1065 or equiv.)
D1—Zener diode, 9-volt, ½-watt (Radio Shack 276-622 or equiv.)
D2—Zener diode, 4-volt, ½-watt (Radio Shack 276-620 or equiv.)
IC1—Integrated circuit, 555-type timer (Radio Shack 276-1723 or equiv.)
Q1—Transistor, HEP-700 or Radio Shack 276-2026
R1—100-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
R2—110,000-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
R3—10,000-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
R4—270-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
R5—4700-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
R6—220-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
R7—10,000-ohm potentiometer, linear taper (*SENSITIVITY*) (Radio Shack 271-1715 or equiv.)
R8—3300-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
S1—Switch, spst, any style pushbutton or toggle you select (*ALARM RESET*) (authar used Radio Shack 275-651)
SCR1—Silican controlled rectifier, Radio Shack 276-1079, or General Electric C106.
Z1—Semiconductar gas detector madel 105 (Available from Sauthwest Technical Praducts Ca., 219 West Rhapsody, San Antonia, TX 78216 for $6.25 pastpaid)
Z2—Sanalert madel SC628 or equiv.
Misc.—Wire, solder, perf baard, push-in clips, cabinet apprax. 3-in. high by 4-in. wide by 6-in. deep (Radia Shack 270-252 shawn), IC socket, knab, 7-pin miniature tube socket far Z1 (Radio Shack 274-1511 ar equiv.), polarized socket far 12-volt input power (Calectro F3-170 shawn), automative-type cigar lighter accessary plug and cord for 12-valt input power (Radio Shack 270-021 or equiv.) etc.

e/e MOBILE GAS ALARM





You can follow this layout exactly making point-to-point wiring connections underneath the perf board and to push-in clips. Take extra care to insure that correct polarity is applied.

an alarm if a transient appears on the 12-volt power supply line.

Operation. The gas sensor element has a fair amount of thermal inertia as shown in Fig. 2. Therefore, after connecting the instrument to a 12-volt car or boat battery, wait for four to five minutes with S1 in *off* position and R7 at minimum (counter-clockwise) resistance. After the time has elapsed, turn S1 on and start turning the sensitivity adjustment slowly clockwise. When the alarm sounds, switch S1 off, turn R7 slightly back, then switch S1 on again. To obtain maximum sensitivity you can repeat the sensitivity adjustment after a half hour.

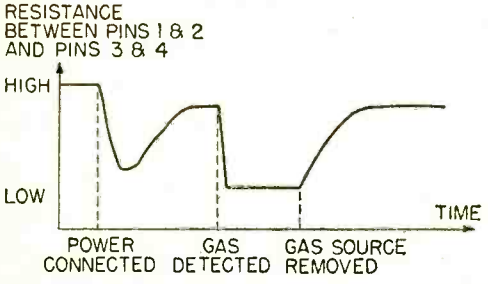


Figure 2 shows why you must warm up the heater element for a few minutes before making a sensitivity adjustment final.

When the buzzer sounds, the only way to turn it off is with S1 (not with the sensitivity adjustment). Check the circuit by rubbing a drop of gasoline or alcohol on your fingers near the sensor. The alarm should then sound. It then takes the sensor four to five minutes to restore itself to the same sensitivity.

Construction. The project is straightforward. Follow the layout shown. All the components fit on a 3- by 4-in. perf board. A 6- by 3- by 2-in. cabinet will house the entire project. Mounting the gas sensor is

(Continued on page 102)

THE ELECTRIC BIKE IS COMING

by Janus Kodrum

□ Never mind the high price of gasoline, fight inflation and still maintain your individuality by electrifying your bicycle. That's what Joachim Egenolf of Munich, Germany did, and you can do it, too!

Not shy of putting in a little effort and time, Joachim took the electric DC motor out of his grassmower and installed over the frontwheel of his bicycle together with a little shaft which presses onto the wheel's rubber tire. He then took the 12-volt battery out of his Volkswagen and placed it on rearcarrier of his bike, securing it with strong elastic bands, and connected motor with battery through an on/off switch. "That's all", he said. "It works perfectly. If you do not own an electrical grassmower, buy a second-hand unit or a factory replacement type. In fact, visit your local auto junky and pickup a spare battery. You may be able to use motors from junked automotive heater units.

Joachim's concoction can reach about 19 miles per hour and if one uses nothing else but the battery, it will go for about one hour. But you do not need to rely only on the battery. At times pedalling isn't a bad exercise, and so you can extend your maximum travel radius.

Mr. Egenolf sees a future in this idea for himself and for every experimenter who feels the pinch of high gasoline prices. The Editor's believe that many of their readers will rig up similar electric bikes in a few hours of toil and enjoy local weekend travel at practically no expense. Your car can recharge the battery during the weeks normal driving. See your neighborhood the unpolluted way. ■

A spring-loaded device holds the DC motor's shaft against the rubber tire offering front wheel drive like the Eldorado.

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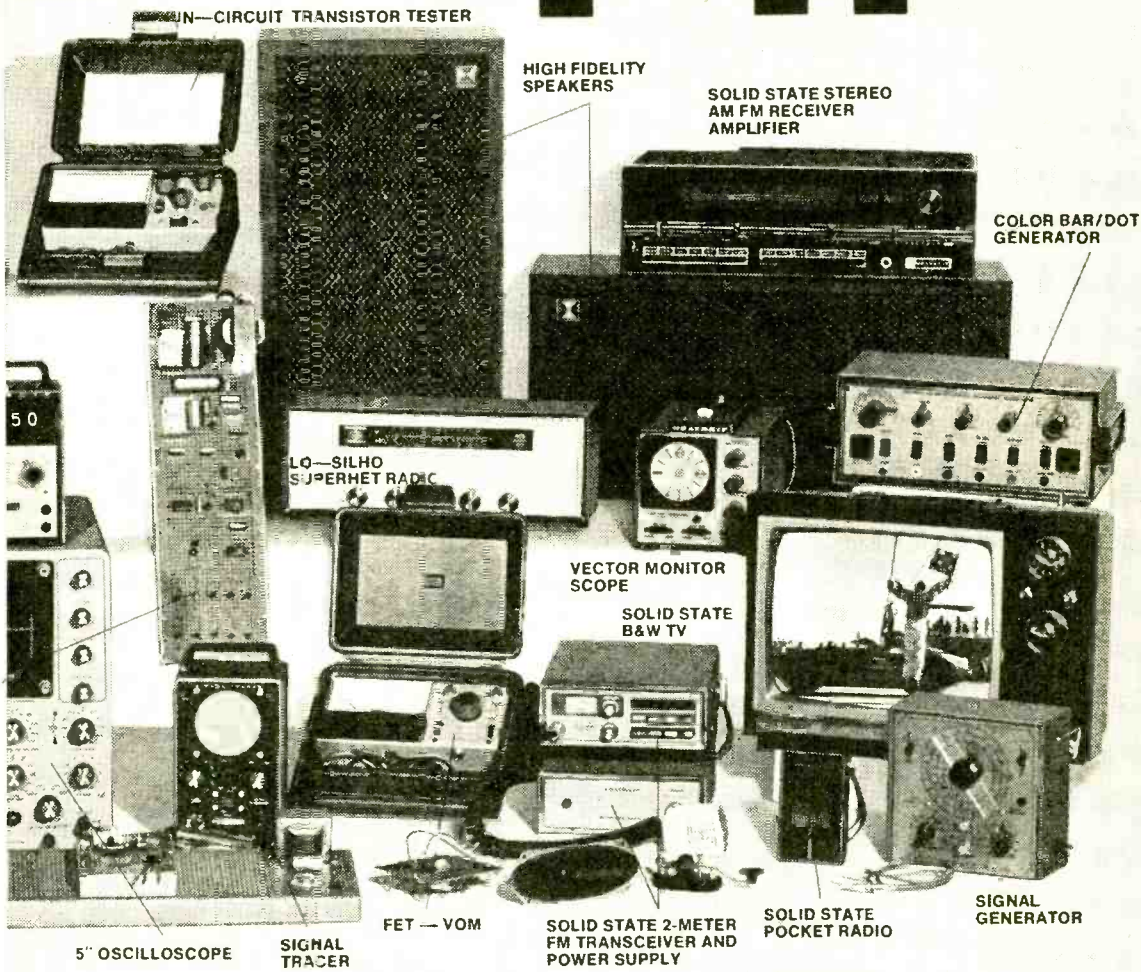

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CIRCLE NO. 21 ON PAGE 17 OR 103

pick and choose your pocket calculator

Four-function pocket calculator from Heath builds from a kit, makes self-service simple. Eight digit IC-2009 costs $89.95.

Panasonic unit includes an entry counter to keep track of total number of invoices. Model JE-2001 price: approx. $99.95.

The recent proliferation of prices, brand names, and models of pocket calculators can make the buyer's choice a difficult one. Calculators which are superficially similar may be quite different in terms of their capability and convenience.

In order for us not to mix our apples and oranges, we decided to consider only under $100 calculators, and we will consider only features likely to be found in this price range. In weighing various available options, we look at them from the point of view of an electronics hobbyist and a high school or a college non-engineering student. For engineering students and engineers, we would rather recommend calculators in higher price brackets featuring scientific notation and transcendental functions. You may, of course, modify our weighting scheme if you feel strongly about

1 Does the calculator come with a guarantee of 90 days or more, and can it be serviced thereafter? **(A)**
2 Is the display clearly visible? **(A)**
3 Is there an 8-digit display? It is a must for everything but the simplest operations. **(A)**
4 Does the start of a new computation, after an = sign is depressed, clear the machine? **(A)**
5 Can you clear the last entry without destroying the sub-total or a previous multiplicand or dividend? **(A)**
6 Is there a floating decimal? A fixed decimal is only good for $ and ¢ computations. For everything else the floating decimal is more convenient. **(B)**
7 Is there a memory register? Full memory register with CM, RM, M+ and M− keys is one of the most important features in an under $100 calculator. If fewer than 4 keys are available for memory functions give it C (if negative numbers cannot be stored in memory, lower to D). **(B)**
8 Can you use the algebraic mode of entry for subtraction? The algebraic mode for subtraction (5−3=) is more natural than the "adding machine" mode (5+3−=) for performing a subtraction. **(B)**
9 Is the calculator equipped with Nicad rechargeable batteries? Can the batteries be recharged without removing them from the calculator? Can the calculator be operated while it is being recharged? For all three, get a **(B)**
10 Is there a constant function? Check the operation (automatic or settable with a switch); does it operate on all 4 functions? Depress 5+3==; it should equal eleven with a "4-function" constant. **(B)**
11 Must an insignificant zero be entered? If the number you enter is (for example) 12, make sure that pushing keys 1 and 2 is the only action required (not 12.00 or 1200). **(C)**
12 Are insignificant zeros truncated? Check for leading and trailing zeros; 5÷4 should result in 1.25 right adjusted (not 1.2500000). **(C)**

with our buyer's point chart

by C. R. Lewart

Bowmar 10-digit calculator includes four extra functions including square root and exchange. Model MX90 price is $89.95.

Radio Shack unit has a separate constant register in addition to a regular memory. Model EC-350 sells for $69.95.

a particular feature.

Put letter **A, B, C,** or **D** with each feature: Letters A means do not buy without it, B says it is an important feature, C means less important but still a nice thing to have, and D means a convenience selection which is certainly up to you. Of course, you may change the weight of any rating.

Size Up Your Choice. Go through the list; if a feature is available, circle the appropriate letter A, B, C or D. To obtain a "box score" for a given calculator, multiply the number of As by 10, the number of Bs by 6, the number of Cs by 3, the number of Ds by 1 and obtain a total (you can use a borrowed calculator to perform this operation).

Here then are the leading features you should look for in the order of *decreasing* importance:

13 Are easily available batteries used in a non-rechargeable calculator (pen-light or 9-volt transistor radio types)? **(C)**

14 Can the calculator be operated for at least 3-hours between battery changes or recharging? **(C)**

15 How is the feel of the keyboard? The keys should exhibit a "typewriter" feel where a slight resistance to the touch must be overcome before the key is activated. This helps prevent a false entry. **(C)**

16 Does the constant option provide squares and reciprocals? In the constant mode, 4X== should give 16; 4÷== should give .25 as the answer (if separate X^2 and 1/X keys are provided, also give the same rating). **(D)**

17 Is a meaningful answer available even if the calculator overflows? Check that when the result overflows you retain the most significant digits and that the decimal point appears eight places from where it *should* be if more digits were available (11111X11111 should display 1.2345432 and the overflow indication on an 8-digit calculator). **(D)**

18 Is there a square root key? It is useful for many technical computations. **(D)**

19 How about an exchange key? An EX key exchanging the multiplier with the multiplicand or the divisor with the dividend, or frequently, the memory register with the current display is quite useful to check the last entry. **(D)**

20 Is there a percent key? The % function is a nice feature, but make sure that it is easy to operate (120+5%= should give 126). **(D)**

21 Is there a power saver feature? A LED display should go out after 20 to 50 seconds to conserve battery power, a special key usually restores the display. **(D)**

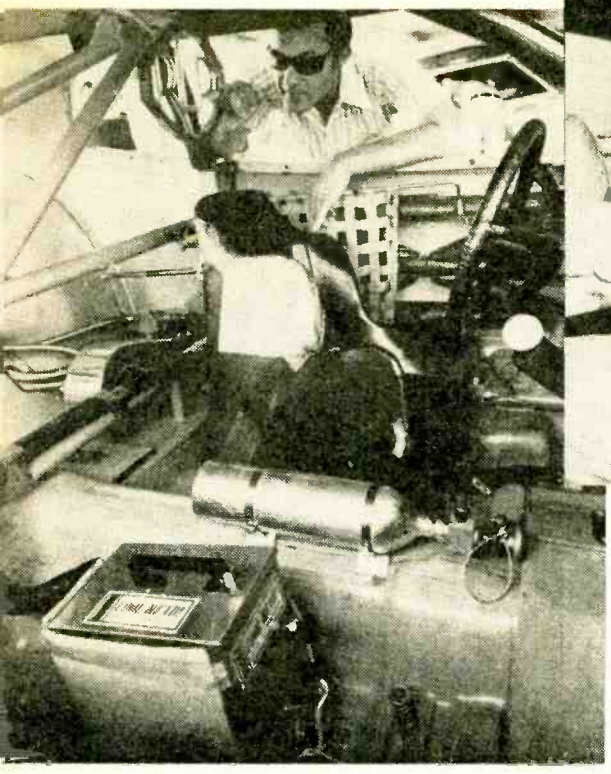
22 Does the calculator clear automatically when turned on? **(D)**

23 Is there a "floating" minus (−3.5, not − 3.5 or 3.5−)? **(D)**

24 Is there a change-sign key? It is of some usefulness; especially if your checking account starts with a negative balance! **(D)**

25 Is there a "get ready" feature? The 5 key should have a small "bump" in the center to help index the hand to the key board. **(D)**

Racing driver Richard Petty undergoes tests while wearing his Cool-Head helmet (right). The square box right of the driver seat (below) contains the ice canister where heat removed from the drivers head is dissipated.



Cool Head for Hot Races

By Joe Gronk

☐ Calm nerves and a cool head are the makings of a champion in any field. For racing drivers this is only too true and now to keep his head cool the racer can fit his helmet with its own electronically controlled cooling jacket.

Racing driver Richard Petty believes he owes his success over the last two seasons to the fact that he "kept a cool head while others didn't!" Petty is talking about races in which his racing helmet was fitted with a special liner which kept his head at a controlled cool temperature. At the 1973 and 1974 Daytona Beach 500, the temperatures inside the cars was reading 105° F yet Petty didn't perspire and he raced home first.

The Cool-Head system was NASA developed for use by helicopter pilots. The system was so successful that it was decided to adapt the system for use by racing drivers. During a test heat run inside an environmental chamber, Petty wore his normal driving suit while being subjected to simulated race temperature and humidity. At 120° F with 70% humidity Petty didn't perspire and felt calm and collected. The results of the automated tests showed that the use of the Cool-Head system cut the drivers' normal race weight loss by two-thirds, the body temperature rise was cut in half and visible perspiration virtually vanished. All these factors help reduce driver's fatigue and improve driver's comfort, which produces all round greater safety—and the checker flag, too!

The secret of Cool-Head, marketed by Aerotherm, Acurex Corporation of Mountain View, California, is the Flexitherm patches—flexible heat exchangers which provide up to ten times the heat transfer of previous methods used for personal cooling. These patches form the liner which goes inside the racing helmet. The patches are so thin, the same size racing helmet can be worn.

A water/propylene glycol mixture is circulated through the patches in the helmet by a small pump. This working fluid is passed through another Flexitherm patch which is wrapped around an ice canister. Thermisters sense heat levels and provide control for temperature. Cool-Head is being investigated by doctors for treating high fevers, migrane headaches and use in cancer chemotherapy. Keeping cool can save lives, too! ■

by Kathi Martin KAI0614

KATHI'S CB CAROUSEL

☐ With the average working gal and guy being squeezed from all sides just to put a meal on the table, there's little left over for anything else. It's no wonder, then, the past few months has brought a lot of mail asking about CB gear which can do double-duty. Maybe Joe Average just doesn't have the loot anymore to spend on every CB gadget that comes down the pike.

The best place you can look to save-a-buck with double-duty equipment is the main CB rig itself. If you're a newcomer to CB and ready to spring for your first rig, ask yourself if you have, or will have need for a walkie-talkie. If the answer is yes, you can save a bundle by getting a walkie-talkie that can also serve as a base or mobile, such as the Fanon T1000.

Here's Why. The high power walkie-talkies are basically full-5 high performance transceivers shoehorned into a hand-held case. Some models are even available with full 23-channel coverage, as is the T1000. Though walkie-talkies are generally designed to be powered by alkaline batteries, rechargeable Nicads and a line-powered supply are also available, as is an automobile power cord (for the cigarette lighter).

Most medium and high power walkie-talkies are equipped with an antenna output jack; a small adaptor such as shown in the photographs allows easy connection to a standard base or mobile antenna. Plug the antenna into the high power walkie-talkie and you've got a battery powered base or mobile station. Plug in a line-powered supply and you've got a mini-packaged base station; or plug in the auto power cord and you've got a full feature mobile. In short, one rig and a simple antenna converter plug makes a base or mobile station; the same rig and the optional line-powered supply, or auto cord, gives a double-duty installation.

Zoom In. A closer look at the Fanon T1000 will show you just what you can expect. First, the T1000 is slightly different from the usual walkie-talkie in that it doesn't use a speaker that doubles as a microphone. Both a speaker and a separate mike are mounted in the side of the case, much like a standard telephone. To use the rig you hold it just as you would a phone, talking directly into the mike while the speaker pours the received signal right into your ear—a handy arrangement when you're working from a noisy location.

Secret of saving green stamps is a multi-purpose unit like this high-power twenty-three channel walkie-talkie. Antenna adaptor "interfaces" between walkie-T and standard PL-259 antenna connector.

The Fanon T1000 high power walkie-talkie is from the Fanon/Courier Corporation, 990 South Fair Oaks Avenue, Pasadena, CA 91105. List price is $174.95. Circle No. 42 on the Reader Service page for more information.

Looking at the front of the rig, working down from the top, there's a combination *battery condition/S/RF* meter, a *meter selector* switch, a *battery saver* switch, side by side linear *squelch* and *volume* controls, a *channel selector* which provides all 23 channels and a *PA* position, a *delta tuning* switch and the *on-off* switch. (The battery saver switch reduces the power output of the transmitter by about one-half for medium and short range work.)

On the rear of the walkie-talkie you'll find a strip with four jacks; each jack has an individual plug which keeps out dust and dirt when not in use. The plugs are secured to the case, so you can't lose them when you take them out. The jacks provide for an external microphone, external speaker (PA), earphone, and external antenna. On the bottom of the transceiver is the external power jack.

The battery pack is external to the transceiver itself and mounts to the side of the transceiver, or it can be worn on the belt with a supplied power cord connecting the battery pack to the transceiver. The battery pack takes 12 Nicads or 10 alkaline batteries; two dummy batteries are provided for "fillers" when operating with alkalines.

The receiver section is double conversion with an overload-immune FET RF-amplifier front-end. A ceramic filter is provided in the IF amplifier for extra selectivity. There is a half-wave noise limiter and squelch.

The transmitter is more or less conventional, with the output feeding an internal loading coil and then the telescopic whip antenna. The loading coil is also used for receiving; both the antenna and loading coil are automatically disconnected when the antenna connector is plugged in.

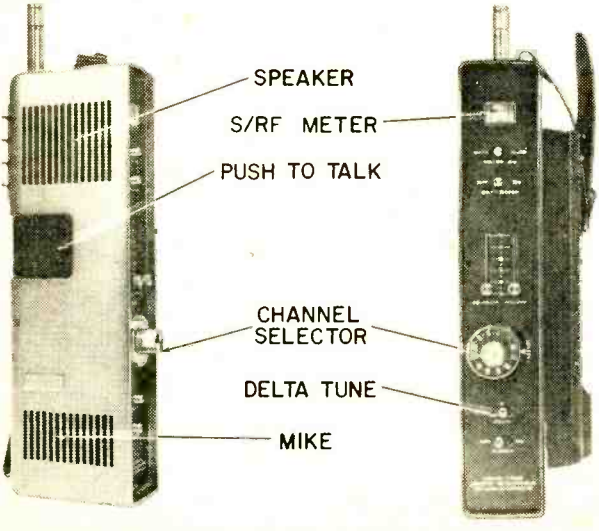
Performance. The T1000's performance, as you'll see, is just about the same as any decent base station transceiver. Using the T1000 as a base station, with the antenna connector adaptor, the sensitivity measured 0.8 μV for 10 dB S+N/N (signal plus noise to noise ratio). Adjacent channel selectivity was 46 dB. Image rejection was 40+dB. The AGC action for an input signal range of 2 to 10,000 μV measured 8 dB. The S-meter is marked in S-units but checked out as a relative signal strength indicator—typical of walkie-talkie S-meters.

The transmitter power output was, typically, highly dependent on the condition of the batteries. With fresh alkalines the transmitter delivered 3 watts RF output to a 50-ohm load. With the batteries run down (from continuous operation) to 10 volts, the power output was 1.8 watts. Using an auto power cord with a car electrical system running at 13.8 volts, the power output was 2.4 watts—the same power output as when a line-powered supply was used.

Both the receive and transmit audio quality are typical of walkie-talkies—attenuated lows and plenty of midrange. A more full-range sound—as might be preferred for base use—was attained by using a larger external speaker and an external microphone. When using an external microphone, the transmitter is still keyed with the walkie-talkie's press-to-talk switch; the PTT switch function is *not* moved to the microphone.

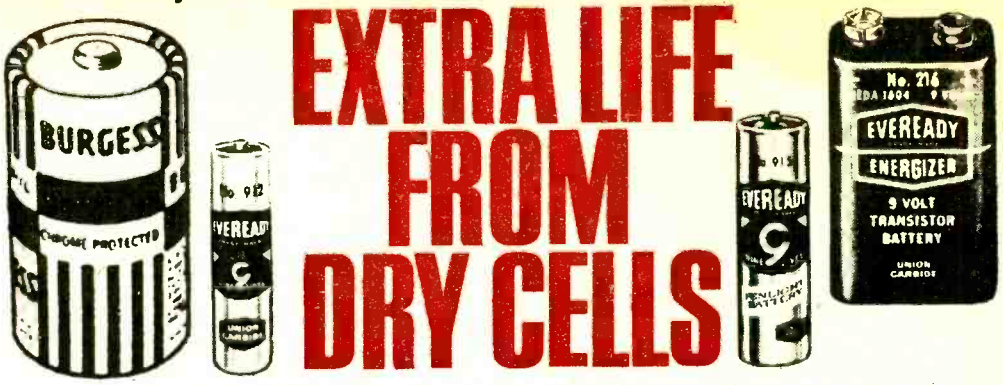
When you've backed the budget up against the wall and can't squeeze out another cent (another shortage!) a high power walkie-talkie such as the Fanon T1000 is the "way to go" for base, mobile and portable coverage from a single transceiver.

