CB Mobile Antennas—Selection and Installation

Elementary Electronics
02342
MARCH-APRIL
1976
$1.00

elementary Electronics

FOR BEGINNERS

UNDERSTANDING CAPACITANCE

OUR BASIC COURSE

RIG-KWIK

The Experimenter's quick-connect breadboard designed for simple-transistor to complex-IC project mockups—complete with built-in, fused power supplies!

Sandbagging CB RADIO

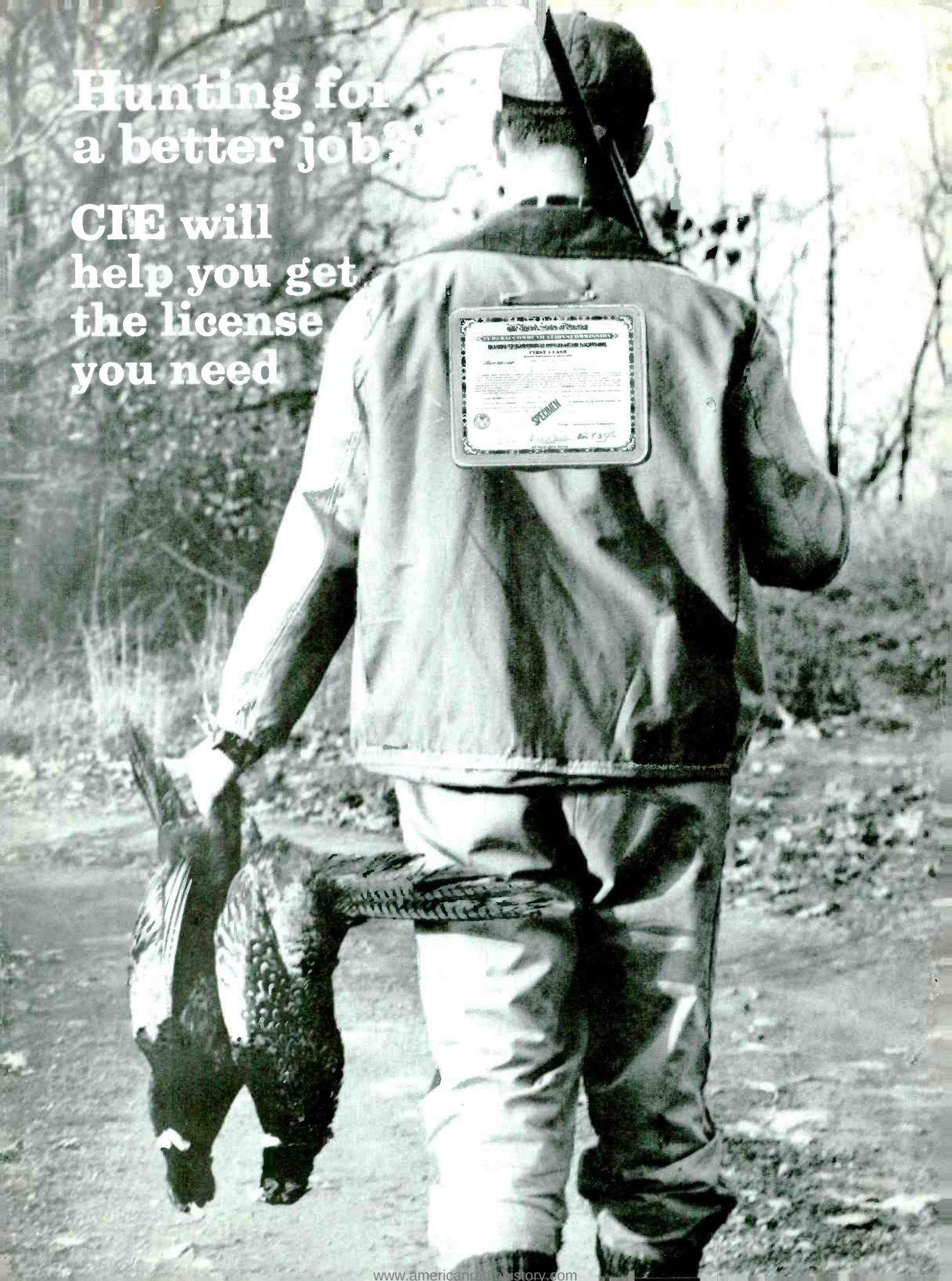
It's legal—it's fun!

M project
mmunications
Build it
or Science Fair or just
o amaze your friends.

PLUS —

Tips on Radio Repair
LED Photometer Project
Sideband Transmission Theory

A DAVIS PUBLICATION



A Government FCC License can help you qualify for an exciting, rewarding career in ELECTRONICS, the Science of the Seventies. Read how you can prepare at home in your spare time to pass the FCC Licensing examination.

If you're out to bag a better job in Electronics, a Government FCC License can give you a shot at job opportunities with *real* futures.

According to the U.S. Office of Education Bulletin (4th Edition): "The demand for people with technical skills is growing twice as fast as for any other group, while jobs for the untrained are rapidly disappearing." There are new openings every year in many different industries for electronics specialists. And you don't need a college education to qualify.

But you *do* need knowledge . . . knowledge of electronics fundamentals. And one of the nationally accepted methods of measuring this knowledge . . . is the licensing program of the FCC (Federal Communications Commission).

Importance of an FCC License and CIE's Warranty of Success

If you want to work in commercial broadcasting . . . television or AM or FM broadcasting . . . as a broadcast engineer, federal law requires you to have a First Class Radiotelephone License. Or if you plan to operate or to maintain mobile two-way communications systems, microwave relay stations or radar and signaling devices, a Second Class FCC License is required.

But even if you aren't planning a career which involves radio transmission of any kind, an FCC "ticket" is valuable to have as Government certification of certain technical skills. It's a job credential recognized by some employers as evidence that you really know your stuff.

So why doesn't everyone who wants a good job in Electronics get an FCC License?

It's not that simple. To get an FCC License, you must pass a Government licensing exam.

A good way to prepare for your FCC License exam is to take one of the CIE career courses which include FCC License preparation. We are confident you can successfully earn your license, if you're willing to put forth an effort, because the vast majority of CIE students have. In fact, based on continuing surveys, close to 9 out of 10 CIE graduates have passed their FCC exams!

That's why we can offer this time-tested Warranty of Success: when you successfully complete any CIE career course which includes FCC License preparation, you will be able to pass the Government FCC Examination for the License for which the course prepared you or you will be entitled to a full refund of an amount equal to the cash price of tuition for CIE's Course No. 3, "First Class FCC License," in effect at the time you enrolled. This warranty is good from the date you enroll until the last date allowed for completion of your course.

CIE HAS CAREER COURSES THAT INCLUDE "HANDS ON" TRAINING

ELECTRONICS TECHNOLOGY with LABORATORY Courses . . . takes beginner from fundamentals to skills required of technician or engineering assistant. Includes Experimental Electronics Laboratory for "hands on" training.

COLOR TV MAINTENANCE and REPAIR... several CIE courses combine electronics theory with the actual construction, testing and troubleshooting a big screen, stolid state color TV.

With CIE you learn at home

With CIE, you learn in your spare time at home . . . or wherever else is convenient. No classroom time, ever. No one to make you go too fast . . . or too slow. With CIE's Auto-Programmed® Lessons you'll pick up facts, figures, and electronics theories you may have considered "complicated" . . . even if you've had trouble studying before.

You can have attractive job opportunities

There have already been many exciting developments and breakthroughs in Electronics and some people might assume there will be no new frontiers . . . no new worlds to conquer. Not so.

Electronics is still growing. In nearly every one of the new and exciting fields of the Seventies you find electronics skills and knowledge in demand. Computers and data processing. Air traffic control. Medical technology. Pollution control. Broadcasting and communications. Once you have the solid technical background you need, you can practically choose the career field you want . . . work for a big corporation, a small company or even go into business for yourself.

Yes, Electronics can be the door to a whole new world of career opportunities for you. And CIE training can be your key.

Send for FREE school catalog

Discover the opportunities open to people with electronics training. *Learn* how CIE career courses can help you build new skills and knowledge and prepare you for a meaningful, rewarding career. We have courses for the beginner, for the hobbyist, for the electronics technician, and for the electronics engineer. Whether you are just starting out in Electronics or are a college-trained engineer in need of updating (or anywhere in between), CIE has a course designed for *you*.

Send today for our FREE school catalog and complete package of career information. For your convenience, we will try to have a representative call to assist in course selection. Mail reply card or coupon to CIE . . . or write: Cleveland Institute of Electronics, Inc., 1776 East 17th Street, Cleveland, Ohio 44114. Do it TODAY.

APPROVED UNDER G. I. BILL

All CIE *career* courses are approved for educational benefits under the G.I. Bill. If you are a Veteran or in service now, check box for G.I. Bill information.

CIE Cleveland Institute of Electronics, Inc.

1776 East 17th Street, Cleveland, Ohio 44114

Accredited Member National Home Study Council

Cleveland Institute of Electronics, Inc.
1776 East 17th Street, Cleveland, Ohio 44114

Please send me your FREE school catalog and career information package today.
I am especially interested in:

- ☐ Electronics Technician
- ☐ FCC License Preparation
- ☐ Color TV Maintenance
- ☐ Mobile Communications
- ☐ Industrial Electronics
- ☐ Electronics Engineering
- ☐ Other_____

Print Name

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City

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Including Electronics Digest®

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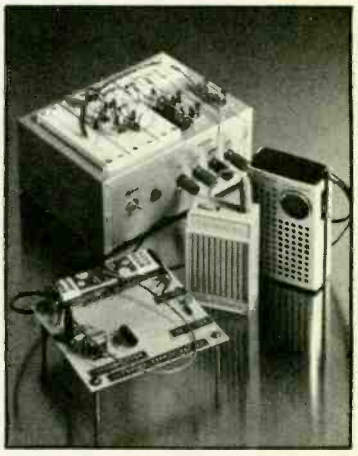
March-April 1976
Volume 16, No. 2



Cover Photo by Walter Herstatt

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BUILD 20 RADIO
and Electronics Circuits

PROGRESSIVE HOME RADIO-T.V. COURSE

Reg. U.S. Pat. Off.

Training Electronics Technicians Since 1946

Now Includes
- ★ 12 RECEIVERS
- ★ 3 TRANSMITTERS
- ★ SQ. WAVE GENERATOR
- ★ SIGNAL TRACER
- ★ AMPLIFIER
- ★ SIGNAL INJECTOR
- ★ CODE OSCILLATOR

- ★ No Knowledge of Radio Necessary
- ★ No Additional Parts or Tools Needed
- ★ EXCELLENT BACKGROUND FOR TV
- ★ SCHOOL INQUIRIES INVITED
- ★ Sold In 79 Countries

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

The "Edu-Kit" offers you an outstanding PRACTICAL HOME RADIO COURSE at a rock-bottom price. Our Kit is designed to train Radio & Electronics Technicians, making use of the most modern methods of home training. You will learn radio theory, construction practice and servicing. THIS IS A COMPLETE RADIO COURSE IN EVERY DETAIL.

You will learn how to build radios, using regular schematics; how to wire and solder in a professional manner; how to service radios. You will work with the standard type of punched metal chassis as well as the latest development of Printed Circuit chassis.

You will learn the basic principles of radio. You will construct, study and work with RF and AF amplifiers and oscillators, detectors, rectifiers, test equipment. You will learn and practice code, using the Progressive Code Oscillator. You will learn and practice trouble-shooting, using the Progressive Signal Tracer, Progressive Signal Injector, Progressive Dynamic Radio & Electronics Tester, Square Wave Generator and the accompanying instructional material.

You will receive training for the Novice, Technician and General Classes of F.C.C. Radio Amateur Licenses. You will build Receiver, Transmitter, Square Wave Generator, Code Oscillator, Signal Tracer and Signal Injector circuits, and learn how to operate them. You will receive an excellent background for television, Hi-Fi and Electronics.

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.

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

SERVICING LESSONS

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

FROM OUR MAIL BAG

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

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

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

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. 577DJ Hewlett, N.Y. 11557

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

NAME.....

ADDRESS.....

CITY & STATE.....ZIP.....

PROGRESSIVE "EDU-KITS" INC.

1189 Broadway, Dept. 577DJ Hewlett, N.Y. 11557

CIRCLE 12 ON READER SERVICE COUPON

HEY, LOOK ME OVER

CIRCLE 57 ON READER SERVICE COUPON

ing transceiver performance and SWR bridge calibration. The coax switch is housed in a rugged anodized aluminum extrusion with attractive sloping front panel for easy control identification. All input and output connectors are located on the rear panel to facilitate a neat installation on both base and mobile-mounted units. Sells for $9.95. For further details, write to Kris, Inc., Pioneer Rd., Cedarburg, WI 53012.

CB Converter For Automobile

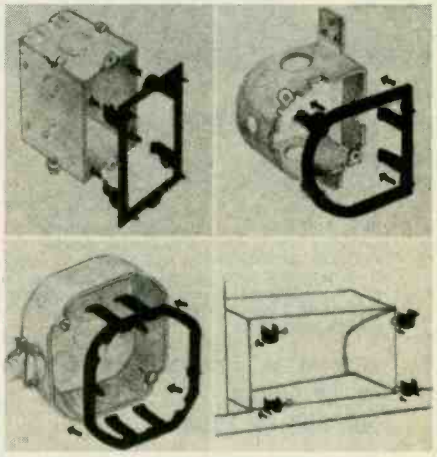
Tenna Corporation has a new low-cost CB Converter that will change any automobile AM radio into a receiver for all 23 CB Channels. Tenna's new CB Converter does not require a license nor the special CB antenna needed for transceivers. It is designed for the motorist

CIRCLE 53 ON READER SERVICE COUPON

who can't pay upwards of $150 for a transceiver and a special CB antenna, but who is anxious to receive CB broadcast information, such as news of detours, accidents, road conditions, and traffic and emergency vehicle status. The Tenna unit is simple to install. One only has to plug it into any standard automobile AM radio and antenna, and attach the Converter to the dashboard with a bracket supplied by Tenna. The existing radio speaker system is utilized. The Tenna CB Converter sells for $34.95. Want more info? Write to Tenna Corporation, 19201 Cranwood Parkway, Cleveland, OH 44128.

Construction Templates

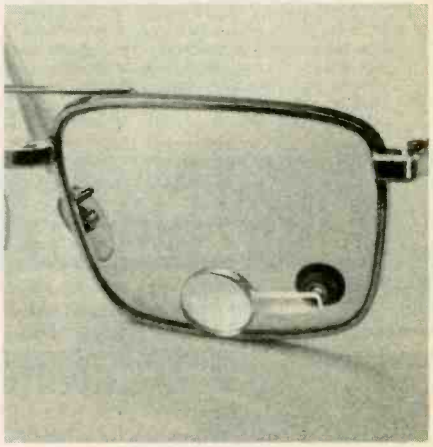
The most frustrating part of putting up paneling or sheet rock is accurately finding the right spots for making openings for switches, outlet boxes, duct work, etc. A new item called Construction Templates makes locating cutouts a breeze and completely eliminates messy chalk lines, measurements, and trial and error methods. Construction Templates



can be used over and over again and they fully guarantee perfect cutouts in every imaginable shape everytime. Construction Templates are designed for the do-it-yourselfer. The price of each set of 3 different templates and 4 universal pin clamps is only $6.00 postage paid. They can be ordered from Construction Templates, Inc., R.F.D. 2, Ridge Hill Road, Woonsocket, RI 02895.

Miniature Magnifying Lens

A new optical aid, called Mini-Loupe, is a miniature magnifying lens offering new freedom and convenience heretofore not found with other optical aids. The Mini-Loupe is a precision lens approximately 11 mm in diameter with an 11 mm arm. Both are mounted in a suction cup with a swivel-type ball socket. This suction cup permits the device to be easily mounted directly to eyeglasses or safety glasses. By mounting the lens in the bifocal area of the glasses, the user can easily see-through it for magnification when looking down or see-around it for normal vision. The swivel-type ball joint between the mounting cup and the



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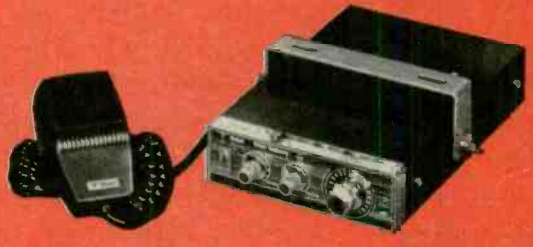
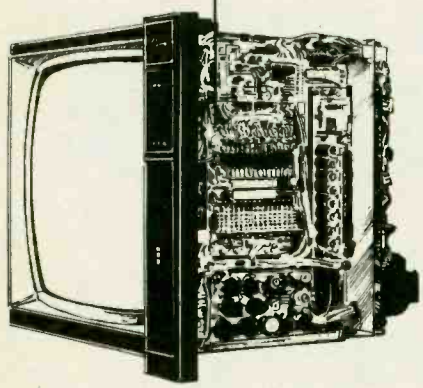
Move up to Teaberry
the Quality CB People



TEABERRY ELECTRONICS CORPORATION Indianapolis, Indiana 46218

CIRCLE 30 ON READER SERVICE COUPON

Four different schools give you this 25" DIAGONAL hobby-kit Color TV...



No other home training school gives you both an exclusive solid state color TV and an SQ® Quadraphonic Receiver complete with four speakers . . . all in one course. You get both for less than the tuition cost of TV or Audio alone from the next leading school. And only NRI's Master Course in Color TV/Audio servicing lets you train on equipment designed specifically for training with exclusive "power-on" features.

NRI doesn't give you hobby kits or commercial sub-assemblies. We invested the time and money to design equipment with learning in mind.

Only NRI gives you this 25" DIAGONAL designed-for-learning Color TV...

It's the only way you can (1) get the feel of typical commercial circuitry, (2) learn bench techniques while building complete units from the "ground" up, (3) perform over 35 "in-set" experiments during construction, and (4) end up with a 25" diagonal solid-state color TV with console cabinet *and* a 4-channel quadraphonic Audio Center.

NRI passes the savings on to you

NRI can save you money because our engineering eliminates the cost of buying from an outside source. We pay no salesman's commission. Students are enrolled by mail only. The savings are passed on to you in the form of low tuition fees, extras like the TV's console cabinet and the four speaker Quad System; a 5" triggered sweep oscilloscope, CMOS digital frequency counter, and an integrated circuit color TV pattern generator. Where NRI supplies a professional color

pattern generator, most other schools use a TV set with a built in alignment generator of no use for servicing other sets. Only NRI designs, engineers, and supplies training kits specifically for learning and professional use. You can pay hundreds of dollars more for a similar course and not get a nickel's worth more in training and equipment.

® Trademark of CBS, Inc.

...plus complete Quadraphonic Audio Center!

More know-how per dollar

That's what it all boils down to, the quality of training you get for the money you spend. In our 62-year history, more than a million students have come to NRI and we're fully approved for career study under the G.I. Bill. We must be teaching something right.

Some of those "right" things are bite-size lessons to ease understanding and speed learning . . . personal grading of all tests, with comments or explanations where needed . . . a full-time staff of engineer/instructors to help if you need it . . . plenty of kits and experiments to give you hands-on training . . . and fully professional programs oriented to full or part-time career needs.

Widest Choice of Courses with CB, Digital Computer, and other career opportunities

NRI offers not one, but five excellent TV/Audio servicing courses so you can tailor your training to your budget.

Or you can study other opportunity fields like Digital Computer Electronics, Citizens Band Radio, Communications, Aircraft or Marine Electronics, Mobile Radio, and more. Send for our free catalog and see for yourself that no one gives you more training and equipment for your dollar. There's no obligation, and no salesman will call.

If card is missing, write to:

NRI SCHOOLS
McGraw-Hill Continuing Education Center
3939 Wisconsin Avenue,
Washington, D.C. 20016

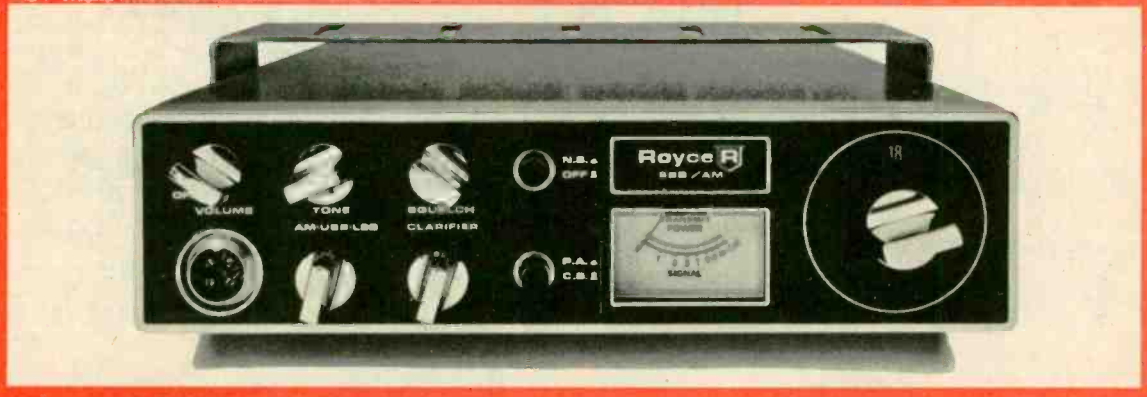
Ready for SSB?
You're ready for Royce!

The ultimate SSB/AM base station!

Royce Model 1-640 SSB/AM CB Transceiver

All of the features you've always wanted—plus a few extras—on a transceiver competition can't touch. Low, sleek silhouette. Modern styling. Full metering. Everything on the Royce 1-640 is bigger and better. But, seeing—and hearing—is believing. Ready for SSB? See Royce first at your Royce dealer's today!

Hand held mike supplied.



Vol-U-Mike + MOS FET RF Stage!

Royce Model 1-630 SSB/AM Mobile Transceiver

Just a flick of the thumb, and you've adjusted the volume level right on the mike, by remote control! That's the new Vol-U-Mike. Plus—new MOS FET (Field Effect Transistor) RF stage which gives you the highest degree of sensitivity and the latest state of the art engineering. Just two reasons to see the Royce 1-630 before you buy *any* mobile transceiver!

Hand held mike supplied.

Royce
electronics corporation
1142 Clay Street • North Kansas City, Missouri 64116
CALL: (816) 842-0252 • TELEX: 426-145

CIRCLE 34 ON READER SERVICE COUPON

HEY, LOOK ME OVER

lens arm permits the lens to be square with the line of sight. It is lightweight, weighing less than 400 milligrams. Worn in tandem, the magnification is doubled. The device is ideally suited for anyone who needs to magnify any area for close viewing: jewelers, draftsmen, printed circuit designers, model builders, laboratory workers, and machinists working on small parts, electronic assembly, or parts inspection will find it useful. The device is available in two magnifications: 2.5x and 4x, and can be shipped anywhere as a pair with both magnifications for only $6.00 total. It may be ordered direct from MecLab, Inc., Box 5398, Pasadena, CA 91107.

Miniature Wireless Mike

This FCC Type Approved FM wireless microphone, measuring only ⅞ cubic inch, is probably the world's smallest. It is completely self-contained, operating on a 1.3 volt mercury battery. The solid-state design offers excellent sensitivity

in picking up the slightest sounds and transmitting them clearly, without wires, through an FM Radio positioned up to 350 feet away. The unit is tuneable thru the entire FM Radio band, 88 to 108 MHz. It's perfect for use as a mike, music amplifier, baby sitter, hot line, burglar alarm, etc. The mike's circuit incorporates two transistors, three diodes, and one IC. It comes complete with battery and tuning device. It's sold with a money back guarantee at only $14.95, plus $1.00 postage and handling. Additional information is available from AMC Sales, Dept. EE, Box 928, Downey, CA 90241.

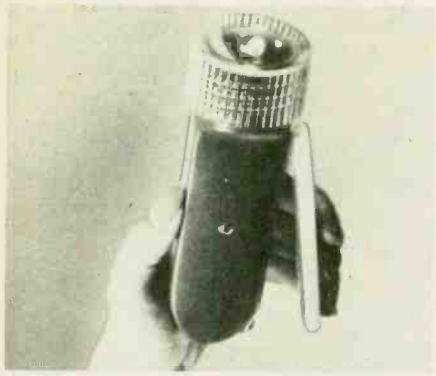
Flywheel Flashlight

Here's a flywheel-generated flashlight that lights the way for free. With it, you don't buy batteries because it uses flywheel energy. Each time you squeeze the handle of this 6-ounce, 2 x 5½-inch flashlight, the alternator generator spins, the flywheel disengages from the clutch,

(Continued on page 16)

"Now what's wrong with the TV?"

HEY, LOOK ME OVER



CIRCLE 56 ON READER SERVICE COUPON

and the flashlight lights for about 2 seconds. By continuous squeezing, the light stays bright. This energy-saving flashlight pays for itself many times over, because you'll never be without an emergency light, and you'll never have to buy batteries for it. It is available by mail, (Stock No. 61,086) $14.95 postpaid from Edmund Scientific Co., 380 Edscorp Bldg., Barrington, NJ 08007.

Lots of Spark

Radio Shack has introduced a new completely assembled, ready-to-install electronic ignition system similar to to those now being offered on the new 1975 model cars. The Micronta Capacitive Discharge Ignition System is said to help overcome the poor mileage and hard starting characteristics of the 1974 models as well as improving the performance of other cars. The capacitive discharge ignition system delivers 50% more spark energy than conventional systems. This results in more complete combustion for improved mileage, faster starting in cold or wet weather and cleaner exhaust emissions. It also increases plug and point life, reducing the need for tuneups. Installation may be easily accomplished in a few minutes on any 4, 6, or 8-cylinder engine having a 12 VDC negative ground electrical system. No rewiring of the vehicle's original ignition system is needed, and an In-Out

CIRCLE 55 ON READER SERVICE COUPON

switch permits instant performance comparisons. The Micronta Capacitive Discharge Ignition System is priced at $54.95. Also available in easy-to-assemble kit form under Radio Shack's ArcherKit brand name for $39.95.

High Voltage Probe

Need a self-contained, direct reading, high voltage and current measuring probe providing for the safe measurement of voltage up to 40,000 Volts DC, and for separate current measurements up to 200 mA, DC? Then look at EICO's

CIRCLE 51 ON READER SERVICE COUPON

Model HVP-5 direct reading, high voltage and current measuring probe. It enables you to accurately measure the high anode voltage of a color picture tube and with a flick of the switch monitor the cathode current drawn by the hoirizontal output tube or the output stage. The high voltage supply affects the focus and the X-ray emission level of the set. The amount of current drawn by the horizontal output stage determines the life of these components. The EICO HVP-5's two circuits are completely separate. Only the meter is switched. The EICO HVP-5 cannot be damaged by placing the function switch in a mA position while measuring high voltage. This feature allows the technician to switch from the mA position to the HV position without disrupting the operation of the set under test. List: $29.95. Get all the facts by writing to EICO, Electronic Instrument Co., Inc., 283 Malta St., Brooklyn, NY 11207. ■

New Albatross single sideband mobile transceiver.

You're on a rescue mission and you're relying on your two-way radio to get through. Otherwise it might be curtains for some guy at the bottom of a canyon.

That's the kind of action and you're the kind of guy we designed our new Albatross single sideband mobile rig for — the CBer who needs the band for effective, dependable communications in emergencies, in heavy traffic, under all kinds of conditions.

The guy who counts on CB.

The Albatross gives you upper and lower sideband selection plus AM on all 23 channels and all the features you'll find in the finest CB equipment.

Yet it costs less than single sideband sets that aren't really in the same league with it.

The new mobile unit features public address capability too, and a sharp high-frequency crystal filter for pinpoint selectivity that helps the receiver cut through all kinds of interference.

The FCC type-accepted Albatross is a precision piece of equipment that looks like it means business under anybody's dash.

And it gives you the performance a serious CBer should demand from single sideband equipment.

If you're one of those people who count on CB communications — sometimes in life-or-death situations — see the new Siltronix Albatross at your dealer's today. It's built for you.

Albatross Recommended Retail Price **$359.95**

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CIRCLE 26 ON READER SERVICE COUPON

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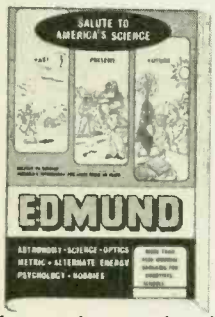
BY BOOKWORM

Free Science Catalog. The new Edmund Catalog (#761) has something for the entire family—do-it-yourselfers, craft and hobby enthusiasts, workshop buffs, serious students and youngsters. It contains hundreds of brand new items, many energy-crisis oriented. Just published, its illustrated pages describe 4500 unusual bargains. All of its more than 4500 items can be conveniently ordered by mail (most prepaid), with 95% of all orders shipped within 3 days. Every item carries a 30-day money-back guarantee. Although cover-priced at 50¢, you can get Catalog #761 free, without obligation, by writing to Edmund Scientific Co., 380 Edscorp Bldg., Barrington, NJ 08007.



Soft cover
164 pages
Free

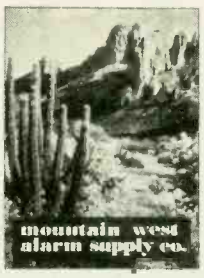
Parts Buyers. Everything in electronics for home entertainment, hobbyists and experimenters is illustrated in the new Radio Shack 1976 Electronics Catalog. The 164-page catalog describes the company's complete line of products. Prices in the new catalog, which marks Radio Shack's 53rd year of operation, are said to show an average increase of less than 1% over last year. Among the many new products being introduced for the first time are a special limited edition Bicentennial radio, a 23-channel citizens band two-way radio with a telephone-type handset, an all-new line of Radio Shack pocket calculators priced from $16.95, a digital multimeter, a precision belt-drive manual turntable, an all-new line of Realistic stereo tape cassette recorders, and many other items. In addition, the new catalog lists hundreds of specialized electronics items, parts and accessories, tools, tubes and transistors, wire and cable, home security products, intercoms, microphones, timers, batteries and a complete library of Radio Shack's own books on electronics and related subjects. Radio Shack's 1976 Electronics Catalog No. 263 is available free, on request from any Radio Shack store or Authorized Sales Center, or from Radio Shack, Department R-19EE, 2617 W. Seventh Street, Fort Worth, TX 76107.