For additional information on the Fanon T1000 circle No. 42 on the Reader's Service Coupon. ■



Double view of same T-1000. Use unit as a mobile without the battery pack shown. A 12-volt DC cord is available for mobile operators.

Economy minded? This Junk Box Project saves money . . .



EXTRA LIFE FROM DRY CELLS

The secret of greatly extended cell life is periodic recharging!

by Steve Money

☐ As you throw that worn out battery from your transistor radio into the nearest trash can, have you ever wondered if there might be some method of getting a bit more life out of a standard battery? An automobile battery gets recharged every time you run the car's engine. How would it be if the useful life of a battery for your radio could be extended in some way?

Now if you go along to your friendly neighborhood radio dealer and ask him about it he'll probably tell you that it can't be done. Well, after all, he is in business to sell you a new battery. Don't give up in despair because you'll be pleased to learn that dry cell batteries, like the one in your radio, can be recharged—up to a point.

It's not too difficult to get several times the normal life out of a standard battery before it becomes useless. If you or the kids use a radio, battery powered model or other battery driven appliance fairly regularly, the cost of replacing batteries may be starting to hit your pocket. So why not scout around the junk box and make yourself a battery charger; this article will give you plenty of handy information about inside a battery, too.

Inside the Cell. Many of the batteries commonly used today, are of the "Leclanche" dry cell type. Let us take a look at the inside of a typical dry cell and see what makes it work.

As a typical example of construction let us take a standard size D flashlight cell and saw it in halves from top to bottom. The inside will look as shown in Fig. 1.

Under the paper or plastic labels on the outside of the cell is an outer metal case which acts as the cathode, or negative electrode, of the cell. This case is made from zinc.

The anode, or positive electrode, consists of a black mixture which fills most of the inside of the cell. This mixture is made up from manganese dioxide and powdered carbon. The active element in the mix is the manganese dioxide but this is a relatively poor conductor of electric current. Carbon, which is a good conductor, is added so that current can flow more easily through the cell.

At the center and running from top to bottom of the cell is a carbon rod. This rod acts as the anode connection out of the cell

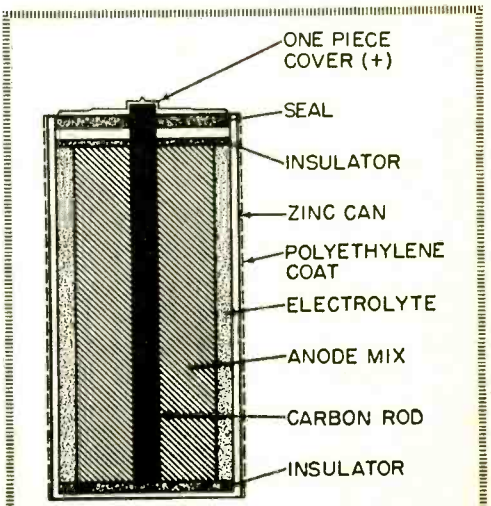


Figure 1. Half a dry cell.

and is usually capped by a cap or plate which serves as the positive terminal of the cell.

Between the anode and cathode is a thin layer of corn starch impregnated with sal ammoniac (ammonium chloride) which forms the electrolyte of the cell. This is the fluid that messes up your radio if you leave "dead" batteries in it for a long time. Normally the electrolyte is prevented from leaking out of the cell by a bitumen or plastic seal at the top of the cell.

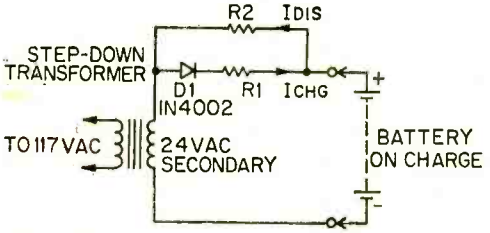
To prevent the cell from being short circuited, the anode and cathode are insulated from one another by fiber disks at the top and bottom of the cell. Thus the only connection internally between the anode and the cathode is through the electrolyte.

Some batteries are built in a different way, but the materials used and the method of operation are similar. Transistor radio batteries are often built in layer form. Each layer forms one cell and since they are effectively connected in series there would be six layers in a normal 9-volt transistor radio battery.

How it Works. Electricity is generated in the dry cell by chemical reactions which occur between the anode, cathode and the electrolyte. If the anode and cathode are brought into contact through the electrolyte, an electrical potential will be developed between them. This potential ionises the electrolyte. The ions in the electrolyte are atoms on which there is a positive or negative charge because they have either lost or gained an electron. These ionised atoms can then migrate through the electrolyte to either the anode or cathode. When an external circuit is wired across the cell, current flows between anode and cathode and the ions flow through the electrolyte to maintain it.

The actual chemical reactions which go on inside the cell as it discharges are quite complex. In the process the zinc in the case dissolves into the electrolyte and becomes converted into zinc chloride and zinc oxide. In time, this case gets eaten away and the electrolyte becomes ineffective or leaks out (that's why some cells are clad in steel). When this happens, the internal resistance of the cell increases so that it can no longer deliver its normal load current. For a new cell the output voltage will be about 1.5 volts. As the cell discharges the voltage falls until it gets below 1 volt when the cell is considered dead and needs to be replaced by a new one.

Recharging? Ever since dry cells were first made there have been various attempts made to recharge them. If a direct voltage is applied across the cell so that current is driven back into it, the chemical reactions that occur in the cell tend to work in reverse (the zinc compounds in the electrolyte are converted back into pure zinc which forms on the case, and the electrolyte returns to its original state).



Find all the parts you need for a simple charger like this in a well-equipped junk box. Table below shows R1/R2 values to use.

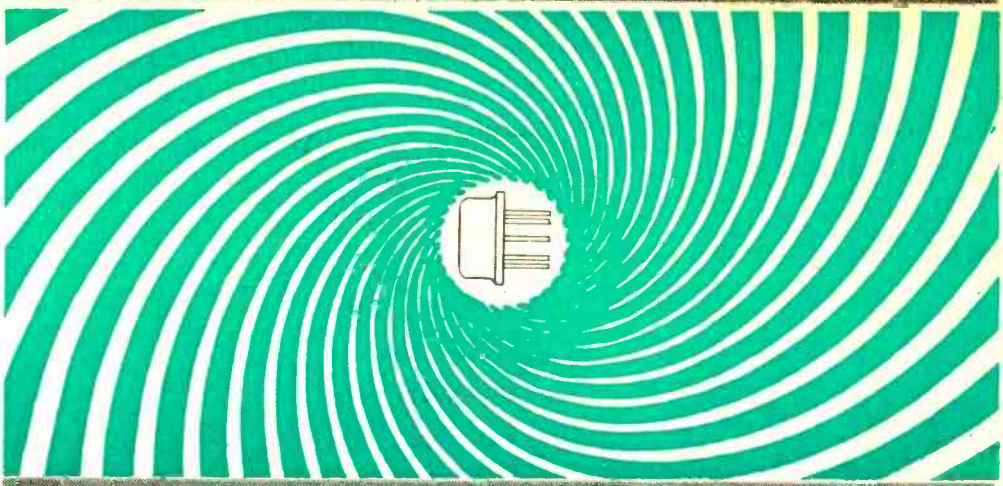
Unfortunately, not all of the chemical reactions operate in reverse so the cell cannot be restored completely to its original "as new" condition by recharging it. In fact, direct current (DC) charging makes the zinc "plate-out" unevenly, so holes will still appear in the case after a time and the cell will eventually die. Nevertheless, this type of charging can increase the effective life of a cell which saves you a few pennys each time.

In the early 1950s it was found that an asymmetric method of charging gave better results. In this system the cell is charged during the positive half cycles of the AC supply and allowed to discharge slightly during the negative half cycles. It seems that this makes the zinc plate-out more evenly on the cell walls, so holes do not form so quickly.

(Continued on page 104)

Battery	Volts	R1 ohms	R2 ohms	I mA
Transistor-type	9	470 (½ W)	10000 (½ W)	10
6 size AA cells	9	120 (½ W)	2700 (½ W)	40
4 size AA cells	6	220 (½ W)	2200 (½ W)	40
2 size D cells	3	68 (1W)	470 (½ W)	125

A Builder's Basic Insights to...



OP-AMP AND DIODE CIRCUITS

Take two basic electronic items—the IC op-amp and general purpose diode—and put them together! We show what makes the whole greater than the sum of the parts!

by J. R. Laughlin

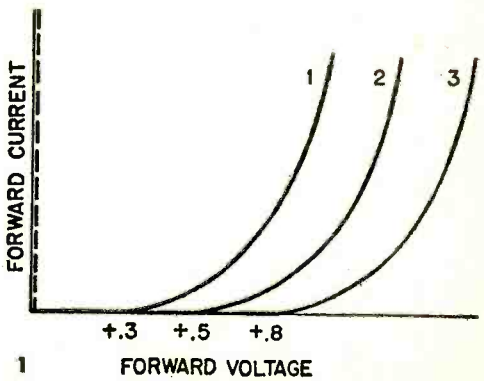
☐ THERE ARE A GREAT number of circuits in use which involve severe compromise because of the non-ideal characteristics of the diode. This article presents a variety of circuits in which the operational amplifier and diode are used together, so the amplifier can extract ideal performance from the diode.

A basic silicon or germanium diode has several outstanding imperfections. There is an effective voltage offset. The voltage offset varies from diode to diode. This offset is strongly affected by temperature. The diode has a nonlinear volt-current characteristic. The diode exhibits a resistance which varies with temperature.

Figure 1 illustrates all of these characteristics. Note that when the forward voltage is below a certain level, but greater than zero, the diode does not conduct. After the diode begins to conduct, it can be seen that the conduction is nonlinear. This is shown by the curvature of the lines on the graph. Curve # 1 is a relative representation of a diode at a low temperature while curve 2 and 3 represent the conduction at higher and higher temperatures. The fact that the curves are not vertical just points out that there is a certain amount of resistance inherent in the diode at all times. As the diode current increases we see the curve become more and more vertical in nature, which means the resistance of the diode is dropping.

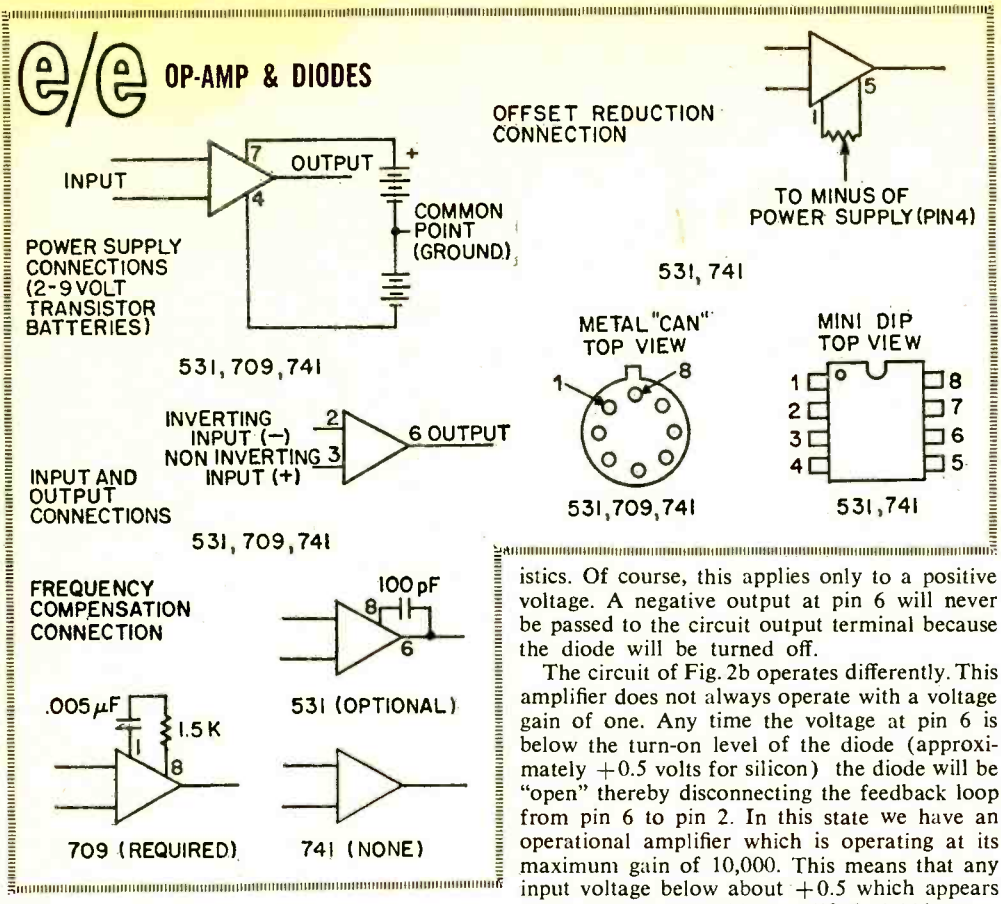
Get Together. When we combine a diode circuit with an operational amplifier, we do it in a manner that makes the operation of the amplifier sensitive to imperfections in the diode. Generally speaking, we can say that the diode imperfections are reduced by an amount equal to the "open loop" gain of the amplifier. This gain, for practically all operational amplifiers, is 10,000 times or greater. Thus, our diode in conjunction with an op-amp will exhibit offset voltage only 1/10,000, or less, as great as normal!

Figure 2 shows two circuits in which a diode



1

Current change is tied to temp and voltage.

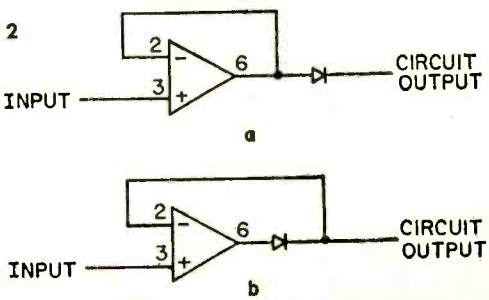


has been incorporated. These circuits are the same except for the routing of the feedback loop (any circuit path from the output to an input; here a piece of wire from terminal 6 to terminal 2). Circuit 2a might as well have never been built! The diode here is not contained within the path of the feedback to the inverting input, hence the output voltage will be subject to *all diode errors* in their full magnitude. Circuit 2b contains the diode *within* the feedback loop. In other words, there will be no feedback unless the diode is involved.

Read On. For sake of simplicity, let's assume that the amplifiers have zero offset voltage and are perfect in every other respect and that they have an open loop, or maximum gain, of 10,000. Circuit 2a is connected with the output wired directly back to the inverting input terminal. This means that it will exhibit a voltage gain, not of 10,000, but of *one* all the time. If we apply an input voltage to terminal 3 this exact voltage will appear at the output terminal of the *op-amp,* pin 6, and will exactly follow input excursions (within the limits of the amplifier). However, the voltage present at the output terminal (to the right of the diode), will be altered by the voltage drop of the diode plus all its other inherent characteristics. Of course, this applies only to a positive voltage. A negative output at pin 6 will never be passed to the circuit output terminal because the diode will be turned off.

The circuit of Fig. 2b operates differently. This amplifier does not always operate with a voltage gain of one. Any time the voltage at pin 6 is below the turn-on level of the diode (approximately +0.5 volts for silicon) the diode will be "open" thereby disconnecting the feedback loop from pin 6 to pin 2. In this state we have an operational amplifier which is operating at its maximum gain of 10,000. This means that any input voltage below about +0.5 which appears on input pin 3 should be amplified 10,000 times.

Keeping in mind that at room temperature a silicon diode will begin to conduct at about +0.5 volts, let's compare the voltages that appear at the circuit *output,* when an input voltage goes from 0 toward a positive value. In circuit 2a we saw that the voltage at pin 6 follows the input voltage exactly. As the input (and output) begins to go positive from a 0 value, no voltage appears at the circuit output terminals until the pin 6 output has reached a level sufficient to start the diode conducting. Regardless of what value of output voltage appears at pin 6, the circuit output will always

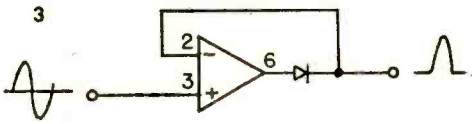


From imperfect to perfect.

be (1) less by the diode drop and (2) nonlinear.

Continuing. Now let's start with zero volts at the input of circuit 2b and increase it in a positive direction. Any positive input value that is very small will be amplified 10,000 times. Hence, when the input voltage has reached only 0.05 millivolts the output at pin 6 will be 0.5 volts and the diode will begin to conduct. In other words, in circuit 2b an output voltage begins to appear at the circuit terminals immediately, and in circuit 2a, only after the input has reached +0.5 volts. For this reason, circuit 2b is sometimes referred to as a "perfect" rectifier. The output curve of this circuit is illustrated by the dotted lines in Fig. 1.

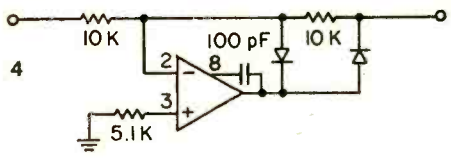
Applications For Experimenters. Try a simple half-wave rectifier. If negative output from



Meter rectifier also needs ripple filter.

Fig. 3 is desired, just reverse the diode. This circuit makes an excellent meter rectifier since a linear scale can be used on the meter. The meter can even be connected from output to ground through a multiplier resistor for higher additional ranges. This circuit can be used quite effectively for low frequency signals.

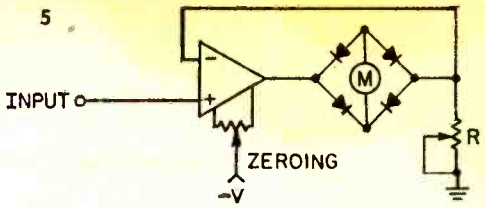
Figure 4 shows a circuit that will give excel-



Cap boosts high freq response.

lent high frequency response and precision rectification. This circuit is useful for comparing the voltage at the input and output of high quality audio amplifiers.

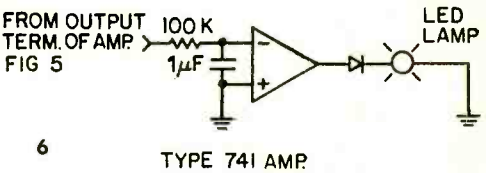
The circuit in Fig. 5 is deceptively simple looking. This metering circuit will read AC voltage and + or — DC inputs without any "lead swapping." On DC, the bridge always routes the DC current through the meter in the same direction, regardless of the input polarity. The circuit operates best using low current meters, particularly on AC. Variable resistor R is adjusted to give the desired full-scale reading. This circuit will accept input voltages of up to ten volts peak if a ± 15 volts is used for the power supply. Higher input voltages should be divided down with a divider. Any type of op-amp can be used here, but for high frequency operation an amplifier such as the 709-type will give good wide-band operation. Just re-



Basic IC version of the VTVM.

member, some types, such as the 709, will have to be "compensated" according to the manufacturers instructions. If DC-only or AC-only operation is desired, a low pass RC network or a high pass RC network can be inserted in the input lead. This circuit also makes an excellent high impedance meter similar to the vacuum tube or FET voltmeter. The input impedance is extremely high permitting it to be used with a standard 10 megohm voltage divider. For greatest accuracy when measuring very small voltages, a zeroing pot should be used with the op amp as shown. This pot is not necessary when handling only higher voltages.

Figure 6 shows a polarity indicator that can

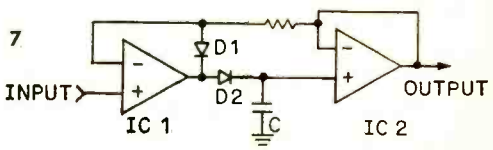


A 68-ohm, ½-watt can limit LED current.

be used with the previous circuit to indicate a "negative" input. Limit LED current to 20 mA with a series resistor.

Hold That Sample. A diode can also be used with an op-amp to read *true* peak voltage. Peak voltages of pulses and other non-sinusoidal waveforms are *not accurately measured* by conventional circuits. Figure 7 shows the diagram of a simple, positive-peak-reading circuit. A positive input to IC 1 will cause its output (at the "top" of C) to go positive by an amount equal to the peak of the input. The capacitor C "stores" this value.

When the input voltage starts to go less positive than its most positive value, the op-amp output immediately swings negative. Diode D2 is now reverse-biased, and the capacitor with th peak value stored in it is isolated from the IC 1 output. Also, IC 2, connected as a voltage follower, exhibits an extremely high input impedance to the capacitor, so it will lose minimum charge between positive peaks of the



Some call it "sample and hold."

input. This IC2 can also furnish enough power to drive a meter or other circuitry. The charge on C is "refreshed" by each positive excursion of the input waveform. D1 conducts during negative excursions and prevents the output of IC1 from "slewing" all the way to the "minus" power supply value.

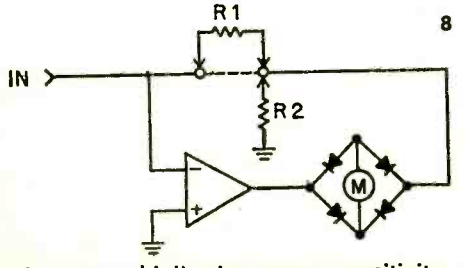
This extreme excursion would result in a slower response of IC1 to positive peaks. For short-duration waveforms, the IC1 should have a *high* slew rate. A 709 or equivalent amplifier can be used here for greatest accuracy of fast waveforms. Note that IC 2 only handles relatively slow inputs and does not need to have a high slew rate. For best storage, C should be of a very low leakage type capacitor (any of the "poly" types).

When making current measurements, the internal resistance of the meter is important because it adds to the circuit resistance; that tends to alter the circuit current while the measurement is being made. Ideally, then, a current meter with absolutely zero resistance is needed for maximum accuracy. This stipulation is a bit hard to meet, especially in the case of an AC current meter.

More Current Facts. Figure 8 presents a "zero drop" AC current meter. In this circuit, the op-amp supplies enough current to the meter to keep its inverting input *at the exact same potential* as its non-inverting input. By keeping these two terminals at the same potential, they are, in effect, shorted together!

The full-scale current reading will be equal to the FS of the meter itself. The meter can be shunted to increase the range; however, it must be kept in mind that the op-amp has to supply all the current flow. This will limit the full-scale range to that of the op-amp.

Current multiplication is easily accomplished by adding resistors as shown in Fig. 8. This scheme will allow much smaller currents to be measured than the full-scale value of the meter. In this circuit, the current through the meter is greater by the rates (R1/R2) than the current being measured. These resistors directly control the gain of the op-amp so it can be set to any fixed amount of gain; 10 would allow a 1 mA meter movement to measure 0.1 mA full scale.

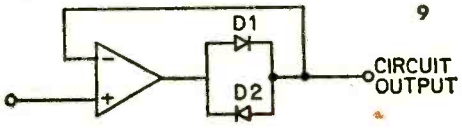


Current multiplication means sensitivity.

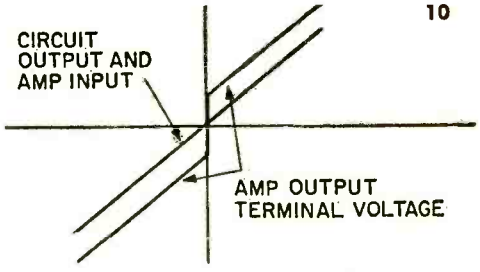
This current meter is not limited to AC measurement but will respond equally well to positive or negative DC currents. The polarity indicator of Fig. 6 can be used with this circuit if desired.

An important aspect of the preceeding current measuring circuits is that their input terminals cannot effectively be "shunted" to extend the range of measurement as with a standard all-mechanical meter. As mentioned before these terminals are effectively shorted together; therefore, a shunt would accomplish no purpose.

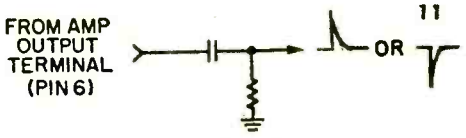
A rather unusual circuit, which, at first glance, might appear to be useless is shown in Fig. 9. According to the previous analysis of how the amplifier overcomes the diode offset voltage, the two diodes (back-to-back in this circuit) would appear to be a plain piece of wire! With a positive DC output, D1 will conduct and the voltage will appear in its entirety at the output terminal of the circuit. Likewise, a negative DC voltage will be passed through D2 to the output terminal unabated. However, you can see that the amplifier output voltage jumps suddenly at the zero crossing of the input voltage as shown in Fig. 10.



A useless circuit?



Basis for a "zero crossing" detector.



Differentiator bi-polar output.

With the addition of a differentiator to the amplifier output terminal, a voltage pulse will be generated whenever zero crossing of the input occurs. These pulses will indicate, by their polarity, the direction of the crossing (from plus to minus, or a minus to plus transision).

We have presented some problems, solutions, and simple experiments associated with the

(Continued on page 97)

This Plain Jane occasional table conceals...

SOUND FORCE--

a 3-way speaker system with downward facing woofer!

by Herman F. Johnson

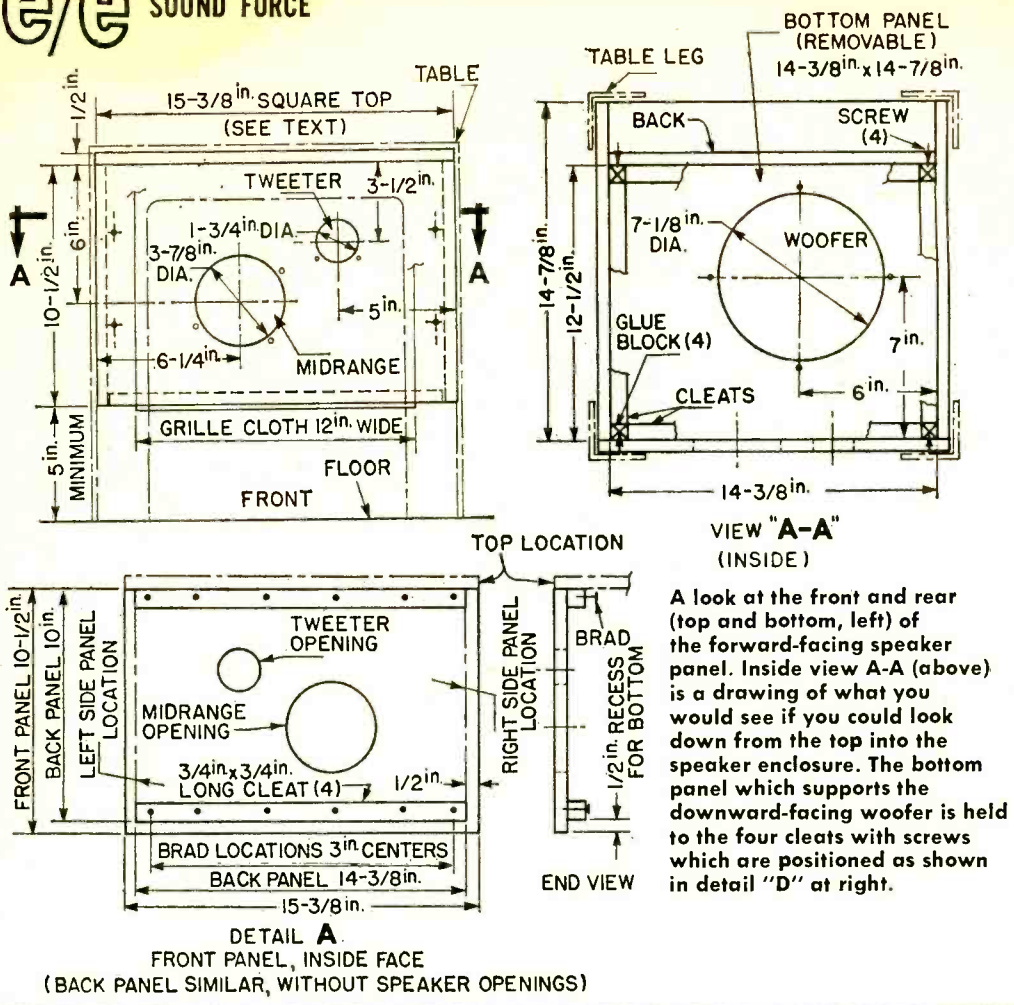
REMEMBER that old saying once in common use, "Children should be seen but not heard!" A loudspeaker should be the direct opposite, it should be heard but not seen. A speaker system need not look like one of the "common box" variety, either. This one *is* a box system, but it was designed to fit into a popular piece of furniture—the small occasional table known as a "parsons table." By employing one of these tables to house a speaker system, the enclosure can be made of unfinished material; wood joints and jointing screws are hidden from view, and for convenience in assembly, the screws are driven from the outside, into the enclosure.

This is a high performance 3-way system that employs speaker components available at Radio Shack. The enclosure is designed to provide outstanding bass performance from a small system. The bass output is enhanced by locating an 8-inch high compliance woofer facing downward toward the floor. A 5-inch midrange driver and a super tweeter face forward to provide the all important midrange and high frequencies. The woofer is rolled off at 500 Hz. The tweeter picks up the highs from 3300 Hz and up. Of course, the midrange unit operates from 500 Hz to 3300 Hz. This frequency division is supplied by a 3-way crossover network that contains sound level controls for the treble and highs. The power handling capacity is rated at 60 watts.

Construction. Before you purchase the speakers, locate a 16-in. cube-shaped occassional table. They are made of high gloss plastic in black, yellow, red and gray colors. Take a good look at the construction of the table before you decide upon the color. The table legs must be right angle shaped, not square, and it should be of one-piece construction rather than the kind with removable legs. These tables are usually found in stores that feature unfinished furniture.

When you have obtained the table that suits your decor, check the inside dimensions between adjacent legs at the under side of the top. This dimension should he 15½-inches in both directions. The dimension 15⅜-in. at the top of the drawing labeled front Elevation allows for 1/16 of an inch at all sides of the top panel for grille cloth covering of the front and both sides of the enclosure. If the dimensions are less than 15½-in. between legs, the square dimensions of the top panel should be reduced accordingly. The dimensions of the top determines the overall dimensions of the other panels.

View "A-A" in the drawing (top removed) indicates the location of all the panels, supporting cleats and glue blocks. Details "A" and "B" locate the cleats. Round dots indicate the location of brads that secure each cleat and glue block to a panel. Details "C" and "D" provide the



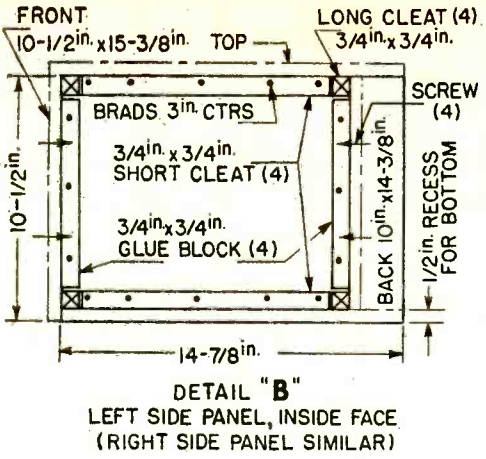
A look at the front and rear (top and bottom, left) of the forward-facing speaker panel. Inside view A-A (above) is a drawing of what you would see if you could look down from the top into the speaker enclosure. The bottom panel which supports the downward-facing woofer is held to the four cleats with screws which are positioned as shown in detail "D" at right.

locations of screw holes (round dots) in the top and bottom panels.

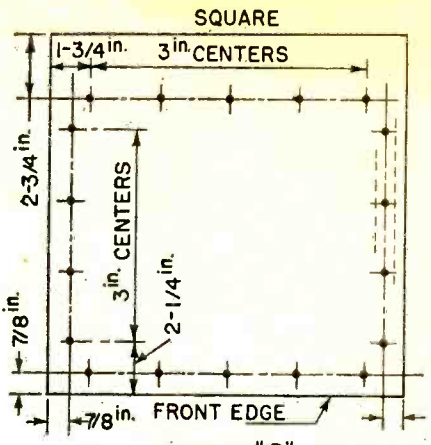
Construction Sequence. You will need a half sheet (48 x 48-in.) of plain particle board, ½-inch thick. Half a sheet is more than enough to build one enclosure, but it is not enough for a stereo pair. When the panels have been cut to size as indicated in the drawings, lay out the center locations for the speakers as shown in the front elevation view and in view "A-A". Carefully cut the midrange and woofer openings with a sabre saw. The 1¾-in. diameter opening for the tweeter is best cut by a hole saw chucked into an electric drill.

Ten feet of ¾-in. square pine is required for cleats and glue blocks. See the Bill of Material for the lengths. The glue blocks are the vertical corner reinforcements, all others are labeled cleats. Pencil-outline the location of each cleat and glue block on one side of each front, back and side panel. Start on the back panel where two long cleats are aligned along the panel edges as indicated in Detail "A". These lines serve as guides when glue is applied. One inch brads secure each cleat and glue block to the panels. Counter sink the brads about ⅛-in. below the surface. The use of cleats assists in the assembly and insures construction of an air tight enclosure (air tightness is a basic requirement to obtain good bass performance).

Next, lay out the screw hole centerlines on the top and bottom panels as shown in Details "C" and "D". Center punch each screw location and drill 1/16-in. holes as indicated. Then, assemble the front, sides,

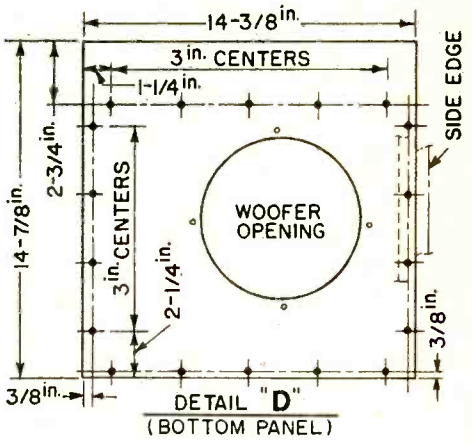


DETAIL "B"
LEFT SIDE PANEL, INSIDE FACE
(RIGHT SIDE PANEL SIMILAR)



DETAIL "C"
(TOP PANEL)

To complete your "box within a box" you will require panels for the left and right sides as detailed on B above; you will also require the top piece shown in detail C. This can be planed or filed as necessary to fit the inside characteristics of your table. Remember, the back panel is similar to the front panel (detail A) but without the speaker openings.



DETAIL "D"
(BOTTOM PANEL)

and back panel in the position shown in view "A-A" and align the top panel. You are now ready to mark screw locations into the top side of the cleats with the 1/16-in. drill. At this point you should examine the screw locations to see if any screw is likely to hit a brad when it is driven. If a screw location appears to be too close to a brad, it is best to drill another hole 1/4 or 1/2-in. away from the brad. When you are satisfied that all screws will clear, reassemble the same panels, down side up, and repeat this process for the bottom panel. When you are satisfied that all screw holes are in the clear, re-drill all of the holes 9/64-in. diameter and countersink for No. 6 screws. It is to be noted that four (4) screw holes are required in the front and back panels for screwing into the glue blocks. All of the panel edges should be given a coating of resin sealer to prevent flake off.

You are now ready for the final assembly —except for the preparation of screw holes to mount the speakers; this data follows under speaker component installation, below. Coat all mating surfaces with white glue between the panel and the cleats; then, screw the top down firmly. Do the same for jointing the front and back panels to the glue blocks you have installed on the sides.

Speaker Component Installation. All of the speakers are mounted to the inside face of the panels. However, the diameters indicated in the drawings will allow the two cone drivers to be "backed in" to their respective openings on the inside faces of the

(Continued on page 58)

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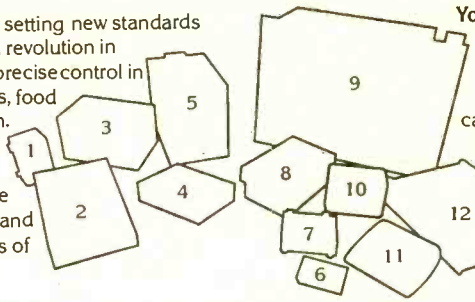

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SOUND FORCE

(Continued from page 53)

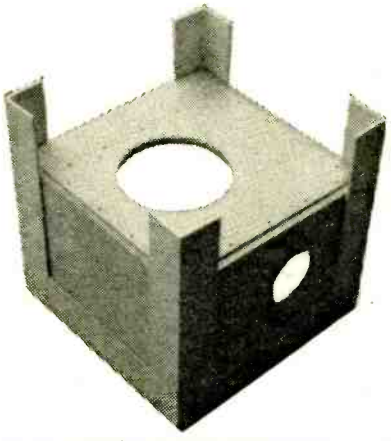
panels, so each driver will be centered in the opening. In this position, center punch all four (4) mounting holes from the frame of each unit. Remove the speakers and drive ½-in. No. 8 sheet metal screws into the panels about ¼-inch deep. Then, remove the screws and scrape off the displaced wood around each screw hole. This proceedure will prevent damage to the cone of a speaker should a screw driver slip when driving a screw. The woofer and the tweeter should be mounted with screws. The hole locations you have marked for the midrange unit should be drilled 11/64-in. or 3/16-in. in diameter for 8-32 machine screws.

The back of the midrange cone must be isolated in the enclosure from the woofer. This is readily accomplished by bolting a plastic cover over the back side of the midrange driver. A dessert bowl was used by the author. Any bowl that is quite stiff and has a flanged edge all around will do the job nicely. There is no need for a gasket. The edge of the bowl can be clamped to the smooth back surface of the speaker's frame by the mounting bolts.

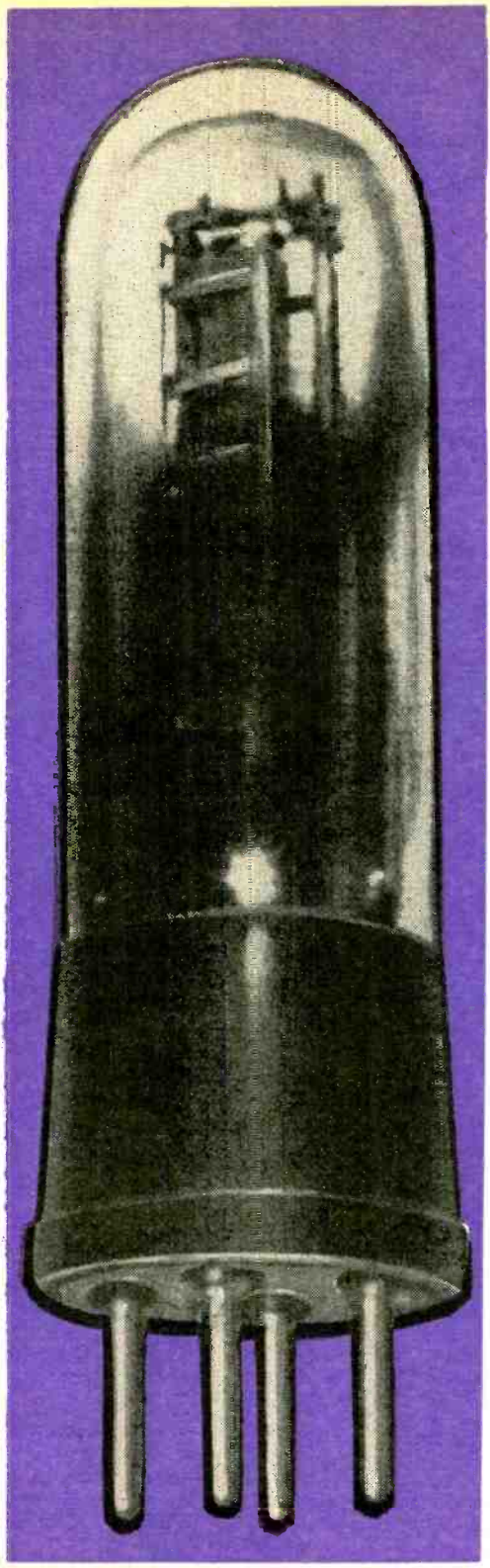
The recessed space behind the back panel is convenient for mounting the crossover network. Draw a horizontal pencil line on the back panel at 4¼-in. from the bottom edge and center mark the location for two ½-in. No. 6 pan head sheet metal screws 4⅞-in. apart. Drive these screws in about half way. Slotted openings are provided on the back of the network for hanging it on two screws. The network is a self contained unit. Hence, three sets of connecting wires must be brought through holes in the back panel for connections between each speaker and a 12-screw terminal strip on the network. Drill holes through the back panel at 1½-in. from the bottom edge for a snug fit to the hookup wires. Follow the instructions attached to the network for connection to the speakers with jumper wires between designated terminals to engage the installed tweeter and midrange level controls that are located on the front of the network.

Cut the speaker hookup wire (zip cord is fine) in about 24-in. lengths. Solder one of these to the woofer terminal lugs, one to the midrange lugs (through a snug fit hole in the side of the plastic cover), and the third to the pull-type binding posts located on the tweeter. Red dot terminals on the speakers should be connected to their respective plus (+) terminals on the network (2, 8, and 10). Unmarked terminal lugs should be connected to the negative (common) terminals on the network (1 and 6). Since two wires must be connected to terminal 6 in a 3-way system, it is a good idea to use spade connectors. The input terminals are located adjacent to terminals

(Continued on page 100)



Check the Bill of Materials appearing on the last page of this article. Of course, you must have one set of materials for each speaker you wish to build. You should always use "zip" cord for speaker connections on moderate and high power installations; never that thin stuff sometimes sold on spools as "speaker hook-up wire." Use it for connecting intercoms, if you must, but stick to the #18 for hi-fi.



THE VACUUM TUBES OF EARLY RADIO

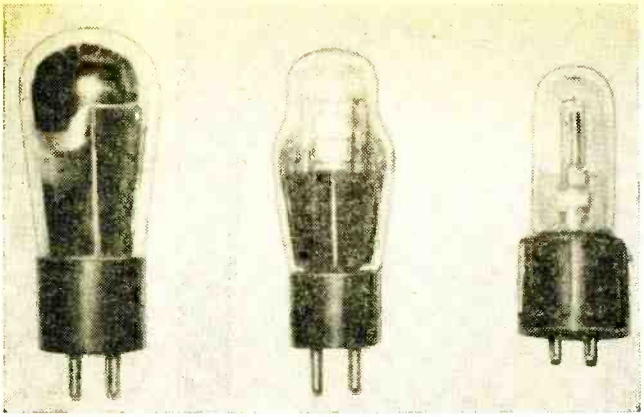
by George Haymans

There's enough nostalgia here for any trivia buff; plus cold hard facts for antique radio collectors!

A LITTLE INFORMATION about socket types and antique radio tube specs can go a long way toward solving "small" problems like missing and unavailable tubes. For example, the first commercially available tube *socket* was known as the UV type. It was used originally for the early Western Electric and military tubes such as VT-1 and 205E. All UV-type tubes, such as the UV 200 and UV 201, were designed for this socket, but the WD-12 tube also fits these sockets. The tube base diameter is 1⅜ inches, and is held in the socket by a pin on the side of the base that locks into a slot on the side of the socket shell. This bayonet-type socket is similar to the familiar bayonet sockets used for small pilot lamps in modern sets. Contact with the four pins at the bottom of the tube base was made by four wide springs built into the socket and connected to the socket binding posts.

A similar socket, although smaller in size, was used for the UV-199 tubes whose base diameter is 1 inch. However, the arrangement of the pins for filament, plate, and grid is different. Only UV-199 tubes can be used in these smaller sockets.

A Second Tube. The UX sockets were a later development. These sockets lacked a shell into which the tube base fitted. Also, in place of the bottom wiping spring contacts of the UV sockets, it used *side wiping* and *locking* spring contacts; the tube



Fairly-easy-to-find type 30 vacuum tube, center, is often substituted fo 01-A, left, and WD-12 shown on right.

was held in position by the side wiping contacts. In place of the bayonet pin (which not only held the UV tubes in the sockets, but also provided orientation of the tube pins to the proper contacts) UX sockets used two large pins for the filament leads. Thus, the tube would only fit into the UX sockets when the large filament pins were inserted into the proper socket holes. Usually, broadcast receivers made *prior* to 1925 were equipped with UV sockets while those made later had UX sockets.

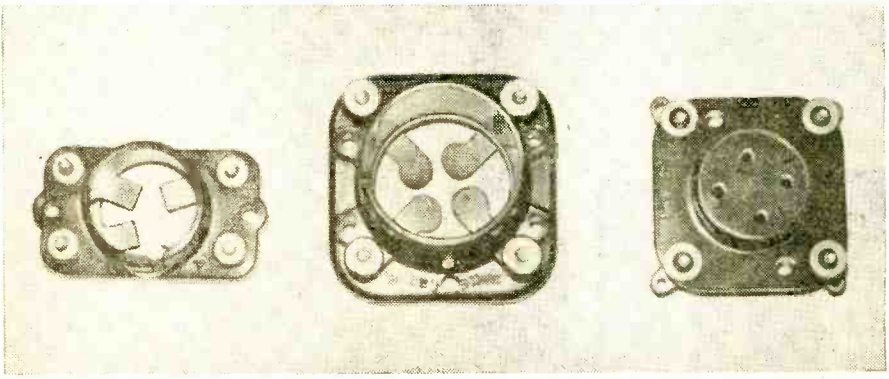
With the advent of the UX sockets, it became necessary for replacement tubes (such as the UX-201A) to fit both the UV and UX sockets. This was accomplished by the use of the larger filament pins for UX sockets and the continued side pin for bayonet-locking UV sockets. Most of the UX-200A and UX-201A tubes available today have this dual socket matching capability.

It was this UX socket that became the standard for many years. And their use continued with the UX-226 AC-type tubes: the UX 224, UX 280, and even the good old UX 210 transmitting type.

Radio's first socket with more than four contacts was the UY. It was designed for the UY-227, the first indirectly heated cathode-type tube built for an AC filament supply.

One More Time. But there was still another early socket. It was designed for the WD-11 tube. Actually, this tube and its socket were the design forerunners of the UX type since the WD-11 tube used one large pin for proper socket orientation plus the side-wiping spring contacts. As many collectors who own such early sets as the Radiola III have found, the WD-11 tube is the only tube that fits this type socket. When other low-drain battery type tubes were marketed that could replace the hard-to-find WD-11, firms manufactured an adaptor which fitted into the WD-11 socket and allowed the use of any (with proper filament voltage) UX-base tube.

Since the WD-11 tubes, like the UV-199 tubes, had their filament pins located diagonally (in place of a side-by-side ar-



Four-pin tube sockets of very early radio—UV small, UV large, and UX.

rangement), adaptors had the internal cross-wiring necessary for use with other tubes. Any set designed for WD-11 or UV-199 tubes will not operate with other tubes unless an adaptor is utilized!

On the other hand, sets with UX sockets have a much greater flexibility and choice of suitable tubes. The 30 series which came out later and included the UX-30, UX-31 etc., along with the 864, all had UX bases and could be used in sets with UX sockets (with, of course, the proper filament voltage supply).