Soft cover
164 pages
Free

Designers Text. *Fundamentals of Electronic Devices* by David A. Bell covers all the important electronic devices in use today in language the student can understand, but also imparts a thorough understanding of the characteristics, parameters, circuit applications, and limitations of each device. The author covers how to design each device into a circuit, estimate circuit gains and impedance, and analyze practical transistor circuits by h-parameters. There are separate chapters on vacuum tubes, the pentagrid converter, the modern CRT, zener diodes, SCR's, and IC's. Also, tunnel diodes, thermistors, and liquid crystal cells. This is a logical division and improves the readibility of the text. Despite the extraordinarily complete coverage of this text, the author has eliminated all unnecessary background material. The level of this book requires no math beyond algebraic equations or logarithms. Published by Reston Publishing Company, Inc., Box 547, Reston, VA 22090.

Hard cover
467 pages
$15.95

Security Equipment Catalog. A new free alarm and security equipment catalog from Mountain West Alarm Supply Co. of Phoenix, Arizona features an informative guide to alarm equipment applications. The guide includes general alarm system discussion, basic installation procedures, and detailed connection diagrams. Alarm equipment offered in Catalog A-76 ranges from relatively simple kits with complete instructions to the latest ultrasonic, radar, and infrared intrusion detectors. Major product categories include Burglar Systems, Fire Systems, Fire and Burglar Detectors (radar, infrared, ultrasonic, switches, heat, smoke), Control Instruments, Remote Controls, Signaling Devices (bells, horns, sirens, oscillators, lights), Telephone Dialers, Lock Specialties, Tools and Books. A large selection of stockroom supplies is also available. A free copy of the A-76 Catalog may be obtained by writing to Mountain West Alarm Supply Co., 4215 North 16th Street, Phoenix, AZ 85016. For mailing outside U.S., include $1.00 handling charges. ■



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SWR adjustments can be made on-the-spot to bring out top performance every time you're on the air.

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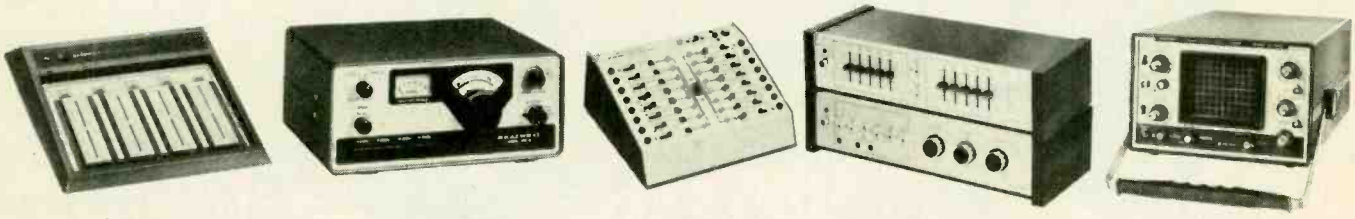

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CIRCLE 1 ON READER SERVICE COUPON

newscan

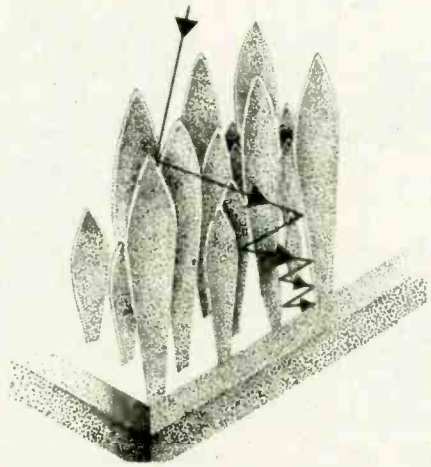
Electronics in the News!

For Better Solar Cells

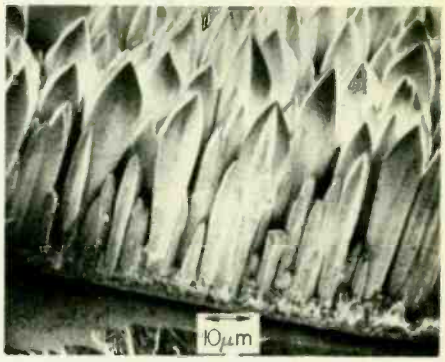
The metal tungsten—fabricated with a special type of surface—has been discovered by IBM scientists to be highly efficient in capturing and holding solar energy. The key advantage of the new material is its ability to hold its heat at high operating temperatures—in the range of 500°C (932°F). At this temperature, most solar materials lose a great deal of their absorbed energy by emitting infrared radiation.

A basic problem in development of high temperature solar absorbing materials is the construction of a surface which absorbs sunlight readily, but emits little *infrared* radiation, thus retaining a large portion of the absorbed energy. The problem is difficult to solve because normally the qualities which make a material a good absorber also make it prone to lose energy readily by emission. Conversely, a material which does not lose energy readily through emission does not usually absorb it readily either.

The new absorbing material was discovered during a semiconductor study in which IBM scientists were growing tungsten films. They noted that the top surface of the vapor-deposited tungsten was black, indicating that it was acting as a good absorber of light. The finding was unusual, since tungsten is normally regarded as both a poor absorber and poor emitter of radiation.



Although "normal" tungsten is a poor absorber and emitter of radiation, the dendrite array captures light particles, or photons, with 96% efficiency—if they enter at angles close to parallel with the dendrites' vertical axes—by a process of repeated reflection. Since tungsten is a poor emitter, energy, once trapped, is largely retained and accumulated for potentially useful work, rather than being radiated away as infrared (heat) radiation.



Scanning electron micrograph of an array of tungsten dendrites on the surface of a new experimental light-absorbing material. 10 μm (microns) equals about 1/2,500 inch.

Microscopic examination of the tungsten surfaces showed that they were covered with tiny vertical spear-like structures known as *dendrites*. Further investigation indicated that such a surface has promising absorption and emission characteristics in exploiting solar radiation to accumulate potentially useful heat.

In spite of "normal" tungsten's poor absorption characteristics, light striking the new material's surface at angles within about 15 degrees of the vertical axes of the dendrites bounces back and forth within a dendrite "maze" and is largely absorbed. The maze effect appears to be because of the tiny size of the dendrites. Their diameters range from about 1/2,500 to 1/5,000 inch. Separation between individual dendrites is comparable to the wavelengths of light and may be as small as 1/50,000 inch. "Large" dendrites may be as tall as 1/500 inch, separated from one another on the average by about the same distance. Interspersed among them is a denser "underbrush" of smaller dendrites, ranging downward in height to approximately 1/2,500 inch.

Better than 96 percent of light from the solar spectrum is captured by the dendrite array. Heat is accumulated effectively because energy is emitted only via the same paths as it enters, within about 15 degrees of the dendrites' vertical axes. In contrast, a surface coated with carbon black, a very good absorber of radiation, emits infrared radiation hemispherically—in all directions from the surface.

At low temperatures, most energy losses occur by conduction—through

(Continued on page 90)

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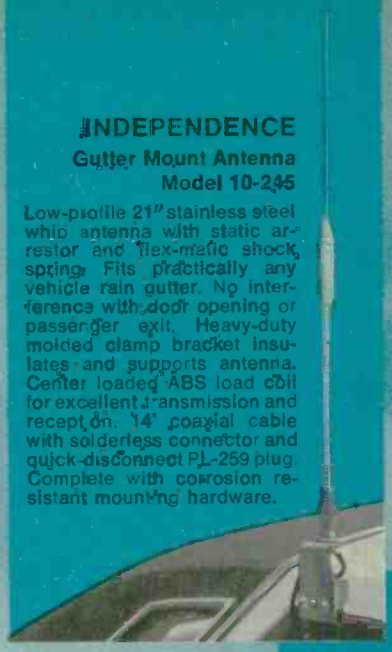
Low-profile 21" stainless steel whip antenna with static arrestor and flex-matic shock spring. Fits practically any vehicle rain gutter. No interference with door opening or passenger exit. Heavy-duty molded clamp bracket insulates and supports antenna. Center loaded ABS load coil for excellent transmission and reception. 14' coaxial cable with solderless connector and quick-disconnect PL-259 plug. Complete with corrosion resistant mounting hardware.



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Roof Mount Antenna
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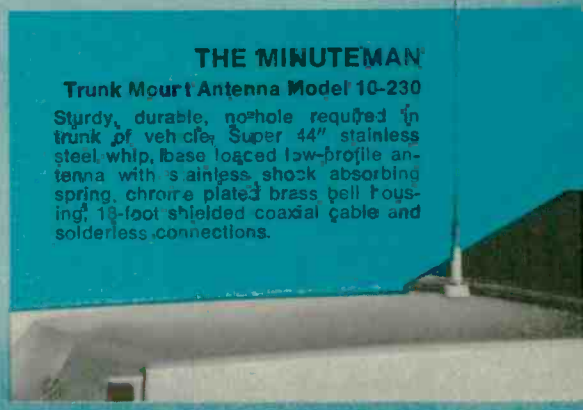

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CIRCLE 23 ON READER SERVICE COUPON

DX central reporting

A world of SWL info!

BY DON JENSEN

In the quest for DX, SWLs often overlook, or forget, that the stations out there don't exist simply to provide us with new listening targets. Our world of DXing has a certain unreal quality to it. Our motivation in listening is usually just for the fun of it. But the stations we hear operate in a real world. And never is this so apparent as when some significant newsmaking event occurs.

People who monitor the VHF/UHF public service stations, especially police channels, are acutely aware that these are the "action bands" that often reflect that real world, sometimes filled with excitement and even violence. Shortwave listeners normally aren't exposed to this. But, every now and then, the shortwave bands offer this same sort of reality.

One such example occurred in November when the African territory of Angola gained its independence from Portugal. After years of political turmoil and guerrilla battles between the Portuguese and Black nationalist groups, Lisbon finally agreed to relinquish control of the potentially rich African territory. But as the independence date drew near, three rival groups were battling for control of the new government-to-be. Even as this is written, the civil war in Angola is continuing.

But the whole drama of the Angolan situation was there to be heard on independence day, November 11, by the SWL fascinated by the news-in-the-making aspect of shortwave listening. Here at DX Central I monitored a number of stations which presented various views on the Angolan situation. At 0230 GMT, Radio Portugal's English language news broadcast was a disappointment. The situation was not only underplayed, but the program had been pre-recorded hours earlier and events had outstripped the newscast.

At 0400 GMT on November 11, South Africa's Radio RSA did lead off its news with the Angolan item, but for this nation, with much at stake in Angola's future, the coverage was skimpy. This cautious coverage of the events, in itself, probably had political significance.

The DX Central prizewinner in reporting that evening was the British Broadcasting Corporation's 0330 GMT newscast to Africa, followed by a twenty-minute program focusing, in depth, on the events in Angola and the circumstances that brought them about. The latter featured recordings from correspondents around the world, highlighting world opinion, plus transoceanic telephone interviews with Portuguese and Angolan leaders directly affected. It was a tremendously interesting and informative half hour.

But perhaps the most exciting listening was the broadcast from Emisora Oficial (renamed, according to later news accounts, the People's Radio and TV of Angola) in Luanda, the Angolan capital. The faction controlling the city and radio station at the time the Portuguese relinquished authority and sailed away, had seized power less than an hour before. This nationalist group had proclaimed its leader the new Angolan president.

Glossary of DX Terms

DX—Distant and/or difficult to hear radio stations.
DXing—Listening to such stations as a hobby.
GMT—Greenwich Mean Time (universal time), a standard time reference for broadcasters and DX listeners, equivalent to EST+5, CST+6, MST+7 or PST+8 hours.
kHz—Kilohertz, a measure of a station's frequency; also kilocycles per second.
MHz—Megahertz; similar to kHz but equals 1,000 kHz.
QSL—A verification, a card or letter sent by a station, in response to a listener's report of reception, confirming that the report was correct.
Shack—The place where a DXer does his listening. It might be a den, a bedroom or the basement.
SWL—Shortwave listener, a DXer who tunes the shortwave frequencies between about 1605 kHz and 30 MHz (30,000 kHz)
VHF—Very High Frequency, the frequencies between 30 and 300 MHz, above the shortwave frequency range.
VLF—Very Low Frequency, the radio frequencies on the bottom end of the spectrum, even below the regular AM radio band, which is 540-1600 kHz.
UHF—Ultra High Frequency, frequencies above 300 MHz.

And, via shortwave, I was hearing live the first address, in Portuguese, by the proclaimed president to his supporters, direct from a stadium in Luanda. Crowd noises, applause and cheering could be heard backgrounding the impassioned speech.

And that, friends, is the real world out there that you can be part of, thanks to SWLing.

New publications. If there is any one

(Continued on page 28)

TRUE SINGLE SIDE BAND FROM PEARCE-SIMPSON

Two big cats that roar!

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*Suggested list price

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DX CENTRAL

(Continued from page 26)

publication that should be in every DXer's shack it is the annual World Radio TV Handbook, published in Denmark. It is packed with all sorts of data a listener needs to know: listings of short and medium wave stations arranged by country, frequency and time of English language programs; information on station addresses and leading personalities; program and schedule data; languages and identifications used by various stations and much more.

The 1976 WRTH is the 30th anniversary edition. It runs over 500 pages, the largest issue yet. It is available for $10.95 from Gilfer Associates, Inc., Box 239, Park Ridge NJ 07656.

Another new book on the market is *DXing According to NASWA*, published by the North American SW Association. The comprehensive 112 page handbook was compiled by well-known DXer Edward Shaw. It is filled with useful information and for the newer DXing hobbyist it is a good introduction to SWLing. The price is $3, postpaid in North America, and it may be ordered from NASWA, P.O. Box 13, Liberty IN 47353.

If TV DXing is your bag, or if you're a regular traveler and would find it useful to know where nearby TV stations are located and the channels they use, then the *WTFDA TV Station Guide* may be your ticket. It is a reference volume containing information on most TV stations in North and Central America. Perhaps most useful and interesting are the series of maps of North America showing, by channel, the locations and call letters of all television outlets. The postpaid price of the TV station guide is $5 and is available from the Worldwide TV-FM DX Association, P.O. Box 163-C, Deerfield IL 60015.

Finally, a whole list of off-beat but interesting station lists are available at small cost from Handler Enterprises, P.O. Box 253, Deerfield IL 60015. Among the lists available are those of U.S. Air Force In-flight frequencies, VHF Marine Weather Forecast stations, VLF Submarine communications frequencies, addresses of major point-to-point communications transmitters and a number of others. These unusual station lists run between one and six pages in length, and prices are between 13 cents and a dollar. A stamped, self-addressed envelope will bring you a list of publications they can supply.

Bandsweep. (Frequencies in kHz, times in GMT)—**1586:** Trans-Atlantic DX on the medium wave band? Among MW DXers it is generally accepted that one of the best bets is the German Westdeutscher Rundfunk, which runs up to 800,000 watts of power! An Oklahoma BCB DXer recently logged them several times during the 0500-0530 time slot. **3,300:** Until not too long ago, TGNA, Radio Cultural in Guatemala City was subjected to rather severe interference on this frequency. Lately, though, the channel has been quite clear of QRM and most listeners will have little difficult in hearing the religious English language programs around 0300 to 0430 hours. **3,316:** The West African Sierra Leone Broadcasting Service at Freetown is a good bet for intermediate level SWLs. It often can be heard with rather good signals from its 0558 GMT sign-on, with interval signal, Islamic chants, English language advertisements and pop music. **4,788:** Sometimes heard during the afternoons, until sign-off at 0000 GMT, especially east of the Mississippi, is VSI8, from Turk Island in the West Indies, This is a very nice DX catch and on the right day, not as tough as you might think. **5,020:** Another ex-

(Continued on page 34)

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With Bell & Howell's Electro-Lab® electronic training system—theory comes to life. And you'll make it happen! In building each of these modern test instruments you'll get experience in wiring, soldering, assembling. Then you'll use the lab for testing, trouble-shooting, and circuit analyzing.

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Choose from these fascinating fields: Home Entertainment, Digital/Industrial, or Communications Electronics!

Pick the field that interests you most. Perhaps your first choice will be to explore the Audio or TV elective of Home Entertainment Electronics and actually build and experiment with new-generation equipment such as a stereo tuner, 4-channel amp, or even a color TV!

Imagine, for example, building that 25"-diagonal color TV! Probing into the technology behind all-electronic tuning. And into the digital circuitry of channel numbers that appear on the screen! You'll even build-in an on-the-screen digital clock and learn to program a special automatic channel selector that goes directly to pre-selected channels!

On the other hand, if you choose Communications Electronics, you'll explore 2-way radio, commercial broadcasting, and more!

Or you might want to get into Digital/Industrial Electronics—a field that is setting new standards of accuracy and revolutionizing industry.

Whatever specialty you choose, you'll be equipped with the kinds of skills that could put you ahead in electronics know-how.

Once you've completed any of these programs, your skills in electronic trouble-shooting could lead you in exciting new directions. While we cannot offer assurance of income opportunities, you can use your training: to seek out a job in the electronics industry, to upgrade your current job, or as a foundation for advanced programs in electronics.

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Although these are self-instruction programs, you still get the same quality and content as if you were pursuing them in any of our 8 resident schools.

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A school's reputation can't be built on what it is going to do.

...but rather on what it has done and is doing right now. That's why Bell & Howell Schools' 45 years of experience in electronics self-instruction is your best guarantee that our "hands-on" learning method really works.

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Simulated TV test pattern.

DX CENTRAL

(Continued from page 28)

citing catch is the Solomon Islands Broadcasting Service, which since it changed to this frequency has become considerably easier to hear. This Pacific area station should be tuned for during the 1000 to 1100 GMT period. **7,345:** Even the listener with the simplest sort of receiving equipment should have no trouble in finding Czechoslovakia's Radio Prague on this frequency. Listen for the English language programs at 0100 GMT. **9,420:** If you are hunting for Asian SWLing, give a try for Radio Pyongyang, North Korea. Two times to catch some English programming are at 1000 to 1050 GMT, and again around 1330. **9,610:** Most DXers are familiar with the Radio Australia foreign service. Now look for the Australian Broadcasting Commission's domestic shortwave outlet at Perth, Western Australia between 1100 and 1600 GMT. **11,835:** There is only one SW outlet in Haiti now. It is Radio 4VEH at Cap Haitien, a religious broadcaster. You can tune its English programming at 0000-0100 GMT. **15,060:** Radio Peking holds forth nightly on this frequency.

(Credits: Richard Allen, OK; John Moritz, Jr., OH; Pitt McNeil, DC; William Davenport, TN; Bob Zilmer, WI; Richard Larson, MN; Larry Talbot, WI; Don Aston, OH; National Radio Club, P.O. Box 127, Boonton NJ 07005; North American SW Association, P.O. Box 13, Liberty IN 47353)

Backtalk. Among the many letters in our DX Central mailbox is one from William Paul Vaughn of Alexandria, LA, who asks about several stations he has heard recently.

"Could you tell me about one announcing as 'Trenton Military,' with airport aviation weather? And how about WOM, Florida High Seas Radio heard at various spots on the bands?"

Well, William, your Trenton Military is CHR, operated by the 708th Communications Squadron of the Royal Canadian Air Force and is located at the RCAF Station, Trenton, Ontario. One of its frequencies is 15,036 kHz. WOM is a coastal radio station operated by the American Telephone and Telegraph Co. and is located at Ft. Lauderdale, FL. You're right, WOM does use a number of frequencies on shortwave, including 4,428.6, 8,792.8, and 13,154.5 kHz. Both are examples of what DXers call utility stations. The "utilities" do not broadcast normal programs for general audiences but are involved with special purpose communications, in these cases, aeronautical and maritime operations, respectively.

Daniel J. Flak of Highland CA, writes, "Your magazine has done a great service in getting many people started in DX. It was White's Radio Log in a similar publication that got me going in 1962."

Our California reader continues, "Especially for coastal residents interested in VHF aeronautical DXing, a commercial concern, Aeronautical Radio Incorporated operates high-powered, highly-directional VHF stations pointed along the major air routes connecting the West Coast and Hawaii and the East Coast and Europe. On the Atlantic side the frequency is 129.9 MHz and on the Pacific it is 131.95 MHz. Since these stations are specifically designed for long distance communication, they are the VHF DXer's best chance at trans-oceanic DX on these frequencies."

Thanks, Dan, for the kind words and information. And for others who don't know, the White's Radio Log listing of U.S., Canadian and foreign stations regularly appears in *Communications World.* ■

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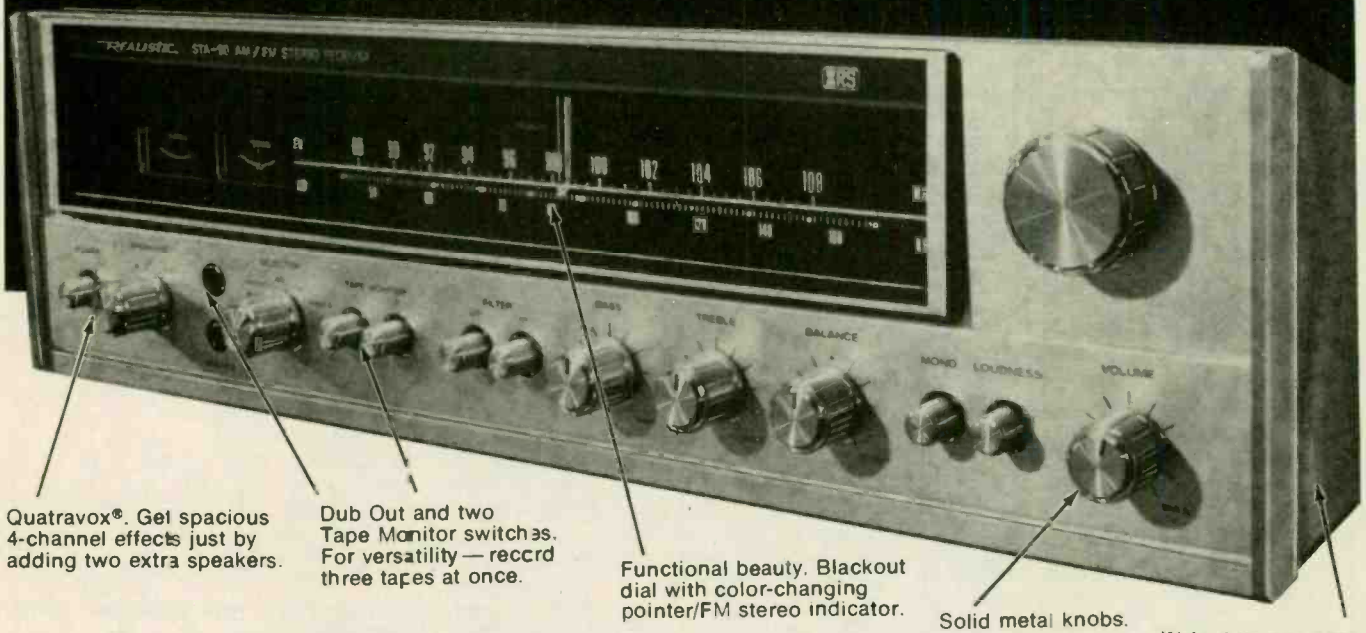

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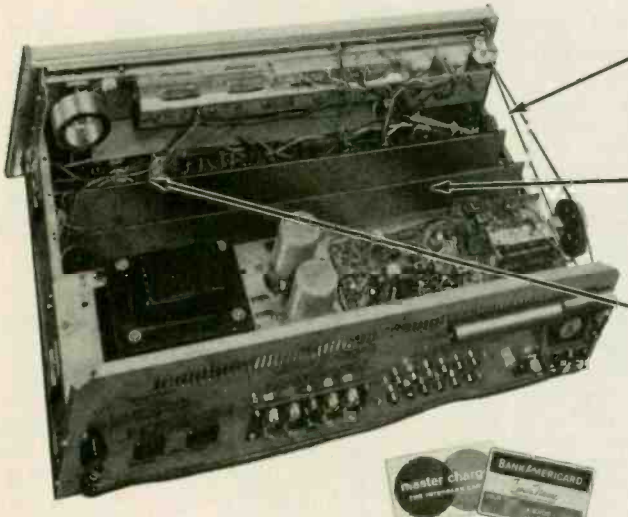

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CIRCLE 32 ON READER SERVICE COUPON

Ask Hank, He Knows!

Got a question or a problem with a project—ask Hank! Please remember that Hank's column is limited to answering specific electronic project questions that you send to him. Personal replies cannot be made. 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

It's the Spark

I have an excellent FM receiver that's hooked up to a brand new UHF antenna. The problem is the interference caused by some cars as they go by. I assume it's from their ignition system. Any remedy?

—C. Z., Putnam, CT

Much of your problem is probably in your lead-in cable. If it's flat TV-type 300-ohm stuff, get rid of it and install 75-ohm coaxial cable. Use good cable and install 300- to 75-ohm transformers at each end, if needed (this will depend on the nominal impedance of the set's input, as well as the particular antenna you're using). If you have a turnstile antenna it will also pick up more impulse noise (car ignition) than a directional type.

Bleed is Splatter

There are so many problems associated with CB I don't really know where to start. But I suppose the most serious in our area is "bleed-over." There are not really that many stations in our city of 20,000 population, it's that they are so LOUD! I took my 123A and 250 Johnson radios to an FCC-licensed technician in Fayetteville a month ago to see if they were properly aligned. He assured me that they were in proper condition and further advised me the problem was due to high-power (linear) amps and overmodulation. He advised that my receiver was being activated by sheer force *and splatter. Actually, I installed two AM sets in May of this year on 27.275 and was licensed as KYI-282 in the Business Radio Service for my church activities. If anything, the stations up there are even louder. I'm at my wit's end!*

—E. P., Lumberton, NC

Sounds like there's a local CB station on 27.225 MHz—not necessarily running overpower—causing cross-modulation in your receivers. Sideband splatter from an overmodulated 27.225 MHz CB rig may also cause interference, but it shouldn't be all that bad. Most likely it's cross-modulation due to front-end overload. An FET front end receiver *might* eliminate your cross-mod problem, but not necessarily so (depends on the overall front-end design). It's likely that an *all-tube* (except for rectifier) transceiver might eliminate your cross-modulation situation. Try before you buy.

Loves 2-Way Radio

I would like to know whether the Breepoop TRD-28 is as good as the Bzgrantzank HE-711? They are 100 milliwatt walkie-talkies, and don't tell me to go CB 'cause I'm only 14 years old.

—S. M., Grand Valley, PA

One toy is as good as another. Part 15 transceivers do not hold up to daily use. If you must go this route, then get the cheapest for the least disappointment.

A Real Long List

Hank, how can I get a list of all the complete frequency allocations of all the shortwave bands (1.6-30 MHz)?

—G. T., Eugene, OR

There is a group in Geneva, Switzerland called the International Telecommunications Union which sells a list of all legally authorized stations on the air. However, it is difficult to prepare a volume like this and it's about two years in the making. Thus when you get it it won't be very useful since stations change frequencies and times at least once each season. Much more practical is *White's Radio Log*, published as part of our sister publication, *Communication World*, twice each year. It's available on the same newsstands as those which carry *Elementary Electronics*.

Old Shellac

I was recently listening to some old 78 R.P.M. records. They had been bought in the late 40s and early 50s. These records have amazing fidelity and most of the new 45 R.P.M. records do not have the same clarity. What gives?

—D. L., Belle Vernon, PA

Late 78 rpm records have a high fidelity potential beyond that of the 45s because of the hard material used for the record itself and also due to the higher speed, which provides a longer wavelength path. This is easier for the stylus to trace. 78s such as the London FFRR series surpass many of today's records in fidelity. They were "Full Frequency Range" with little compression and/or extra "processing." Modern 45s are compressed, equalized and "brightened" for the now-sound—hi-fi it ain't.

Good Guy Steps Forward

Donald E. Erickson offers to the readers of ELEMENTARY ELECTRONICS *free* photocopies of schematic diagrams available in Perpetual Troubleshooters Manual, Vols. I through XXII. Any hobbyist needing assistance should send Make, Model, number of tubes, and other identifying info to Don at 6059 Essex Street, Riverside, CA 92504. Be sure to include SASE (self-addressed, stamped envelope).

Trekkie Topics

There is an information center to answer fans' questions about Star Trek and pro-

(Continued on page 38)

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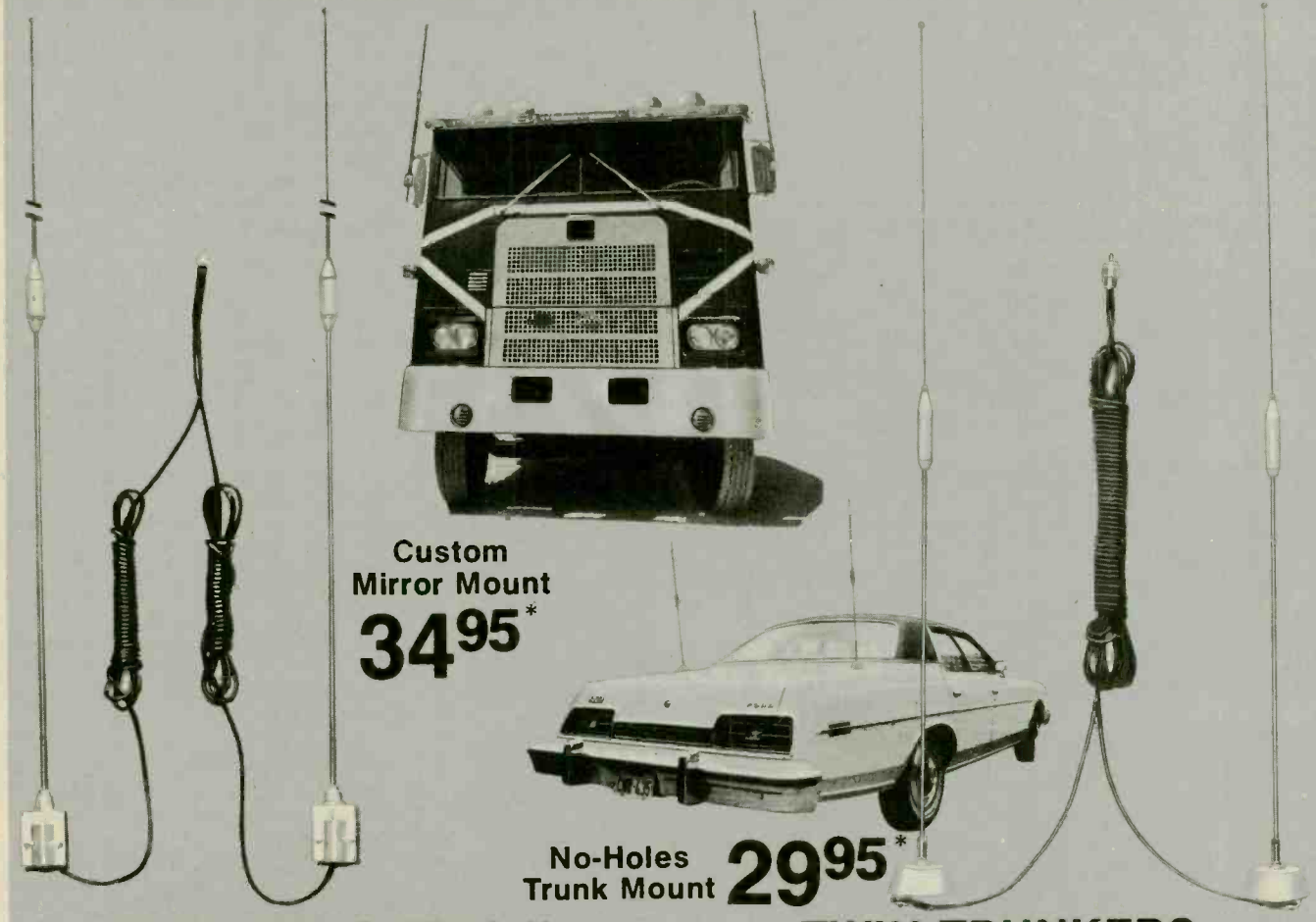

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CIRCLE 32 ON READER SERVICE COUPON

ASK HANK, HE KNOWS!

(Continued from page 36)

vide new fans with complete information. Write to: Star Trek Welcommittee, c/o Shirley Marewski, 481 Main St., Hatfield, MA 01038. Be sure to enclose a self-addressed, stamped envelope.

And while we're on this subject, my thanks to D.S., of Norman, OK who wrote, "Trekkies don't die, they just fade away in contentment."

Look for a Round Peg

Hank, I've always wondered how rectangular holes can be cut in Bakelite. Is there any way I can cut a perfect hole the size I want?

—T. B., Santa Barbara, CA

There is no need for a perfect square hole because the lamp bezel has a lip which will cover the edge of the hole. Drill one large hole first plus a few other small ones in the corners of the square hole you want to cut. Use narrow triangular files to make square corners and straight sides. But you might also consider doing it the way I do—drill for *round* panel lamps. That is, you can do it that way if you have the same kind of drill bits I do—*round* ones!

Leave TTL Project Alone

How do I modify the TTL Power Supply in the Sept/Oct 75 issue of Elementary Electronics so as to supply 0.5, 6, and 9 Volts in one unit? Could I use different IC's and switch them in and out? I'd like to use it for a shaver, radio and calculator.

—B. B., Placenta, CA

Don't modify it. You'll be sorry! It was specifically designed for tight regulation of its 5 VDC output. Besides you can build a *simple* power supply for a radio, which doesn't need the regulation of the TTL supply. In fact, a *really* simple supply for a low-voltage shaver wouldn't even need a filter, just a rectifier and a dropping resistor.

Light Suits Him

Is it against the law to put an electrical fixture in a closet? I need light to pick out the clothes I need.

—A. M., Sistersville, WV

First, let me say that we all have a common problem. We lose our sense of color as the light diminishes. A brown pair of slacks looks like a dark blue one in the dimness of a closet. By all means, install an electrical fixture according to the code in your area. This means Romex or BX cables in the walls, fixture totally inclosed with suitable switching circuit. Don't go for those add-on lamps operated by the opening of a door. These cheap jobs require a long run of "zip" or lamp cord to an outlet. You're inviting the fire department to your home.

Lend a Helping Hand

Some of our readers need assistance that only you may be able to give. Please help.

▲ Kenneth J. Barratt, of 4000 N.E. 44th Street, Vancouver, WA 98661 needs the schematic diagram for the Canadian Marconi Co. transceiver (148-174 MHz) model DJ30. He'd like to know its "new" price also.

▲ If you have the specifications for the UX-112-A, UX-201-A, C-301-A, and CX-340 vacuum tubes, please send info to Claude B. Elliot, 7A Brighton Terrace, Broomall, PA 19008.

▲ A new antique radio collector needs schematic (and possibly tubes) for a Montgomery-Ward Airline, model 62-1100 and the chassis No. is 83WG-401E. Write to David Blackwell, 110 Fourth Street, Bemis, TN 38314.

▲ Bill Coleman, Sr. of 114 Circle Dr., Rocky Mount, NC 27801 needs the schematic diagram for the Bendix Aviation Model 847S Field Set Receiver (AM/FM).

▲ Attention: model railroaders! Tony Bruce, P.O. Box 394, Chino, CA 91710 is looking for an old GE "Astrac" unit plus receiver. Can anyone help?

▲ Sergei Leoniuk of 369 Piermont Rd., Cresskill, NJ 07626 needs service info and schematic diagram for the Grebe CR-12. Lend a hand, boys! ■

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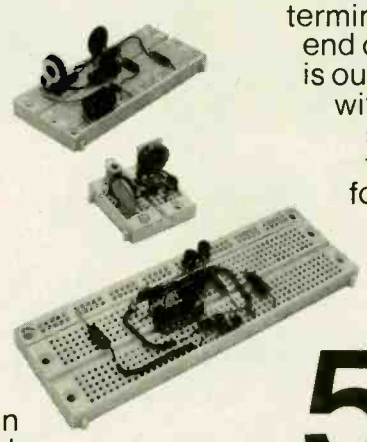

2. Stop wasting your time designing circuits. Design Mate™ 1 will help, by providing you with QT hookup versatility (see above), a continuously-variable 5-15V, 600mA 1%-regulated supply, and a voltmeter to monitor supply or circuit. Plug it in, turn it on and start designing more by soldering less. At $49.95,* you can afford to.

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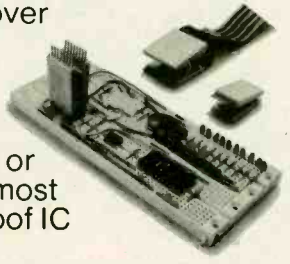

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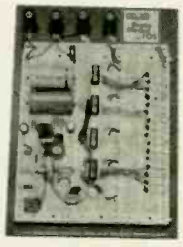

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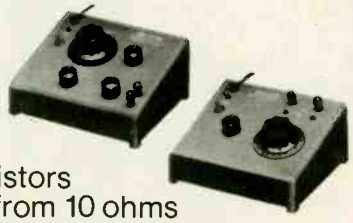

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RIG-KWIK

Flexible breadboard system uses low-cost power supply kit. Handles ICs with +5, and ±15 V DC power. Easy to build, and cheap!

By The Staff of Elementary Electronics

On our cover this month we show Rig-Kwik, a modern version of the experimenter's "breadboard" which can be used for a wide variety of projects, ranging from the simplest which use only one power supply voltage to those advanced ones which need plus and minus voltages up to 15 volts as well as a third supply of plus five volts.

Though we still use the term "breadboard" to describe anything used to wire experimental or prototype circuits, it's been a long, long time since kitchen breadboards actually were used to develop circuits. While Grandpa used to drive nails into the board to hold down coils, capacitors and tube sockets, today a complete circuit often takes up less space than the nail itself.

Over the years specialized electronic breadboard systems were developed to keep pace with new technologies. As the transistor replaced the tube the breadboard hardware was changed, eliminating the special clamps needed for heavy wire and substituting miniature multi-wire locking terminals that could handle the extra fine wire of solid state devices. Finally, we now have the integrated circuit (IC), and even solid-state electronic breadboards are too large—the hardware just doesn't make for easy breadboarding with subminiature components.

Now that solid-state component terminals are mostly standardized on 0.1-in. spacing, it has been possible to come up with a "breadboard" that accommodates virtually all the small signal solid state devices of the types used by hobbyists. A typical example is the QT socket strip from Continental Specialty Corp. These American-made QT sockets are available in many different configurations, but basically they all allow any component or wire lead to be plugged into a "board" and instantly get four multiple terminals for additional connections. Use a small U-shaped jumper and you have eight connections—and you can add jumpers until you get as many terminals as needed. The QT sockets snap together so you can easily construct a breadboard of any size or configuration needed, and if you look carefully at those professional-type developmental kits costing many hundreds of dollars you'll find many of them use the very same QT breadboard socket strips.

Along with the standardization of solid-state component lead spacing there are "standard" hobbyist voltages in the sense that many, though not all, projects use 5, 15, ±15 (bipolar) or 24-30 volts as the required DC power. By combining such a power supply with a matrix of Continental Specialty QT sockets we have come up with a prototype breadboard unit for well under $50 that compares favorably with larger laboratory breadboard kits that are priced well into the hundreds of dollars.

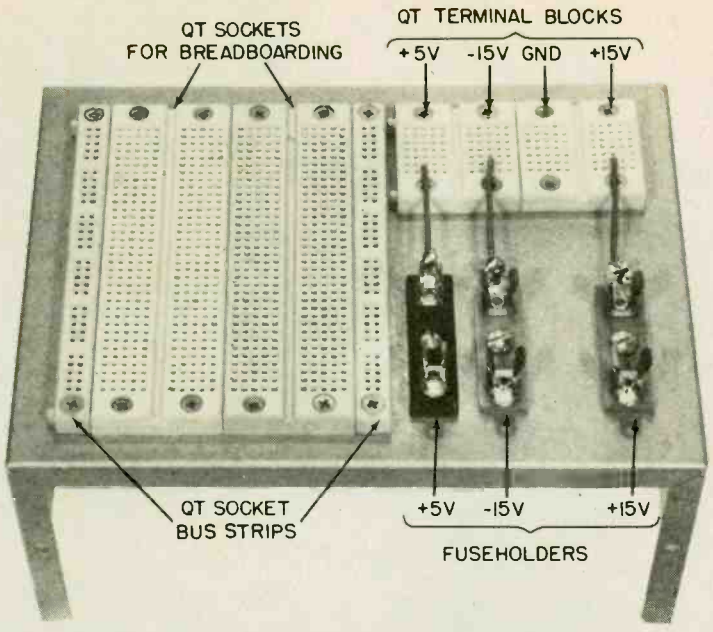
Just such a unit is shown here. Costing less than

$40 (the final price depends mostly on how many and which QT sockets are used), Rig-Kwik provides regulated power supplies of 5.0 volts at 1.5 amperes, and ±15 volts at 150 mA. QT sockets have been used in Rig-Kwik to provide two component boards for transistors, diodes and ICs, two power distribution rails (one on each side) and three power distribution pads for the power supplies.

QT test socket strips. (Quick Test) These sockets let you breadboard any circuit as fast as you can stick short pieces of #22 solid wire into the holes in the sockets. Each temporary terminal consists of five connected solderless tie points. The individual points are spaced so that standard DIP-packaged ICs, transistors, Op Amps, all resistors (under 1-watt size), capacitors, and other small components can be directly plugged in and then interconnected. When the circuit has been tested, improved and finalized, the components are simply pulled out and the breadboard is ready to go again with another experimental circuit.

The drawing shows how the QT socket strips are hooked up internally. There are ten different kinds of QT sockets (strips), ranging from $3.50 to $12.50 each, and carrying from 14 to 108 5-point terminals (holes) each.

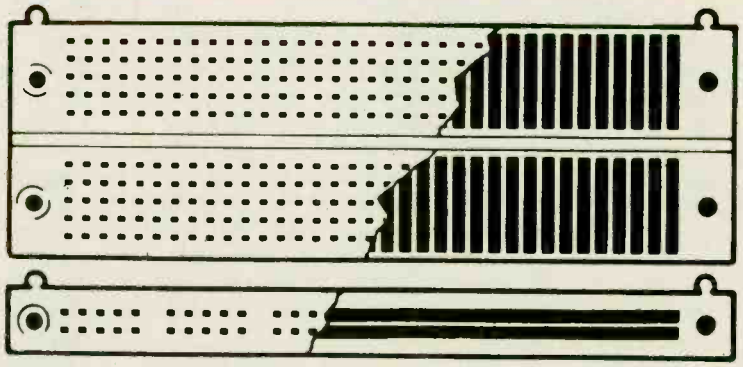
Our Rig-Kwik uses two each of the following QT strips: QT-35S (70 terminals x 5); GT-35B (two bus strips each, for GND or power voltages); and QT-7S (voltage bus pads). This configuration would cost you $27.00 for the breadboard strips, and it can accommodate about six or seven IC packages plus lots of associated circuitry. You could save $8.50 by getting just one QT-35 now, and leave room to add more later when your breadboard work gets more complicated. The choice of sockets is an entirely individual matter. Just be



Each of the three power supplies has its own fuseholder, permitting use of fuses of correct size to protect components for whatever project is being built on Rig-Kwik. The four small QT sockets at upper right let you run up to 27 leads from each to QT sockets at left, where breadboarding takes place.

Compact power supply board mounts all components except power transformer, supplies regulated power: +15 VDC and −15 VDC at up to 150 mA, and 5.0 VDC up to 1.5 amperes. Kit for this supply includes transformer, and costs $12.95 from Bullet Electronics (address in Parts List).

These cutaway views of Continental Specialties QT sockets show (at right) how metal strips under the connecting holes hook rows together. B-voltages come from smaller, individual 28-hole strips.



sure you use a chassis box large enough to accommodate at least one more QT socket (or more) than you think you might need at first.

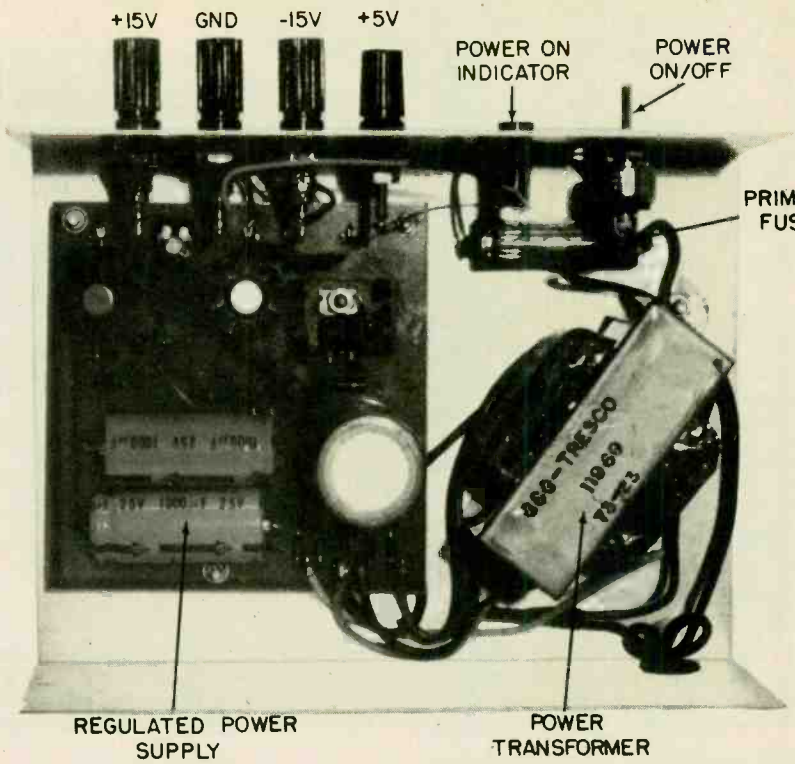
The chassis shown is a small deluxe Rig-Kwik so most of its available top surface space is taken up by the two QT sockets. But you can use only one, or as many more, QT sockets as you think you may need.

Fuse blocks are provided so both of the power supplies, which are not themselves internally short-circuit protected (to keep the price down), as well as the experimental circuit of the moment can be protected. More on the fuse setup later.

Construction. Our Rig-Kwik was assembled inside and on top of the two parts of an aluminum box whose dimensions are 7-in. W x 5-in. D x 3-in. H. The power supply is inside, and the QT sockets and fuse holders mount on top of the cabinet.

While the QT sockets aren't inexpensive, they are a permanent investment because they will be used many times. Figure out what you think you'll need, and add, say, one extra QT socket for more complicated projects later. Before you start construction you should get the catalog of these sockets from Continental Specialties by circling number 75 on the Reader Service Coupon. If you prefer getting the catalog even faster you can write direct to Continental Specialties Corp., 44 Kendall St., New Haven, CT 06509. They sell direct so you can select those sockets you want and order from Continental if they aren't stocked locally.

D.C. Power. The power supply is available in kit form from Bullet Electronics for $12.95. The kit includes the power transformer and the printed circuit board which mounts the entire power supply (except the transformer). This is a good deal because it saves you money (the transformer alone would cost five or so dollars) as well as the time and trouble of getting the parts together and etching the circuit board. Those who have a good junk box of spare parts can of course put it together for even less than the cost from Bullet Electronics. The Bullet kit has all the parts needed to build the regulated power supply which makes available (with one per cent load regulation) (a) a +5-VDC supply at up to 1.5 amps, (b) a +15-VDC supply at up to 150 mA, and (c) a negative −15 VDC supply, also up to 150 mA. The two 15-volt supplies can be hooked together to provide one 30-volt supply if desired. Finally, the two 15-volt supplies are so designed that they *track* each other. That is, if anything should happen to



Inside view of Rig-Kwik shows fuse for protection of power supply transformer (upper right). Neat construction is easy if you use the power supply kit. If you plan to use more Continental QT sockets for elaborate projects you'll use a larger metal cabinet than this one.

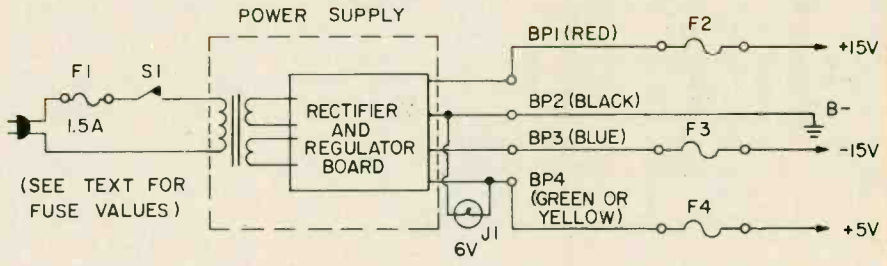
cause one or the other 15-VDC source to go slightly high or low, the other supply will follow it, in the opposite direction to minimize the effect on the circuit they are powering.

To keep the cost down, these regulated supplies are not internally protected against short circuits. That's why the fuse sockets shown are provided. This is a better way of protecting the supplies, because the fuse sizes can be chosen for each particular project to protect the parts in the project, and they will also at the same time protect the supplies.

The printed circuit board that comes with the power supply kit has a few component lead holes which need slight enlarging. Don't try to force a lead into a hole as you might wind up breaking the printed circuit board. Instead, use a #56 drill bit to enlarge the hole.

It will be easier to install and connect

(Continued on page 96)



PARTS LIST FOR RIG-KWIK

F1—1.5-A fuse (Radio Shack 270-1274 or equiv.)
F2, F3, F4—various size fuses, depending on external circuit—see text. (Radio Shack 270-1270 through 270-1280, depending on size required)
I1—6-V pilot lamp (Radio Shack 272-1140 or equiv.)
QT experimental hook-up socket strips—Continental Specialties Corp. 44 Kendall St., New Haven, CT 06509. This project uses two each QT-35S, QT-35B, QT-7S.
Power Supply Kit, Bullet Electronics, Box 1465, Lake Worth, FL 33460—$12.95 postpaid.
MISC. Metal Cabinet—3-in. H x 5-in. D x 7-in. W. (Radio Shack 270-254 or equiv.) **Push-in terminals** (eight required) 1/13-in. or 3/64-in. diameter (Radio Shack 270-1392 or equiv.) or Vector T-28 flea clips. 1-in. #4 machine screws, nuts and lockwashers (3 each needed), plus 1/4-in aluminum stand-off spacers (3 needed).

SANDBAGGING WITHOUT TRANSMITTING

Sandbagging—what's that? Read on to get in on a rewarding part of CB action.

by William S. Little

Oscar Brown checks out Smokey and road conditions with his Pace transceiver before hitting the turnpike!

☐ ***The popularity of CB Radio*** is becoming greater every day. A few short years ago walkie talkie sets were introduced as a toy for kids and grew into a toy for adults. Today CB is no longer a toy but in many cases a necessity. CB radios are being operated from cars, trucks, boats, snowmobiles, motorcycles, planes, trail bikes, bulldozers, taxis and other types of vehicles, and a new vocabulary is being born.

Truck drivers are the most beneficial users of CB. With hours of monotonous driving as they travel from city to city, truckers find CB one of the most valuable aids they have. It both keeps them company and is a necessity, keeping them alert and relaxed during their long hours on the road. If they are not talking, they are sandbagging.

Tune in. If you ever have the chance to sandbag on CB, don't miss it. You could be in for hours of enjoyable entertainment listening to the often comical conversations of the truck drivers. Tune in on channel 19 and try it for yourself.

Here's the way it goes. "Breaker, breaker, broke. How about it, one-nine?" "Yah, go ahead broke. You got the Snow Blower here at this end." "Yah, thanks for the break Snow Blower. I'm southbound in a Portable Parking Lot (auto transport carrier). Just passed Smokey (police) coming on to the highway northbound, and he's really got the hammer (gas pedal) down. What's your 20 (location)? This is the Rambler."

"Thanks for the info (information) Rambler. I'm at 110 mile post, just past the exit. That Smokey must be at my back door, I'll keep an eye-ball out for him. 10-4."

"Ya better, Snow Blower, it'll cost you some green stamps if they nail you for speeding. They're pretty hungry around here."

"Yah, well thanks for calling. I sure appreciate the info. You're beginning to fade, so best of 3s to ya, 8s to the wife. Have a good day today and a better one tomorrow."

"Same to you Snow Blower. Catch ya later. 10-4 we gone."

"Breaker. Rambler, you still in there?"

"Yep, come on, come on, I got you." "You got the Cowboy, Rambler. Heard you in there. Where did you say that Smokey was?"

"At 110, northbound. All wrapped up in a plain white wrapper, should be at about 114 by now."

"OK Rambler, thanks. I'm at 110 southbound, about 5 miles behind you. I'll watch your back door for you and you can watch my front. 10-4?"

"10-4. Will do. I've got to make a pit stop (fuel stop) at the next exit, but it's been nice talking to ya. It's clear up to here. I'm going to back off now. 3s and 8s to ya. We gone."

"10-4 Rambler. We clear." "Breaker for the Cowboy." "Yah, go ahead, we gotcha."

The Jargon. The truck drivers have created their own vocabulary, using the 10-code where they can, then adding their handles (names) to identify themselves.

They use handles such as Whiskey Jack, Iceman, Preacher, Country Cowboy, Grease Monkey, Clear Water, Swamper, Lumberman, Fisherman, Hunter, Brown Doggie, Grey Goose and many, many more. You will hear them refer to their rigs as Cattle Wagon, Portable Parking Lot, Baby Carriage, Cornbinder, Gravel Buggy, Lumber Wagon, 18 Wheeler, or Hedge Hopper.

Truckers specialize in reporting anything they see on the roads to the other drivers. They report weather conditions, road construction, accidents, traffic tie-ups, detours, obstructions on the travelled portion of the road, stalled vehicals and police.

Police are their favorite topic of conversation. Where they are, what they are driving, radar, speed traps, direction of travel, and what they are doing. And they actually help the police, by reporting their presence. Once the police are on the roads, the report goes out and the trucks settle down to the maximum speed limit. No one will exceed the speed limit if he knows a police car is half a mile ahead or behind him and usually most other cars not equipped with CB radios will follow suit if they see the trucks are not exceeding the speed limit. If there is an accident, the truckers will send out a report and it will be only minutes before the police receive it.

Joining in. If you are riding on the highway in a car or truck equipped with a licensed CB radio, switch to channel 19 and start sandbagging.

(Continued on page 90)

Basic Radio Repair at Home

Here's how you can use electronic basics and simple tools to fix radios and save money, too!

by Jack Darr

THERE ARE A LOT of interesting and money-saving things that the novice can do to the many pieces of electronic equipment around the average home. A lot of electronic repair work is very easy—if you have some basic knowledge and some simple test equipment. That's what this article will be about. You won't find any complicated math or theory—just practical tests that you can make at home with simple test equipment. For some things you'll have to take the set to a professional service technician. These tests will tell you when this is necessary.

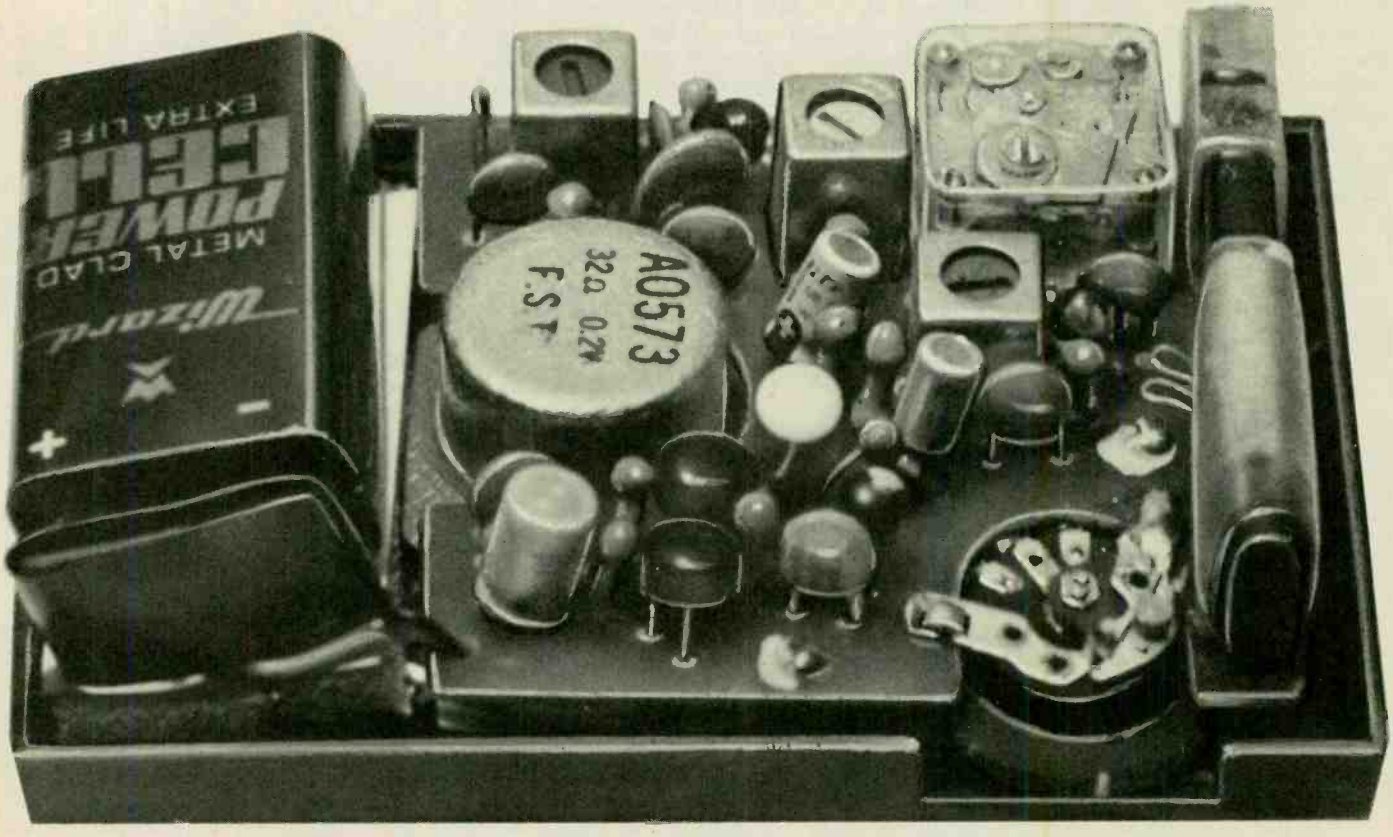
All repairs in electronics are simple—that is, *after* you find the trouble. In many cases, though, finding the trouble is what's complicated. However, the great majority of troubles are simple little things. What you want to do is find out all you can about the trouble before you go to the repair shop. You can save a lot of money by finding and fixing these simple things yourself. We'll give you the basic methods of finding troubles, and a lot of practical information about ways of fixing them. There are some things you should *not* do, too. These can cost quite a bit of money to have a technician undo. We'll warn you about these, too. With a basic knowledge of electronics, and one simple piece of test equipment, you can make a surprising number of repairs with no trouble. In just a little while you can save enough money to pay for your tools and test equipment!

The Test Equipment. Let's start with the basic piece of test equipment. You have to read various electrical quantities, and this is the only thing that will do it. This tester is a "volt-ohmmeter," called a "VOM." Fig. 1 shows a typical unit. This is a very compact unit, but accurate enough for professional use. You can get these all the way from about $10.00 up to a couple of hundred. If you're going to do quite a bit of repair work, it will pay to get a good one. It'll last a long time if you're careful. I've got one that's been in use for more than 20 years!

These can read AC and DC voltages, DC current, and resistance. We'll show you how to make these tests as we go. There are several things you should check when buying your VOM. These will make it easier to use, and your tests will be more accurate.

One is the test leads. The prods should have very sharp tips, so that you can get a good contact in tight places. They should have slip-on clips, with rubber insulators. These are very useful; you can clip one prod to the set, leaving one hand free to do other things, or clip both prods to test points.

Using the VOM. The very first thing you should do when you get your VOM is *read the instruction book!* One comes with even the simplest VOM. This book will tell you how to make each test. You'd be surprised how many men won't do this. Now, let's see how to use



the VOM to make the most common tests.

Reading Voltage. A lot of electrical tests will call for reading the voltage at certain points. Why? Because no electronic apparatus will work at all without the right power supply. So this should be your very first test. Let's use a small battery-powered transistor radio for an example, since there are so many of them. If the radio doesn't work, the first thing that should be checked is the battery voltage.