During WW II, the Army Signal Corps developed a military version of the 864 under the type number VT-24/864. This tube was far more rugged and less microphonic than the WD-12. It is an exact electrical replacement of the WD-11 and WD-12, but only fits UX sockets. It and the UX-30 are currently available at relatively low cost from a few suppliers. Their use in UX sockets will allow proper operation of any set originally designed for the UX 201As, which are rather difficult to locate, and expensive when available. A table is shown giving proper filament voltage for the various type tubes mentioned plus some possible filament sources. Remember that even if an old tube is "unused" it is not new! Its physical age probably checks-in at 50 years!

Clean-up Fix-up. Aging metal tends to become brittle due to crystallization. Furthermore, electron flow at the surface drops off. Rough handling could cause filament breakage, and a filament supply of higher than rated voltage could result in early burnout. Back in the '20s, several types of tube rejuvenator or reactivator were available. These "cooked" the tube filaments, without any plate voltage, at a slightly higher than rated voltage.

A "cooking" process restored the tube's emission of electrons. To use this process on our "unused" old/new tubes, we must hold the voltage placed on the filament to the rated voltage since use of a higher voltage could result in the burnout of the filament. Cook the tube for several hours. Not only does this restore emission because of more electrons being brought to the surface of the filament, but crystallization due to age is reversed since the filament is heated enough to restore the continuous ductile characteristic to its metal.

Many old tubes will be found to have their glass envelopes loose from their bases. Work in several drops of epoxy cement with a toothpick and allow to harden. This situation will then be corrected without any change of external appearance that other cements could cause.

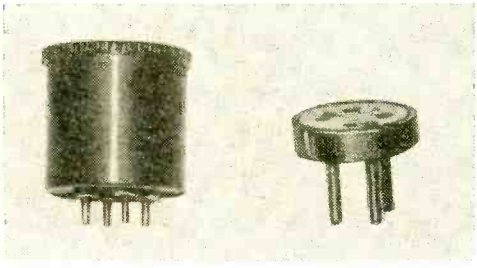
Despite the age-old proverb that acid core solder should not be used in electronic construction, many early tube manufacturers, including even RCA, did use solder with some acid content in order to speed up the soldering of leads to pins during manufacturing. Some slight corrosion on the tube pins at the solder is an indication of this. Its removal, along with clean bright pins and socket contacts, is important for efficient operation of old tubes in the old sets.

To clean up your old tubes and socket contacts, cook the filaments at rated voltage, and operate at rated voltage. Your old set will have a better chance of reaching its optimum performance. ■

Old-Time Tube Sockets

Tube Type	Socket Type	Rated Fil. Volts	Fil. Supply Source
WD-11	WD-11 Special	1.1	Single dry cell
WD-12	UV	1.1	Single dry cell
VT-24/864	UX	1.1	Single dry cell
UV 200	UV	5.0	6-volt wet battery
UV 201	UV	5.0	6-volt wet battery
UX 200A	UV or UX	5.0	6-volt wet battery
UX 201A	UV or UX	5.0	6-volt wet battery
UX-30	UX	2.0	2.0-volt wet cell
UV-199	UV Small	3.0	(3 dry cells in series
UX-99	UX	3.0	with 30-ohm rheostat)

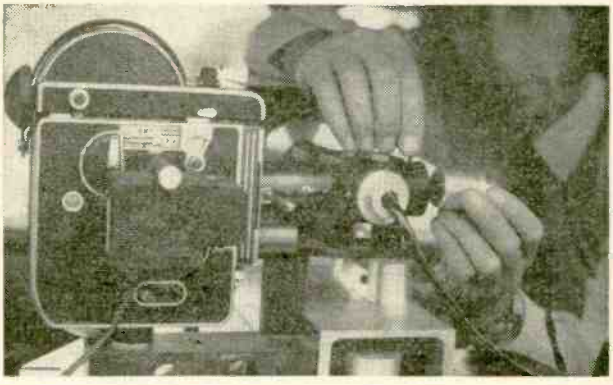
Note 1. A single dry cell indicates a large No. 6 cell or four or more D flashlight cells connected in parallel.
Note 2. 6-volt wet battery refers to the old 6 volt, three cell storage battery . . . modern VW and cycle batteries will serve.
Note 3. 2.0-volt wet cell, refers to a single cell storage battery, usually available from military surplus dealers.



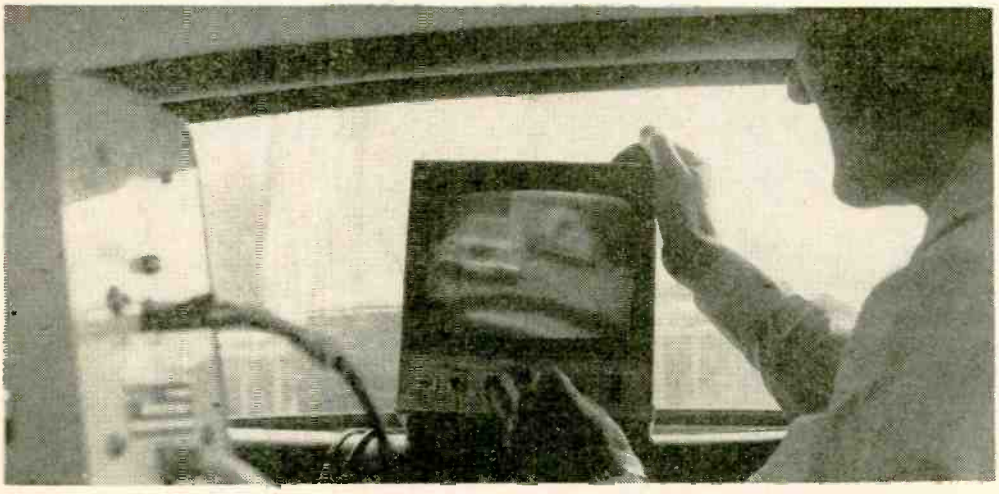
Adaptors such as the one at left allowed a set to operate with tubes at hand (UV small to UV large); on right, UX base tubes can sub for WD-11 type used in Radiola III set.

what you see

□ Even the most roadworthy of drivers proceeds along the highways without paying 100 percent attention to his direction of travel. The evidence of this is accurately recorded through the eyes of the driver. This is accomplished by a device which records on film not only the situation seen by the driver, but also the subject on which the driver is focusing his attention. The device consists of a plastic cap to which two fiber-optic cables have been fitted. One cable "looks out" above the bridge of the driver's nose and "sees" the road ahead. At the same



Fiber images from the driver's view are fed to both a motion picture camera and a video tape recorder. Fine adjustments on both are made continuously.



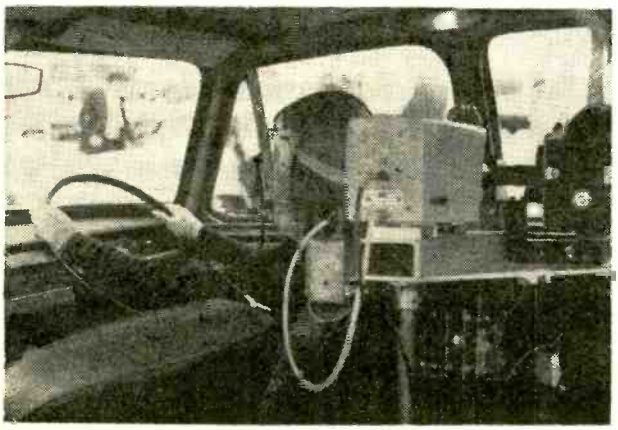
The TV monitor displays what the driver sees. The motion of his head positions the fiber-optical system to view whatever is in front of his nose. A narrow light image is focused on the eye, and any movement of the eye causes this light spot to be superimposed on the TV image, indicating where the eye is focused.

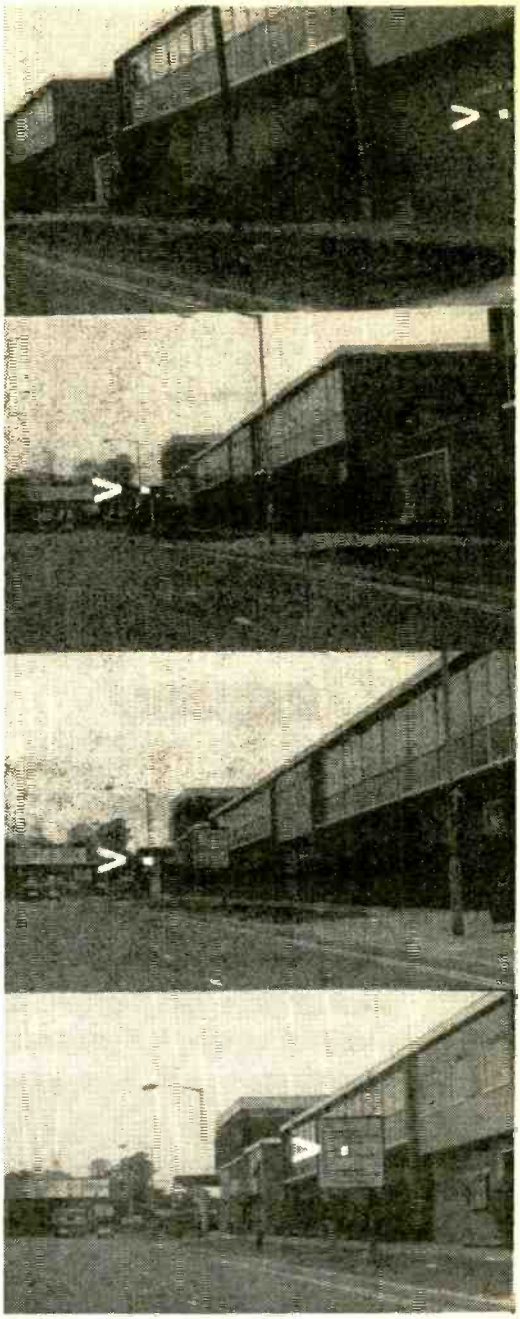
ain't where you go

by Gabe Comlete

time a light is shone onto the driver's right eye and is reflected off the cornea into the other fiber-optic cable to the side of the eye. Any movement of the eyeball due to a change of subject matter results in the spot of light moving from its normally central position. The view ahead of the driver and the spot of light are superimposed on each other and recorded on movie film and video tape. Scientists study the film frame by frame and build up a picture of a driver's visual behavior. The study shows what a driver doesn't see as he drives a car. ■

Chomping at the bit, the fiber optical system is held in place by the driver biting on the bracket. The system does not move with respect to the eye as the car hits bumps and holes in the road.





Follow the pictures from top to bottom, a sequence of events the driver sees. White arrows indicate exact center focus of eyes on objects in driver's view. Attention is focused on roadside, not road.

e/e builds a kit... ESE Digital Stopwatch

All-electronic stopwatch action digital display runs nine

☐ Sometimes, after what seems an endless search, we run across some oddball equipment that seems to answer a particular need, but by the time we're finished experimenting, we find solutions to many other petty irritations that plague hobbyists.

When we first heard of the ESE Model ES-400 Digital Stopwatch Kit we thought we had the solution to our color print problems, for here was a device that provided a large, extra bright digital readout up to 10 minutes (three digits), with manual and/or remote *start*, *stop*, *reset*, and *running reset*. We could now accurately time the color printing processing steps without constant fumbling with an electric timer. To time each step we could simply use a "running reset"; each time we pressed the reset switch the timer would return to zero and automatically resume timing (we could also reset to a locked zero).

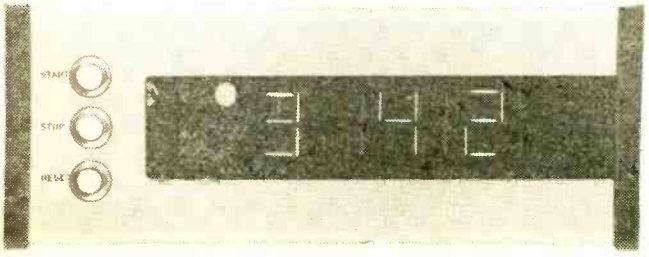
As it turned out the clock also proved ideal for timing sequences when editing film and tape, served as a precise photography timer for developing and exposure, and also served as a precise, easily used period/play timer for one of the e/e staff who manages a junior basketball team.

What It Is. As shown in the photographs, the ES-400 is highly styled with a minimum of front panel hardware. There are push switches for *stop*, *start* and *reset*; that's all. Power is applied when the line cord is plugged in—though we suggest a power switch be installed on the rear as we'll show later. The digital display is presented by three extra-bright RCA Numitron (low-voltage) tubes. Pre-drilled holes on the rear apron can be used for a remote control socket, a power switch, or anything else you'd like to hang on the stopwatch.

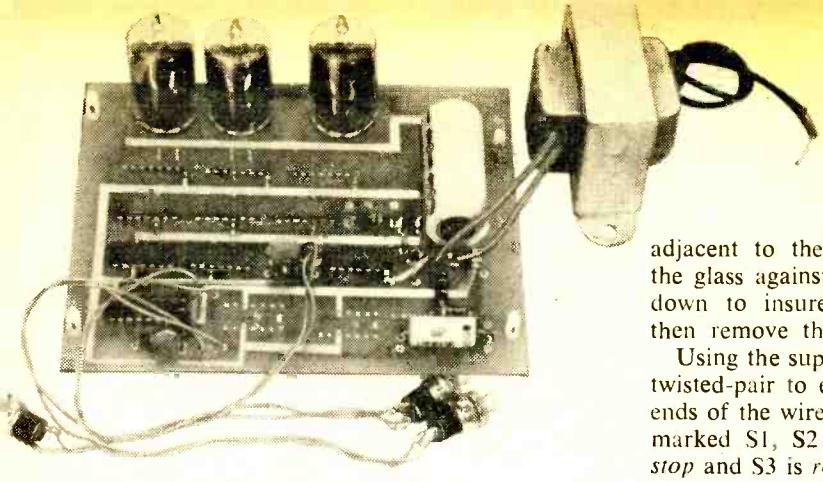
Actually the model ES-400 a miniature version of ESE's model ES-500 six digit clock/timer (stopwatch), which can read up to 12 hours and also features fast and slow time advance. The ES-500 kit costs $30 more than the ES-400,s $60 price tag.

As it turned out, the ES-400 kit (provided in kit form for experienced hobbyists and radio/TV technicians) is a "convenience package" of the wired unit priced at $85. It comes with virtually no instructions other than a schematic and pictorial layout of the printed circuit board. Yet the project is so simple for anyone with a smattering of common sense it should take no longer than two hours from the time you open the kit to the time you apply power.

How It's Done. First step is to assemble the PC board. The copper foil must be lightly scrubbed with steel wool or an abrasive household cleanser such as Ajax to insure easy, low solder-heat connections; then the board must be thoroughly rinsed under running water. Position the PC board so it corresponds to the PC layout and plug in the ten integrated circuits. Make certain you get the IC's oriented correctly. Each IC has a small moulded dot on one end which corresponds to the "half-moon" indicated in the PC layout. Tack-solder two



"The board's assembly should take no more than 45 minutes, even if you triple-check each connection," said our lab tech. "Almost all components are on a single printed circuit board."



with a big bright incandescent minutes fifty-nine seconds!

opposite-end pins on each IC, then double-check that every IC is installed with the correct polarity in its proper position. Then, check it a third time!

When you are absolutely certain the ICs are correctly installed, use a small, low-heat iron (about 25-40 watts) to solder the IC terminals to the foil. Note that each IC has at least two terminal connections on the top side of the PC board (the board has foil on both sides); *the holes are not plated through*—you make a solder connection on the top side of the board even if these terminals are soldered to foil on the bottom of the board.

Next, install the four silicon diodes (double check polarity with the pictorial) and the five capacitors and six resistors, making solder connections only to the bottom foils.

Finally, install the three tubes in the sockets and solder the pins to the bottom foils. The PC board is now completed (it took us about 45 minutes), and there's not much more assembly left.

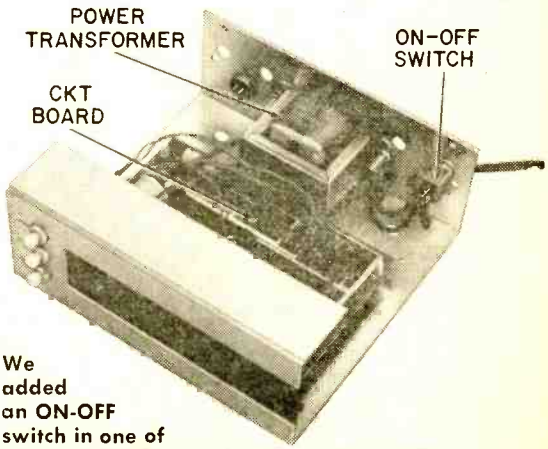
Temporarily install the three push switches on the front panel. Look at the black glass which protects the tubes. Note that three edges are supplied with two-sided sticky-tape. The fourth edge has no tape and is tapered (to clear the cabinet's side). Remove the protective strips from the tape, position the glass behind the front panel with the tape facing the front panel and the small edge with tape immediately adjacent to the three switches, and press the glass against the cabinet. Rub the glass down to insure good tape adhesion and then remove the switches.

Using the supplied wire, connect a 6 inch twisted-pair to each switch. Solder the free ends of the wires to the PC board terminals marked S1, S2 and S3, S1 is *start*, S2 is *stop* and S3 is *reset*.

Cut the yellow lead from the supplied power transformer short and tape the end. Twist the red wires together and connect them to the PC board terminals labled SEC (adjacent to diode D1).

Finishing Up. Install a supplied press-fit stand-off terminal in each of the four PC board mounting holes. Position the board in the bottom of the cabinet, and using gentle pressure, force the stand-offs into their matching chassis holes. Route the switch wires to the left and install the switches on the panel. Finally, mount the power transformer on the rear of the chassis using the supplied hardware. If you seem to have extra standoff insulators left over just forget about them. The line cord passes through the supplied rubber grommet and connects to the transformer's black wires. We suggest you mount a miniature power switch in one of the pre-drilled rear holes as shown in the photographs.

The large rear hole is used for a remote control socket whose connections can be



We added an ON-OFF switch in one of the pre-drilled holes. Unit times to 10 min.

The modes ES-400 Digital Stopwatch in kit form is from ESE, 10418 La Cienega, Inglewood, CA 90304. Cost is $59.95. Circle No. 43 on the Reader Service page for more information.

ESE DIGITAL STOPWATCH

bridged across the switch terminals. The recommended connector is just too expensive ($10), we suggest an inexpensive DIN or Amphenol connector available from local parts distributors. Even if you have double and triple checked every connection, assembly shouldn't take more than two hours. It's very easy.

When power is applied the display can be just about anything. Pressing the reset switch should result in an all-zero display. If it doesn't, try the other two switches as you might have mixed them when installing the switches on the panel. If the display won't reset to all zeroes, or resets to some specific time, or if the display doesn't count properly, it is almost certain you have missed some IC solder connections on the bottom of the board, or the IC top-of-board connections.

While we haven't seen the larger ES-500 12 hour kit, we understand it's the same type of "convenience package," so it should not be any more difficult to assemble—though we wish the PC holes were plated through to simplify soldering.

Summing Up. The end product works very well—it's a good, useful timer and stopwatch. The bright, relatively large display is certainly much more convenient that those itty-bitty LED displays that have become fashionable in hobby equipment. Most important, however, the ES-400 kit is pure enjoyment for the experienced hobbyist; it's a lot more fun to think out a few things than wade through paragraph on how to install a locknut and washer, or how to assemble a four piece cabinet. While we would not suggest this kit for a rank beginner who may need detailed instructions, anyone with a couple of successfull homebrew projects under his belt should have absolutely no difficulty with the ES-400. For those who require detailed instructions, ESE has a line of digital "standard kit" timers, clocks, frequency counters and multimeter.

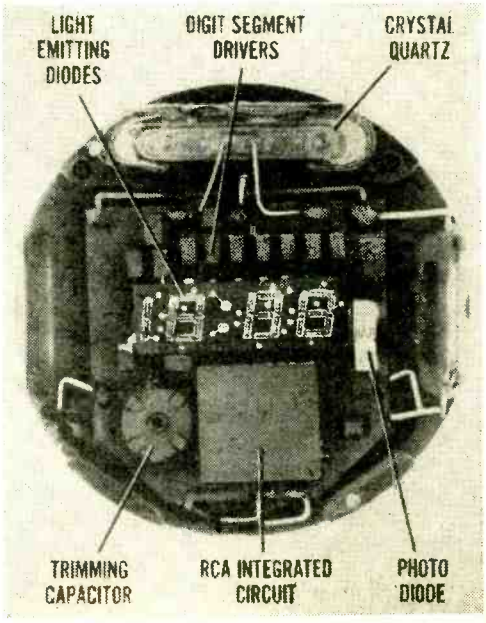
For additional information on the ES-400 and standard digital kits circle No. 43 on the Reader Service Coupon. ■

TICK TOCK TAPS ARE BLOWN BY QUARTZ CRYSTALS

The latest craze in jewelry across the country is the super-accurate, and tick-tock-less, electronic watch. Why all this interest in electronic watches, and when will the price be more in the range of the general public? Well, the forecast is that by 1980 at least one-third of worldwide watch production will involve quartz-crystal electronic designs, selling for as little as $25.

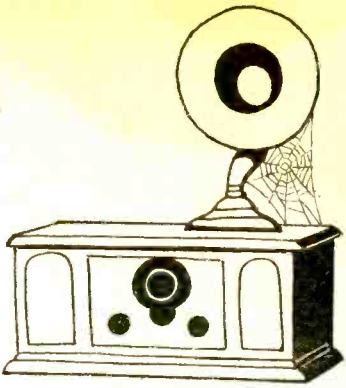
The electronic watch supplants the traditional watch's array of gears, levers, pinions and other assorted hardware. The time can be displayed in digits, and the electronic watch offers a degree of accuracy said to be 10 times better than that of mechanical or electromechanical watches on the market.

Basically, here's how the new solid state digital watches work: A quartz crystal replaces the traditional spring-driven balance wheel. Quartz—when electronically stimulated—oscillates at 32,000 times a second, compared with only 2½ times a second for the conventional balance-wheel mechanical watch. A tiny integrated circuit divides these oscillations down to electronic pulse rates for hours and minutes. The pulses are then transmitted to activate the display, which tells you what time it is. ■



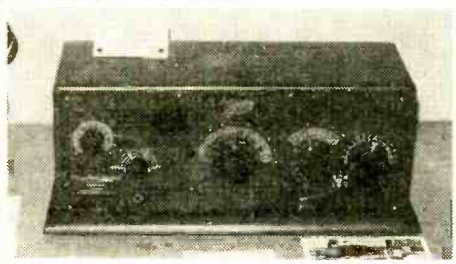
Here is an enlarged view of the complex circuitry within a Pulsar electronic watch. A quartz crystal oscillates 32,000 times a second. Although the outline of unlighted diodes appears as 18:88, only the proper segments of these diodes light up to show the correct time when the watch is in operation.

ANTIQUE RADIO CORNER



by James A. Fred

☐ Hello out there in radio land! It seems as if all the radio collectors were away on vacation this past summer. No one wrote me any letters. I know there is more action in the winter in restoring radios and like equipment, but summertime with all the travel connected with vacations should have produced many wonderful finds in flea markets, antique stores, and junk shops. Did you make it a habit of stopping every time you passed one of these places? I was returning from a trip to Ohio this past summer and stopped at a roadside second hand store. The owner had four old car



This 1923 Zenith receiver was on display at the AWA summer conference at Purdue University, West Lafayette, Indiana.

radios, six old automobile lamp bulbs with a tip on top, still in good working condition, a six-tube Splitdorf battery radio, circa 1923, and a horn and reproducer from an old phonograph. You see you can never tell what you will find in a store of this kind.