In almost all of these tests, you'll find that there is a right way and a wrong way to do them. There are reasons for this, which we'll give you as we go. The first step is always setting the VOM to the right range. A battery provides DC, so set the VOM switch to DC VOLTS. Now, be sure that the range used is greater than the highest voltage you'll find. For example, the common transistor battery is 9 volts. We set the VOM to the 12-volt range, and we're safe. If you do not know the voltage, start with the VOM on the highest range, take a reading, and then work your way down until you can get a reading with the meter-needle about in the middle of the scale. This avoids "slamming" the meter-needle, which may damage it. The better-quality VOMs have protective devices built in, which helps to prevent damage; but the cheaper ones don't, so watch it.

Now let's check the battery in the

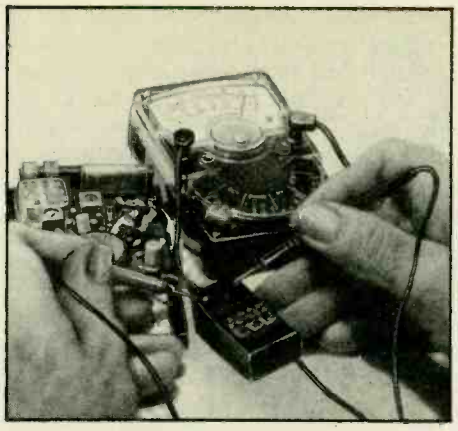


Fig. 2. Reading battery voltage of a little radio. The radio must be turned on.

little radio. Take it out, and touch the test prods of the VOM to the terminals on the top of the battery. The red test prod is positive or "+" (technicians say "plus") and the black test prod is negative or "–" ("minus"). The battery terminals will be marked on the case. If the meter needle goes backward, to the left, the prods are reversed. Fig. 2 shows how this is done.

Now, if the meter reads 9 volts, is this the right way to check a battery? No. This is a "no-load" test, and won't tell you too much. The right way is to put the battery back in the radio, plug it in, and then turn the radio on. Now read the battery voltage; you're taking a full-load reading. If the battery is beginning to get a little weak, you'll read the full voltage with no load, because the VOM takes only a very small current. With the radio on, "what you see is what you get": this is the voltage under load. If the battery voltage drops quite a bit when the radio is turned on, it's getting weak.

Practical hint on all dry batteries: There are two kinds, the standard cells, and the rechargeable types. These are interchangeable, as long as you get the right voltage on the radio. Each of these cells has a normal voltage of 1.5 volts. To find out how many cells are used in a battery, just divide the voltage by 1.5; in a 9-volt battery, there are 6 cells.

Here's a useful figure. When one of these cells has been used up, its voltage under load will drop to about 1.1 volt or less. This is the "cutoff figure" to tell when the battery is about done. In our 9-volt battery, if the voltage drops to less than 6.6 volts (6 cells times 1.1), the battery is ready for replacement. Some radios will still play a little with the battery this low, but not for long. Fig. 3 shows the connections and polarity of the standard dry cell battery. The metal case is always negative, and the round dot terminal on one end is positive.

Types of Batteries and Connections. Each radio is designed to play

Fig. 3. Typical dry cells, showing polarity. The small round brass nub on top is the positive terminal. The bottom of the case is the negative terminal.

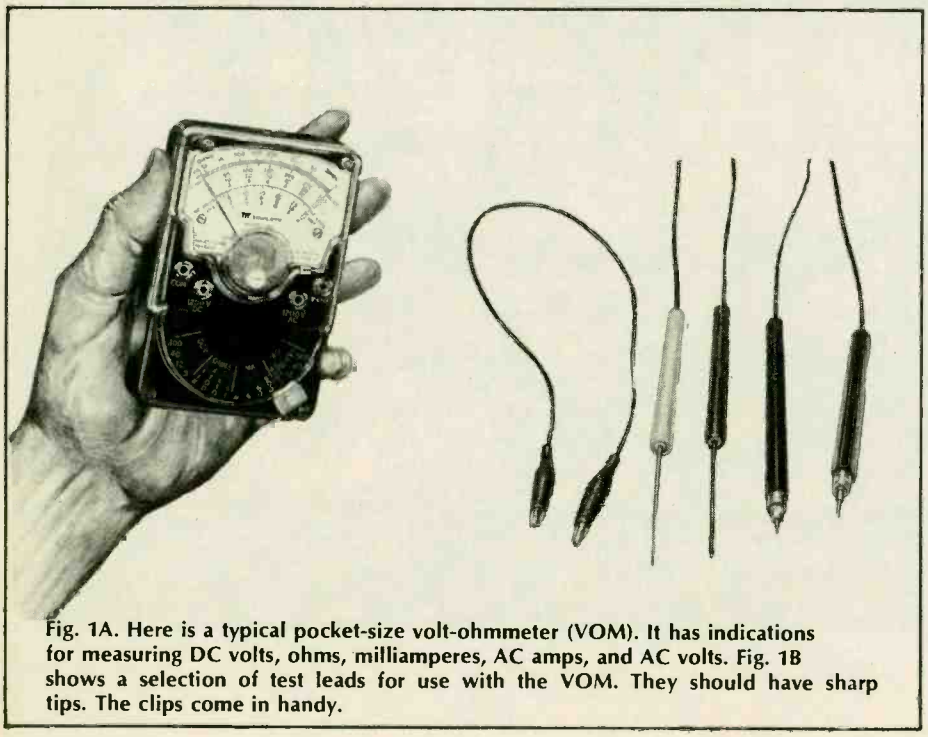


Fig. 1A. Here is a typical pocket-size volt-ohmmeter (VOM). It has indications for measuring DC volts, ohms, milliamperes, AC amps, and AC volts. Fig. 1B shows a selection of test leads for use with the VOM. They should have sharp tips. The clips come in handy.

Fig. 4. Typical 9-volt transistor battery. Plug and terminals are polarized. Battery cannot be hooked up in reverse.

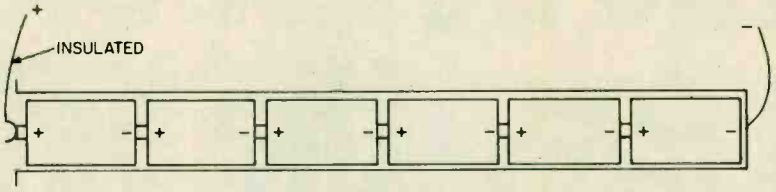


Fig. 5. Six dry cells hooked up in series give you 9 volts and longer life than the smaller battery. Be sure that all cells are put in correctly.

with a certain voltage. This may be 6, 7.5, 9, 12 volts, and so on. Nine volts is probably the most common. There are two ways of getting this. One is to put all of the cells into a little case, with snap-on terminals, like Fig. 4. The other is to connect 1.5-volt cells in series to make up the 9 volts, as in Fig. 5. The difference here is in the battery life. This is directly related to the size of the battery. The little 9-volt battery won't play as long as the 6 cells in series, simply because there is more "active material" in the 6 cells.

When you replace batteries in one of the separate-cell radios, watch out for the polarity. This will be marked in the battery holder, as in Fig. 6. When they're all in the right way, the voltages will add up. As you can see, if you put one in backward, this will subtract that much voltage, and can make you think the battery is dead when it isn't. This is another one of the "wrong things" you must watch out for.

Battery Holder Problems. Here are a few things about all battery-operated radios, and anything else using batteries. These cause a lot of the troubles, so watch out for them. For one, if a battery goes dead, take it out. All of the older types of dry cells, and some of the cheaper new ones will "spew" a liquid if they are left in the case too long. Some say they "spill acid"; this isn't true. However, they do have a solution called "sal ammoniac" (ammonium chloride); this will attack the brass of the battery terminals. In some cases, they can almost eat them out entirely. (In case you were wondering, a "dry battery" isn't dry at all; it's damp. They have to have liquid so that the chemical reaction can take place.)

If your radio has been damaged like this, you can make repairs. If the damage isn't too bad, you can often clean up the spring terminals. You can run a small dot of solder on the contacts to make good connections. If the clips have been eaten up so badly that they won't hold the batteries, you can sometimes find replacement holders at radio-TV supply houses. If these aren't handy, you can make up new contacts by getting a piece of thin brass "shim-stock" from an auto supply house. With tin-shears, you can cut out and bend to shape until you have a duplicate of the original. This can be riveted in place or soldered. If there is enough of the old holder left you can clean this up and solder the new one to it.

The negative terminal of the batteries will usually be connected directly to the metal of the battery holder. The positive terminal must be insulated from it. You can do this by putting a thin piece of plastic or insulating paper between the terminal and the main part of the holder, and bolting this together. Insulating washers can be used on the bolts. Standard color code for battery wires is red for positive and black for negative. Be sure to check the way the batteries were hooked up in the original, and the color of wire used, in case it was different. Make up a scratch-paper drawing of the battery holder, showing the polarity and wire colors, etc. This will serve as a reminder.

Reading Curent Drain. The last thing in the battery department is the current drain. This is a very important test. If the radio is drawing too much current the battery life will be very short. This is expensive. This can be checked with the VOM, but we must do it in a different way. Up till now we have been reading voltage by putting the meter "across" the circuit as in Fig. 7A. To read current, we must break the circuit and connect the meter in series with it; the current flows through the VOM as in Fig. 7B. This is easier than it sounds. Set the VOM to the "mA" scale (see Fig. 1) on the highest range: 0-600 mA. Put the clips on the test prods. Now take the plug off the battery and snap it back so that only one of the connections is made. Now clip one test prod to the battery plug's open terminal, and the other to the open terminal on the battery. Your meter is now in series with the battery. Be sure that the switch is off while you're hooking up.

(Continued on page 52)

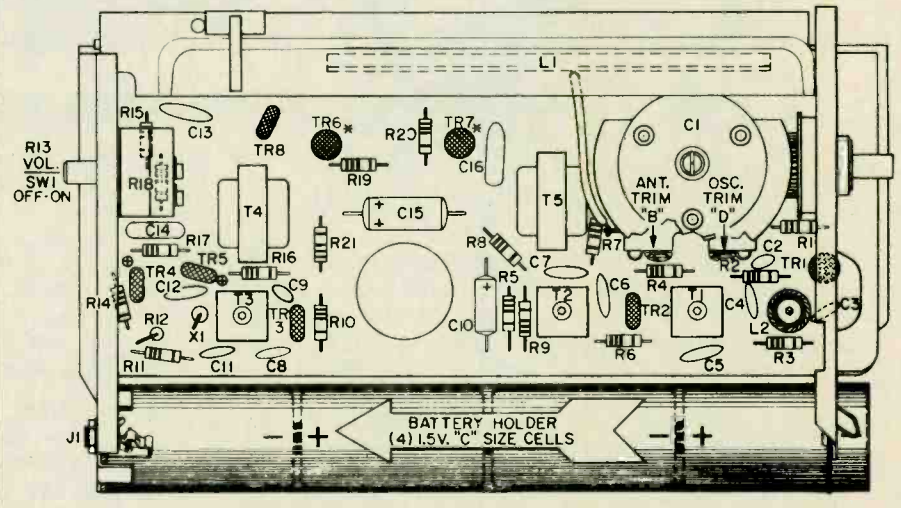


Fig. 6. Typical small radio chassis showing battery holder. This one uses a 6-volt supply. Note polarity markings.

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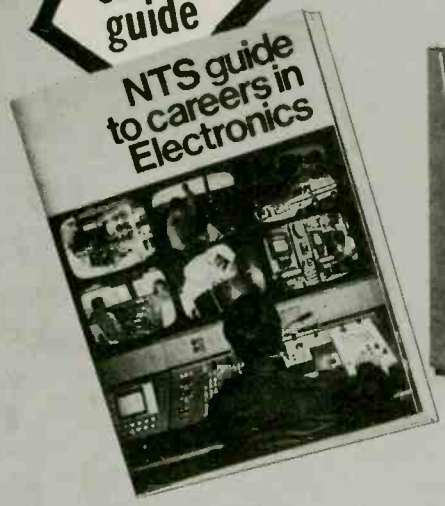

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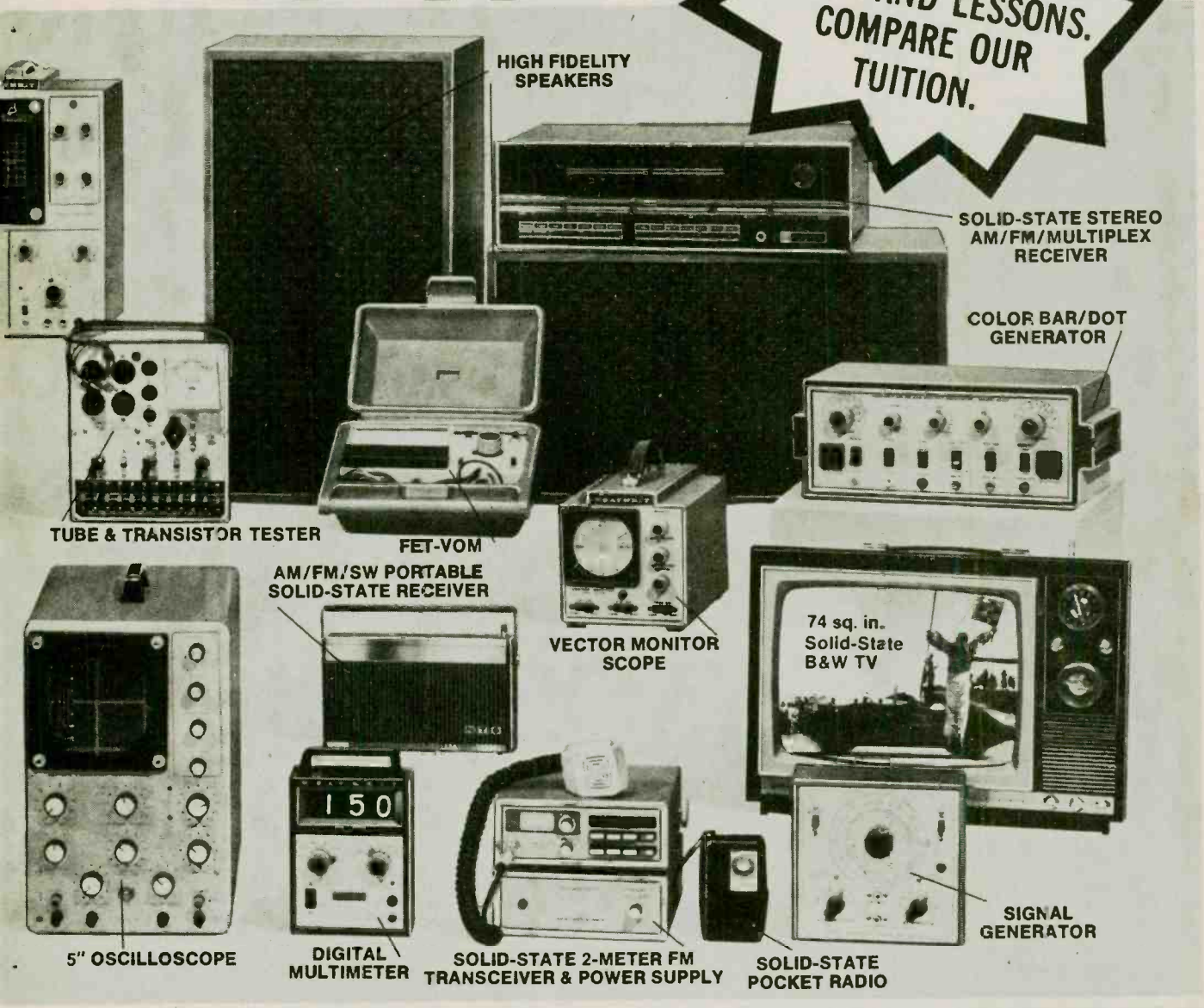

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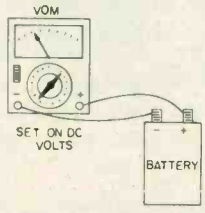
(Continued from page 47)

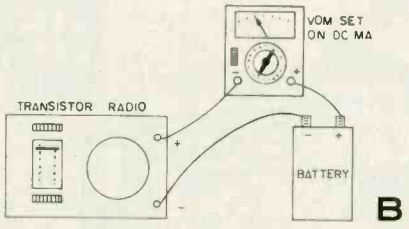
If you left the positive terminal of the battery open, the red test lead should go to it, and the black lead to the battery plug. The meter should read up-scale (to the right). However, if it backs off-scale to the left, turn the set off and reverse the clips.

Now turn the radio on and check the meter reading. If this barely moves the needle, switch to the 60-mA range. However, if you see a reading of 200 or 300 mA on the 600-mA range, look out! This shows that the radio is taking far too much current. It will probably have to go to a shop for repair. The normal current depends on two things: the number of transistors in the radio, and the setting of the volume control. Start out with the switch on but volume turned way down.

In the average 6-8 transistor radio you'll see a reading of about 12-14 mA; 10-12 transistor sets, perhaps 20-22 mA at low volume. Turning the volume up will make the reading go up to about 30 mA on the 6-8 transistor sets, and to about 40-50 mA on the 10-12 transistor sets. The meter needle will wiggle with loud parts of the sound. This is normal. By the way, if you do find far too much current, you may save a little bit on the service charge if you will tell the shop technician exactly what you found.

This test is also handy if you suspect that you have a bad battery. If a new battery shows only normal current drain on the radio, but lasts only a short time, the battery is probably too old. Dry batteries have a normal shelf life of at least a year. You can extend the life of your dry cells (once you get them home from the store) by keeping them in your freezer.





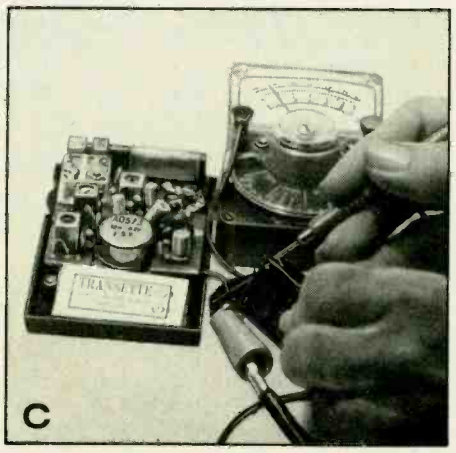


Fig. 7. To read DC voltage (A), VOM must be connected across the battery. To read current (B), meter must be connected in series, with battery lead going to radio. In C we see the author reading battery current drain of a small radio. Put plug on sideways so that only one contact is made. Then put meter between battery and radio.

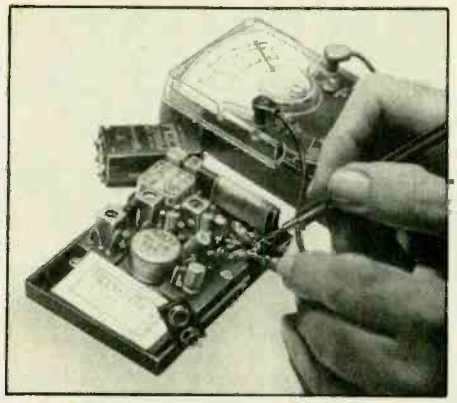


Fig. 8. Checking resistance of switch contacts with ohmmeter. Note that the battery has been disconnected.

Fig. 9. Speaker terminals are on little insulated terminal board on the speaker frame.

Important hint: When you finish this test, be sure to reset the VOM switch to the highest DC VOLTS scale or OFF position. Never leave your VOM on a current-range. If you forget, and connect this across a battery, you can damage the meter. Make it a habit to always reset the switch to DC volts and you're safe.

Checking Continuity. Here's another test we can make with the VOM. This is one that will be useful in every kind of electronic testing. In general, we call this "continuity testing," and we use the ohmmeter in the VOM to do it. Every electrical circuit must be "continuous." Current, signals, and everything else must have a complete path, or they won't work. You'll see several examples of this in just a minute. The ohmmeter in the VOM has a little battery. When you set it to the "ohms" ranges (Fig. 1) the battery causes current to flow if the circuit is complete; the resistance is read on the top scale. If you set the switch to "X1" you read this scale directly. 200 ohms is center-scale. Short the tips of the test prods together; the meter should swing all the way to the right, to "0." This means a dead short. If the needle doesn't stop on zero with the prods shorted, set the "Ohms Adjust" control of the VOM. This is under the thumb of the hand in Fig. 1, but it will be plainly marked on all VOMs. Adjust this till the reading is zero with prods shorted. (This tells you that the ohmmeter is properly set up so that your readings will be accurate.) For simple continuity testing, use the X1 range. For higher resistance you can use the "X10" range. On this, you multiply the reading by 10; a reading of 200 means 2000 ohms, and so on, up to the highest range which is "X1K," an abbreviation for "kilohm" or 1,000 ohms. This means multiply the reading by 1,000. Now let's see how to use this test on our little radio.

Checking the Switch. Let's say that the radio has good batteries, but when we turn the switch on nothing happens: no sound, no voltage drop on the battery. The first thing to check with these symptoms is the on-off switch. Set the ohmmeter to X1, and *disconnect the battery*. Continuity tests must *never* be made with any power on the thing being tested. Now turn the switch on, and touch the ohmmeter prods to the switch terminals. (See Fig. 8.) These will be on the back cover of the volume control, and almost always easy to get at. With the switch closed you should read absolutely zero resistance, if the switch

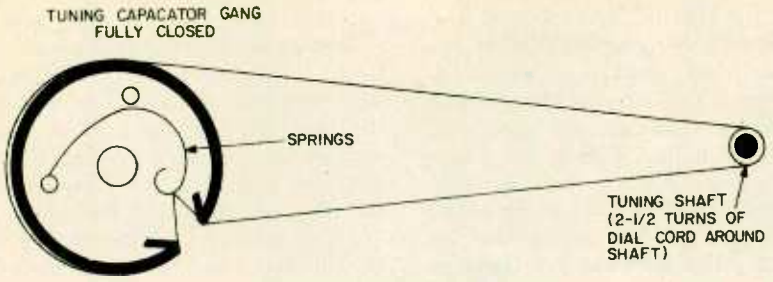
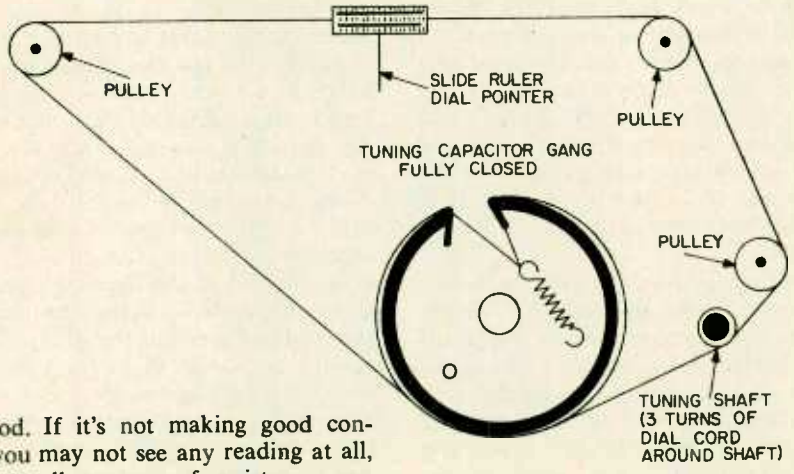


Fig. 10. The easy one: simple drum dial with cord drive.

Fig. 11. The slide rule dial. Harder, but not too much. Follow stringing directions in text.



is good. If it's not making good contact you may not see any reading at all, or a small amount of resistance, say 50-75 ohms. This means that the switch is very dirty.

Most of these have open contacts, and it's easy for a piece of lint to get between the contacts. Check these closely with a magnifying glass. A good way to clean dirty contacts is to open the switch, then slip a thin piece of paper between them. Now close the switch and pull the paper back and forth. The surface of the paper is just rough enough to clean off lint and polish up the contacts. Take the paper out and recheck. In some cases the contacts can be bent so that they're not even touching. With luck, you can bend them back so that they do. If not, the volume control and switch will have to be replaced.

Wiring. There's an old joke among technicians about the customer who brings in a set (any kind) and says, "It's just a loose wire somewhere!" He agrees; it is. Of course, the loose wire may be inside a transistor, a capacitor, a coil, or anywhere! This is even more true in little transistor radios. These all use very fine wires, for connecting the speaker, batteries, antenna, and so on. These are very easy to break while you are working on the radio. So be very careful when moving parts around.

You can check wires with the ohmmeter. Just put one prod on one end and the other on the other end of the wire. If it isn't open you'll get a zero-ohms reading. For example, check the battery wires by hooking to one end of the battery holder and putting the other test prod on the switch terminal. One lead from the battery holder always goes to the switch. You can tell by checking the color of the wire. Wires from the chassis to the loop antenna can also be checked. There are almost always four wires on the typical loop antenna. If one of these is loose, check on the other end to see if you can find where it came from; there will often be a broken end with insulation of the same color.

These tiny wires can be hard to work with unless you know how to handle them. To resolder a wire you'll have to strip the insulation off for about ¼ inch from the end. If you try to cut it with a knife you'll probably break the fine wires. Instead, do this: Touch the insulation near the open end with the tip of a hot soldering iron; this will melt the plastic, and it can be carefully pulled off with your fingernail. Before trying to solder this, "tin" the end by touching the end with the tip of the soldering iron, with just a little fresh solder on it. You'll see the solder flow to the wires. Don't leave the iron on there too long; the wire will conduct the heat, and melt the insulation off too far back. Just "hit and git," as fast as possible. Practice this, and it's easier than it sounds.

Speaker Testing. The speaker is another part that's easy to identify. It'll be bolted to the case, behind the grille, and the back end will usually come up through a hole in the PC board of the chassis. There will be two wires going to it. These should be green and black, but you'll find other colors used. At any rate, you can usually tell that these two

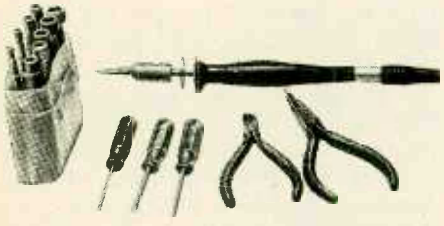


Fig. 12. These are the tools you'll need: long-nose and diagonal pliers, three small screwdrivers, and a set of nut-drivers.

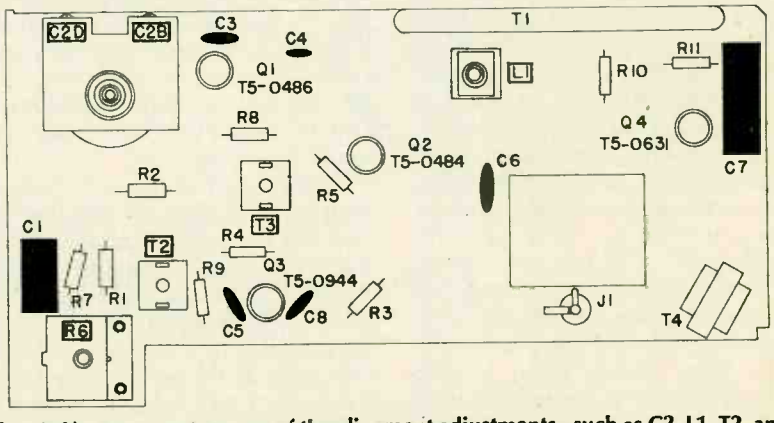


Fig. 13. Never, never turn any of the alignment adjustments—such as C2, L1, T2, and T3 on this board. If you do, you'll make things much worse!

wires go through the hole to the speaker. The symptom of possible speaker trouble is good batteries, current-drain normal, but no sound when the switch is turned on. (We just checked the switch, remember?)

The easiest way to check is to trace those two wires. Set the VOM to X1, and touch one prod to the end of each wire. This should show you a small resistance reading, about 3-4 ohms, and you should hear a little "click" sound from the speaker itself. This is due to the battery voltage of the ohmmeter, and is just as good as the meter reading. No click, and no meter reading; the speaker's coil is open.

To replace the speaker, you'll have to take out the PC board chassis. Remove the small Phillips-head screws around the edges, until the chassis is free. Lift it up and out very carefully, so that you don't break any of the fine wires. This will expose the speaker, and you can repeat the test to be sure. For a definite test, unsolder either one of the two wires to the speaker, and check right on the speaker terminals (Fig. 9). If you got a dead short reading and no click on your first test, but now the speaker clicks and shows a small resistance, the speaker is good but you have a short in the radio. This is very apt to be a bad transistor, and it is a shop job for a technician. Here again, if you can tell him what to look for, it will make the job faster.

If the speaker is definitely bad you can replace it. It will be held in place by small screws around the rim. Take the old speaker along with you to the radio-TV supply house. The replacement must be an exact duplicate of the original, or you won't be able to get it into the case.

Earphones and Jacks. Most little radios have an earphone jack on the case. This little thing can cause what seem to be speaker problems, since the speaker circuit goes through this jack. There is a tiny switch in it, which is opened when the earphone is plugged in. If this switch doesn't close again when the earphone plug is pulled out, you will have all the symptoms of an open speaker. This can be checked with the ohmmeter. Connect the prods across the wires going to the switch and plug in the earphone. By the way, earphones can be checked just exactly like speakers. They should make a click when the ohmmeter is connected across the plug. This switch can be cleaned up in the same way as the power switch. Look it over with a magnifying glass, and be sure that the contacts are closing, and making good contact. If the earphone is bad, you can get a replacement. Watch out for one thing: Take the radio with you and and make sure that the sub-miniature plug *fits*. There are *three* different sizes of these plugs, although they all look alike to the naked eye. Most of the plugs are molded on the cord, and very difficult to replace. You can try it if you want to, but be sure that you have the right plug. The earphone unit itself can often be pried apart to get at the wires. These are also very thin wire, and easy to break.

Checking Volume Controls. The volume control is another part that's easy to identify. If you hear a loud scratching noise every time you turn it, the resistance element is dirty. You won't need to use a meter for this; your ears will do. Many of them can be cleaned up by spraying "contact cleaner" into the case and turning the knob back and forth several times as you do. If this quiets the scratching noise, fine. If it doesn't, the control will have to be replaced.

Once again, take the radio with you when you go to the radio-TV supply house. Replacement controls are available, but as usual it must be an exact duplicate. For another very helpful hint, leave the old control in place until you get ready to begin the job. When you do, make up a rough sketch of the control, all wires going to either the control or switch with their colors and location.

The volume control will usually be located on one corner of the PC board, so that the knob can come out through a slot. Most of them have three comparatively heavy lug terminals. These are the electrical connections to the control, and also the mechanical mounting. They'll be soldered to "solder pads" on the edge of the board. Melt the solder and loosen these up very carefully. Be sure that all of the lugs are loose before you try to take the old one off. Don't use too much force—it is very easy to break off the corner of a board. Heating the lugs and then brushing briskly with an old toothbrush is a good way of removing solder.

When you put the new one in, tin each of the lugs on the side that will be next to the board. Leave just a little solder on them. Then put it in place and all you have to do is heat each lug till the solder melts. Don't pile up solder on the lugs; the only part that's doing any good is the solder *under* the lug. Also, be sure that you haven't accidentally spattered tiny blobs of solder onto the PC board. This can cause short circuits between conductors, and damage the radio. Look it over carefully.

Replacing Dial Cords. In most of the larger transistor radios the dial pointer will be driven by a strong cord from the shaft on the front panel. Simple systems use the cord to turn a round dial with the frequency figures around the rim, something like the one in Fig. 10. The system used in radios with a straight dial and sliding pointer is basically the same, just a little harder to work on (Fig. 11). Here, the drive shaft turns the drum on the end of the tuning capacitor, and also moves the pointer along a straight slide mounted on the cabinet.

Replacing these can be a little tricky, but not too hard after you get used to it. The first thing to do is "close" the plates of the tuning capacitor. This sets the dial at the low end of the scale, 550 kHz. You'll see a small coil spring hooked to the drum on the tuning capacitor shaft. Tie one end of the new cord to this. Come out of the slot in the drum and go to the tuning-drive shaft. Wrap 2½ turns of the cord around the shaft, and then go back to the drum, going around in the opposite direction. Come back through the slot and tie the cord to the end of the spring. To get enough tension to make the shaft turn the drum, pull on the loose end of the cord until you get it tight enough, then hold the loop with long nose pliers while you tie it tightly. That's the easy one, of the type shown in Fig. 10.

For the slightly more complex one of Fig. 11, start with the drum in the same position, which is usually fully counterclockwise. Tie the cord to the spring as before. Now come out the slot, and go CCW (right to left) around the drum. Go over to the tuning shaft and wrap three turns of cable around it. Next, go up to the pulley on the right end of the dial scale as you look at it from the back. Over this and along the top of the scale, over the pulley at that end, and then back to the drum. Go around in the same direction, and into the slot and tie to the spring again.

The trick to doing this is to hold the cord in one hand and keep a constant, small pull on it at all times. This keeps it from jumping off pulleys, and so on. When you get all the the way around, thread the free end of the cord through the spring with your free hand, and then take up the slack. It may take a bit of practice, but you'll learn how to "hold with one hand and tie with the other" in a very short while. In this type, the pointer is a thin piece of metal which slides along the edge of the dial frame. Your capacitor is set at the 550

(Continued on page 94)

Customizing CB Mobile Antennas

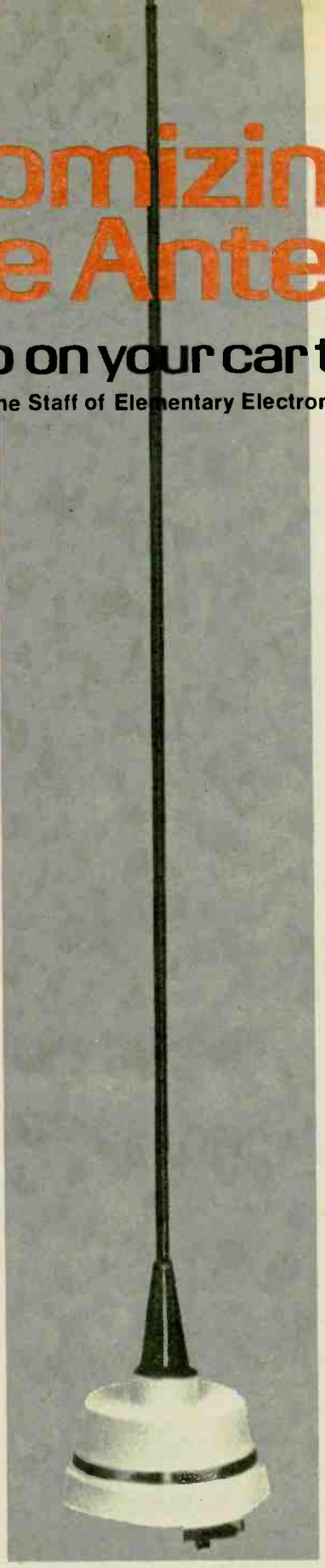
Put the best whip on your car to up your range.

By The Staff of Elementary Electronics

As the TV commercial says, "You've come a long way baby!" Too bad the commercial doesn't refer to CB because if anything's come a long way it's been CB, particularly the CB mobile antenna. From the early choice of a body- or bumper-mounted 108-inch steel whip antenna, the CBer of today has a selection of antennas and mounting hardware that permits just about any type of customized mobile antenna system. It is even possible to assemble a *mobile beam* for your car, one that concentrates your signal right down the turnpike. But mobile beams is getting ahead of the story, so let's go back to basics and show how you can customize your mobile antenna system to fit your particular operating and installation requirements.

The basic CB antenna. The antenna to which all others are compared remains the 108-in. ¼-wavelength whip. Trouble is, for maximum efficiency the whip must be mounted above a groundplane. The only mobile groundplane is the roof of the car, and many early CBers did, in fact, mount their 108-in. whip on the roof. Unfortunately, these roof-mounted whips had a bad habit of shattering toll booth lights and getting snagged in trees. There is even a case on record where a rooftop 108-in. whip caught in a tree and the roof was peeled open like a sardine can.

Matching. Another problem with the 108-in. whip is that it really isn't 50 ohms. Actual impedance values fall in the range of 15 to 30 ohms depending on the precise mounting location. This impedance mismatch wasn't much of a problem when all CB rigs used tubes because they all had tuning controls, and *everyone* tuned the rig to match the antenna system. Today, a transmitter's tuning controls are sealed, or internal, where the user can't get at them: Since the rigs are factory tuned for a 50 ohm load it's obvious they can't work with maximum efficiency if the antenna is less than 50 ohms because there's no way to adjust the transmitter's output tuning. You can, of course, use an antenna matching device such as Radio Shack's Model 21-924 Mobile Antenna Matcher.



Hy-Gain's Model 559 Hellcat 4 trunk lip mounting mobile whip makes for easy no-hole installation with just two set-screws holding it securely to the lip of the trunk.

The Mobile Antenna Matcher is simply a device that functions as an impedance-matching transformer between the transmitter and antenna system. Once adjusted it allows the transceiver to put out its maximum RF power regardless of the antenna system impedance or SWR. For those who prefer the gain advantage of a ¼-wave length whip the Antenna Matcher is a *must*.

Smaller Antennas. To meet the needs of CBers who want something smaller and easier to install than the typical ¼-wave whip with its heavy spring and body or bumper mount, the CB antenna manufacturers have come up with just about every conceivable type of loaded antenna and mounting system. The reason these small, loaded antennas have not totally replaced the 108-in. whip is because the full length whip still has the advantage of *gain*. In order to shorten an antenna you can't simply cut off a few inches, or a foot or more, and say, "Aha, I now have a short antenna." It doesn't work that way. The short antenna must be the *electrical equivalent* of at least ¼-wave length—the same as the 108-in. whip. To get the same electrical characteristics a loading coil must be placed somewhere in the remaining antenna section so a transmitter looking into the antenna sees a ¼-wave length antenna. The loading coil can be placed just about anywhere. If located at the top of the whip we say the antenna is *top loaded*. If the loading coil is at the base of the whip we say the antenna is *base loaded*. If the loading coil is near the center we have a *center-loaded* antenna. Though the performance of loaded antennas is not as good in a direct comparison with a 108-in. whip, because the loaded antenna is usually installed in a better location from the standpoint of radiation pattern, or because the loaded antenna has a builtin matching transformer that allows the transmitter to deliver its maximum po-

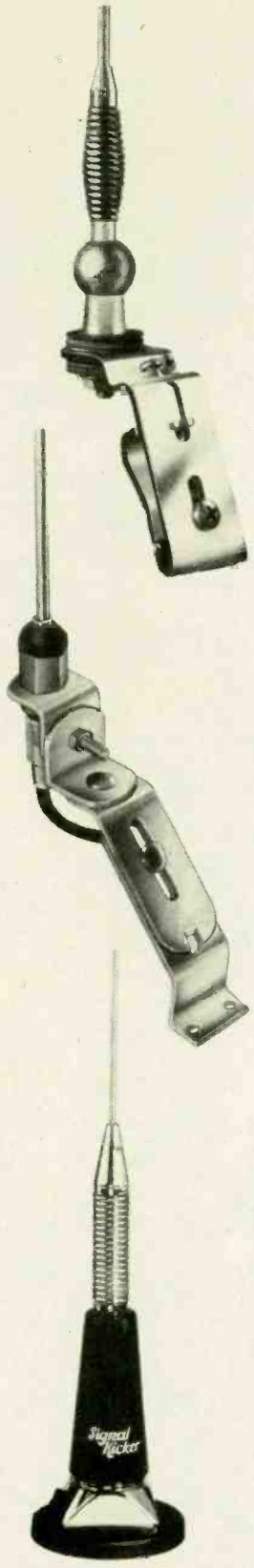
tential power, as a general rule the performance from a loaded antenna is often equal to that of a full length whip. More important, being considerably smaller and lighter than the whip, the loaded antenna lends itself to individual customizing of the antenna system. Just about any convenience you can think of is now available in CB mobile antennas.

For example, let's assume you have only a rare need for CB. You don't want the equipment out where it can be damaged but you do have need for instant availability when you need CB. Antenna Specialists has a standard mobile antenna with an extra-powerful magnetic base, their model MR-178. You simply plunk the antenna on the roof of your car and it will stay there until you're ready to take it off. If you want something a little more sturdy, but quickly secured and easily removed, you'll find several companies offer models of the "rain gutter" antenna. Again, we have a smaller, loaded antenna but this time it's secured to a clip-like device that attaches to the rain gutter with two screws. There is even a model that eliminates the screws and has a simple clamp that locks the clip to the rain gutter. Rain gutter antennas are available from Lafayette Electronics, Radio Shack and the Breaker Corp.

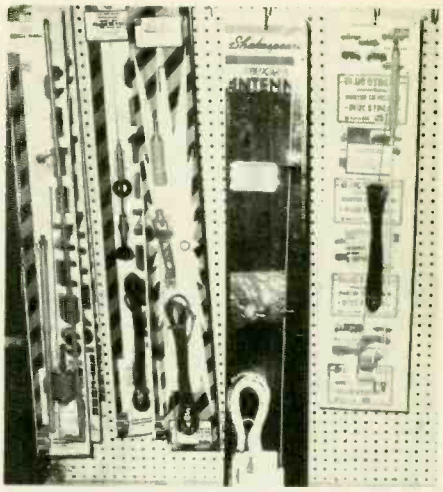
Rear Deck Mounts. For passenger cars the most common place for mounting the short CB antenna is on the rear deck, and there are two common mounting assemblies. One type, such as the Lafayette 42R01521WV, installs in the trunk groove with two mounting screws. Some similar mounts use one screw—it doesn't make any difference. It is normally positioned in the center of the rear deck right behind the rear window. Because it is secured to the car's body, the antenna remains upright when the trunk is opened. The mount itself has a small, angled, telescopic bracket that is adjusted so those trunk lids that open up and back don't strike the mount.

The second common rear deck mounting assembly is secured directly to the lip of the trunk lid. This mount does not require any holes to be drilled in the body. Rather, two screws force a U-clamp to lock around the lip and provides a more or less permanent mount. There is a plastic or metal case on the outside that conceals the connection between the transmission line and the antenna. The coax cable snakes

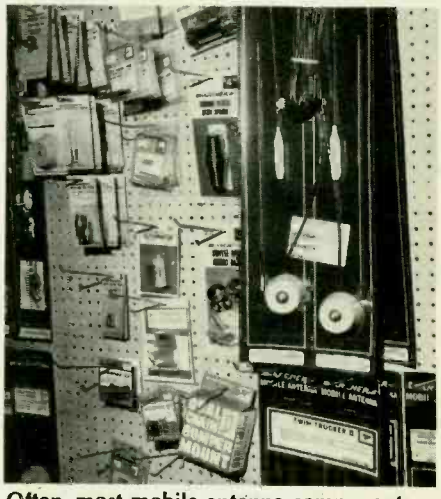
(Continued on page 90)



The Turner SK400 series gutter mount, SK500 series trunk groove mount, and SK910 magnetic base antennas enable CBers to make quick, simple, hole-free installations on their vehicles.



The typical Citizens Band distributor will stock many different types of mobile antennas; generally by two or more manufacturers.



Often, most mobile antenna components are available individually packaged as on this Radio Shack pegboard display. Radio Shack also offers most types of mobile antennas under their own brand label.

Component packagers such as Calectro also have point-of-purchase pre-packaged displays of antenna components and hardware. You can often find standard replacement parts as well as specialized hardware such as small antenna matchers.

e/e checks out the...

HEATHKIT GB-1201 DIGITAL STOPWATCH

Solve your timing problems with Heath's handy digital stopwatch.

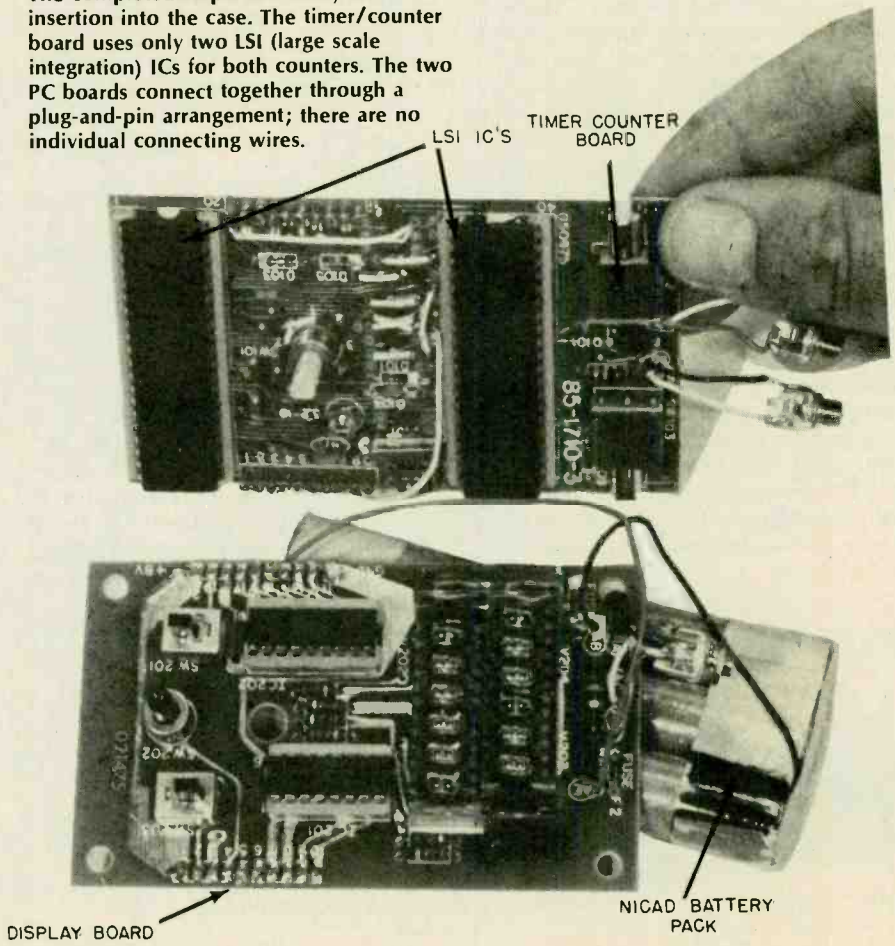
If you shop around long enough and are willing to settle for some little known brand name you will most likely locate a digital stopwatch that sells for less than the $99.95 Heathkit gets for their model GB-1201. If, however, you want something that does more than just time the start and finish of any single event it's going to cost you a lot more. In fact, we don't even know if anything else has all the timing features of the GB-1201 for we haven't been able to find its equal in the local stores.

Features. Basically, the GB-1201 has two independent timing sections which can be used concurrently, or one can control the other. We simply haven't the space to detail every function, but here are some highlights. A single 7-position function switch determines the operating mode for the entire stopwatch. Five of the seven positions are timing modes. The remaining two positions are programmable counters that allow the stopwatch to count up to, or down from, a user-programmed interval up to 9 hours, 59 minutes, 59 seconds. The timing modes, however, provide intervals to 99 hours, 59 minutes, 59.99 seconds—that's right, to 99/100s of a second. (The actual display digits are xx xx xx.xx (hours, minutes, seconds, hundredths of seconds).

The GB-1201 is conveniently hand-sized with operating switches positioned to fall naturally at the thumb and index fingers. It is powered by rechargeable Nicad batteries; the supplied (wired) charger plugs into a jack at the top of the case. The front panel has the function switch, power switch, a display on-off switch (to conserve battery power), and the *timer reset/counter load* switch. On the left side of the case is the S/S (start/stop) timer switch. On the right side of the case is the F/S (final/stop) switch.

How it works. The setting and order-of-operation of the function, S/S and F/S switches determine the timing modes and order of display. For example, pressing the S/S switch sets the timer running (remember, two timing circuits are started). The next time the S/S switch is pressed timer A—which is shown on the display—is stopped and the display indicates elapsed time. But timer B keeps running. Pressing the S/S switch starts timer A again and the timing cycle can be repeated. At the end of the final cycle to be timed the F/S switch is pressed. The timer will indicate the timing of the last cycle. But if the S/S switch is pressed after F/S the display will indicate the total elapsed time from the original timer start to the

The completed stopwatch ready for insertion into the case. The timer/counter board uses only two LSI (large scale integration) ICs for both counters. The two PC boards connect together through a plug-and-pin arrangement; there are no individual connecting wires.



The GB-1201 Digital Stopwatch kit including an accessory sunshade and a pre-wired battery charger is priced at $99.95. An optional carrying case is available for $4.95. Both are available by mail order from the Heath Company, Benton Harbor, Michigan 49022. They are also obtainable at local Heathkit Electronic Centers. Circle No. 31 on the Reader Service card for more information direct from the Heath Company.

e/e Digital Stopwatch

final F/S stop—including all the pauses between the timed cycles.

There are accumulation, split and accumulated activity timing functions. And provision is made for remote S/S and F/S control through two jacks on top of the case. The same jacks can be used to trigger audible alarms and relay control circuits. The instruction manual shows several complete circuits using readily available components.

Calibration. Accuracy of the clock is determined by a crystal controlled oscillator that provides a specified non-instrument aligned accuracy of ±0.003% at 80°F. If you have access to an electronic counter you can instrument align the stopwatch to a higher degree of accuracy. However, the extra accuracy is not usually needed and the procedure is quite complex as there's little room to maneuver once the kit is assembled—it's sort of tight inside the case.

Extreme temperature changes have no practical effect on accuracy because the stopwatch uses a crystal controlled clock. 25°F to 125°F is the specified operating range for +0% to —0.003% accuracy vs. temperature, and that will handle just about every use you will have for the stopwatch.

A full charge of the built-in nickel-cadmium batteries provides approximately 40 hours of operation with the display turned off except when needed to make a reading. Approximately four hours operation per charge is attained when the display is continuously lighted.

Assembly. The circuit is split up onto two printed circuit boards: one board with the display circuits, the other with counters and other components. A pin-and-socket arrangement allows the boards to be stacked for final assembly without need for individual connecting wires. The printed wiring foils on each board are high-density and a small wattage, fine-tipped soldering iron as well as considerable kit building experience is necessary. It's very easy to solder-bridge two or more foils so extra care is *a must*. We don't suggest this as a beginner's kit.

The board assemblies and the rather large Nicad battery pack are installed in the case as a single unit, and though there's lots of room for checkout before installing the case, everything is as tight as can be when the case is applied; so make all your checks for cold solder joints, shorts, and other potential problems before you do any part of the final assembly.

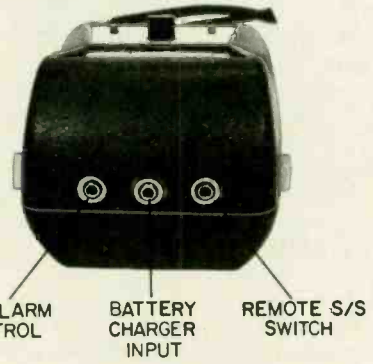
Heathkit supplies a lanyard so the stopwatch can be "dangled" from your neck, shoulder, belt, or however you prefer. The lanyard is secured when the case is closed up, and cannot be removed unless the case is opened. So decide in advance whether you want to use the lanyard or not; the field is not the place to start disassembling the stopwatch.

The whole bit looks and reads complicated when you first start out, but a couple of evening's work is all it really takes from start to finish.

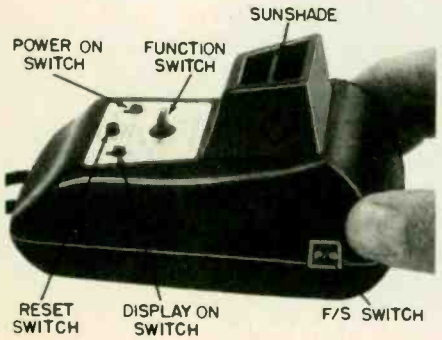
How it works. The stopwatch is quite accurate. The best way we could check it was to compare the timing against WWV, and against the phone company's time signals. As far as we could determine the stopwatch was "right on." It was not possible to make a laboratory type check because the Heathkit GB-1201 is more accurate than our digital photographic timers; in fact, we wound up using the Heathkit stopwatch to calibrate our darkroom digital timers, which do not have a crystal time base—the reason the stopwatch is more accurate. We left the stopwatch to bake in the sun in a closed car, and put it in a refrigerator's meat storage bin. In both instances we could neither note nor measure any change in accuracy for practical hobby and sport timing purposes.

A fully charged Nicad battery pack tested with all display units *on* delivered nearly five hours continuous operation, almost one hour more than Heathkit's rating of four hours operation with the display continuously on. With the display turned off except for a final reading we attained well in excess of 40 hours operation. Since Nicads do age after hundreds of charge and discharge cycles Heathkit's claim of four continuous hours per charge—though conservative—is probably representative of what you can expect after several months of heavy use, and you could therefore expect to get 8 to 20 or more hours in intermittent use with sparing use of the display. Although there is no battery condition indicator, and the instruction manual implies no way of knowing whether or not the stopwatch is running with an adequate battery charge, in our model the display suddenly turns noticeably dim and, in fact, it can barely be seen when the batteries are almost pooped out. In a few minutes the display became erratic with zeroes blinking on and off. Until the time of erratic zero display we could measure no change in the timing accuracy. If you go out with the batteries fully charged, which takes about sixteen hours, or overnight, you'll get the full four hours of continuous display operation—and that's enough for any ball game, rally, or whatever else you'd likely use a timer for.

The GB-1201 Digital Stopwatch kit including an accessory sunshade and a pre-wired battery charger is priced at $99.95. An optional carrying case is available for $4.95. Both are available by mail order from the Heath Company, Benton Harbor, Michigan 49022. They are also obtainable at local Heathkit Electronic Centers. For additional information circle No. 31 on the Reader Service Card. ■



The three jacks on top of the case provide connections for the battery charger, S/S remote start switch, and a control "trigger" for an audible alarm or control relay circuit. An F/S remote stop switch connection is made through the center (tip) contacts of the S/S and F/S jacks. For more information on the GB-1201 circle No. 31 on the Reader Service card.



An accessory sun shade is supplied with the kit. It simply clips into place and allows the red LED display to be more easily seen in bright sunlight. Note the F/S switch on the side of the case. The S/S switch is directly opposite. When the stopwatch is held normally in the hand, the thumb and index finger fall naturally on both switches.

by Kathi Martin, KGK3916

Kathi's CB Carousel

It's amazing, the FCC allows hobby CB contacts and CB becomes America's hottest growth industry. Fact is, the FCC is buried under an avalanche of CB license applications SO HIGH just about nothing else is getting done: the FCC is running months behind on amateur and commercial licenses.

Problem Solvers. Anyway, with everyone jumping on the CB bandwagon and CB antennas sprouting like corn in an Iowa field we are not without new problems. Fact is, in trying to untangle a couple of new problems for local CBers I ran across some accessories originally intended for radio amateurs that are more at home on the Citizens Band.

First problem came from my neighbors Nancy and Joe, who own a home and boat at Lake George, N.Y. Seems the CB signal was pooping out about half way up the lake, and what was needed was a directional antenna system on the house. But (A) Nancy and Joe have enough trouble making the payments on the boat and weren't ready to spring for a tower and a "moonraker," and (B) Nancy didn't want an antenna that was almost as big as their hide-away cottage.

The BoosTwenty. Okay, if they didn't want a super-antenna maybe I could soup up the receivers with a preamplifier; only how would I get the preamp out of the way when the transmitter was turned on? The answer was found in a "BoosTwenty"—an in-line preamplifier providing about 20 dB amplification from 2 to 30 MHz. What's different about this preamp is it gets out of the way automatically when the transmitter is activated.

The whole bit is inside a metal box about 1¼" x 1½" x 6". Standard coaxial SO-239 connectors are provided on the ends for input (from antenna) and output (to transceiver). A two-screw binding strip is used for connection to the power source which should supply 12 to 15 VDC at about 50 mA.

Without power applied the unit *fails-safe*, connecting the antenna directly to the transceiver antenna jack. When power is applied a relay switches the preamp into the line. When you hit the PTT switch the preamp instantly senses the RF and drops the relay out, once again connecting the antenna directly to the transceiver. When the PTT is released the preamp senses the RF is off and switches the preamp back in again. In any condition, if something goes wrong the preamp *fails-safe*, making a direct antenna-to-transceiver connection.

This little gem is from an outfit called Telco Products Corp., and is sold in amateur radio (and some CB) stores. It is list priced for $39.95 (I bought it for less).

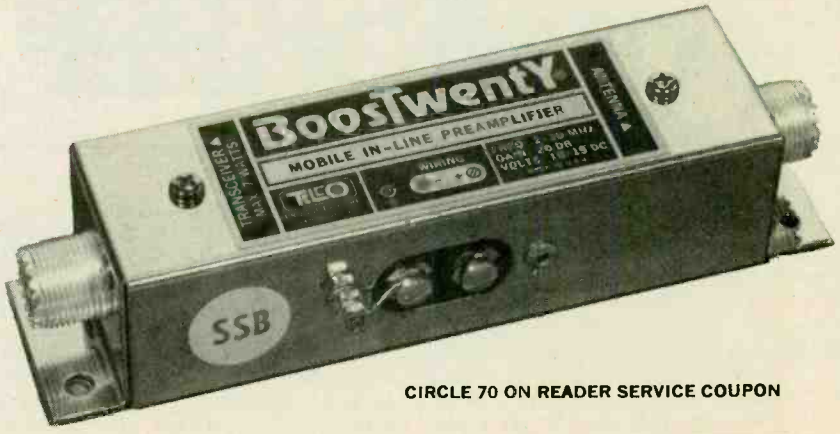
A quick check on my Tektronix spectrum analyzer showed the BoosTwenty to have 18 dB gain at 27 MHz—the 2 dB difference is well within normal tolerances and accuracy of the measuring equipment. As for overload, a 100,000 *u*V input produced no spurious or cross-modulation, so the device doesn't create any new problems while solving old ones.

To sum things up, the BoosTwenty gave Nancy and Joe just enough extra gain for their transceivers to provide a readable signal up and down the lake.

Power for the BoosTwenty was taken off the battery in the boat and off the base station's power supply pedestal. If you have a base station that is normally powered by the 117 VAC line voltage you'll need a small 12 volt power supply (75 mA maximum). You can use batteries but they'll wear out mighty fast.

New TVI filter. My second *problem solver* also comes from the Telco Corp., and I discovered it while searching for the preamp. This gem is called the Telco XL-1000 Adjustable Low Pass

The BoosTwenty in-line preamplifier and XL-1000 adjustable low pass filter are available locally from authorized CB dealers for $39.95 each. If unobtainable in your area order direct from Telco Products Corporation, 44 Seacliff Avenue, Glen Cove, N.Y. 11542 for $39.95 each (postpaid). For more information direct from Telco circle No. 70 on the Reader Service card.



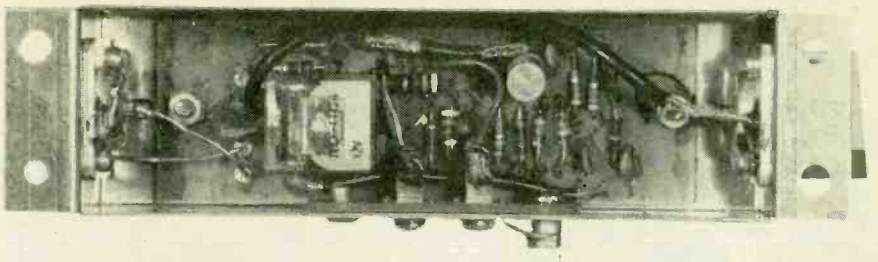
The BoosTwenty preamplifier is small enough to tuck under a dashboard or mount on the back of a transceiver. At a base station it can even hang loose. It works with both positive and negative ground systems. It provides about 20 dB RF amplification from two to 30 MHz.

CIRCLE 70 ON READER SERVICE COUPON

Filter, and crushes just about any harmonic TVI from a CB rig. (It's also priced at $39.95).

This gadget caught my attention because the guy next door put up his new CB antenna about five feet from my TV sky hook, and he was pouring the herringbone down two channels.

The XL-1000 is a combination antenna matcher (matches slightly high SWR antenna systems to the rig), low-pass filter and *tunable filter*, and it's the tuneable part that make the XL-1000 different. The top of the filter has five controls (actually variable capacitors). Two are used to set the minimum system SWR (you must connect an SWR meter between the rig and filter for the initial set-up). Two of the controls are used to tune out interference on channels 2-3-4 and 4-5-6, while the final control is used as an SWR adjustment and a filter for channels 7 and up (I guess *up* means through channel 13). As a general rule, harmonic interference from a CB rig affects channels 2 and 5 (slightly), possibly channel 9 (rare); and other types of signal—as opposed to overload—interference would be caused by *spurs*, which you shouldn't have in a CB rig.