We had a very enjoyable visit with many of our readers at the AWA summer conference at Purdue University. Correspondence and telephone conversations are nice, but are never as good as an eye-to-eye visit with a fellow collector. The host for the conference was the Indiana Historical Radio Society. Over 70 members of the AWA and IHRS attended the meeting.

Exhibits of Magnavox, Zenith, Crosley, Radiola, Atwater Kent, de Forest, and Kennedy were enjoyed by the visitors. Slide shows were presented on Crosley and the Jack Gray Museum, on Radiola, on 100 years of brass pounding, and others. A banquet honoring the 100th anniversary of the birth of Marconi closed the meeting. Bruce Kelley, secretary of the AWA, was the featured speaker.

The Jack Gray Radio and Wireless Museum located at Mason, Ohio will be incorporated into the new studios of educational TV station WCET now being built near Cincinnati. The museum will then be reopened to the public.

I know that many of you collectors have Magnavox horns, and other early equipment that had a Magnavox decal on it. I have good news for you if the decal needs to be replaced. The Magnavox Company has tooled up to reproduce the decal that can't be told from the original. See your local Magnavox dealer for an order blank so you

This Balkite Trickle Charger is a real antique, and a simple device, too. The transformer is in the can on the left; the electrolyte is in the glass jar.

may order them.

Dayton Hamvention. As I mentioned last year, one of the events you should never miss, if you live within driving distance of Dayton, Ohio, is the Dayton Hamvention and electronic fleamarket. It is probably the largest one held in the United States. This year was no exception, and one of the first items I found and purchased was a Belkite Battery Trickle Charger. I would like to tell you something about it.

As you can see from the photographs it consists mostly of a tall steel container that houses a transformer and a small glass jar. The charger was patented on May 27, 1924 by the Fansteel Products Co. Inc., North Chicago, Illinois. It is rated at 4 to 6 volts and .5 to .65 amperes.

Normally when a battery radio was turned off in the evening the charger was turned on to replace the energy used while the family was listening to the radio. The charging rate was set so low it could be left connected to the battery for long periods of time.

It was known for many years prior to 1924 that certain metals when immersed in various liquid solutions would permit current to flow in one direction only. This rectifying action produces a pulsating direct current which is useful for charging lead acid storage batteries. Aluminum, tantalum, and lead are some of the metals that possess this property. Some solutions or electrolytes that can be used are ammonium phospate or borate, dilute sulphuric acid, and common borax. As the rectifier operates it is only necessary to replace water as the electrolyte evaporates. The maximum working voltage of this electrolytic cell is 40 and the current density is 40 to 50 milliamperes per square inch of aluminum electrode.

ANTIQUE RADIO FACT SHEET

☐ Collectors of antique radio and wireless equipment can get a Fact Sheet from Elementary Electronics which includes information on antique radio publications and clubs, and a listing of public and private radio and wireless museums. To get your copy send a long stamped self-addressed envelope to Antique Radio Corner, ELEMENTARY ELECTRONICS, 229 Park Avenue South, New York NY 10003. ■

The charger I purchased had no electrolyte, but it did have a tantalum wire electrode and a round lead electrode. Since borax was the easiest obtainable material, I made a saturated borax solution and poured it into the jar. I connected the motorcycle battery, mentioned in the July-August issue of Elementary Electronics, to the charger. An ammeter connected in series with the battery and charger showed 20 milliamperes of current flowing. Since this was much below the rating shown on the nameplate, I concluded that some material other than borax should be used with the tantalum wire.

With this thought in mind I prepared a strip of aluminum ½-inch wide by .050-inch thick and put it in place of the tantalum wire. It was necessary to form an oxide film on the aluminum before any rectifying action would take place. To form the electrode

(Continued on page 97)

Julian Stark and Warren Johnson are putting the finishing touches on the switch box for the horn speaker contest at the meeting of the IHRS at Fort Wayne, Indiana.

MODERN CIRCUITS INSIDE CB

How CB fights crystal controlled inflation!

by the Elementary Electronics Editorial Staff.

☐ In previous installments of this series we've shown how the transmitter and receiver circuits work, and we've discussed how a specific design might be of particular importance to *your* CB application. A common thread when discussing these circuits has been crystal controlled single frequency vs. frequency synthesizers.

In this issue we'll go into the *why* and *how* of single frequency and synthesizer oscillators; we'll also look at *noise limiters*, because if you can't hear through the noise you might as well go look for a telephone.

The least expensive form of frequency control in transceivers of substantially less than full-23 coverage (say, 6 channels) is the crystal controlled oscillator. Each channel requires two crystals, one for the receiver oscillator and one for the transmitter. You usually buy these crystals in matched pairs for a particular model transceiver or a particular type of transmitter. Many crystals work in many different models. A pair of crystals usually costs well under $10, and if all you need is single channel coverage you don't pay for coverage you don't need. Similarly, if you need coverage on two or three channels, again, you have a minimum investment.

Mushrooming Bucks? But what about the CBer who wants full-23 coverage? If we stick with designs requiring a pair of crystals for each channel, the rig would require at least 46 crystals, their basic price would add at least $100 to the total transceiver cost!

We cut selling prices of modern 23 channel CB transceivers by using a crystal synthesizer to reduce the total number of crystals needed for full coverage. It is possible— as we mentioned in previous installments—to mix the outputs of two oscillators, or signals, together to produce a third signal (this is the principle of superheterodyne receivers). By extensive use of oscillator output mixing, or "beating" as it is commonly termed, we can secure full-23 coverage with only 16 crystals; fewer if we're willing to use some tuned, rather than crystal-controlled, low frequency oscillators.

Figure 1 shows how a typical crystal synthesizer works. Oscillator 1 has twelve switch-selected crystals; oscillator 2 has two crystals selected by switch S1b, which is controlled by switch S1a; oscillator 3 also has two crystals, selected by switch S1c. At all times switch S1 determines which crystals are used for all three oscillators.

For illustration, assume we want to receive channel 1, which is 26.965 MHz. Channel selector S1 will select the 38.275 MHz crystal for osc. 1; the 11.310 MHz crystal for osc. 2; and the 11.765 MHz crystal for osc. 3. The signal arriving at the receiver's antenna is 26.965 MHz.

Here's How. First, the received signal of 26.965 MHz "beats" in the first mixer with the 38.275 MHz signal from osc. 1. One of the products of beating the two signals is a mixer output of 11.310 MHz (the difference between 38.275 and 26.965 MHz). Then the 11.310.MHz signal is fed to mixer 2 where it beats with the 11.765 MHz output from osc. 3. One of the output signals of

mixer 2 is 455 kHz (the difference between 11.765 and 11.310 MHz), which is fed to the receiver's IF amplifier. Note, incidentally, that because of the two required receiver mixers the receiver is automatically double-conversion.

For the transmitter channel 1 signal, the outputs of oscillators 1 and 2 are beat in mixer 3. The difference between 38.275 and 11.310 MHz is 26.965 MHz, so this mixer output becomes the drive signal for the transmitter.

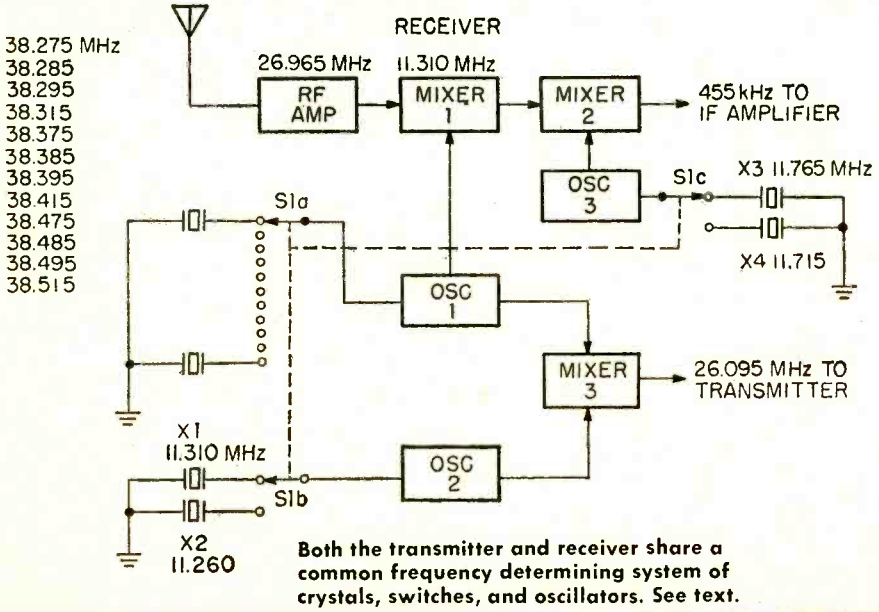
Note that the 38.275 MHz crystal also serves for channel 5 when S1b switches in the 11.260 MHz crystal for osc. 2. Just for fun, take time out to figure which crystal combinations serve for what channels.

If you've done the pen and pencil work, you'll discover a frequency combination which isn't an authorized CB frequency. Generally, the transceiver's channel selector will have an uncalibrated blank space for this frequency. And if you're on your toes you should be asking about the other output frequencies from the mixers; after all, we've been referring only to the difference frequencies. What of the sum frequencies, and the signal fundamental frequencies? Normally, the signal and sum frequencies lie outside the bandpass of the succeeding circuits and are not a problem. For example, the total signal output of mixer 1, when the receiver is tuned to channel 1, is 26.965 MHz, 38.275 MHz, 65.240 MHz (sum) and 11.310 MHz (difference); obviously, the other signals are so far removed from the desired 11.310 MHz they will be filtered by the normal tuned circuits of the mixer 2 input.

Keeping It Clean. When there is the possibility that harmonics of the mixer's output will beat with any other mixer output signal, including harmonics of harmonics, which could cause interference problems, the mixer's output will be passed through a bandpass filter to remove everything except the desired signal.

A logical question at this point is: "Where are the savings? Isn't the cost of the extra oscillators and mixers equal to or greater than the cost of the unneeded crystals?" The answer is *no*. A double-conversion receiver requires two local oscillators and two mixers —no more than used for a crystal synthesizer. The transmitter would still require an oscillator so the only "extra" stage is the mixer which often replaces a buffer amplifier; so again there are no extra circuits. When the mixer does not replace a buffer, it's an extra, but the cost of one transistor and a few components is actually *less* than the cost of one crystal—and the synthesizer saves at least 30 crystals!

To further reduce costs in this age of the



Both the transmitter and receiver share a common frequency determining system of crystals, switches, and oscillators. See text.

shrinking dollar, some manufacturers now replace the two crystals needed for the receiver (osc. 3) with a fixed-tuned circuit, reducing the total number of crystals to 14. Savings are reflected in a lower transceiver price.

One manufacturer goes so far as to provide optional full-23 coverage through the use of a synthesizer. The rig is sold with the necessary crystals for oscillators 2 and 3, but only one crystal for osc. 1, which therefore provides coverage for *two* channels. The user can purchase crystals for additional channel coverage as required; but keep in mind that (generally) one additional crystal provides transmit and receive for two channels. The cost advantage is obvious.

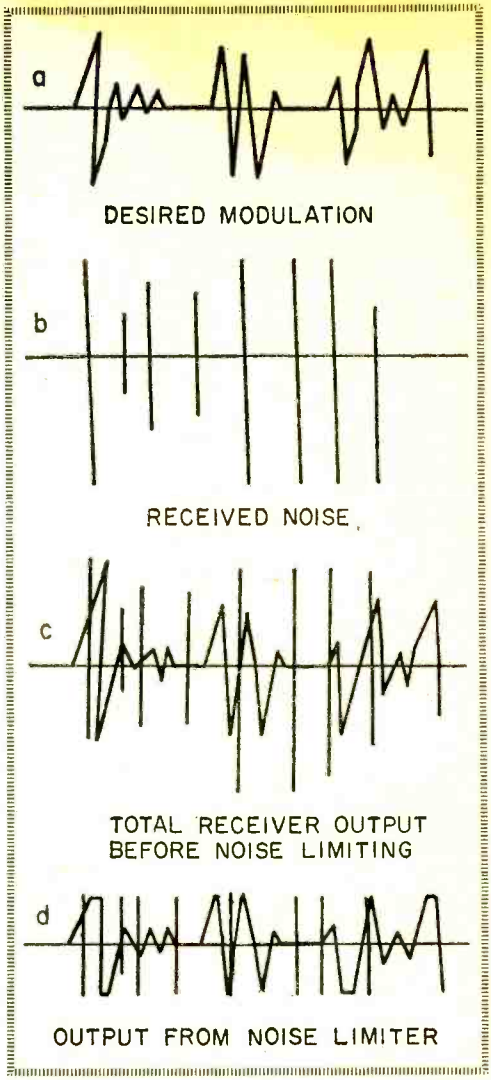
Noise Limiters. Frequencies assigned to the Citizens Band are among the noisiest in the whole radio spectrum. Everything from automobile ignition systems and medical equipment to the neighbor's sewing machine and electric drill produce enough hash to literally drown out a weak CB signal. Most noise is primarily *impulse noise*—sharp noise spikes received simultaneously with the desired signal, and all CB transceivers incorporate some sort of device to attenuate or actually remove the noise impulses.

The simplest form of noise limiter is the so-called floating series or parallel type, and it's unimportant to know precisely how they work; rather, it's important we know their limitations

Both limiters do exactly what they say, they limit the amplitude of the noise impulses to a tolerable level. Figure 2 shows how they work. Figure 2a is the desired modulation from the received signal. Figure 2b shows, separately, the noise impulses received along with the signal. Figure 2c is the resultant audio output before processing by a noise limiter. Figure 2d is the final audio heard in the speaker after limiting.

Note that the combined unlimited output shown in Fig. 2c has noise pulses of greater amplitude than the desired modulation: it is these high level impulses that create the "grind" which irritates the listener and obscures the intelligence.

When limiting is applied for noise reduction, the maximum amplitude of the signal is allowed to approach between 50 and 80 percent of the maximum peak value; everything above this ceiling is clipped off the signal, as shown in Fig. 2d. In this manner the noise impulses are limited to a maximum value equal to the maximum peak



Impulse type noise depicted here in (b) is formed by both man-made sources (auto high voltage ignition) and natural (lightning).

modulation level. Since the modulation itself is peak limited, some distortion is added to the signal, but more importantly, the noise "grind" is sharply reduced.

Old Days. Some early gold-plated-special CB transceivers employed an adjustable noise limiter whereby the limiting ceiling could be established by the user. Naturally, the lower the ceiling the greater the noise reduction, and the greater the audio distortion. Operators using maximum limiting for maximum noise suppression also suffered maximum audio distortion, and their complaints of "excessive distortion" to the manufacturer's resulted in the elimination

(Continued on page 76)

EXPERTS AGREE
The TV of the future is here... in the Heathkit Digital-Design GR-2000 TV

"At **ELEMENTARY ELECTRONICS** they said: "The fact is, today's Heathkit GR-2000 is the color TV the rest of the industry will be making tomorrow... there is no other TV available at any price which incorporates what Heath has built into their latest color TV."

The **FAMILY HANDYMAN** reviewer put it this way: "The picture quality of the GR-2000 is flawless, natural tints, excellent definition, and pictures are steady as a rock. It's better than any this writer has ever seen."

POPULAR SCIENCE pointed out "more linear IC's, improved vertical sweep, regulators that prevent power supply shorts, and an industry first: the permanently tuned I.F. filter."

The **RADIO-ELECTRONICS** editors said the Heathkit Digital TV has "features that are not to be found in any other production color TV being sold in the U.S.:

"On-screen electronic digital channel readout ...numbers appear each time you switch channels or touch the RECALL button... *On-screen electronic digital clock*... an optional low cost feature... will display in 12- or 24-hour format... *Silent all-electronic tuning.* It's done with uhf and vhf varactor diode tuners ... *Touch-to-tune, reprogrammable, digital channel selection*... up to 16 channels, uhf or vhf... in whatever order you wish... there's no need to ever tune to an unused channel. *LC IF amplifier* with fixed ten-section *LC IF bandpass filter* in the IF strip... eliminates the need for critically adjusted traps for eliminating adjacent-channel and in-channel carrier beats. No IF alignment is needed ever. *Touch volume control*... when the remote control is used... touch switches raise or lower the volume in small steps."

POPULAR ELECTRONICS took a look at the 25-in. (diagonal) picture and said it "can only be described as superb. The Black (Negative) Matrix CRT, the tuner and IF strip, and the video amplifier provide a picture equal to that of many studio monitors..."

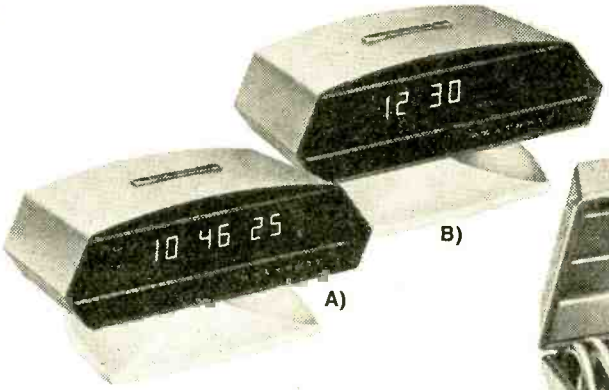
Furthermore, the Heathkit GR-2000 is an easier kit-form TV to build. **POPULAR ELECTRONICS** pointed out that "Each semiconductor has its own socket and there are 12 factory-fabricated interconnecting cables... The complete color adjustments can be performed in less than an hour."

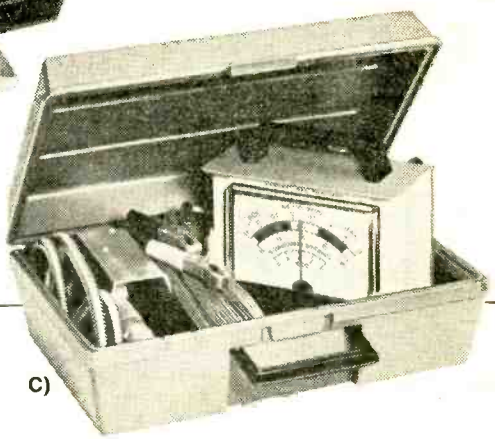
To sum up, **POPULAR ELECTRONICS** concluded its study by stating, "In our view, the color TV of the future is here — and Heath's GR-2000 is it!"

Why not see what the experts have seen? The Heathkit Digital Design Color TV — without question the most remarkable TV available today.

Mail order price for chassis and tube, $669.95 Remote Control, $89.95 mail order. Clock, $29.95 mail order. Cabinets start at $154.95. (Retail prices slightly higher)."

TOMORROW'S PRODUCTS are in kit-form today- with Heathkit electronics





(A) New Heathkit Digital Electronic Alarm Clock. Like no other clock you've ever owned ...with features as new as tomorrow! Wakes you with an electronic "beep" and shuts off at a touch — no fumbling for knobs or switches. And if the power goes off, you still get to work on time — the clock has its own emergency battery supply. Other features are a 24-hour alarm cycle with AM indicator light to aid in setting; 7-minute repeatable snooze cycle; 12 or 24-hour time format; automatic brightness control. Kit GC-1092A, 82.95*. Shipping weight, 5 lbs.

(B) New Heathkit Digital Electronic Calendar/ Clock. In this unique timepiece, we swapped the alarm feature for the date — and held the same low price featured in its alarm clock twin. Reads out the time in hours, minutes & seconds, with big orange digits. Plus, it gives you the month and day, either automatically for 2 seconds out of every 10, or anytime at the touch of an electronically activated control. It also features 12 or 24-hour time format, automatic brightness control, and built-in fail-safe reserve battery supply. Kit GC-1092D, 82.95*. Shipping weight, 5 lbs.

(C) New Heathkit Exhaust Gas Analyzer. A timely kit for the week-end mechanic and the professional alike. Checks exhaust gas of cars for pollution level and measures air/fuel mixture to help you tune for top economy. Also a great training aid in automotive mechanics classes for demonstrating results of proper anti-pollution system adjustments. Easy to assemble, simple to use. Kit CI-1080, 59.95*. Shipping weight, 6 lbs.

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CIRCLE NO. 1 ON PAGE 17 OR 103

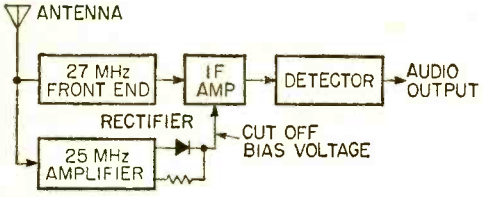
INSIDE A MODERN CB SET

(Continued from page 71)

of the adjustable limiting feature. Today most CB transceivers use a "floating" limiter which automatically establishes an acceptable limiting level depending on the strength of the received signal. It's not the best limiting but it's not the worst—it's adequate for most users.

Ultimate noise suppression is obtained from a "noise suppressor," a special type of circuit which actually punches a "hole" in the received signal where a noise pulse normally would be. These holes have little effect on modulation distortion, but are almost 100 percent effective at reducing sharp impulse noise. Some manufacturers have described their ordinary noise limiters as "suppressors", but that's like comparing watermelons with lemons.

And Today. . . . There are several types of noise suppressor circuits; the easiest to understand is the "RF suppressor" shown in Fig. 3. (All suppressors work on essentially the same principle.)



Perhaps the finest form of noise eliminator in CB is the RF-type employing a separate front end at 25 MHz that listens for "noise."

Note that in addition to the receiver's normal front-end (RF amplifier, oscillator, and mixer), a 25 MHz RF amplifier is also connected to the antenna. The noise impulses received at 25 MHz are essentially identical to the noise impulses at 27 MHz; since there is little, if any, broadcasting activity around 25 MHz the output of the 25 MHz amplifier will be noise. (The actual "noise frequency" is selected for an unused part of the radio spectrum.)

The output of the 25 MHz amplifier is rectified into DC voltage pulses corresponding to the received noise impulses. This voltage (or current, depending on receiver design) is used to bias the receiver IF amplifier to cut-off, so no signal can pass through the IF amplifier when a noise impulse is received. (Often, a separate noise-gate is inserted in the IF amplifier which is "closed" by the DC voltage pulses.) Each time the IF amplifier is cut off, a "hole" is punched in the received signal. Since the noise impulses are of very short duration in relation to the modulation, there is little, if any, distortion added to the received signal.

The noise suppression rectifier is usually designed only for sharp impulse noise. Long-term noise would produce a cut-off which would interfere with the received signal. To accommodate both short and long duration noise a noise suppressor is teamed up with a limiter, so the limiter can handle long duration noise. Together they provide the best possible noise suppression, though the extra circuits needed for the suppressor do increase the selling price.

Final Limiter Facts. A question often asked by many readers is: "Why do some transceivers have noise limiter switches?" The switch really serves no useful purpose unless you're operating on a mountain miles from man-made noise sources, and even then the normal atmospheric background noise might still require noise limiting. The only purpose of the noise limiter switch is to convince the user the noise suppression circuits are really working. No matter how bad the noise interference might be on your transceiver, it would be a lot worse without some form of noise reduction.

Only one manufacturer ever produced a CB rig without a noise limiter, and that was a mistake in design: the design engineer simply forgot about the noise limiter until after the unit went into production! Attempts to add a limiter to the finalized printed circuit board produced barely perceptible noise reduction and the transceiver was a failure—the few early purchasers quickly spread the word and an informed CBer wouldn't touch one with a 15-foot pole. Effective noise limiting is the first consideration in any transceiver design.

Next issue we'll discuss "talk power"—how you get the most effective modulation, and how you can take a weak, unreadable signal and turn it into a "wall of sound" without raising transmitter power. ■

Have you heard about the new ruling by the FCC about antenna height? It's official! We CBers can use a tower to boost our antenna as high as sixty feet above the ground. You cannot use a tower on, say, your house roof, and it must be an "omni' type to qualify for topping out at sixty feet; keep your directionals to 20 feet to comply. —*Kathi*

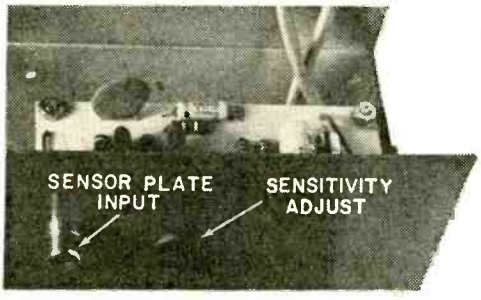
Better home safety through hobby electronics...

electronic INTRUDER DETECTOR

Easy to build proximity sensor adds to existing burglar alarm!

by Charles Rakes

IF YOUR PRESENT burglar alarm system is lacking in a variety of input sensors, because the expense of the better motion and capacity activated sensors is above your budget, then consider building our ID proximity sensor. The ID proximity sensor will operate with *any* alarm system that uses a *normally closed sensor* circuit (99% do). An important feature of our proximity circuit helps to make it quite simple for you to build—no coil of any type is required in the oscillator detector circuit. I doubt that you will find one like it anywhere. Also, this sensor will work hand-in-hand with the alarms as presented in the March-April 1972 issue of ELEMENTARY ELECTRONICS.



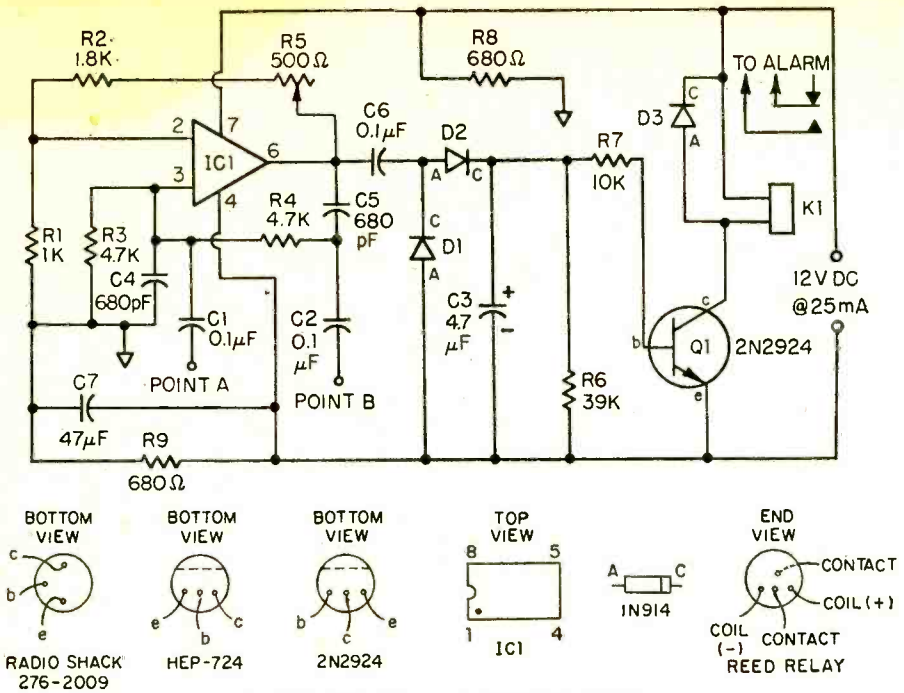
The two wires you see at the rear are for 12 VDC power to operate the unit and a two wire cable from the normally open relay.

What Can It Do? With the ID sensor you can protect almost any metal object that can be isolated from earth ground—file cabinets, safes, window screens, door knobs, metal plates located under rugs, metal cookie jars! It can even be used to test your reflexes.

Here's what makes it tick. A single IC is connected in an RC high frequency oscillator circuit that is operating near the cut-off frequency of the device. Potentiometer R5 sets the feedback level just within the point needed to sustain oscillation. The RF signal produced at the output of the IC (pin 6) is fed to D1 and D2 which supply a forward bias current to the base of Q1 to keep the relay energized. With a metal object connected to the input of the sensor, and when an object is moved in close proximity to this metal object the capacitance to ground is increased which unbalances the capacitance between C4 and C5. This causes the oscillator to stop and the relay drops out (opens).

Putting It Together. The sensor may be constructed in any metal or plastic cabinet, but if the PC board is used, a cabinet 2½- x 4¼- x 2-in. is necessary to make the project neat.

If a PC board isn't used, try to follow the general layout of the PC board to



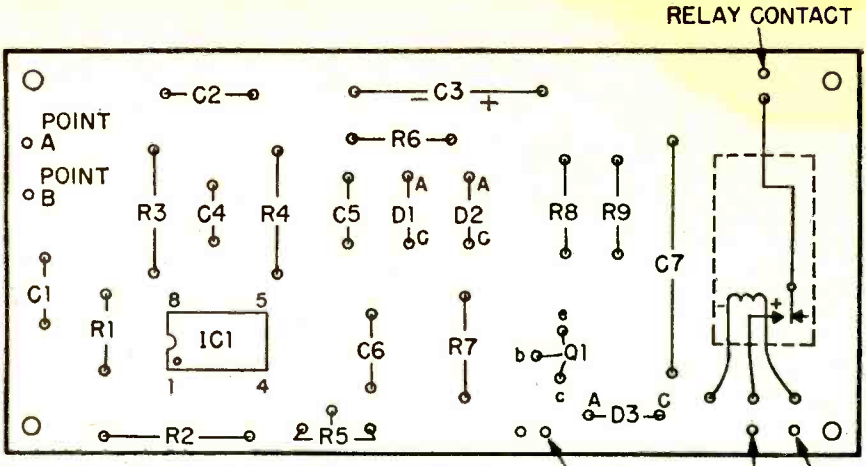
PARTS LIST FOR A PROXIMITY SENSOR

C1, C2, C6—0.1 uF capacitor, 16 VDC or better (Radio Shack 272-1069 or equiv.)
C3—4.7 uF electrolytic capacitor, 16 VDC or better (Radio Shack 272-1001 or equiv.)
C4, C5—680 pF disc capacitor, Sprague 5GA-T68, Mallory GP-368, Allied 710-1068, etc.
C7—47 uF electrolytic capacitor, 16 VDC (Radio Shack 272-1004 or equal.)
D1 to **D3**—1N914 silicon diode (Motorola HEP-R0052 or equiv.)
IC1—741-type integrated circuit, any convenient type for point-to-point wiring, 8-pin mini-dip package for PC board use (Radio Shack 276-007 or equiv.)
K1—Relay, low current 12 VDC coil, Electronic Applications Co. 1A12AH fits PC board (reed-type relay) Radio Shack 275-003 for point-to-point wiring
Q1—2N2924 transistor, HEP-724, Radio Shack 276-2009, etc.
R1—1000-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
R2—1800-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
R3, R4—4700-ohm, ½-watt resistor (Radio Shack 271-00 or equiv.)
R5—500-ohm potentiometer, PC-type (Radio Shack 271-226 or equiv.)
R6—39,000-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
R7—10,000-ohm, ½-watt resistor (Radio Shack 271-00 or equiv.)
R8, R9—680-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
Misc.—Wire, solder, 3½- x 4½- x 2½-in. high case, phono jack, hardware, etc.

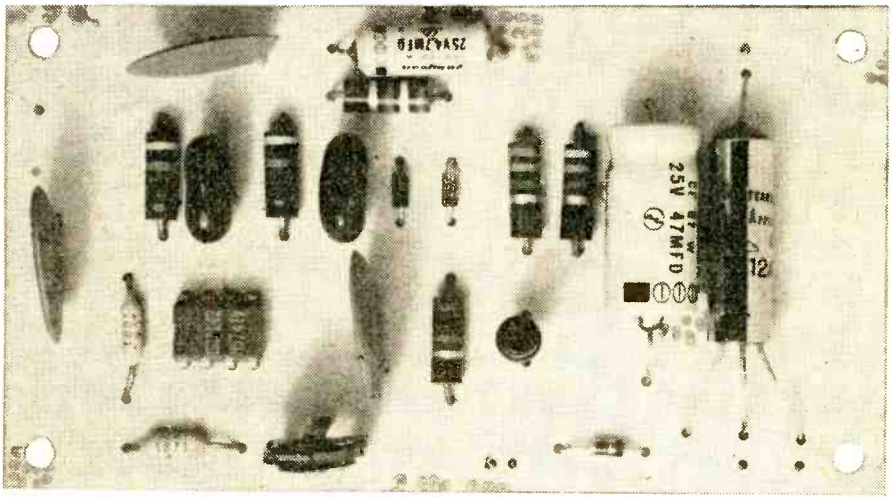
An etched and drilled printed circuit board for this project plus reed relay K1 are available for $7.70 postpaid from Krystal Kits, P.O. Box 445, Bentonville, AR 72712; printed circuit board available separately at $3.95, postpaid. Postal money orders will speed delivery. Otherwise allow 6-8 weeks for delivery. Canadians add $1.50 for additional postage.

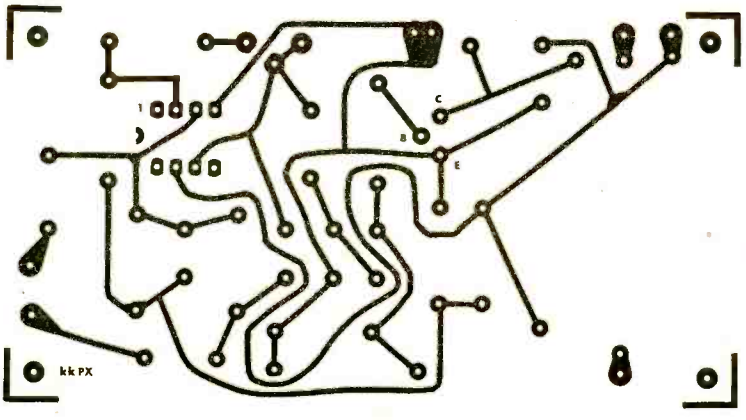
avoid any circuit operating problems. If the PC board approach is used, follow the component layout diagram to mount all parts on the board, then solder all parts in place. Take extra care when installing the semiconductors—be sure that each lead is in the proper location *before* soldering. A ¼-in. hole should be drilled in the cabinet to allow adjustment of the sensitivity pot R5. A phono jack is mounted in the front of the case and connects to the sensor input lead. The power input leads and relay wires run through the back of the cabinet.

Putting It To Use. A choice of inputs are available; input A is suited for small metal objects while input B is to be used for large objects. The selected input is wired to the phono jack mounted on the front of the cabinet. Circuit common (that's the negative battery lead) must be connected to a good earth ground such as a water pipe or the ground wire in a three wire electrical system if the sensor is to operate properly. The



Bigger than life view (above) shows completed PC board with reed relay. Place C7 negative lead in hole nearest diode D3. Hole next to "-battery" is circuit common; connect to ground. See text. The minus side of battery (left) connects to Q1 (e).





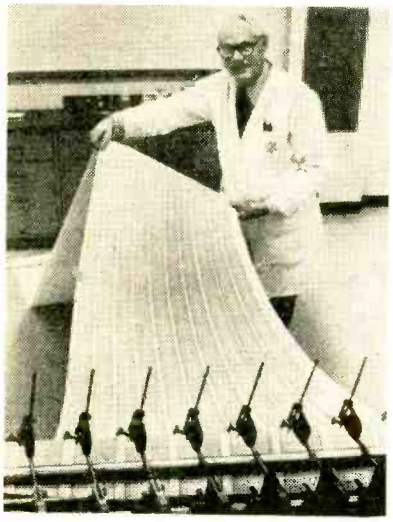
Flip the PC board (shown above) and the copper wiring pattern looks like the drawing at left. In fact, it's an exact size duplicate for those builders inclined to make their own.

newscan

Electronics in the News!

Faking Mother Nature

Right now, in the heart of New Jersey, they're faking Mother Nature by turning on and off the intense light of a desert sun, the ocean's salt spray, and the humidity of an equatorial rain forest. "They" are the people in the mechanical testing laboratory at Western Electric's Springfield, New Jersey Purchased Products Engineering (PPE) and Inspection facility. It's their job to test, inspect and, whenever they can, improve the products Western Electric purchases for the Bell System.



Ball point pen refills are kept drawing concentric circles for their entire writing lives in the pen testing machine. To meet standards, that writing life has got to be long enough for the refill to draw a continuous line of no less than 5,000 feet.

Lab personnel check over 5,500 products . . . things like batteries, phone booths, circuit boards, pole line hardware, capacitors, ladders, and aerial tents.

These products are used throughout the U.S., so they must perform under a wide range of environmental conditions. Instead of carting products from one geographic point to another for testing, the PPE staff uses machines that recreate operating conditions like high and low altitudes, dense humidity, and extreme temperatures in their mechanical testing lab.

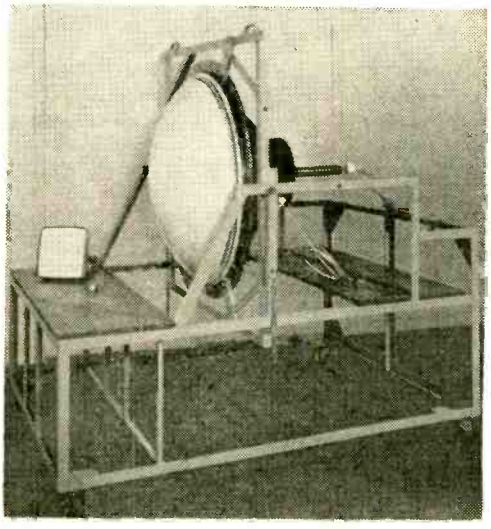
Fakery? Yes. But no fooling. A product will have to withstand more punishment in the lab than it will ordinarily encounter in the field. For example, the lab staff can subject products to extreme heat and cold in an environmental chamber that produces temperatures from –40°F to 300°F. In another chamber, products have to stand up to 98 percent humidity.

Then there are the "your-life-flashes-before-your-eyes" machines like the chamber whose high oxygen atmosphere speeds up aging and corrosion. Or take the ball-point pen tester. Pen refills spend their entire writing lives drawing concentric circles on test paper in this machine. To measure up to WE standards, that writing life has got to be long enough for the refills to draw a continuous line of at least 5,000 feet.

Inks and other products that must be color fast also get a lifetime's worth of wear in the lab's weathering machine. A 24-hour exposure to the machine's ultraviolet light is the equivalent of one month in the brightest sunshine. Naturally, the weathering machine simulates rainfalls at timed intervals.

Big Is Big

The world's largest cathode ray tube has been developed by Thomas Electronics Inc. for the U.S. Air Force. The complete CRT, weighing 226 lbs., including implosion panel, magnetic shield, and mounting flanges, will be used in an advanced simulator during undergraduate pilot training research to produce visual images of flight situations. Seven CRTs are combined to provide a unique panoramic field of view for student pilots. *(Turn to page 99)*



World's largest cathode ray tube (shown with a 10-in. model) will be used by the U.S. Air Force during research for undergraduate pilot training.

e/e checks out...

Lafayette's new AM/FM Tuner

Model LT-D10 also processes Dolby encoded broadcasts!

WITH FM TUNERS getting more and more sensitive, there are a lot more people listening to stations whose signal is received just over the noise level. For this reason, and to increase the listening audience, many FM stations now use Dolby signal processing, so that marginal signals can be received noise-free, *if* the listener has a Dolby decoder connected to his FM tuner. Unfortunately, if the listener doesn't have a Dolby decoder, the full-time Dolby FM station is received with screaming highs, and no amount of tone control juggling is going to get the signal back to its original state.

Good Dolby FM receivers usually carry a price tag to match their improved performance, but with the introduction of Lafayette's model LT-D10 AM/FM Dolby tuner, quality reception, FM and Dolby-FM, is available at a budget price; and as far as our tests indicate, the AM performance is among the very best.

The LT-D10, priced at $229.95, is basically an AM/FM-stereo tuner with a switch-selected Dolby decoder for FM. Standard features include a stereo beacon, center channel FM and signal strength AM/FM tuning meters, an MPX filter, an FM mute, and an internal "linecord" FM antenna in addition to the 300-ohm antenna input. A rod antenna and external connection are provided for AM. An extra feature is a panel lamp dimming switch.

Select-a-Slope. The Dolby, which functions only for FM reception, is selected by a front panel switch. For standard FM reception the de-emphasis is always the U.S. standard of 75 *u*sec. When the Dolby is switched in, the de-emphasis can be 75 *u*sec or 25 *u*sec, as determined by a switch on the rear apron. Presently, all FM stations use 75 *u*sec pre-emphasis as specified by the FCC. It has been proposed that Dolby FM stations be permitted 25 *u*sec pre-emphasis so they might raise their average level of modulation, thereby expanding their coverage (reception range). If the FCC does, in the future, permit use of 25 *u*sec pre-emphasis for Dolby, the Lafayette LT-D10 will be ready for it without making modifications to the tuner.

Three outputs are provided. The one for the main amplifier has individual left and right level adjustments, which are recessed screwdriver-adjust controls on the rear apron. There is also a fixed-level tape output on the rear. The tape output is also available at standard phone jacks on the front panel.

The LT-D10 AM/FM Dolby tuner is from Lafayette Radio Electronics, 111 Jericho Turnpike, Syosset, L.I., NY 11791. Price is $229.95. Circle No. 41 on the Reader Service Page for more information.

Lafayette's forword thinking engineers made this Dolby equipped FM tuner complete with 25 *u* sec/75 *u* sec de-emphasis switch. Since then, FCC regulations have changed to permit the 25 *u* second de-emphasis characteristic in U.S. FM transmitters. For more information, see next page and circle No. 41 on the Reader Service page.

e/e LAFAYETTE AM/FM TUNER

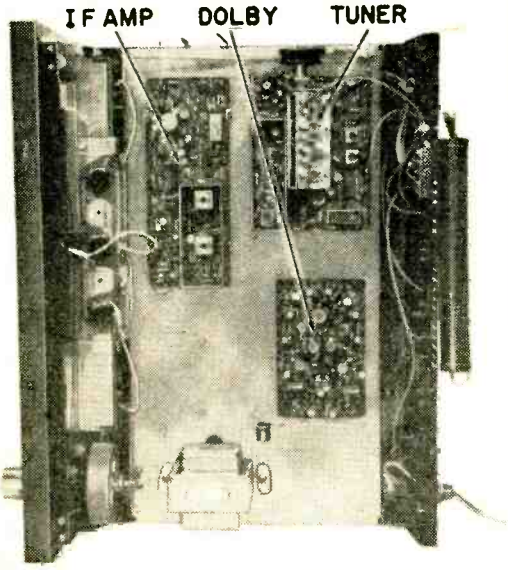
The circuit is as modern and up-to-date as is possible. The front-end has an FET RF amplifier and mixer which results in essentially overload-resistant reception. The front-end output passes through IF filters for excellent selectivity and through an all-IC IF amplifier and multiplex decoder.

Except for the oscillator, the AM tuner is a single IC with an IF filter.

Performance. Sensitivity of the FM tuner was at least as good as tuners priced considerably higher, measuring 1.6 μV IHF, with full limiting at 5 μV. The high-fidelity sensitivity (60 dB quieting) was 8 μV. Full mute release was attained with 7 μV. The frequency response was notably flat: +0/−0 .5 dB from 20 to 15,000 Hz. Distortion at standard test level was 0.25% THD; signal-to-noise ratio was 67 dB without the Dolby.

The FM selectivity (ability to separate stations on alternate channels) was very good even when compared to higher-priced tuners; it was excellent compared to other budget and moderate price equipment. The stereo separation measured 33 dB. Output level corresponding to 100 percent modulation (mono) was 700 mV.

The FM Dolby performance was excellent; judged on the basis of listening tests it was among the best we've heard regardless of price.

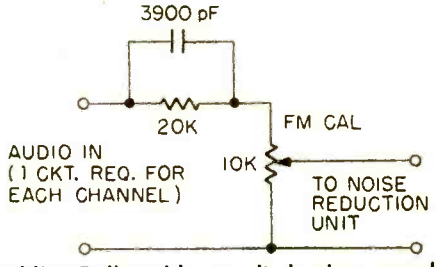


Everything in its place and on PC boards. Clean and uncluttered interior compared to old tube days with hodge-podge wires.

The AM reception was outstanding; well above average for much higher priced tuners and receivers. Of note, the AM tuner could dig out *clean* signals from AM stations usually buried in the noise level. It's an ideal choice for someone who also wants to DX the AM band.

For additional information on the Lafayette LT-D10 circle No. 41 on the Reader Service Coupon. ■

FLASH—Our lab works fast, furious, and sometimes even overtime, but the latest FCC ruling on 75-25 μsec FM pre-emphasis (the amount by which high frequency audio is boosted for transmission) caught this report "in progress" on the editor's desk. The FCC now permits FM stations to alter their pre-emphasis characteristic from the current 75 μsec figure to a more realistic 25 μsec *if* they begin encoding their broadcasts in the "Dolby B" mode of noise reduction. Such a step permits listeners with standard "75 μsec" tuners, radios, and receivers to hear a basically unchanged sound since a loss of brightness brought about by the 25 μsec pre-emphasis signal is restored by a selected boost of treble tones in the Dolby B process. The decision to go "25 + B" is entirely up to individual stations; in fact, they have the option under current rules *not* to switch. Readers with an FM tuner within range of FM stations broadcasting the new "25 + B" mode can add the simple circuit (shown below) to each channel and use an "outboard" Dolby B noise reduction system. Benefits, according to Dolby Laboratories, are one or more of the following: full-program dynamic range, improved signal-to-noise ratio, improved weak-signal reception, and a reduced likelihood of interference.



Adding Dolby without quite having enough cash or credit to get a new Dolby tuner, like the Lafayette, is possible with one of the "outboard" Dolby units and this simple home-made network. "FM Cal" is to be set so "Dolby Tone" from station gives "Dolby Level" reading on meter(s) of the noise reduction unit you are utilizing.

C/C's ALL NEW BASIC COURSE IN ELECTRICITY & ELECTRONICS

This series is based on
BASIC ELECTRICITY/ELECTRONICS,
Vol. 1, published by HOWARD W. SAMS & CO., INC.

TRANSFORMING AC

What You Will Learn . . .

Your understanding of AC electricity will now be used to show how two common electrical devices work. You will learn how a transformer transfers power from one winding to another. You will learn how to calculate the change in voltage, current, and impedance produced by a transformer with a known turns ratio, and how to select the proper turns ratio to produce a particular change. You will also learn how a magnetic amplifier controls a large AC current with a smaller DC current.

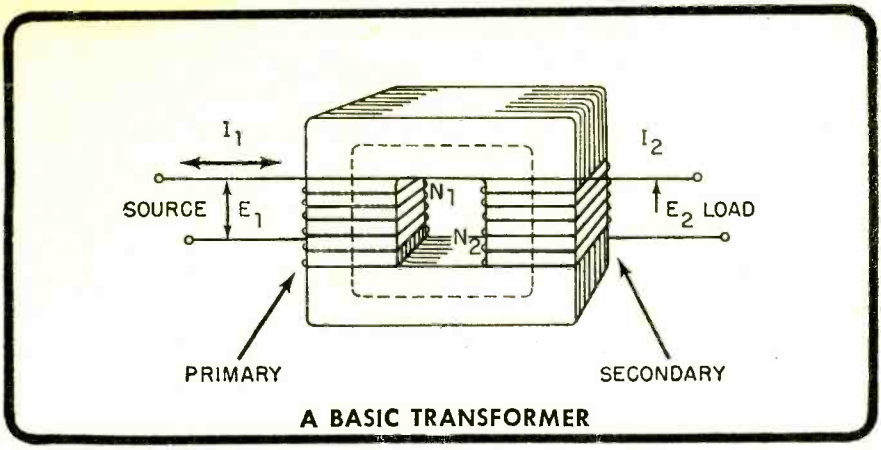
WHAT IS A TRANSFORMER?