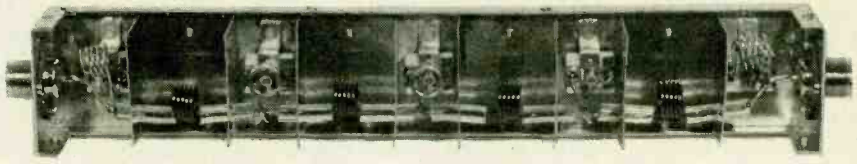
Inside the BoosTwenty is an IC RF preamplifier and the RF transmit sensor. The "fail-safe" relay switches the preamplifier into the transmission line when receiving. When the unit senses RF, or the power supply fails or is turned off, the relay connects the transceiver's antenna jack directly to the transmission line.

Since the problem channels are 2 and 5 the XL-1000 is tailor made for CB because one tunable filter covers channels 2 through 4 while the second tunable filter covers 4 through 6. Needless to say, I wouldn't be writing any of this if the XL-1000 wasn't a winner all the way. The XL-1000 crushed that TVI from my neighbor's rig like a giant squashing an ant. I've never seen a TVI filter work that well before. Of course, as with all TVI filters, a solid ground is an absolute must if the filter is to work 100%. Fact is, without a good ground a filter might not work at all—the harmonics from the transmitter might zip right around the outside of the filter's case and up the transmission line to the antenna. So not only did I have to locate this filter for my neighbor, I had to hold a six food ground rod while he drove it into the ground with a two pound sledge hammer.

By the way, the XL-1000 is made for kilowatt amateur radio transmitters so it's built like the Rock of Gibralter. (I wonder how much the price could be trimmed if a 5-watt version was made for CB?)

Anyway; that's my two problem solvers for this month. While the Telco Corp. accessories are sold only in local stores (no mail order that I know of), you can get more info by circling No. 70 on Reader's Service card. ■

The XL-1000 Channel Guard looks like no other TVI filter because it has controls for matching a 50 to 70 ohm antenna system and individual series tuned TVI filters. The filter is matched by adjusting the SWR controls for minimum SWR reading between the transceiver and the filter.



CIRCLE 70 ON READER SERVICE COUPON

The XL-1000's internal works look like the Rock of Gibralter because the filter was originally intended for amateur radio transmitters rated to 1 KW. Each section is in a separate shielded compartment to prevent interaction with adjacent sections, which could reduce attenuation at the TVI frequencies. The unit is normally sealed to prevent tampering. We cut the filter open to show you what goes into getting rid of your neighbor's complaints.

Kathi Blinks for Safety

There are two problems in nighttime auto emergencies—seeing and being seen! The Heathkit Emergency Strobe Light will make your car more visible at night. If your car breaks down, a bright, flashing, amber light warns oncoming traffic while you're on channel 9 calling for help. A non-mar, magnetic base holds the light securely on your car and a 12-foot cord with a cigarette lighter plug supplies power. It operates from any 12-volt DC electrical system. The GD-1026 can be plugged in and placed on the car's roof without leaving the car. Kathi assembled the GD-1026 in one evening. For a complete Heathkit Catalog which describes the GD-1026 ($29.95) as well as 350 other electronic kits, write to Heath Company, Benton Harbor, Michigan 49022.

CIRCLE 31 ON READER SERVICE COUPON

BUILD LITE-COM!

Photo-transistor receiver and LED transmitter work on visible or invisible light, with or without fiber optics.

by C. R. Lewart

AT THE SAME TIME that food and drink prices keep going up, and UP, the cost of electronic components keeps going lower and lower. You can now communicate over a beam of light for less than ten dollars using two electro-optical semiconductors which weren't even available except in development labs a few years ago. These transducers* convert electrical signals into light, and then convert light back into electrical signals. Thus you can use the Lite-Com to send messages and music over a beam of light without most of the previously-required circuitry.

Less-sophisticated light detecting devices have been available to the experimenter for some time. There are photocells made of selenium and of cadmium sulfide which have been off-the-shelf items for years. They are used in light meters and in cameras to measure light. However, their response time is much too slow for accurate transmission of sound. Photo-transistors, on the other hand, have excellent audio frequency-response characteristics, and are ideal for the project which we describe here.

The Lite-Com uses two electro-optical transducers: the *photo-transistor*, which converts light variations into electricity, and the LED (Light-emitting diode), which converts electrical signals into changes in light intensity. Lite-Com is an easy-to-construct project using those transducers which will give you the basic circuitry for many other projects you will think of after you've put it together and seen how well it works. Combining these two circuits with other equipment should make some interesting Science Fair and other experimental (and practical) systems.

Light Detector. The basic detector used in the Lite-Com is the photo-transistor. Every transistor is sensitive to light when its cover is removed. Light falling on the base region of a transistor has the same effect as electric current being "pumped" between its base and emitter. This effect was recognized early in the development of transistors. Because transistors were not intended to be light-sensitive in their original applications (how would you like your radio to quit when exposed to light?) they are mounted in hermetically-sealed, non-transparent metal or plastic enclosures.

You could of course cut through the transistor enclosure to make a regular transistor into a photo-transistor but in the process more likely than not you would destroy the transistor. But for little more than a dollar you can buy a photo-transistor specially designed to do the job. It is hermetically sealed but has a small glass window on top to permit light to fall directly on its base region. Most commercially-available photo-transistors use the NPN config-

* A *transducer* is any device which accepts energy in one form, such as heat, light, or electricity, and converts it into some other form of energy, such as mechanical motion. Telephone receivers (and transmitters) as well as loudspeakers, are widely-used transducers.

uration. Some photo-transistors have three terminals, emitter, base and collector, while others have only two terminals, the emitter and collector. In either case light falling on the transistor generates the base-emitter current.

In a three-terminal photo-transistor there are other ways to control the base-emitter current. You can bias it by connecting a resistor between the base and collector, or you can vary the light sensitivity of the photo-transistor by connecting a potentiometer between the base and emitter. However, for Lite-Com either a two- *or* a three-terminal photo-transistor will do the job. Another option the photo-transistor designer has lies in the light region for which the photo-transistor is most sensitive. The two usual choices are in the visible light spectrum or in the infrared region as shown in the Spectral Response Graph To be able to operate with "invisible" infrared light we selected an infrared sensitive transistor with its peak sensitivity at 0.9 microns.* The visible light region extends from about 0.4 microns to 0.7 microns (violet to purple). If you want to experiment with visible light our infrared transistor will still work, as its sensitivity stretches into the visible region. However, a different photo-transistor (see the Parts List) will give you better results with visible light.

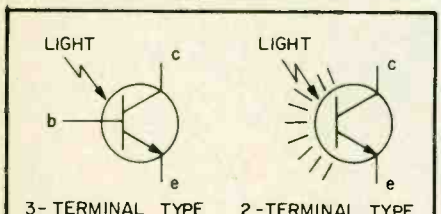
Light Sources. To generate a signal proportional to the sound energy Lite-Com uses an infrared LED. The LED generates light when it is forward-biased. That is, when its anode (+) is connected to the positive battery terminal (and its cathode, of course to the negative). Be careful, however, not to connect an LED (or any other diode) *directly* to a source of positive voltage. Doing so will burn the diode out at once, because it will draw too much current. This is because the LED (just as other diodes) has a very steep voltage/current curve. Unless you put a current-limiting resistor in series with the diode any battery voltage larger than about 1.5 volts will cause the current drawn to exceed the maximum allowable value, and the diode will burn out. When in doubt always figure the size of the resistor required, using Ohm's law:

$$R = \frac{E(\text{volts})}{I(\text{amps})}$$

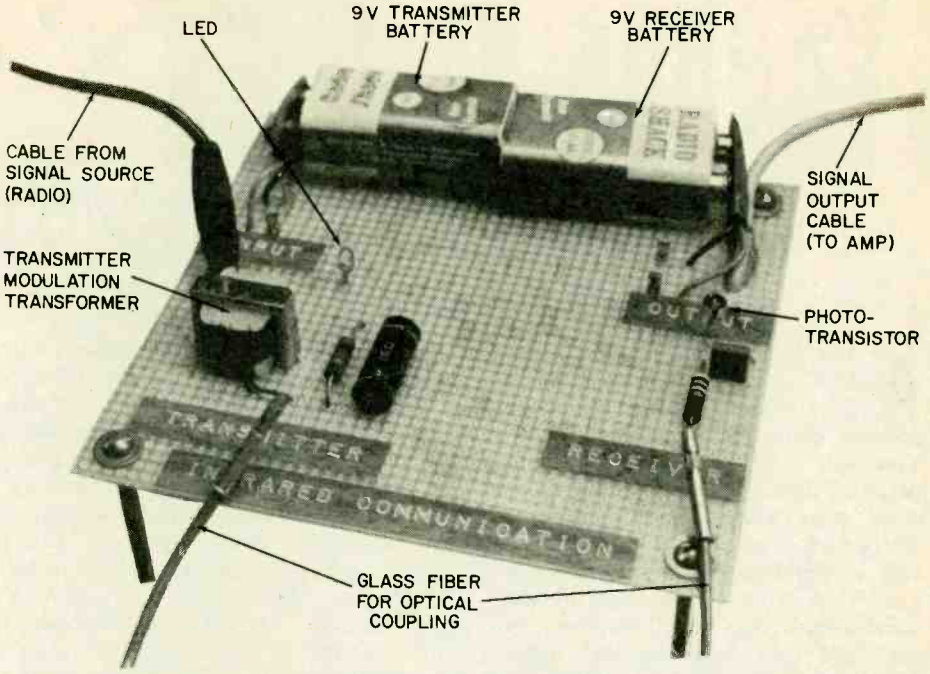
For example, for a battery voltage of 9 V, with the maximum allowable current through the diode 30 mA, assume a voltage drop across the diode of 1.5V. The limiting resistor value in this case would be found by using these figures in the formula:

$$R = \frac{(9\text{-}1.5)}{0.030} = 250 \text{ ohms}$$

*one micron = 10^{-6} meters (one millionth of a meter)



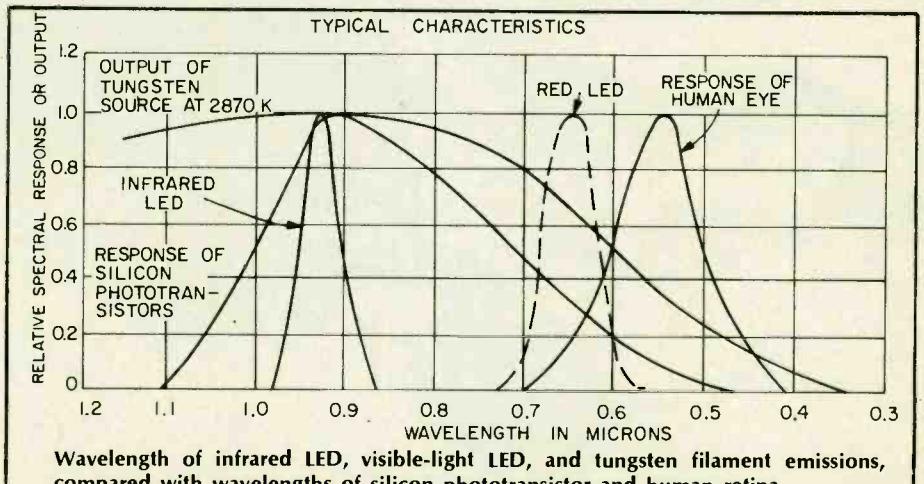
Ordinary transistor—light-sensitive, if open. Phototransistor has clear window, omits base connection.



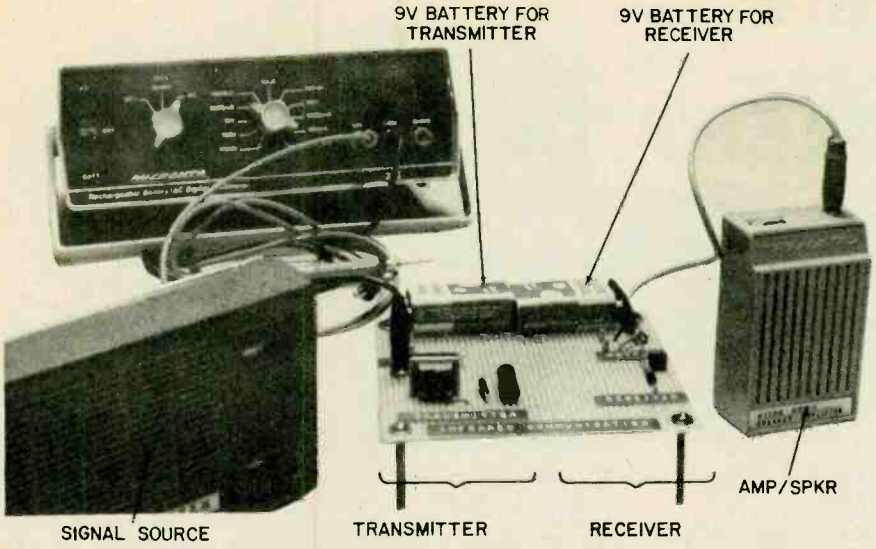
Closeup of transmitter and receiver built on one chassis for demonstration. Units may be separated by any distance provided light path is provided from transmitter's LED to receiver's phototransistor.

Just as photo-transistors can work in various light regions, LEDs can also be designed for various light frequencies or colors. Currently you can buy red, orange, green, and infrared LEDs. Light-emitting diodes generating invisible infrared light are particularly useful for building burglar alarms, or in areas where ambient light would be disturbing. Under such conditions an infrared filter can be used to attenuate the visible ambient light and pass only the infrared radiation. Common features of LEDs, as compared to incandescent light sources, are fast response up into *megahertz* region, and low power consumption. Thus they are ideally suited to transmission of voice frequencies.

Transmission Medium. Both infra-



Wavelength of infrared LED, visible-light LED, and tungsten filament emissions, compared with wavelengths of silicon phototransistor and human retina.

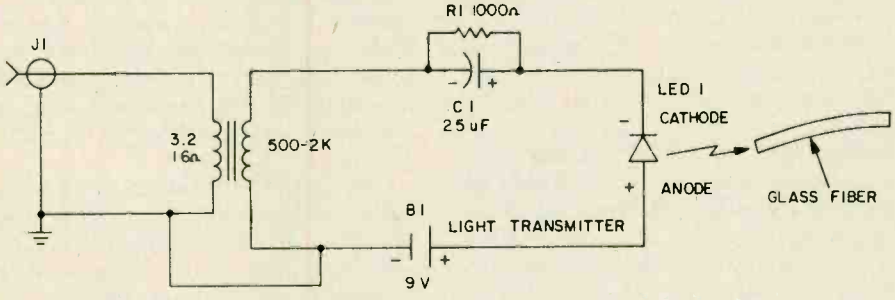


Lite-Com uses electrical signals from radio (or other source) to modulate infra-red LED transmitter. Receiver phototransistor senses infra-red light variations, feed external amplifier/speaker. LED and photo-transistor may be coupled directly, with lenses, or with glass fiber optics.

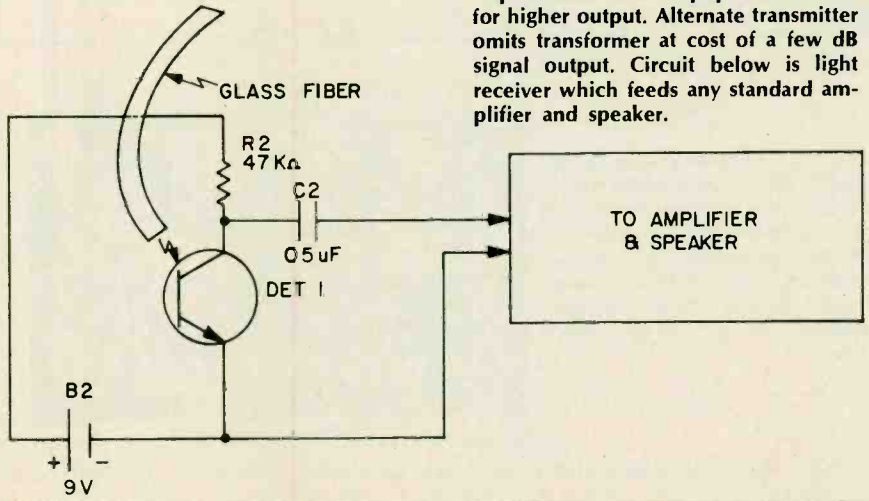
red and visible light propagate along straight lines through the air. This path can be bent by prisms, mirrors, lenses or bundles of glass fibers. In fact you will have the most fun by using one or more glass fibers between the transmitting LED and the receiving photo-transistor. You can tie the glass fibers in knots and they will still pass the visible or infrared light energy. Our Parts List gives suppliers of glass fibers for experimenters. You can even use just one glass fiber about 1/16-inch in diameter, and any convenient length.

Setting It Up. To use the Lite-Com we modulate the output of the LED with sound signals such as the output of a radio, a tape machine (connect from the earphone output jack), a ceramic phono pickup, or a microphone and mike amplifier. The light can be transmitted directly (by placing the LED face-to-face with the photo-transistor), or more conveniently by transmitting the light signals through a glass

(Continued on page 93)



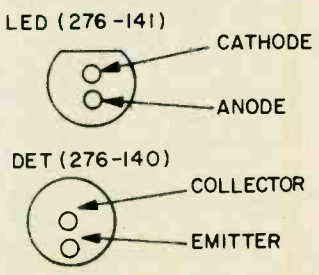
Top circuit uses stepup transformer for higher output. Alternate transmitter omits transformer at cost of a few dB signal output. Circuit below is light receiver which feeds any standard amplifier and speaker.



PARTS LIST FOR LITE COM

AMP—transistor amplifier with speaker (Radio Shack 277-1008 or equiv.)
B1, B2—9 V transistor radio batteries
C1—25-uF, 35-V capacitor (Radio Shack 272-1026 or equiv.)
C2—0.5-uF, 35 V or more capacitor (Radio Shack 272-1071 or equiv.)
DET 1—Infrared photo-transistor (Radio Shack 276-140 or equiv.) or photo-transistor for visible light (Radio Shack 276-130 or equiv.)
J1—phono jack (Radio Shack 274-336 or equiv.)
LED 1—infrared light-emitting diode (Radio Shack 276-141 or equiv.), or visible light LED (Radio Shack 276-026 or equiv.)
R1—1000-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
R2—47K-ohm, ½-watt resistor (Radio Shack 271-1000 or equiv.)
T1—audio output transformer. Primary may be anywhere from 500 to 2000 ohms, secondary between 3.2 and 16 ohms (Radio Shack 273-1380 or equiv.)
Misc.—Perf board, battery connectors. A selection of glass fibers (also called fiber optics) can be obtained from Radio Shack (page 72 in the 1976 catalog) or from Edmund Scientific, Barrington, N.J. 08007. Edmund also carries many optical components for the hobbyist.

PIN CONNECTORS



e/e checks out the...

WEATHERALERT TA-3

Listen to National Weather Service broadcasts with this solid-state receiver featuring crystal control and automatic alarm.

CIRCLE 69 ON READER SERVICE COUPON

☐ From the rockbound coast of Maine to the sunny shores of California the U.S. is slowly being blanketed by a network of FM stations operated by the National Weather Service on 162.40 and 162.55 MHz. Each station has an effective range of about 40 miles (50 miles in flat country) and broadcasts up-to-the-minute weather reports for its specific area. Stations are now operating in 126 towns and cities across the U.S., covering most major metropolitan areas and virtually blanketing the Atlantic, Pacific and Gulf coasts. At present only Arkansas, Idaho, Montana, Nebraska, Nevada, New Mexico, North and South Dakota and Wyoming are without coverage by the NWS weather station network.

Disaster Alert. Now what's so important about weather that so much time and effort should be spent to give out a report you can get just as easily from your local AM radio station? The reason is that the weather stations will soon become an instantaneous national *Disaster-Alert* service. Presently, the stations serve as local disaster alerts—for example, in the Florida keys the weather stations warn of approaching hurricanes, while in the midwest the stations give early warning of cyclones and tornados. But you need a special receiver such as the Weather-alert Model TA-3 to take advantage of the automatic disaster warning service; the ordinary weather receiver does not provide the disaster-service function.

The differences between the common weather receiver and the Weatheralert are the automatic alarm and crystal control. Although some weather receivers are crystal-controlled, others are not, and the user often has to fiddle with a tuning dial to get good reception. When your life might depend on reception of a special warning signal you do not want to fool around with tuning circuits, hence, the reason the Weatheralert is crystal controlled.

Automatic Alarm System. Each weather station is equipped with a 1050 Hz tone generator. The station transmits the tone for approximately 13 seconds before broadcasting a special disaster announcement such as a hurricane warning. Weather receivers specially equipped to receive both the weather broadcasts and the disaster alarm, such as the Weatheralert TA-3, have a single frequency audio detector and an electronic siren. Normally, the receiver's volume control is just cracked open so power is on but no sound is heard—this is the "ready" standby position. When the receiver detects a 1050 Hz signal from the weather station it samples the signal for three seconds to make certain it is a tone burst and not a random 1050 Hz signal from a voice announcement. If the 1050 Hz signal is present for the full three seconds the detector triggers an electronic siren that overrides the receiver's volume control. The siren screams loud and clear, warning the user to turn up the volume control to hear the voice announcement.

You can easily see why the weather stations are scheduled to be part of a national emergency warning system. When they are all connected to a "national radio line" it will be possible to broadcast the warning tone and an emergency announcement to the entire country.

Features. The Weatheralert TA-3 is one of the first popularly priced weather receivers to have the disaster alarm function in addition to crystal control. It operates off a 9-volt transistor radio battery or an AC power unit which is supplied with the receiver. The receiver (with AC power unit) is priced at $39.95.

The TA-3 is about the size of a pocket transistor radio. The top of the receiver has only a volume control, red powerlight, speaker and telescopic antenna. The channel selector switch is located on the bottom since there is only one weather station in any area, so

The Weatheralert Model TA-3 is available from Lafayette Radio and many leading department stores. Price is $39.95. It is also available by mail order from Weatheralert, 1301 West Armitage, Melrose Park, Illinois 60160 for the regular retail price plus $2.50 for shipping and handling. Circle No. 69 on the Reader Service card for more information direct from Weatheralert.

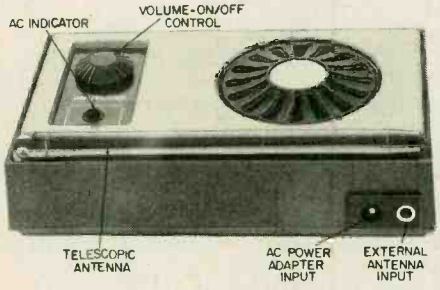
The case is not an empty shell; there's plenty of circuit hardware. No tuning capacitor is evident because the receiver is crystal controlled. Much of the hardware around the volume control is the detector for the 1000 Hz tone and the electronic siren.

you set the switch just once—to hear a station—and that's it until you move to an area using the other weather service frequency. Two jacks on the back are for connection of the power unit and an external antenna.

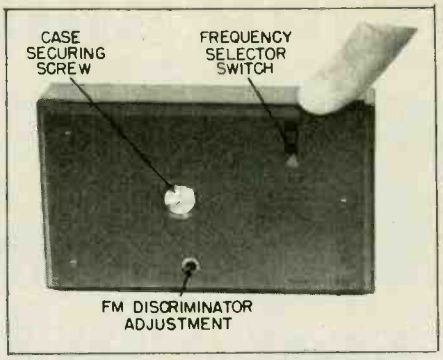
Normal operation is with the AC power unit, the battery serving only as a standby in the event of a power failure. When AC power fails an alkaline battery will provide up to 10 hours continuous operation. When operating from the AC power unit the red powerlight is on. In the event of a power failure the unit automatically switches to battery power and the red light goes out to conserve power.

Checkout. Since sensitivity measurements have little meaning when a receiver depends on a telescopic antenna, we tested the Weatheralert receiver by comparing it with several popular weather radios also having built-in telescopic antennas. Two of the radios were actually VHF "police" radios equipped with crystals for the local weather station. With the test site almost 30 miles from the transmitter the Weatheralert outperformed the other weather radios in terms of solid, 100% intelligibility. In fact, two of the radios couldn't bring in the weather station at all—all we heard was some hash indicating a station was somewhere in the noise. Further, the Weatheralert outperformed a considerably more expensive "police" receiver and was the equal of another "all-band" receiver (priced at $149.95) as far as receiving the weather station was concerned.

We tested the Weatheralert receiver's alarm siren by first making certain it worked with a signal generator, and



The automatic alarm siren sounds even if the volume control is turned all the way down (but not off). The power light glows only when the receiver is powered by the AC power unit. In the event of a power failure the receiver shifts automatically to an internal battery. Connections for the power unit and an external antenna are on the rear. The telescopic antenna (shown in the collapsed storage position) provides reliable reception from 40 to 50 miles. For difficult reception areas, or longer distances, an external antenna is required.



A switch selects either of the two frequencies presently used for the weather service. Each area has a transmitter on only one of the two frequencies, so once the switch is set you forget it. The discriminator adjustment is set by the factory for optimum reception (best sound quality).

then by using the test transmission of the weather station. Every week the local station transmits the 1050 Hz alarm tone to test their equipment and to enable users to check alarm equipped receivers. Three seconds after the weather station transmitted the tone the siren in the Weatheralert went off. The siren wail lasts as long as the tone burst is transmitted by the station and is of sufficient level to be heard throughout a typical one family house or aboard a boat.

Extra battery. When the Weatheralert is used just for occasional checks of weather conditions the battery will last for many months. If you plan continuous monitoring by all means use the AC power unit. We suggest you keep a spare battery taped to the case, for in the event power is knocked out by a disaster, such as a hurricane, the extra battery will mean almost a full day's worth of continuous weather station monitoring. And as coverage is expanded it is only a matter of time before emergency announcements for the public will be provided by both the weather stations and local broadcast stations. So your weather alarm radio will do double-duty, providing continuous weather reports and instant contact with local and national rescue services. In the New York City area we heard the weather station announce special Coast Guard bulletins, asking those listeners affected by the bulletin to monitor the appropriate Coast Guard channel.

Summing up. The Weatheralert TA-3 does everything it claims, and does it well. It is an excellent, sensitive, weather receiver, and for its relatively low price an excellent disaster alarm. If you live in an area frequently subject to the quirks and ravages of natural disasters the TA-3 should be on your "must have" list. ■

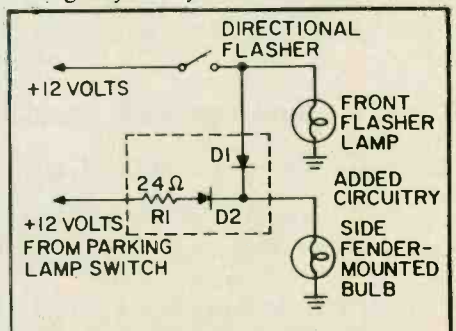
Turn Signals from Side Marker Lights

☐ Side clearance lights are the lamps usually mounted on the front and rear fenders. These lights can be made to provide additional driving safety by adapting them to flash *in unison* with the directional flashers if the auto does not now have rear flashers.

The circuit diagram shows how the present auto or pick-up electric wiring is modified so the side lights will also flash. A 24 ohm resistor is added in series with each side-clearance lamp bulb filament. This reduces the brilliance of the side bulb to about half of what it was originally. An epoxy diode is used to isolate the parking lamp filament from the flashing light circuit.

A separate wire lead is run from the side lamp to the directional flasher lamp on the same side of the auto. The side clearance lamp will then flash in unison with the front directional flasher lamp. A second diode is used to isolate the flasher filament from the parking light circuit so that it will not turn on when the parking light turns on.

Make good electrical connections by using instant auto electric connectors or soldering with a good soldering iron. Wrap all connections and components with a good amount of black plastic electrical tape so that they will withstand the weather. The side clearance lights will now flash not only with the directional signals but also when the emergency 4-way flasher is turned on. ■



PARTS LIST FOR ADD-ON TURN SIGNALS

D1, D2—Diode 1 amp, 50 PIV or better (Radio Shack 276-1135 or equiv.)
R1—24-ohms, 1-watt resistor (Radio Shack 271-1000 or equiv.)
Misc.—wire, electrical tape.

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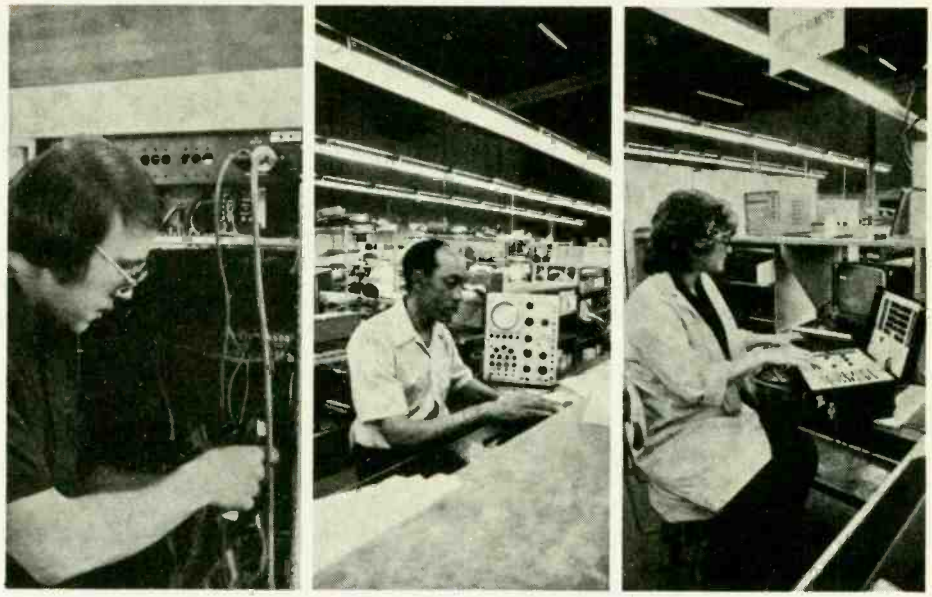

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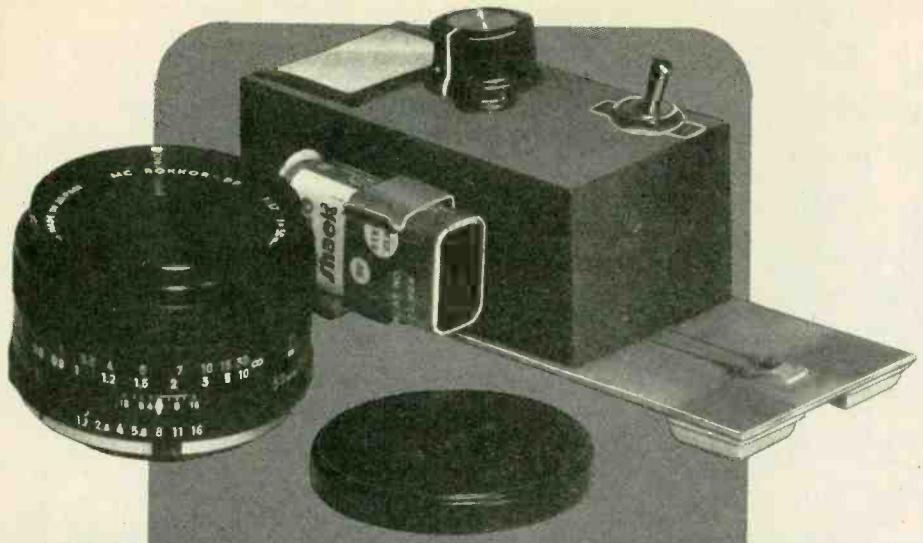


USE THIS LED/CHIP PHOTO HELPER

Easy-to-build indicator uses two ICs and Stop-Go readout for perfect enlargements every time!

by David A. Duncan

Quality control is especially important in operating a darkroom, and of all the various meters, controls and other instruments employed in making enlargements, the most important and useful one is the photometer.