A *transformer* is a device for changing the voltage of AC electricity. Transformers work on the principle of induction. Basically, a transformer has two windings—a primary and a secondary—wound on the same core. This core can be laminated iron, ferrite, or air.

Through the principle of *induction*, the alternating current flowing through the primary winding sets up an alternating magnetic field in the core. This magnetic field, in turn, *induces* an alternating voltage in the secondary winding (or windings). In this way, *energy is transferred* from the primary to the secondary.

A transformer that reduces the voltage in a circuit is called a *step-down* transformer. This is true, for example, of a transformer which steps the 120-volt main supply down to 6.3 volts for #47 pilot lamps or the diode bridge in a 5 volt power supply for "TTL" integrated circuits.

A transformer that is used to increase the voltage in the circuit is known as a *step-up* transformer. An example is the special high-voltage transformer which produces the many thousand volts needed to operate a television picture tube.



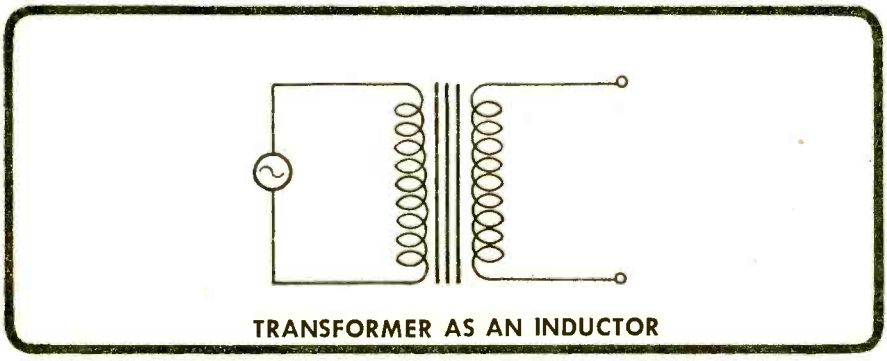
A BASIC TRANSFORMER

The basic transformer has two windings—primary and secondary—wound on a laminated-iron core. The two windings are insulated from each other and from the core.

The primary winding is connected to the energy source, and the secondary winding is connected to the load. As alternating current flows through the primary, a pulsating magnetic field is set up in the core. As the constantly changing magnetic field cuts the turns of the secondary, a voltage is induced in the secondary winding.

What Is Transfered?

The amount of voltage induced in the secondary winding depends on how many turns of wire the secondary contains compared to the number of turns of wire in the primary winding. So, if the secondary has only half as many turns as the primary winding, the voltage will be stepped down to half its original value. If the secondary has twice as many turns as the primary, the voltage will be stepped up to twice its original value.



TRANSFORMER AS AN INDUCTOR

The difference in the number of turns is known as the *turns ratio* of the transformer. If the primary winding has N_1 turns and its voltage is E_1, the secondary winding with N_2 turns produces voltage E_2.

$$\frac{E_1}{E_2} = \frac{N_1}{N_2}$$

The power consumed in the secondary circuit of a transformer must be supplied by the primary. Since the voltages are constant in each circuit, the current in the primary circuit must vary to supply the amount of power demanded by the secondary. Current in the primary depends on the current drawn in the secondary circuit.

QUESTIONS

Q1. If a transformer primary has 1,000 turns and the secondary has 6,500 turns, what is the turns ratio?

ANSWERS

A1. $\frac{N_1}{N_2} = \frac{1{,}000}{6{,}500} = 1$ **to 6.5**

Q2. If 85 volts is applied to the primary winding of the transformer in Question 1, what is the voltage at the secondary?

A2. $\frac{E_1}{E_2} = \frac{1}{6.5}$ $E_2 = E_1 \times 6.5$
$= 85 \times 6.5$
$= 552.5$ **volts**

Q3. Can a transformer be used with DC? Why?

A3. A transformer cannot be used with direct current. A direct current in the primary does not produce a pulsating magnetic field.

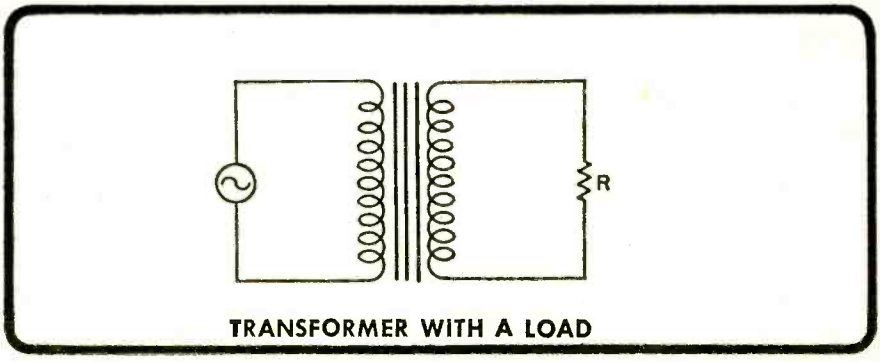
Q4. If there is no load between the terminals of the secondary of a transformer, will current flow in the secondary?

A4. No current will flow.

TRANSFORMER POWER

If the transformer were 100% efficient, all the power from the primary winding would be transferred to the secondary for delivery to the load.

Suppose a transformer has 1,000 turns in the primary and 6,500 turns in the secondary. If 100 volts is applied to the primary, 650 volts will appear at the secondary. Now, suppose the load connected to the secondary is a 65-ohm resistor. It will draw a current of 650/65, or 10 amperes, and the power consumed will be 650 × 10, or 6,500 watts. This power must be supplied by the primary winding. Assuming no loss in the transformer, the primary winding must supply 6,500 watts. The primary current, therefore, will be 6500 watts/100 volts, or 65 amperes.



TRANSFORMER WITH A LOAD

In the example, the current was stepped down in exactly the same proportion as the voltage was stepped up. The power transferred from the primary to the secondary does not change, however, regardless of the turns ratio. This is true providing the rating of the transformer has not been exceeded and assuming 100 percent efficiency.

QUESTION

Q5. How will the magnetic field produced by current flow in the secondary affect the current drawn by the primary?

ANSWER

A5. The secondary magnetic field will decrease the total magnetic field acting on the primary and, therefore, will decrease the impedance of the primary circuit. **The primary will draw more current.**

TRANSFORMER EFFICIENCY

So far we have assumed that no power is lost in the transfer from the primary winding to the secondary winding. However, no transformer has absolutely 100 percent efficiency. Some power is lost in heating the core, and some is lost in the resistance of the windings. But, transformers are very efficient; their efficiency often reaches very nearly 100 percent. Therefore, for rough calculations, it is permissible to assume 100 percent efficiency.

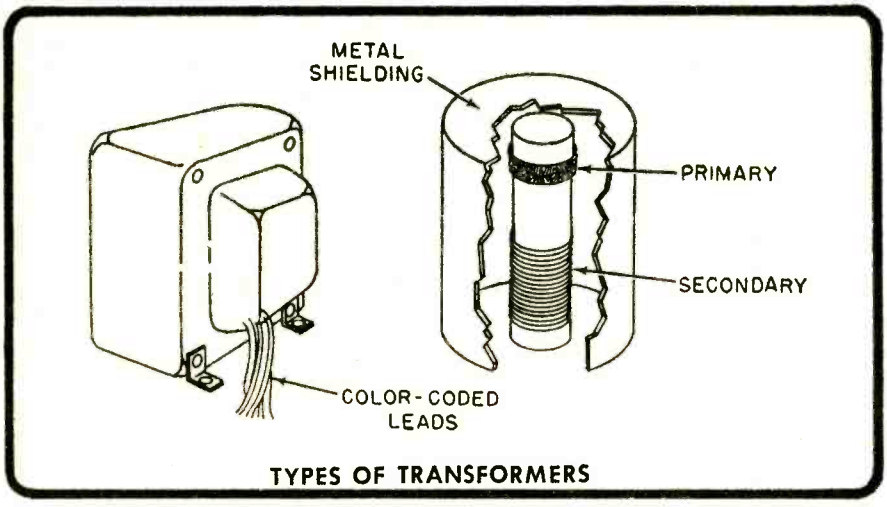
As with any other device, the efficiency of a transformer is equal to:

$$\frac{\text{output power}}{\text{input power}}$$

Most transformers have an efficiency in the range of 97 to 99 percent. So even if you neglect the losses, your calculations using 100 percent as the transformer efficiency will still be accurate within 1 to 3 percent.

TRANSFORMER LOSSES

The power loss in transformers is due to three factors. The first is simply *resistance* in the windings; no winding is a perfect conductor. The second factor that causes power loss in transformers is *eddy currents*. The iron in the core of a transformer is a conductor. When the changing magnetic field produced by the primary coil cuts through the iron of the core, small currents are generated in the core material. These currents dissipate power as they pass through the resistance of the iron. These currents are called *eddy currents*. This type of loss is held to a minimum by using thin sheets of iron, called *laminations*, in the core. These thin sheets are insulated from each other (often by oxidizing the surface of the sheets) and thus shorten the conducting path for the eddy currents.



TYPES OF TRANSFORMERS

The third factor that causes power loss in transformers is *hysteresis*. It takes a certain small amount of power to magnetize a piece of iron. This power must be expended again when the magnetic field is reversed. Since the magnetic field in a transformer is reversed many times each second, these tiny expenditures of power add up to a noticeable loss. Hysteresis loss can be reduced by constructing the core with a type of iron that is very easily magnetized and demagnetized.

QUESTIONS

Q6. If a transformer supplies 1.9 amperes at 100 volts (190 watts) to a resistive load in the secondary circuit, and if it dissipates 200 watts of power in the primary circuit,

ANSWERS

A6. The efficiency of the transformer will be 190/200 = **95%.**

what is the efficiency of the transformer?

Q7. This transformer has a relatively (high, low) efficiency.

A7. It has a relatively low efficiency. (An efficiency below approximately 97% is considered to be low.)

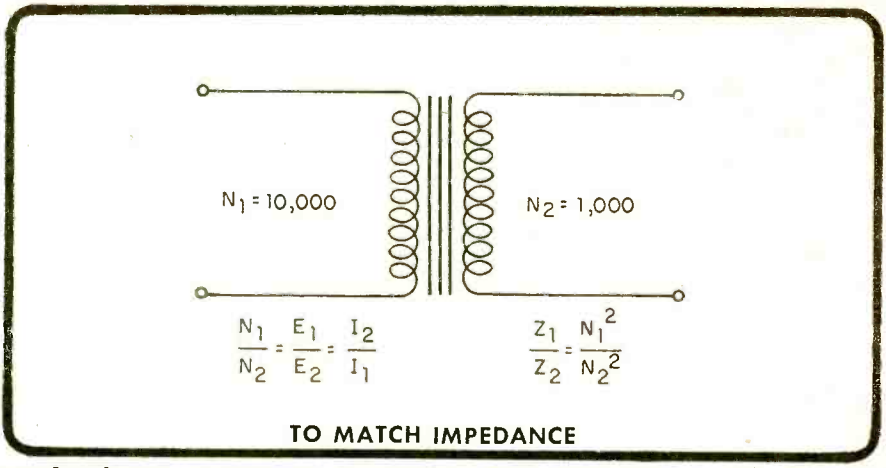
Q8. Does an air-core transformer have hysteresis or eddy currents?

A8. An air-core transformer has neither eddy-current nor hysteresis losses.

TYPES OF TRANSFORMERS

There are many varieties of transformers, ranging from huge power-station units to tiny subminiature radio-frequency types.

Most transformers are designed to transfer power. Others, however, are built to transfer only signal voltages.



TO MATCH IMPEDANCE

Power-distribution transformers are rated in KVA (kilo-volt-amperes) rather than in kilowatts or other power units. The KVA rating refers to the apparent power carried by the transformer—the real power is smaller by the load power factor.

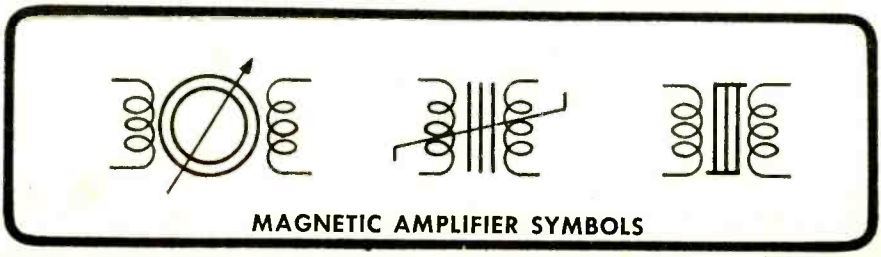
Special transformers, wound to precision specifications, are used in metering applications to measure the current and voltage passing through large power-transmission lines.

A step-up transformer increases voltage and decreases current at the same time. A step-down transformer decreases voltage and increases current at the same time. Also, a transformer can transform impedance, but the impedance change is more pronounced than the voltage change. In fact, a transformer changes impedance by the *square* of the turns ratio:

$$\frac{Z_1}{Z_2} = \frac{(N_1)^2}{(N_2)^2}$$

MAGNETIC AMPLIFIERS

Magnetic amplifiers are special transformer-like devices that use a small amount of power to control larger amounts of power, thus acting as amplifiers. They are simple, rugged, and efficient as compared to other forms of amplification. The following are some of the symbols used to denote magnetic amplifiers.



MAGNETIC AMPLIFIER SYMBOLS

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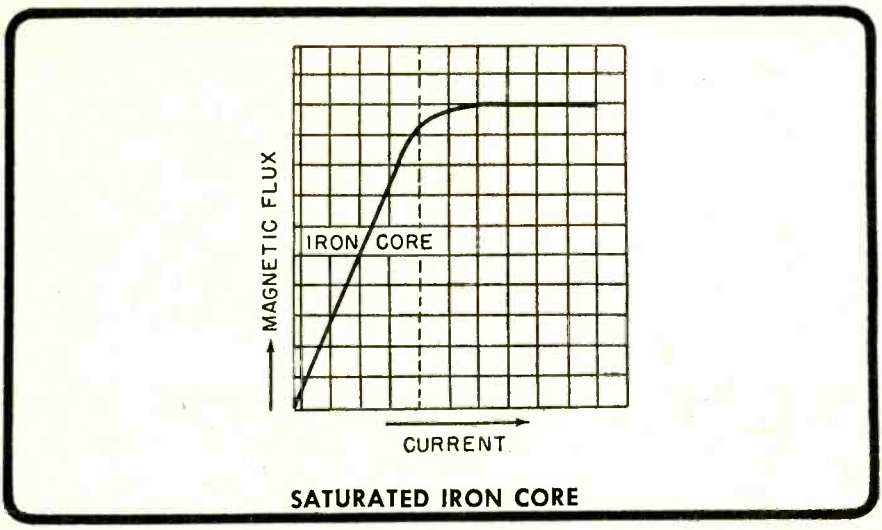
GTE SYLVANIA

Magnetic amplifiers take advantage of a special property of iron or steel in a strong magnetic field. To explain how a simple magnetic amplifier works, let's first review the basic principles of a coil.

When a current flows in a coil, a magnetic field (flux) is set up inside and around the coil. If the current is AC, the field also alternates. But, in any case, the strength of the magnetic field (the number of lines of flux produced) depends on the material inside the coil as well as how much current is flowing through the coil.

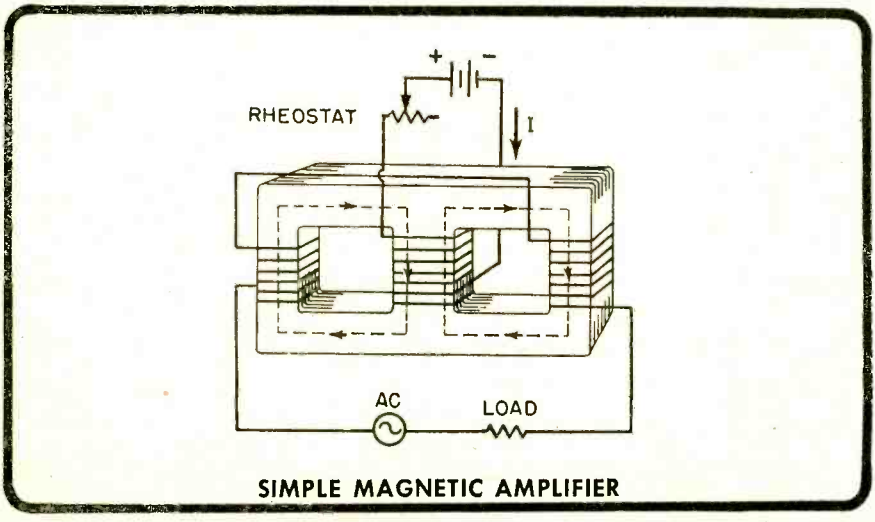
Magnetic-Amplifier Applications

A typical magnetic amplifier controls both the magnetic properties and the AC resistance (called reactive impedance) of the coil by electrical means. To more easily understand how this can be done, look at the curve of current versus magnetic flux in iron.



SATURATED IRON CORE

As the current and the flux increase, a point is reached where the curve bends. A further increase in the current produces less and less of a flux increase until, finally, further increase in current produces no additional flux. At this point the core contains as many lines of flux as it can possibly receive; it is said to be *saturated.*



SIMPLE MAGNETIC AMPLIFIER

To make a magnetic amplifier, manufacturers wind two different coils on a core similar to the construction of a transformer. But instead of a primary and a secondary, this core has a *control* and a *load* winding.

With no current in the *control winding*, the current flowing through the *load winding* is limited by a strong resistance (reactive impedance). But if enough DC current is passed through the control winding to saturate the core, then as the saturation point is approached, the impedance of the load winding decreases, and more current will flow through the load.

Since the control winding uses less power than the load winding, we have an amplifier—a device in which a small amount of power controls a large amount of power.

As AC current flows through the load winding, an AC voltage can be induced back into the control winding. This would be a loss of power. But, the control winding is made immune to the induced voltage by using a *three-legged core.*

Both parts of the load winding are connected in series in such a way that the AC flux lines they induce in the center leg are equal and opposite and thus cancel each other. This means there is no AC induced in the control winding, yet the control winding still exerts its influence over the load circuit.

QUESTIONS

Q9. A coil with an unsaturated iron core has a relatively (large, small) reactive impedance.

Q10. If magnetic flux is added from an outside source (such as a separate coil on the same core) until the core is saturated, will the coil have a higher or lower reactive impedance.

ANSWERS

A9. A coil with an unsaturated iron core has a relatively **large** reactive impedance.

A10. If the core is saturated, reactive impedance will be **lower.**

WHAT YOU HAVE LEARNED

1. Transformers are electrical devices which convert AC voltage and current from one value to another.

2. Transformers contain at least one primary and one secondary winding. The windings are coils and are sometimes wound on iron cores.

3. Current flowing in a conductor develops a magnetic field about the conductor. Magnetic lines of force cutting through a conductor cause current to flow.

4. Transformers can be designed for AC but not for DC.

5. Transformer action is a transfer of energy. AC in the primary generates a magnetic field which induces current in the secondary.

6. Transformers are rated as follows: **Voltage ratio.** The voltage ratio specifies the number of volts transferred between the two windings. The transformer can be used as either a step-up or a step-down unit, depending on which winding is used as the input. **Turns ratio.** A ratio of primary turns to secondary turns. **Frequency.** Because of AC reactance, transformers are designed for use at a specific frequency. Use at any other frequency may damage the windings.

This series is based on material appearing in Vol. 1 of the 5-volume set, BASIC ELECTRICITY/ELECTRONICS, published by Howard W. Sams & Co., Inc. @ $22.50. For information on the complete set, write the publisher at 4300 West 62nd St., Indianapolis, Ind. 46268.

LITERATURE LIBRARY

101. Kit builder? Like weird products? *EICO's* 1975 catalog takes care of both breeds of buyers at prices you will like.

102. *International Crystal* has a free catalog for experimenters (crystals, PC boards, transistor RF mixers & amps, and other comm. products).

103. See brochures on *Regency's* 1975 line-up of CB transceivers & scanner receivers (for police, fire, weather, & other public service/emergency broadcasts).

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

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

106. Get *Antenna Specialists'* cat. of latest CB and VHF/UHF innovations: base & mobile antennas, test equipment (wattmeters, etc.), accessories.

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

108. Compact is the word for *Xcelite's* 9 different sets of midget screwdrivers and nutdrivers with "piggyback" handle to increase length and torque. A handy show case serves as a bench stand also.

109. *Bomar* claims to have C/B crystal for every transceiver . . . for every channel. The catalog gives list of crystal to set interchangeability.

110. A *Turner* amplified mike helps get the most from a CB rig. This free brochure describes line of base & mobile station models.

111. *Midland's* line of base & mobile CB equipment, marine transceivers & accessories, and scanner receivers are illustrated in a new full-color 16-page brochure.

112. *EDI (Electronic Distributors)* has a catalog with an index of manufacturers' items literally from A to Z (ADC to Xcelite). Whether you want to spend 29 cents for a pilot-light socket or $699.95 for a stereo AM/FM receiver, you'll find it here.

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

114. From *Olson* get their new, bargain-packaged 36-page, full-color tabloid (a new issue every 2 months). It contains their latest electronics parts, supplies, and hi-fi components. Pick up a copy at Olson stores coast-to-coast or send for a free copy today.

115. *Trigger Electronics* has a complete catalog of equipment for those in electronics. Included are kits, parts, ham gear, CB, hi fi and recording equipment.

116. Get the HUSTLER brochure illustrating their complete line of CB and monitor radio antennas.

117. *Teaberry's* new 6-page folder presents their 6 models of CB transceivers (base and mobile): 1 transceiver for marine-use, and 2 scanner models (the innovative "Crime Fighter" receiver and a pocket-size scanner).

119. Besides *Browning's* colorful leaflet on their Golden Eagle Mark III base station, their packet includes other surprises. The LTD is pictured in actual size on a card for you to test on your car's dash. Specifications are given for both the SST and LTD.

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

121. *Cornell Electronics'* "Imperial Thrift Tag Sale" Catalog features TV and radio tubes. You can also find almost anything in electronics.

122. *Radio Shack's* 1975 catalog colorfully illustrates their complete range of kit and wired products for electronics enthusiasts—CB, ham, SWL, hi-fi, experimenter kits, batteries, tools, tubes, wire, cable, etc.

123. It's just off the press—*Lafayette's* all-new 1975 illustrated catalog packed with CB, hi-fi components, test equipment, tools, ham rigs, and more.

124. *Mosley Electronics* reports that by popular demand the Model A-311 3-element CB beam antenna is being reintroduced. Send for the brochure.

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

126. *B&F Enterprises* has an interesting catalog you'd enjoy scanning. There are geiger counters, logic cards, kits, lenses, etc.

127. There are *Avanti* antennas (mobile & base) for CB and scanner receivers, fully described and illustrated in a new 16-page full-color catalog.

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

129. Semiconductor Supermart is a new 1975 catalog listing project builders' parts, popular CB gear, and test equipment. It features semiconductors.—all from *Circuit Specialists*.

130. *Heath's* new 1975 full-color catalog is a shopper's dream—chockful of kits and gadgets everyone would want to build and own.

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121	122	123	124	125	126	127	128	129	130
131	132	133	134	135	136	137	138	139	140
141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160
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Not Valid After April 17, 1975

Antique Radio Corner

Continued from page 68

it is necessary to connect the aluminum to the plus side of a direct current power supply putting out around 100 volts, and connect the lead electrode through a 25-watt lamp to the minus side of the power supply. When the voltage is applied the lamp will glow brightly, but as soon as the oxide is formed the lamp will go out. After the lamp goes out the electrolytic cell is ready for use.