This light-measuring instrument indicates numerically, via a meter movement or other readout indicator, the amount of light from an enlarger lens striking the enlarging paper on the easel below the lens. This is done by using a light-sensitive device to generate or regulate an electrical signal, which in turn is amplified and indicated by a display mechanism. After reading the indication of light intensity coming from the enlarger, one opens up (or closes down, as required) the diaphragm opening of the enlarger to get the right amount of light. After that, each time a new negative is put in the enlarger the photometer is placed under the enlarger for a moment, the photometer readout is examined, and the enlarger diaphragm is again made larger or smaller to produce the desired reading on the photometer. This ensures that the same amount of light will come from the enlarger on exposures made with the new negative.

During several years' use of such instruments, it was found that most photometers on the market today have at least one drawback. If the meter uses a mechanical movement, the meter face is difficult to read accurately. Even with special glow-in-the-dark faceplates or internal illumination one still has to get inconveniently close to the meter to be able to read it in the subdued illumination of the darkroom. Some meters employ a special mechanism on the meter movement that will lock the needle in place during a measurement, allowing the user to turn on the room lights to read the meter. However, these are expensive, and are thus out of the question for most experimenters. Another system often found in darkroom equipment employs digital readout with seven-segment LEDs for the display. While this is fine, being very easy to read in the dark, it also carries a high price tag, as it requires elaborate analog-to-digital (A-D) converters and digital circuitry. Still another, and from the author's experience the best, is the LED/chip Photo-Helper described here.

The most noticeable feature of this LED/chip meter is, of course, the display. In place of a meter or number readout, one of five light-emitting diodes (LEDs) indicates the degree and the direction the aperture of the enlarger lens must be stopped in order to project a predetermined amount of light to the easel, and subsequently to the photographic paper. By using the calibrated control on the LED/chip the projected light can be accurately measured.

The display comprises five red LEDs, each of which represents a deviation of one f/stop from the values indicated on either side. The center LED represents the null—the desired light intensity. Those to the right indicate that a high f/stop is being used (not enough light projected) and those to the left signify a low f/stop (too much light projected). This system has recently been adopted by a major camera manufacturer in Japan in one of its cameras as a light-metering system.

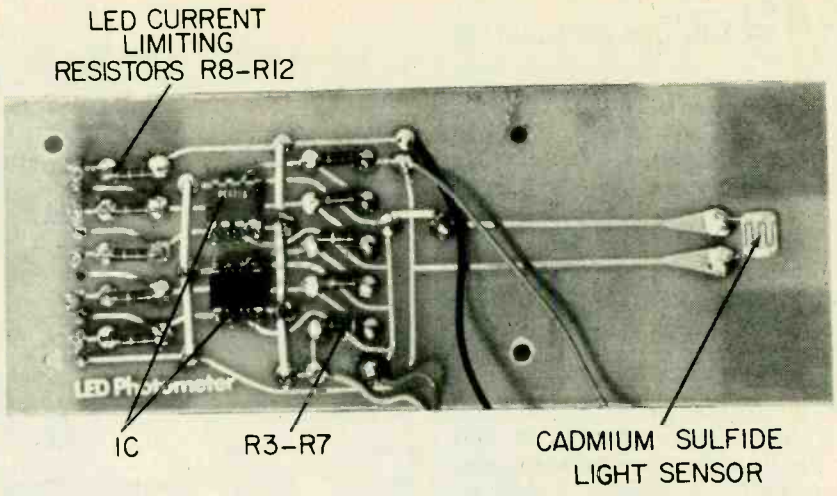
About the Circuit. Refer to the schematic diagram of the LED/Chip. The heard of the meter is the simple A-D (analog-to-digital) converter, and the LED display which it controls.

The A-D converter uses four operational amplifiers (OP-amps) as voltage comparators, and a voltage-dividing ladder made up of resistors R3 through R7. The voltage divider supplies positive reference voltage ratios of 0.78, 0.68, 0.58 and 0.47, which amount to 14, 12.2, 10.4 and 8.5 VDC, respectively, when used with an 18-volt supply, to the inverting (—) inputs of comparators A, B, C, and D. Photocell R1 and control R2 make up a second voltage divider, the tapped voltage of which is dependent on the amount of light striking R1, and the setting of R2. The output of this divider is applied commonly to the noninverting (+) inputs of all four comparators. The LEDs

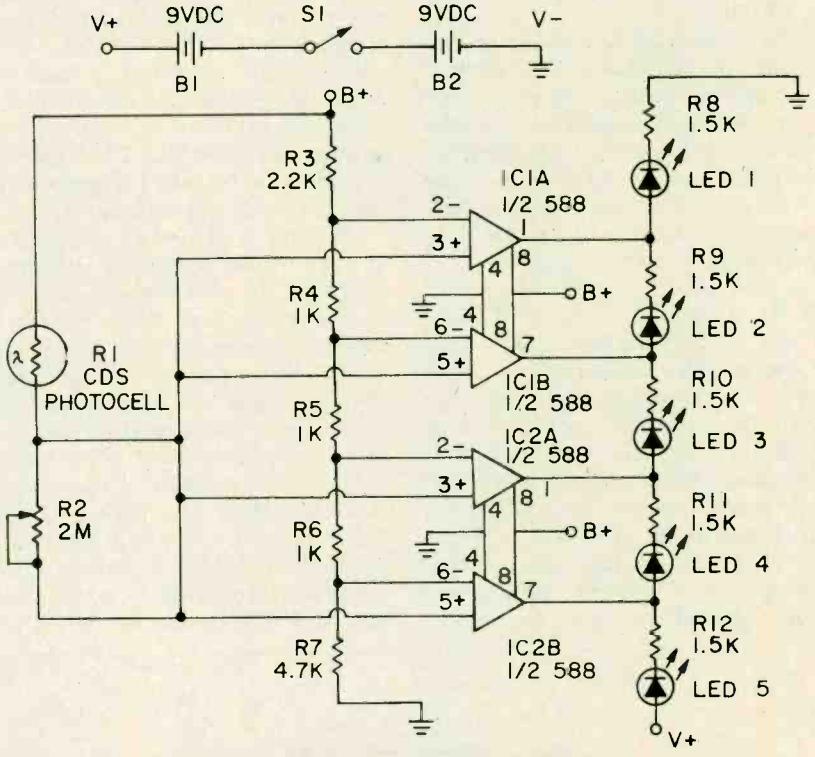
and their current-limiting resistors are connected between the outputs of the comparators, with one LED going to the V+ line and another to the V— line, as indicated in the schematic diagram. The operation of this display circuit is described later in this article.

In order to simplify the discussion, the operation of the A-D converter and the LED/chip meter are analyzed in terms of a typical measurement. Let's assume there is enough light falling on the cadmium sulfide photocell, R1, to give it an effective resistance of 318 Kohms (the effective resistance of such a photocell varies directly with the amount of light falling on it). Control R2 is set for half a megohm, resulting in an output of 11 volts which is applied to the + inputs of the comparators. On the — inputs, remember, there is 14-volts at the comparator A, 12.2-volts on comparator B, comparator C has 10.4-volts, and 8.5-volts is being applied to comparator D. These voltages come from resistor ladder R3-7, derived from the 18-volt V+ supply. With each comparator, if the voltage level on the + input is greater (more positive) than the voltage on the — input, the output of the comparator will go to the level of V+. If however, the + input sees less voltage than does the — input (— input is more positive), the output will drop to the value of V- (zero). With this in mind, consider the example. Comparators A and B have 11 volts on their + inputs, but have 14 volts and 12.2 volts on their — inputs. Since the — inputs are more positive than are the + inputs, the outputs of these comparators will be at zero. However, while comparators C and D also have the common 11 volts applied to their + inputs, only 10.4-volt and 8.5-volt signals are being sent to their — inputs. As the + inputs of these comparators are the more positive, their outputs will go to V+ (18 volts).

Now consider the LEDs, beginning with LED1. The cathode of LED1 is tied to V—, and its anode to the output of comparator A. As shown above, this output is at V— potential, so no current can flow through the LED: it remains Off. Limiting resistors R8 through 12 can be disregarded in this discussion as they only serve to limit the current through the LEDs and in no way affect the operation of the A-D converter or display. The cathode of LED2 is connected to the output of comparator A (at V—) and its anode to comparator B, which is also at V— level. Again, no current flows through the diode, and it remains unlit. LED3 is connected be-



Assembled LED/chip Photo-Helper has light sensor on board, at right. Five LEDs are mounted under the transparent window at left. Only one LED lights at a time. View of the printed circuit board with components in place. Light sensor is at right end, five LEDs at left.



PARTS LIST FOR LED/CHIP PHOTO-HELPER

B1, B2—9-VDC transistor radio batteries (Radio Shack 23-464 or equiv.)
IC1, IC2—dual-741 integrated circuits, packaged as 558 (Radio Shack 276-038 or equiv.)
LED1 through 5—Light-emitting diodes 1.6 to 1.75 volts at 20mA (Radio Shack 276-042 or equiv.)
R1—Cadmium sulfide photocell (Radio Shack 276-116 or equiv.)
R2—2.0 megohm potentiometer (Radio Shack 271-093 or equiv.)
R3—2.2 K, ½-watt resistor (Radio Shack 271-000 series or equiv.)
R4 through 6—1 K, ½-watt resistors (Radio Shack 271-000 series or equiv.)
R7—4.7 K, ½-watt resistor (Radio Shack 271-000 series or equiv.)
R8 through 12—1.5 K, ½-watt resistors (Radio Shack 271-000 series or equiv.)
Note: ¼-watt resistors acceptable if available
S1—SPST toggle switch (Radio Shack 275-602 or equiv.)

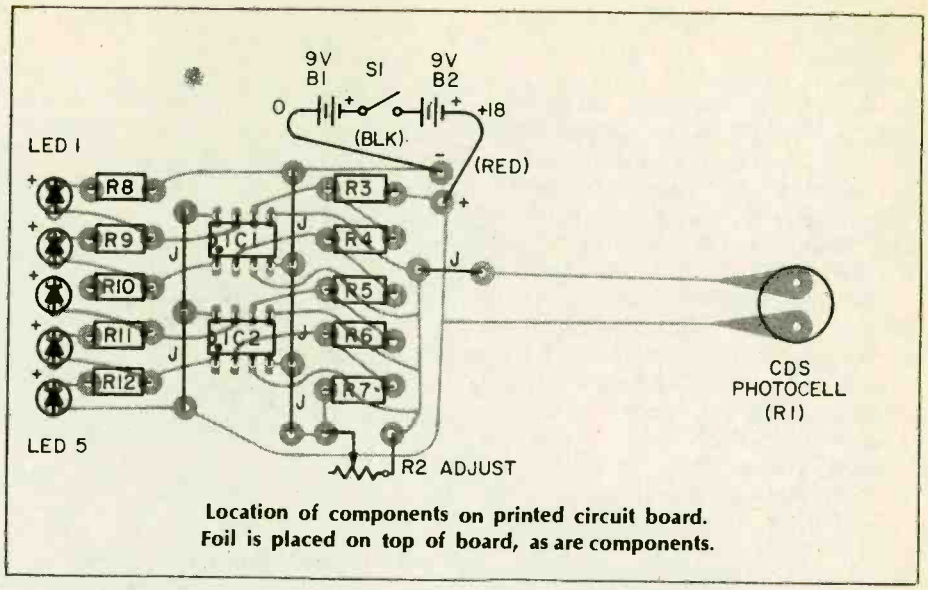
Misc.—Plastic cabinet 3¼-in. D x 1¼-in. H x 2-in. W (Radio Shack 270-230 or equiv.), etching kit for printed circuit boards (Radio Shack 276-1576 or 276-1560 or equiv.), control knob.

e/e LED/CHIP PHOTO-HELPER

tween comparator B (V—) to comparator C (which is now at V+). The voltage difference between these two outputs causes current to flow through LED3, turning it On. LED4 is positioned between the outputs of comparator C and comparator D, both of which are at V+. This LED sees no current between the two V+ (leveled) outputs, and therefore does not come On. Finally, LED5 is located between the V+ output of comparator D and the V+ line itself, and also remains Off. This system will result in one (and only one) LED being lit at any one time, under normal conditions. (Under a fluorescent or Xenon light source, which flashes at a rate of 120 Hz, the LED/chip meter sees the lights as both On and Off and will display this by turning On two or more LEDs).

As the intensity of light at the photocell is altered, or control R2 is changed, each comparator will go from V— to V+, or vice versa, according to the change in voltage level at the output of the R1-R2 voltage divider. If each situation is carefully analyzed it can be seen that only one LED will be On, all others remaining Off.

Note that since the two voltage dividers R1/R2 and R3 through R7 are connected to the same V+ source, and since the resultant output of the A-D converter is dependent only on the voltage differences between the various points in these dividers, changes in the supply voltage will not affect the operation or calibration of the LED/Chip Photo-Helper unless of course such extremes are reached that the circuits cannot operate or are destroyed). Also, since no "ground" reference is needed, a single voltage supply, such as a single battery, may be used.



Location of components on printed circuit board. Foil is placed on top of board, as are components.

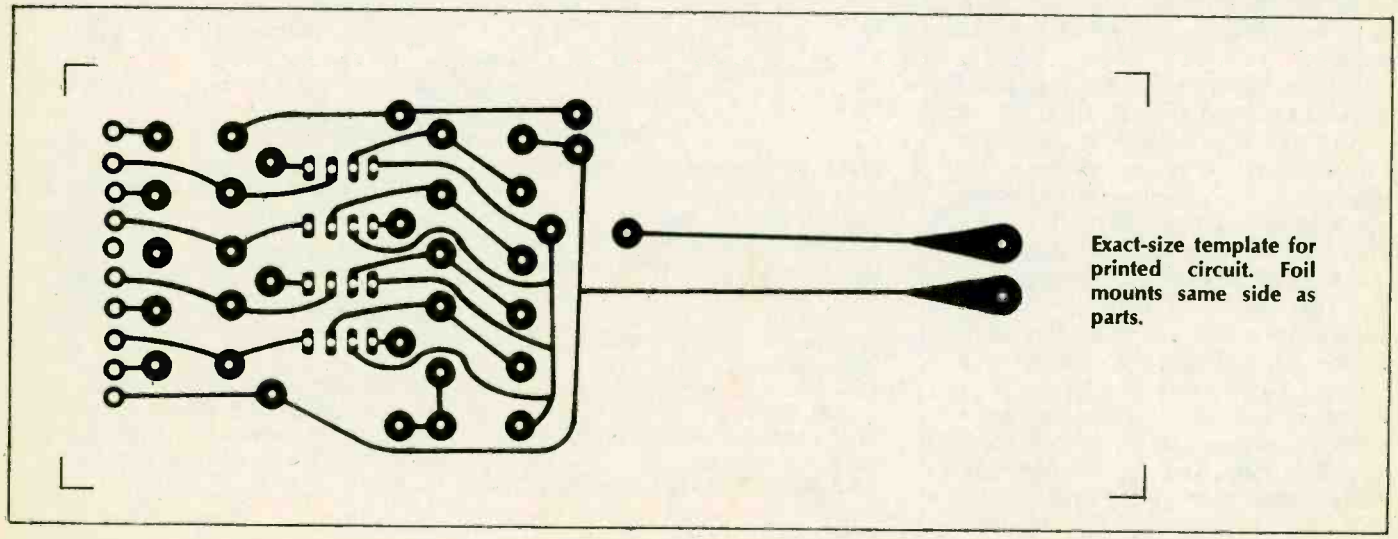
Construction. Except for the battery, power switch S1 and control R2, the entire circuit of the LED/chip is built on a single one-sided printed-circuit board. Any means of construction may be used, as dress is relatively unimportant. However, the LED/chip using a printed-circuit board is easier to build and to use in the darkroom.

Position and install the resistors, jumper wires, integrated circuits and LEDs on the circuit board as indicated in the component location chart immediately following the printed-circuit foil pattern. Pay special attention to the polarities of the light-emitting diodes, and **use heat sinks** (such as a pair of longnose pliers) when soldering these devices in place, as they are easily destroyed. Also note the orientation of the integrated circuits. IC sockets may be used for the ICs if desired, and they make it easy to construct with no danger of destroying the ICs while soldering them in place.

Prepare a suitable enclosure for the LED/chip by drilling holes for control R2 and switch S1. Drill or cut a window at the position where the five LEDs will be visible when the PC board is mounted in place, and another opening to allow the light from the enlarger to reach the photocell. The cabinet for our prototype was prepared so that the end of the PC board bearing the photocell projects beyond the side of the enclosure. The prototype's printed circuit board was manufactured as a mirror-image (reverse) of the foil pattern shown here, and the components mounted on the foil side, so the PC board itself is the bottom of the cabinet, and is secured to the cabinet just as its original bottom was, using the same hardware. Mount four rubber feet to the underside of the cabinet to prevent the cabinet marring the easel of the enlarger.

Testing and Using. To test the

(Continued on page 100)



Exact-size template for printed circuit. Foil mounts same side as parts.

RADIO SIDEBANDS--WHERE THE POWER IS

by Norman Crawford

ALL COMMUNICATION is by means of *change*, or *modulation* of some kind, whether it's electronic communication, smoke signals, or the lanterns in the Old North Church in Boston which sent Paul Revere on his famous midnight ride 200 years ago. There are three basic ways a carrier can be changed, or *modulated*, to convey information from a radio transmitter to a radio receiver. These three ways are AM, FM, and PM (Amplitude Modulation, Frequency Modulation, and Phase Modulation). For a close look at how AM works, see the sketches of waveforms and discussion in the January/February 1976 issue of *Elementary Electronics*. That article also explains how the detector converts the amplitude modulated radio frequency (RF) carrier wave back into audible sound signals (audio).

But examining waveforms is not the only way to gain an understanding of AM. If we look, instead, at what happens at the dial of the receiver as the carrier is modulated, we get another view of AM—one that will help us to a better grasp of the inner workings of not only AM, but FM and PM as well.

A Dial's-Eye view of AM. Imagine a radio receiver with a dial which lights up at any point where a signal appears. By moving the tuning indicator to one of the lit points, the operator could hear in his loudspeaker the speech or music being transmitted at that frequency. Such an imaginary dial would appear as in Fig. 1.

The lights indicating the presence of a signal appear in the figure as vertical lines, with strong signals appearing as tall lines and weaker signals as short lines.

Imagine further that we can use a magnifying glass to closely inspect the area around one of the bright lines, and at the same time can set the tuning indicator to that bright line, so we can hear in the loudspeaker any signal being sent (Fig. 2).

The magnifying glass shows us a single bright line indicating a carrier at 840 KHz, while the loudspeaker gives us only a low-level hiss, indicating that an unmodulated carrier is present, but no information is being sent. (To continue our Paul Revere analogy, we could say that the steeple is present, but no lanterns have been hung.)

Now, let us ask a flutist to step before the microphone and play a 700-Hz tone. Immediately, of course, the flute's tone is heard in the rceiver's loudspeaker. But the most surprising thing happens at the receiver dial: Here, (see Fig. 3), two *new* frequencies appear—small bright lines on either side of the carrier. Looking closely, we see that each of the new frequencies is spaced exactly 700 Hz from the carrier—one above, at 840,700 Hz, and the other below, at 839,300 Hz. These two new frequencies are called *side frequencies*, and are the lanterns in the steeple—the indication of information being sent.

If we ask the flutist to play more loudly, we find that the side frequencies grow taller, until, at 100% modulation each one is exactly half the height of the carrier. (See Fig. 4).

Now, let us suppose that another flutist joins the first, and this second musician plays a tone at 1100 Hz (in this case blowing slightly louder than the first flutist). We now find a second group of side frequencies spaced 1100 Hz each side of the carrier (Figure 5).

With the two flutists playing, we have the beginning of a *band* of side frequencies on each side of the carrier. The higher frequency is the *upper side band*, and the lower frequency is the *lower side band*.

If the two flutists are now joined in the studio by a rock group (or a symphony orchestra), the many instruments, playing many different frequencies simultaneously, will cause many side frequencies to appear, and the sidebands will be composed of a very complicated group of side frequencies, constantly changing as the musicians play. Figure 6 can be thought of as a snapshot of the sidebands for a very brief period in time. This is called a *spectrum display*, and the group of frequencies shown is called the spectrum of the signal.

In this spectrum display, we observe that the upper and lower sidebands extend equally far from the carrier—about 5,000 Hz in the figure—and that they are always exact mirror images of each other. As the sound striking the microphone changes, the the sidebands change in a mirror-image manner. A snapshot (spectrum display) taken a few seconds later might look like Fig. 7.

Is This Sideband Necessary? The fact that the two sidebands are mirror images of each other makes us wonder if they are both necessary. It's just as though Paul Revere's friend had hung a complicated set of lanterns on the *right* side of the steeple, and then had hung an identical set on the *left*. The second set would have been unnecessary because the first set would have given him the message, and Paul would have been on horseback and gone long before the second set could be lit!

In the same way, we can get the message through by using only a single sideband, instead of the mirror-image pair. Such a system is called a *single-sideband system*, and is abbreviated SSB. SSB

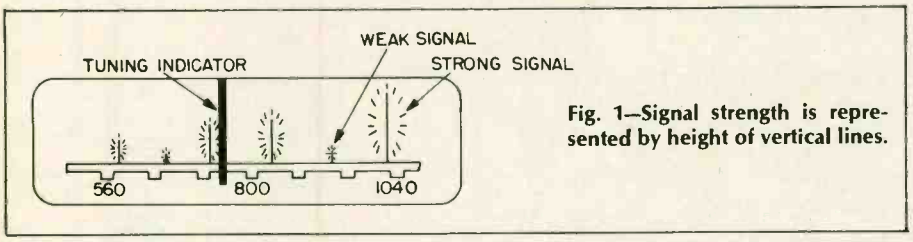


Fig. 1—Signal strength is represented by height of vertical lines.

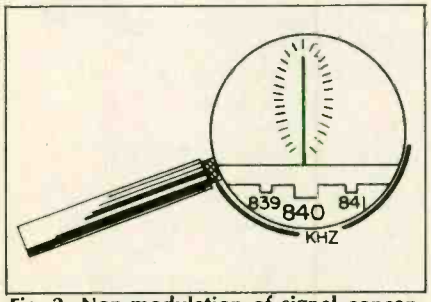


Fig. 2—Non-modulation of signal concentrates signal strength at the carrier frequency.

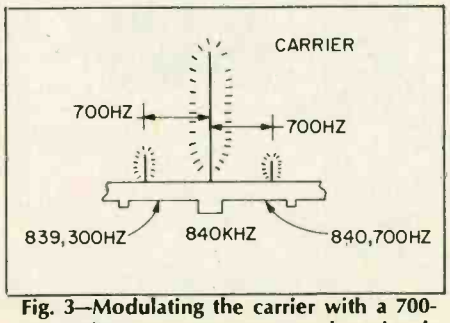


Fig. 3—Modulating the carrier with a 700-Hz audio tone generates weaker signals 700 Hz above and below carrier.

offers many advantages over conventional AM systems, especially for voice communication.

Eliminating the Carrier. If only one sideband is needed to get the message through, we can also ask whether the carrier itself is absolutely necessary. Can we get the message through without the carrier?

The answer is, definitely yes! With proper modulation methods, we can eliminate the carrier completely, and still send the message. To continue our Paul Revere analogy, we are saying that it is only the lanterns that are essential to the message; the steeple could be eliminated if we could find a way to hold the lanterns in place.

Figure 8 shows the result of eliminating the carrier, but keeping *both* sidebands.

This is called a *suppressed carrier system*. The most striking result of suppressing the carrier is seen in the waveform displays of Fig. 8. First we see that, in the absence of an audio signal, there is no carrier (Fig. 8). Second, we note that the envelope representing the original audio signal is somehow tangled up inside the waveform, in such a way that it can't be extracted by a simple "power-supply"–kind of detector (envelope detector) described in the Jan.-Feb. 1976 article on modulation.

The result of eliminating the carrier looks so unusual that we wish we could put it back. So that's exactly what we do. At the receiver, we insert an artificial carrier, carefully adjusted to the right frequency and strength, which restores the waveform to its more familiar appearance, (Fig. 8), and allows us to detect it with a conventional detector.

But, you might ask, why go through

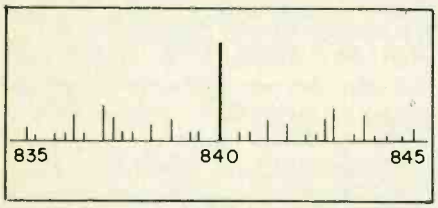


Fig. 6—Complex audio modulating signals generate complex sideband frequencies.

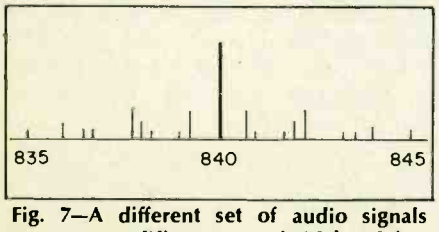


Fig. 7—A different set of audio signals generates a different set of sideband frequencies.

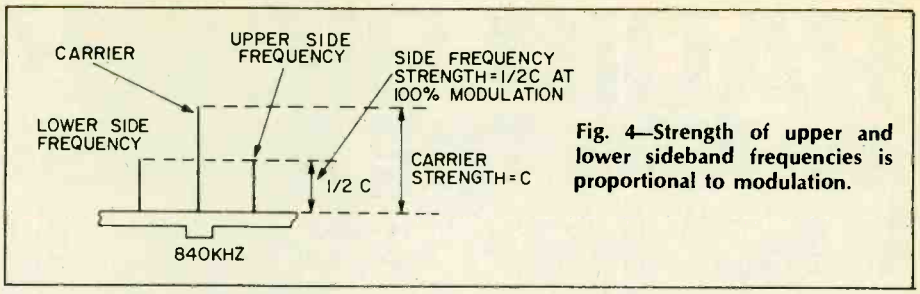


Fig. 4—Strength of upper and lower sideband frequencies is proportional to modulation.

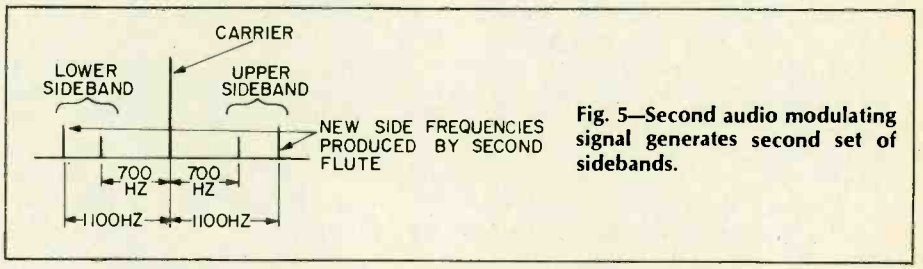


Fig. 5—Second audio modulating signal generates second set of sidebands.

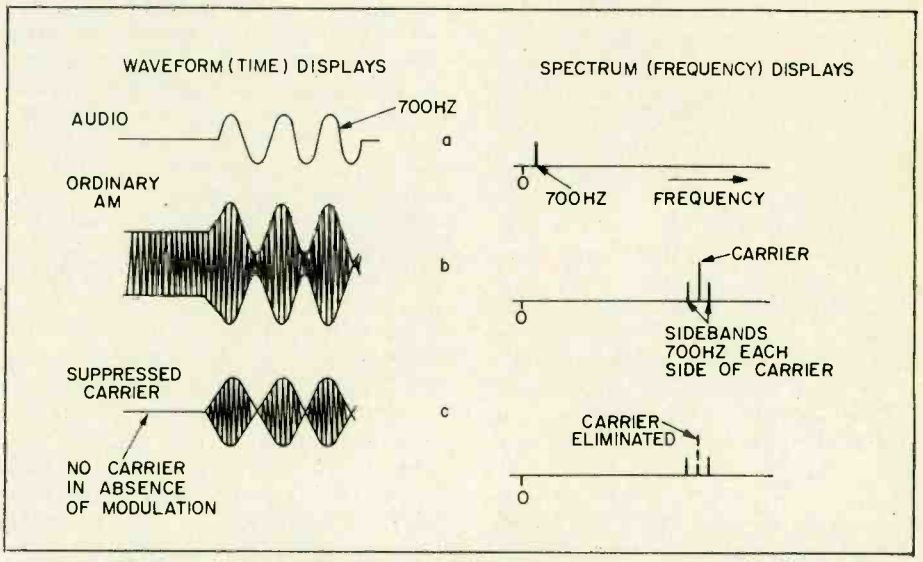


Fig. 8—Elimination of the carrier leaves the sidebands, which include the audio information. Carrier is reinserted at the receiver.