With the aluminum electrode and borax solution the charging rate was approximately 0.2 amperes. This was still below the nameplate rating, but was adequate to charge the 6-volt battery.

You can make your own electrolytic rectifier charger if you so desire. Perhaps I will describe how to make a replica of this charger in a future issue of this magazine.

As you read this column it will be late fall and collectors will be planning their activities for the winter months. This is the time to restore some of the sets you picked up during the summer months and were too busy to work on. I plan to give you much valuable information on refinishing cabinets, restoring panels, and redoing the engraved lettering on the front panels of many of the old radios.

In closing I want to emphasize again the importance of putting your address on your letters. ■

Op-Amps & Diodes

Continued from page 50

combined use of diodes and operational amplifiers. Some circuits such as the AC meter can stand alone and be useful while the circuit of Fig. 9 and Fig. 11 can be used to gather information in larger systems such as automatic checkout devices or industrial process control. We hope it has added something more to your knowledge of the broad electronic spectrum. ■

---

131. *E. F. Johnson's* new full-color catalog for CB transceivers and accessories is now available. Send for a free copy. They also have a free brochure on their line of scanner receivers.

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

133. Get the new free catalog from *Howard W. Sams*. It describes 100's of books for hobbyists and technicians—books on projects, basic electronics and related subjects.

134. *Sprague Products* has L.E.D. readouts for those who want to build electronic clocks, calculators, etc. Parts lists and helpful schematics are included.

135. The latest edition of *Tab Books'* catalog has an extensive listing of TV, radio and general servicing manuals.

136. *Leader's* catalog features "Instruments to Believe In." They have a complete line for industry, education and service, featuring oscilloscopes/vectorscopes, many generators, accessories, etc.

137. *Pace Communications* has a packet of information for you. The "Citizens two-way radio" answers all the questions from how to operate one to how much they will cost to operate. A booklet on Pace's scan/monitors to keep you informed is included.

138. *Pearce-Simpson* has a booklet, "Citizens Band Radios & Scanners," which pictures and describes the various models in this line. A section on CB antennas is included.

139. For the latest information on CB transceivers by *Courier*, send for their literature.

140. Featured in *Siltronix's* brochure are single sideband/AM citizen band transceivers, pictured and described with extra features and specifications listed. VFO sliders for monitoring are pictured as well as export models of linear amplifiers.

141. *Lee Electronics Labs* has an inexpensive circuit analyzer, which is featured in this catalog.

142. Available from *Royce Electronics* is a 28-page, full-color catalog for CBers (base, mobile and handheld transceivers; accessories; and test instruments).

143. A set of Abraxas/4 speakers contains a rugged 12-inch longthrow woofer with a 22-oz. Alnico magnet, a 5-inch sealed-back rubber-damped midrange, and two 3-inch dome tweeters from *Designers Audio Products*.

144. For a packetful of material, send for *SBE's* material on UHF and VHF scanners, CB mobile transceivers, walkie-talkies, slow-scan TV systems, marine-radios, two-way radios, and accessories.

145. For CB'ers from *Hy-Gain Electronics Corp.* there is a 50-page, 4-color catalog (base, mobile and marine transceivers, antennas, and accessories). Colorful literature illustrating two models of monitor-scanners is also available.

146. *Robyn International* has 4-color "spec" sheets for each model of their CB (base and mobile) transceivers and monitor-scanner lines.

147. *Telex's* 4-page, 2-color folder illustrates their new line of boom microphone head-sets for CB'ers and hams, as well as their line of communications headphones.

148. *Surveyor Manuf. Corp.* offers you two catalogs in 4-color. One features their Electronics 2000/Surveyor CB, pictured with descriptions and specifications. Their Monitor/Scanner, Surveyor Model 4H 4U, is featured in the second catalog.

149. *Cush Craft* has a catalog on Citizens Band Antennas for every purpose. The Ringo base antenna is featured, as is the new Superfire 8-element horizontal/vertical power beam.

150. For TV or communications towers, aluminum spells rugged strength. An 8-page brochure from *ASCOM* details 30 models to fit every need for CB, ham, commercial 2-way radio, or home/institutional installations.

151. For a complete audio accessory line-TV, tape, phono and radio for home and auto, send for *Audiotex* catalog FR 73-A.

152. Send for the new, free descriptive bulletin from *Finney Co.* It features the Finco line of VOM multitesters (and accessories) for electronics hobbyists and service technicians.

153. A full-color brochure on *Tennelec's* scanners is available. They have portables, 3 bands—12 channels and 3 bands—16 channels. Outstanding features and specifications of the tri-bands are listed.

Use Coupon on Left!

Hey, Look Me Over

Continued from page 22

ing bracket makes it possible to quickly remove the radio for indoor or portable use, and as a precaution against theft. The radio has plenty of volume, has a built-in electronic horn, and uses three "C" cells for greatly extended playing time. Its durable black and red oval-shaped enclosure is weatherized and has a 3-in. safety reflector on the back. The Archer Road Patrol AM Bike Radio is priced at $14.95. Archer products are available at Radio Shack stores in all 50 states and Canada. ■

Ask Hank, He Knows

Continued from page 24

Funny Pages

Is there an electronic comic book I can buy? I want to get started early in electronics.

—G.S., Spring Lake, NC

You sure can! *The Science Fair Story of Electronics* is a full-color, 24-page booklet tracing the history of electricity through the latest developments in electronics. Your Radio Shack dealer has your copy, and it's free while the supply lasts. And, to pick up reading speed and vocabulary, not to mention knowledge, think about reading magazines and books on the subject.

Poor Wiring?

I connected an electrical ground to the brass screw on the outlet plate next to my shortwave receiver. The rig is very noisy. When I connect the ground lead to another outlet plate the noise disappears. Why?

—C.M., Ft. Benning, GA

I bet the ground connection to the plate and metal box behind it is poor or non-existent. Use an electricians trouble lamp and touch one lead to the hot line in the box (black wire) and the other lead to the metal box. The lamp should glow with normal brilliance. If not, something is wrong. Another test—connect an ohmmeter between the two brass plates you mentioned. The resistance should be zero. But play safe; connect an AC voltmeter from plate to plate making sure there is no AC voltage potential between the two.

Always the Hard Way

I want to convert my General Electric Message Mate, Model 4ER35A22, to a channel 9 CB monitor. The frequency it receives on now is 9335.000 kHz. How do I go about it?

—M.P., Elizabeth, NJ

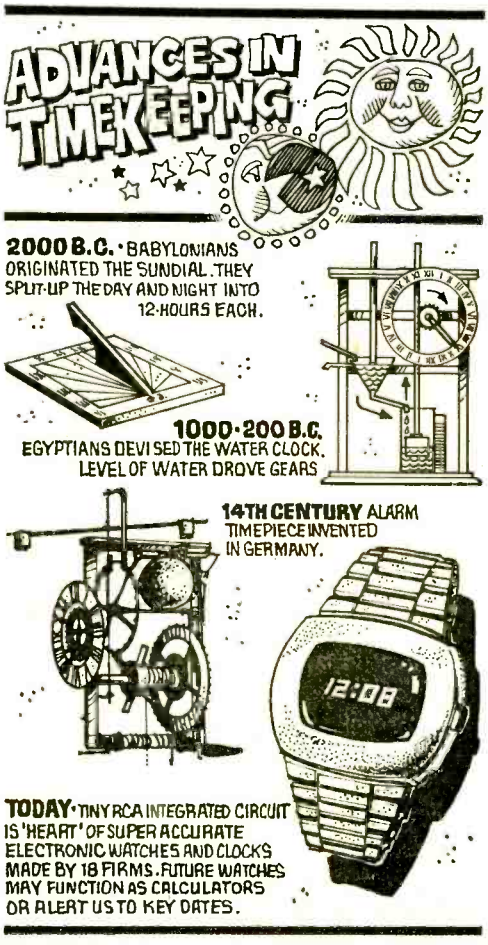
If all you want to do is monitor CB channel 9, I suggest you visit a local ham-CB dealer and pick up a used CB rig. Throw away the mike and use it as a receiver only. Multichannel CB rigs will open the door to other channels also. For good monitoring a good antenna is needed too!

Mini Snoop

I would like to build or buy a monitor that I could attach to my telephone at my place of business. I want to activate it by a tone signal from my home or other business telephone and hear what is going on at my business during my absence. I realize that anything of this nature attached to someone elses telephone would be illegal, however I cannot see any objection to a person attaching it to his own business telephone.

—C.M., Alexander City AL

You've got to be kidding. Didn't you ever hear of Watergate? Electronic snooping is a dirty word no matter how you try to justify it. If you don't trust the people you work with, get someone else. But, before you fire anyone, see a shrink—you may need help.



DX Central Reporting

Continued from page 28

0430 . . . **11672**—Some readers have asked how they can log *Radio Pakistan*. Well, one of the best bets is the English newscast at 1750.

(Credits: Ken Earhart, PA; Mike Hardester, CA; Tony Jones, Paraguay; Al Miller, OH; Andrew Robbins, MI; John Kolb, CA; North American SW Association, Box 8452, South Charleston, WV 25303)

Backtalk. William Slaughter of Santa Maria, CA, has a problem . . . buying a SW receiver. Bill says he's contacted some of the old line equipment manufacturers only to find, according to his letter, "they no longer manufacture short wave receivers . . . only ham gear."

"Can you help me out at all," Bill asks.

You're right, it is becoming harder to buy a shortwave receiver. But the Drake Company in Miamisburg, OH, makes a couple of models including the very fine SPR-4. Priced in the neighborhood of $500 it may be too dear for many SWLs—but well worth it if the price is no object.

Radio Shack has its new DX-160, a successor to its popular DX-150 receiver, which I predict will soon be as big a hit with DXers as was the "150." Its price, at this writing, was about $160.

I'd be interested in the experiences of you readers who have recently purchased communications type receivers (not the portable all-band models) recently. What would you advise others seeking receivers in today's market?

An old friend and fellow DX author, Tom R. Sundstrom, of Willingboro, NJ, dropped a note to DX Central reporting that on May 26 he listened to a "commercial-less" coverage of the Indy 500 race via the American Forces Radio and TV Service, broadcast by the VOA's Greenville station on 15430 kHz. Tom's letter reminds me to remind all you sports buffs that you'll find plenty of sports action, year-round, on AFRTS shortwave.

The last letter this month comes from Arthur Ehrsam, Duluth, MN. Art asks for some dope on the Worcester Space Magnet antenna. The Space Magnet, Art, is a directional antenna for medium (not shortwave) wave reception. A self-addressed envelope with your request for specifics and price should be sent to Worcester Electronics Laboratory, R.D. 1, Frankfort, NY 13340.

And until next time, good DX to you all! ■

Bookmark

Continued from page 81

Edward J. Bukstein has been written for the doctor, nurse, hospital technician, and any other medical specialist who desires a better understanding of the electronic principles governing the electronic equipment used daily in hospitals and medical centers. In addition, service technicians who are called upon to service medical equipment will find this a valuable reference. This easy-to-read book is not intended to make medical personnel electronics experts but to familiarize them with the basic electronic principles of medical equipment. Such knowledge will permit them to use the instruments more effectively, to interpret meter readings and displays more meaningfully, and to perform bedside troubleshooting of equipment more easily. Published by Howard W. Sams & Co., Inc. Get the Sams catalog describing this book and many others by writing to the publisher, 4300 W. 62nd St., Indianapolis IN 46268.

Newscan

Continued from page 82

Designated the 36M10, the cathode ray tube posed unusual handling problems during many sequential processing, testing and finishing steps because of its unprecedented size and weight.

The 36M10 delivers more light output than any previously manufactured cathode ray tube, with a total radiated output in excess of 10,000 lumens. The typical 60-watt bulb used in normal home lighting situation produces 870 lumens.

The CRT, which is a magnetic deflection type of 80° included angle, is required to provide a 1000 line raster brightness of between 630 and 840 foot lamberts. The electron gun designed to accomplish these levels incorporates a dispenser cathode for long tube life and delivers 5.8 mA, at a final acceleration of 38 kV. The specially developed phosphor screen, which has a conversion efficiency of approximately 50 lumens per watt of beam power, thus produces a total radiated light output in excess of 10,000 lumens.

The 36M10 has been developed for use in the Advanced Simulator for Undergraduate Pilot Training (ASUPT) for the United States Air Force. In the ASUPT system, seven CRT window combinations are clustered about a P 37 B aircraft cockpit to provide an effective 260° x 140° field of view. The entire cockpit

CRT/window assembly is mounted on a motion platform. The TV images presented by the CRTs are computer generated in real time. All seven channels are operated simutaneously to provide a continuous visual image over the entire field of view. ■

Sound Force

Continued from page 58

No. 1 and 2. The input terminal adjacent to terminal No. 2 is the plus (+) terminal.

Sound Damping. A minimum amount of damping material is recommended to be installed inside the enclosure to absorb reflections from the inside surfaces, back to the woofer. Cut two pieces of one-inch thick fiberglas to fit over the cleats and glue blocks at the back and on one side. And, cut a third piece to fit over the cleats at the top. Staple or thumb tack the damping material to the cleats.

Your enclosure is now complete except for the final installation of the bottom panel containing the woofer. Install four (4) lengths of ⅜-in. by ¼-in. self stick foam weather strip tape on the face of the bottom cleats along the inside edge of each cleat to insure air tightness under the bottom panel. Then, screw it down in place.

Grille cloth provides an attractive method of covering the exposed unfinished front and side panels. It is sold by most electronic parts stores by the foot from rolls 32 or 36-in. in width. Three 12-in. inch wide strips about 14-in. long will cover the front and both sides when centered so that the edges are between the panels and the table legs as indicated in the front elevation view. Pick out a soft, cloth like, grille material that will take a smooth right angle bend. Coat the edges with rubber cement, about ½-in. wide, with a paint brush to prevent fraying. Staple or tack an end edge of the material to the bottom edge of the front panel (a paper stapler will do the job if held firmly), then draw it up over the edge of the top panel and staple it to the top. Repeat this process for covering both side panels. It is also a good idea to cover the woofer should a pet crawl under and damage the cone. Staple an 8½-in. square piece of grille cloth to the bottom panel.

Before inserting the enclosure into the table, examine the inside skirt edges of the table below the top. If these edges are a

(Continued on page 102)

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(Continued from page 100)

sharp right angle, round them over with a file to avoid abrasion of the grille.

With the table in an upside down position, lower the enclosure down between the legs. Then drill two holes 9/64-in. diameter through the table legs and into both side panels in a low position about 11-in. below the top of the table and at about 1¼-in. from the outside right angle corner of each leg. Drive ¾-in. No.6 round head, plated, wood screws in until the table leg is drawn snug to the enclosure. These four screws are all that is required to support the enclosure in the table.

Operation. As stated earlier, the bass response is rebust. If the lows are too strong for your ears, cut back on your bass control at your receiver. It is of considerable advantage to have variable output for both the midrange driver and the tweeter. The midrange control should be advanced more than half way and the tweeter control to about one-quarter turn for most listening rooms. ■

Bill of Material for Sound Force

Quantity	Name	Size	Material
1	top panel	15⅜-in. sq.	½-in. particle board
1	bottom panel	14⅜-in. x 14⅞-in.	
2	side panel	14⅜-in. x 14⅞-in.	½-in. particle board
1	front panel	10½-in. x 15⅜-in.	½-in. particle board
1	back panel	10-in. x 14⅜-in.	½-in. particle board
4	long cleats	¾-in. sq. x 14⅜-in.	pine
4	short cleats	¾-in. sq. x 11-in.	pine
4	glue blocks	¾-in. sq. x 8-in.	pine
44	flat head wood screws	1-in. No. 6	—
4	machine screws	1¼-in.	—
7	sheet metal screws	½-No. 8	—
60	wire brads	1-in.	—
1	occasional table	16-in. x 16-in. x 16-in.	plastic
1	woofer	8-in. (Radio Shack 40-1341)	—
1	mid-range	5-in. (Radio Shack 40-1292)	—
1	tweeter	1¾-in. (Radio Shack 14-1274)	—
1	network	3-way (Radio Shack 40-1339)	—

Misc.—Grill cloth, rubber cement, glue, speaker cord, connectors, 4-sq. ft. of 1-in. fiberglass, etc. (Author used Sycro "Parsons Table" from Sycro division, Dart Industries, Inc., Syracuse, NY 13201)

Gas Alarm

Continued from page 34

easy, it fits into a 7-pin miniature tube socket. Pins 1 & 2 are interchangeable, as are pins 3 & 4. Though we mounted the sensor in the same cabinet as the rest of the circuit, you may want to install it at some remote location in your boat or trailer and connect it via a 3-wire, No. 18 stranded cable to the alarm box. Use the cabinet as a heat sink for transistor Q1; it does not have to be insulated since the collector on the metallic transistor tab is at ground potential. You can pick the 12-volt supply from the cigarette lighter or by making a separate connection to your battery. Use a socket for the integrated circuit to avoid

(Continued on page 104)

"10-4 there 'Checkmate' . . . the handle here is 'Talking Dog'!"

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READER SERVICE PAGE

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overheating the pins when soldering.

There is a strong possibility that a number of asphyxia-related camping tragedies could have been avoided if this simple gadget had been on the job. Of course, nothing takes the place of *safety first!* A propane-fired cooking stove should *not* be used to warm an enclosed camper or trailer while people sleep. Similarly, children should be taught the dangers of "haphazard" adjustment of kitchen knobs. ■

Extra Dry Cell Life

Continued from page 46

evenly on the cell walls, so holes do not form so quickly. The cell also charges more efficiently.

Charger Circuit. The basic circuit for a charger suitable for use with dry cells is shown in the schematic. A small transformer is used to provide an AC supply of 24 volts at about 250 mA. Diode D1 is a small silicon rectifier such as the 1N4001; it half-wave rectifies the supply to produce a pulsating DC voltage across the cell. Resistor R1 limits the charging current fed into the cell. The second resistor (R2) provides the path for the discharge current which will flow when the diode stops conducting during the negative half cycle. The value of R2 is adjusted so that the reverse (discharge) current is about one tenth the forward (charge) current.

The amount of charging current depends upon the size of the battery and varies from about 10 mA for a small 9-volt transistor battery up to about 125 mA for a size D flashlight cell. Values for R1 and R2 for some typical battery arrangements are given.

For other batteries or combinations of cells resistors R1 and R2 can be made variable and adjusted by experiment. With R2 out of circuit, adjust R1 so that the current into the cell is about the same as the current you intend to draw from it in use. Reconnect R2 and set it so that the reverse current through R2 is about 10 percent of the current of R1.

When using size AA or D flashlight cells, it is usually convenient to mount them into a plastic battery holder. These holders take 4 or six cells which are simply clipped into the holder and automatically connected in series to the holder terminals. Of course you could make your own cell

holder and save money.

Charging Technique. Batteries are usually rated to deliver their normal discharge current continuously for about 10 hours. When they are used intermittently, say for 3 or 4 hours a day, the cells recover between periods of use and the life will be extended to a total of about 20 to 25 hours.

When you recharge dry cells it is best to recharge them regularly after every three or four hours use. This way the cell doesn't deteriorate too much before being recharged. It is best not to let the cell voltage fall below about 1.25 volts before recharging the cell. The length of charge is not critical and can be between 6 and 12 hours.

At the end of a charging session the voltage across each cell may be as high as 2 volts, but this will fall to the normal 1.4 to 1.5 volts quite quickly. If the cell gets hot while it is being charged, the current flowing into it is too high and *should be reduced!* If a cell starts to leak electrolyte, throw it away. You may be able to charge it, but the mess it will make is just not worth the trouble.

How much life can you expect to get from a typical dry cell? It depends a little on how long the cell has been on the dealer's shelf before you used it. For a standard size AA penlight cell it has been found that a life of better than 100 hours of intermittent service can be obtained by recharging the cell regularly. That's worth a few extra cents for sure. ■

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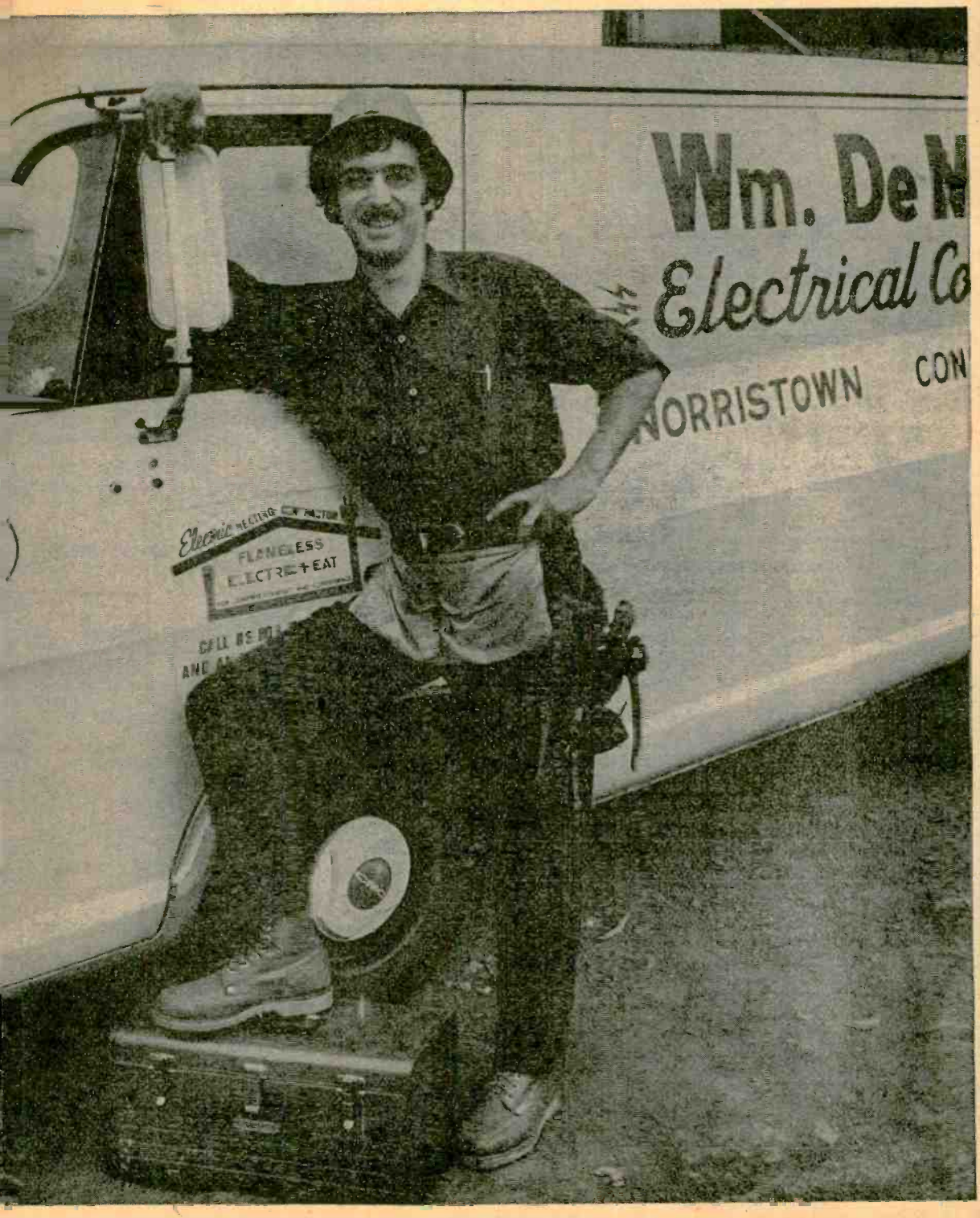

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