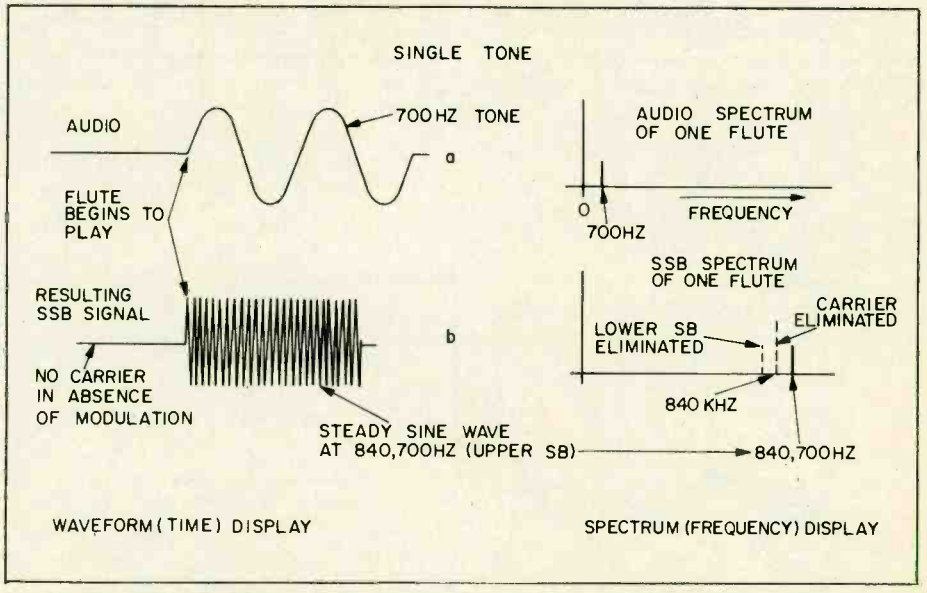


Fig. 10—At onset of 700 Hz audio modulation the carrier sideband appears. With no modulation, no sidebands are present.

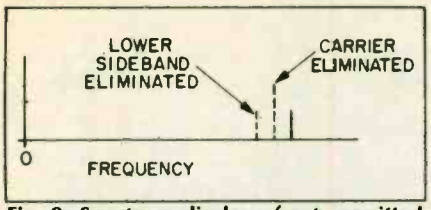


Fig. 9—Spectrum display of a transmitted signal modulated by a 700-Hz tone—lower sideband suppressed.

all the motions of first removing the carrier, and then putting it back? What advantage does this gain for us?

The most compelling reason for carrier suppression is the saving in transmitter power. A transmitter could pour 10,000 watts into its carrier, and only a few millionths of a watt of this would arrive at the receiver. It makes much more sense to eliminate the huge transmitter wattage, and instead build a small oscillator at the receiver to provide the few millionths of a watt needed to imitate the carrier.

The power saving becomes even more interesting when we observe how little of the total transmitter power goes into the sidebands. At 100% modulation, a transmitter with 100 watts in the carrier will have only 25 watts* in each sideband for a total of 50 watts in the pair. So, only one-third of the transmitter's 150 watts of total power is in the information-bearing sidebands.

Single-Sideband—Sending Only the Necessities. If each sideband of a 100-watt transmitter provides only 25 watts, then eliminating the carrier cuts the total power from 100 + 25 + 25 = 150 watts, down to 25 + 25 = 50 watts. But, as we pointed out earlier, each of these two sidebands is a mirror image of the other; one of them can be eliminated without hurting the message a bit! Figure 8 shows the spectrum display of an SSB transmitter modulated by a 700-Hz tone. The dotted lines show where the suppressed carrier and the eliminated lower side band would have been.

Dropping one of the unnecessary sidebands reduces the required power down to 25 watts, with only a small decrease in the ability of the signal to get through. Or, if we wish, we can design the transmitter to pour all its available power into that one sideband, with a consequent increase in our ability to get the message through—and without changing the transmitter's size, weight, or power! The only price we pay is the requirement that we insert an artificial carrier at the receiver, to allow us to detect the information in the sideband sent.

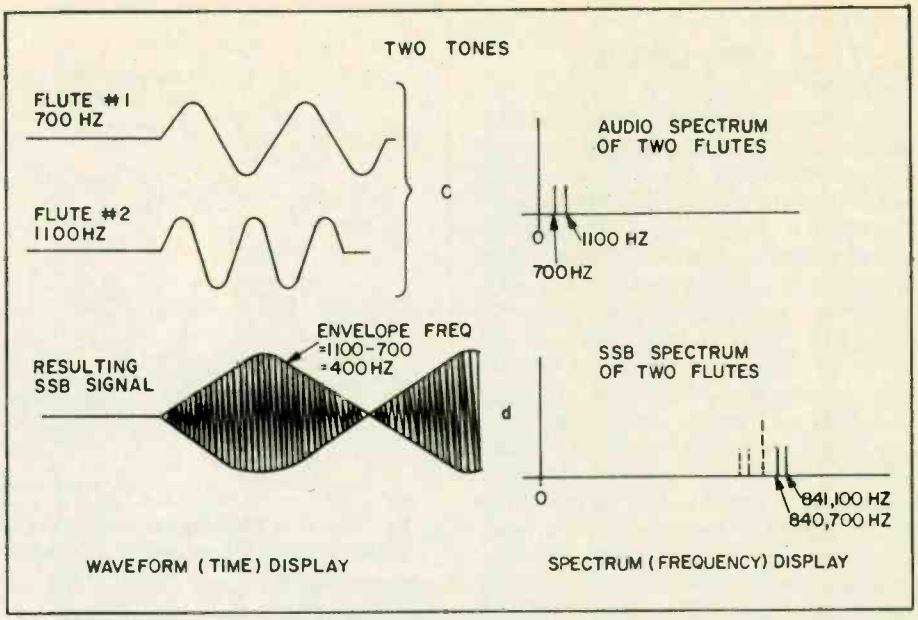


Fig. 11—With two modulating audio signals we have two sidebands generated.

SSB Waveforms—A Surprising Story. Now, with SSB concepts firmly in hand, if we look back to the world of waveforms we shall find a most surprising and interesting story.

Figure 9 tells this story. In Figure 10a, we see our familiar 700-Hz flute tone, and on the right of Figure 10b we see the SSB spectrum resulting from modulating an SSB transmitter with this tone. But on the left of Figure 10b we get our first surprise. True, we would expect no carrier, before the tone begins—we've seen this before, in Fig. 8. (the suppressed carrier case). But when our flutist begins to play, we get a single, steady sine wave from the transmitter—with no evidence of modulation of any kind! Can this be a signal? It looks just like a carrier!

Can't Tell the Lanterns from the Steeple without a Program! The steady sine wave of Figure 10b is indeed a signal; not a carrier. In the first place, it will get bigger (more amplitude) if the flutist plays louder, and will get smaller if he plays more softly. It is, therefore, amplitude modulated—for SSB is just a form of AM. But the *pitch* of the flute—the 700 Hz—is *not* packaged neatly in an envelope, as it was in Figure 8b (standard AM) and in Figure 8c (suppressed carrier). The only clue to its 700-Hz pitch is the fact that this single carrier-like frequency is *700 Hz from where the carrier would have been* if we had sent it!

You can see, then, that re-inserting the carrier at precisely the right frequency is essential to recovering the proper pitch. If the carrier was supposed

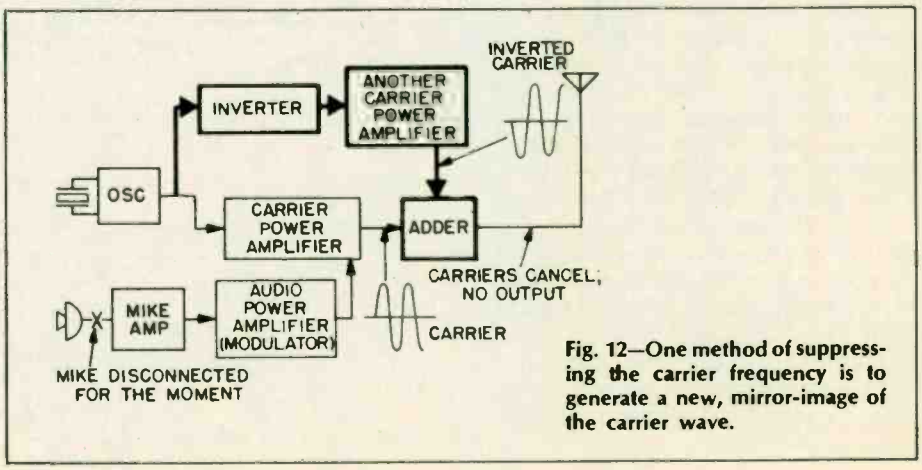


Fig. 12—One method of suppressing the carrier frequency is to generate a new, mirror-image of the carrier wave.

* In case you're wondering how, in Fig. 8, we could say the sidebands at 100% modulation are *half* the carrier, while here we're saying they're *one-quarter*, remember that Fig. 8 shows relative *voltages*. Since power is proportional to the *square* of the voltage, and since *one-half* squared is *one-quarter*, then each sideband's *power* at 100% modulation is *one-quarter* of the carrier power.

to be 840,000 Hz, and it is instead reinserted at 840,030 Hz—only 30 Hz high—then the flute tone will come out of the speaker 30 Hz low, at 670 Hz instead of 700 Hz. Conversely, a reinserted carrier at 839,970 Hz—30 Hz low—will obtain for us a higher pitch:—730 Hz. Therefore, we must know precisely where the carrier should have been if we are to re-create the exact sound which struck the microphone. This is the additional complexity that we endure to obtain the advantages of SSB.

Tuning by Ear. In a practical situation, the speech and music errors introduced by even a slight carrier error are so obvious that it's easy for a listener to simply readjust the inserted carrier frequency until the reproduction "sounds right." This is possible because, as soon as more than a single, simple tone is transmitted, our ears quickly detect the errors in the complex waveforms, such as speech and music, which we have encountered all our lives, and a simple twist of the knob quickly clarifies the reception.

Two-tone Waveforms for SSB. As an illustration of what can happen if more than one tone is sent via SSB, look at Figure 10c. Here, our flute-playing pair is again intoning their 700-Hz and 1100-Hz pitches. On the right of Figure 10d, we see the *two* resulting sidebands—one, 700 Hz from where the carrier would have been, and the other, 1100 Hz from the same location. The carrier and lower sideband are shown dotted, indicating that they have been removed. If we compare this SSB spectrum with Figure 8c, (the suppressed-carrier, *double*-sideband case), we observe that, in *both* cases, *the receiver is simply looking at two frequencies.* Therefore, the waveforms should be very much the same in the two cases, even though one arises from a *single* flute tone, and the other, from *two* flute's tones. In the earlier figure, (suppressed carrier), the two frequencies were 2 x 700 = 1400 Hz apart, and the resulting waveform had peaks at a 1400 Hz rate. In our present figure, (10d), the two frequencies are 1100 − 700 = 400 Hz apart, so the peaks occur at a 400 Hz rate. Note that this frequency—400 Hz—never occurred at the microphone; it is the *difference* between the two tones generated by the flutists. But the most important fact is that the waveform of a *single* flute modulating a *double*-sideband transmitter is the same as *two* flutes modulating a *single*-sideband transmitter.

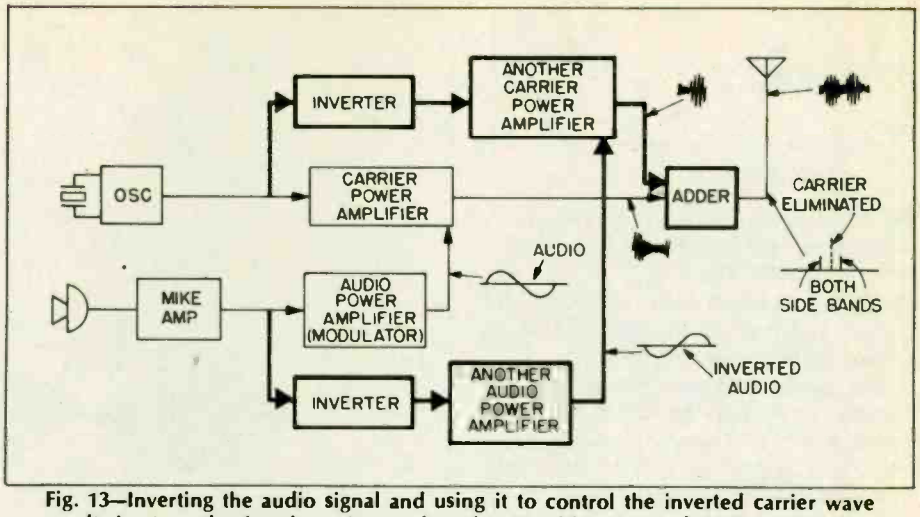


Fig. 13—Inverting the audio signal and using it to control the inverted carrier wave results in strengthening the uninverted carrier. Resulting unequal carriers no longer cancel, hence produce sidebands at antenna.

Hardware for SSB. Since SSB is merely a very sophisticated version of ordinary AM, you might expect that you could generate a SSB signal by some kind of change to the basic AM system. In fact, a three-step change to that figure will give an understanding of how SSB is generated. In the first step, (Fig. 11), we have added another carrier power amplifier, an inverter, and an adder (the new parts are shown in bold lines).

The new amplifier provides an "upside-down" carrier which, when added to the original carrier, cancels it—provided the gains of the carrier power amplifiers are the same. The result is no carrier output at all—the carrier has been suppressed.

In Figure 12 we show the second step of the change.

Here, the *audio* signal is inverted and passed through another audio power amplifier. This inverted audio signal is used to control the output of the new inverted-carrier amplifier. Since the audio supplied to the inverted-carrier amplifier is "upside-down," it will *weaken* the output of the amplifier at the same instant that the "right-side-up" audio is *strengthening* the output of the "right-side-up" carrier. The two carriers are therefore unequal, so they can no longer cancel each other; hence, an output will appear at the antenna. This output is the *double*-sideband, suppressed-carrier signal of Figure 10c.

SSB by Sideband Filtering. The third step of our three-step change consists of merely adding a filter to eliminate one of the sidebands—either one. In Fig. 13, we have chosen to eliminate the *lower* sideband.

The signal from the antenna is now a single-sideband signal, and will have the waveforms and display of Figure 10.

Other Roads to SSB, This SSB system was chosen as an easy-to-understand system which can be developed directly from a standard AM transmitter. It is not the most practical configuration, but, understanding it, you will easily understand the more practical systems explained in the many books and articles on this subject.

In the next issue of *Elementary Electronics* we will look at FM and PM, see how they differ from AM, and show simple hardware for obtaining these important forms of modulation. ■

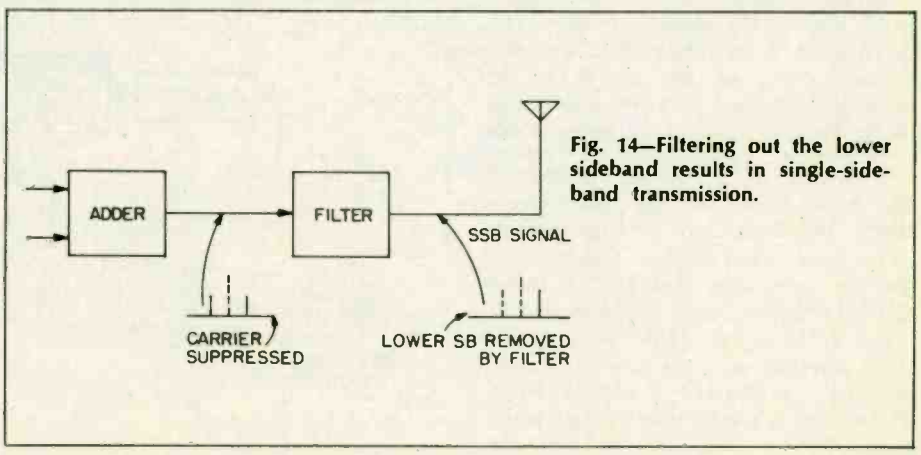
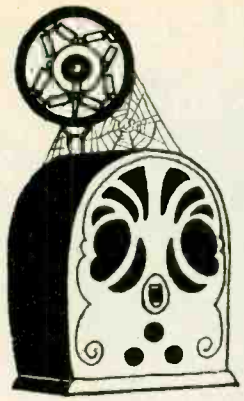
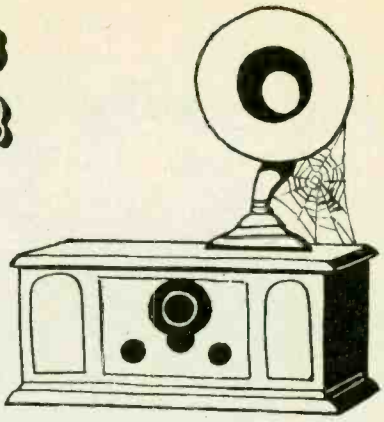


Fig. 14—Filtering out the lower sideband results in single-sideband transmission.



ANTIQUE RADIO CORNER

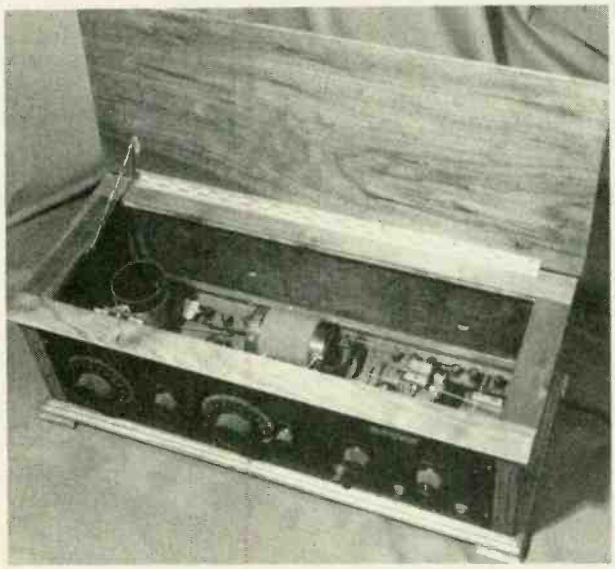


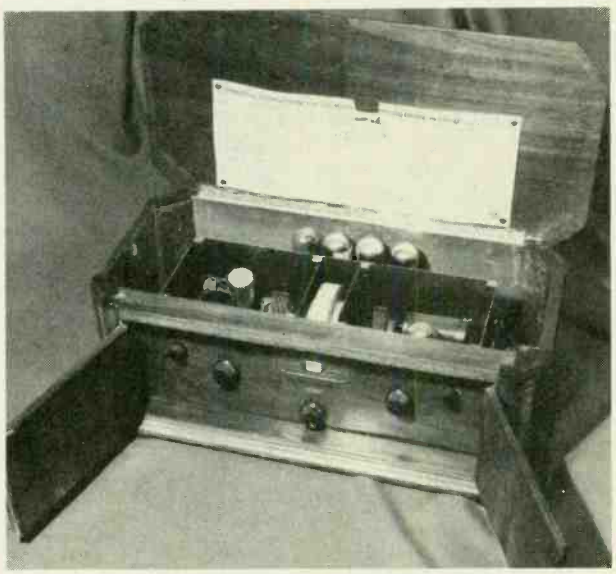
by James A. Fred

☐ Hello, out there in Radioland! We are in the middle of winter and I'll bet you are restoring some of the radio sets you found last summer. It is amazing to talk to collectors and find out how many really old radios, speakers, and tubes keep turning up. I hear from many would-be collectors who claim that there are no radios in the communities where they live. Except for a very few places in the United States you should have no trouble finding radios. In 1975 I visited collectors in Iowa, Nebraska, North Carolina, Virginia, and Indiana and also received many letters from other collectors. Invariably I found collectors who had added 10 to 25 sets, speakers and many vacuum tubes to their collections during 1975. Atwater Kent breadboards are turning up, Crosley Pups are coming out of hiding, and many crystal sets are being found. You just have to talk radios to your friends, look in newspapers, and haunt flea markets and antique shows if you want to find radios. Never give up and your collection will grow steadily.

Browning Labs. Since we are all interested in collecting radios made in the 20s I want to go back for our history lesson to the Browning-Drake Company. Glenn H. Browning and Fred H. Drake were engineering students at Harvard University when they met, and ultimately they founded the Browning-Drake Company.

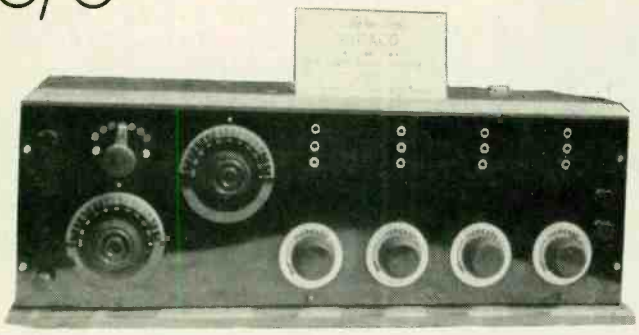
The radios in use in 1923 usually consisted of a detector and one or more stages of audio amplification. As a result it was difficult to separate local stations and nearly impossible to receive distant stations. Browning and Drake believed that a radio frequency amplifier ahead of the detector would improve a radio receiver more than anything else. They attacked the problem together and soon developed circuits and test methods that enabled them to predict the gain, selectivity, and sensitivity of an RF amplifier. They developed new designs for RF coils that reduced the coupling between primary and secondary. Browning and Drake were able to wind the primary of the RF coils with very fine wire in a narrow winding while the secondary was wound with larger wire over a longer space. They started by selling kits for home-built radios using coils made to their design by the National Company. These early kit radios were built on a wooden board very much like the breadboards used by Atwater Kent. This proved to be unpopular with housewives since it was difficult to dust and clean a breadboard receiver. So, like Atwater Kent, they began to manufacture radios in table cabinets. One of the photographs shows the Browning-Drake Regenaformer receiver made in 1923. It consisted of an RF amplifier,



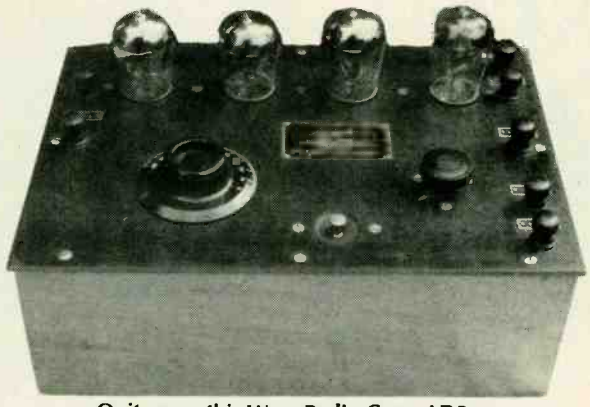


This Browning-Drake Regenaformer receiver was built in 1923 and the one at the right is a Browning-Drake Hetrodyne receiver.

e/e ANTIQUE RADIO CORNER



This Miracle 4-tube TRF radio belong to George Hausske, Wheaton, Illinois.



Quite rare, this Ware Radio Corp. AD2 4-tube receiver is also owned by George Hausske.

regenerative detector, and one or two audio amplifier stages. Another photo shows a 1927 model Browning-Drake Heterodyne receiver.

In November 1937 Browning Laboratories was incorporated by Glenn H. Browning and Ralph L. Purrington. Early products were a short-wave receiver, a preselector, a frequency meter, and short wave converters. About this time the 42 to 50 megacycle Frequency Modulation broadcast band was authorized by the FCC, and Browning Laboratories, Inc. offered the first FM tuner for this band. Many other electronic products, particularly test instruments, were manufactured prior to 1958 when the Citizens Band service was authorized by the FCC. It has been a long time between 1923 and the present, but here is one company that was able to survive by meeting the radio and electronic needs of the American people.

Another pioneer. Another man who contributed to the early development of radio was Nathan B. Stubblefield. You are going to say you never heard of him. I had heard of him, but this information was supplied in a very interesting story sent to me by W. A. Rudolph of Memphis, Tennessee.

Stubblefield is believed to have demonstrated wireless transmission of voices at Murray, Kentucky in 1892. If this is true he predated the Canadian Reginald Fessenden. He refused to act on a suggestion made by a lawyer friend to apply for a patent on the device. In 1902 he demonstrated radiophone transmission before 1000 witnesses, again in Murray. At that time his son, Bernard played a harmonica over the radio transmitter. Later in 1902 he took his equipment on a tour of Washington, Philadelphia, and New York. In a patent application dated April 5, 1907 he sketched a proposal for radio-telephone communication to and from moving trains.

One of the reasons very little is known about Stubblefield is that he was not a scientist. He was a farmer who was able to make mechanical parts and repair his own machinery. Businesswise he wasn't very smart and so he was taken in by a fast talking swindler who caused Stubblefield to lose everything he had including his radio apparatus and his home. He was found dead, in a little shack he had constructed from lumber scraps and tin, on March 28, 1928.

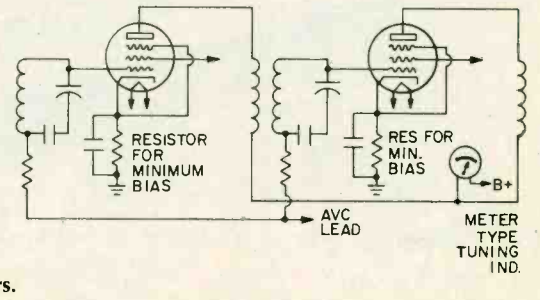
The Stubblefield story is kept alive by the Murray Chamber of Commerce and by accounts like this, quoted from the *Commercial Appeal* published in Memphis, Tenn.

In the next issue of *Elementary Electronics* I will have a story about Dr. Mahlon Loomis, a denist in Philadelphia. He is supposed to have transmitted radio signals in 1872 from an antenna held aloft by a kite.

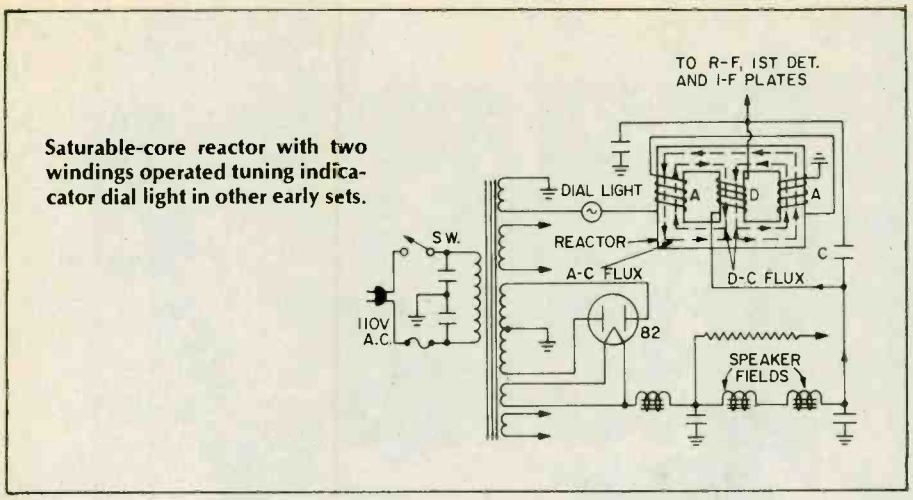
More tuning indicators. To continue with our discussion on tuning indicators we will consider the tuning meter and the dial light resonance indicator.

From our previous discussions we know that on a strong signal the grid bias on the RF amplifier and other tubes is increased by the AVC action and their amplification factors are decreased. When this happens the plate current of these tubes also decreases. An ordinary moving coil milliameter is connected in the plate circuit of one of these AVC-controlled tubes. The current through the meter will be small on loud signals and large on weak signals. This meter is called an "S" meter (Signal Strength) on communications receivers. On a broadcast receiver it is called the tuning indicator. The meter is usually one that has the pointer at rest on the right-hand side, or a conventional zero-left reading meter can be used if it is turned upside down. The pointer stays at the extreme right on strong signals, and swings to the left when there is no signal received.

Some receivers, including several Majestic sets, used the regular dial lamp in the set to indicate when it was tuned to resonance with the incoming signal. A saturable-core reactor having three legs on the core and three windings (one on each leg) was used to accomplish this. The circuit diagram helps explain how it works. The basic idea is to make the changes in DC plate current of the AVC-controlled tubes control the flow of AC through the dial lamp, making it brighter and dimmer as the station was tuned in and out of resonance. As shown in the drawing, two AC coils having an equal number of turns are



Meter-type tuning indicator was used in the plate circuits of AVC-controlled tubes in early receivers.



Saturable-core reactor with two windings operated tuning indicator dial light in other early sets.

mounted on the outer legs of the reactor core. They are connected in series with the dial lamp which obtains its operating voltage from a secondary winding on the power transformer. The center leg winding is connected in series with the plate circuits of all the AVC-controlled tubes, so that it carries the total plate current of these tubes.

When the receiver is not tuned to a station high DC plate current flows through winding "D". The reactor is so designed that the DC magnetizes the iron core beyond its saturation point. Hence the dial lamp current flowing through coils A-A produces no change in the magnetization of the iron core. As a result the reactance of these coils is low, and full current flows through the circuit, lighting the dial lamp to full brightness. When the receiver is tuned exactly to the station frequency, the negative bias placed on the AVC-controlled tubes reduces the plate current of these tubes. Since this current flows through center leg coil "D", it reduces the strength of the magnetism in the core when the station is tuned in correctly. This greatly increases the reactance (impedance) of coils A-A, thereby limiting the dial lamp current flowing through them, and causing the lamp to glow dimly. The closer the receiver is tuned to resonance with the station the dimmer the dial lamp gets. Thus the dial lamp serves as a visual indicator of how well the station is tuned in.

New history of radio. A new history of radio is being written and published by W. M. Dalton in England which will consist of eight volumes. Being written by an Englishman it gives one a different viewpoint on the development of radio communication than the one commonly accepted in the United States. Volume 1, "How Radio Began," and Volume 2, "Everyone an Amateur," have been received. Volume 3, "The World Starts to Listen," will be available soon.

Volume 4, "Radio Becomes a Profession," Volume 5, "The Birth of TV," Volume 6, "The Pressbutton Age," Volume 7, "WWII and After," and Volume 8, "Transistor Radio," will follow along over the next year or two.

I have just finished reading Volume 1 and am very much impressed with the vast amount of information, written concisely and to the point, about wireless and radio development up to WWI. There are four chapters in this book: 1, Magnetism and Electricity; 2, Electrical Engineering; 3, Wireless-telegraphy, and 4, The Thermionic Valve. Very little math is included, and it is non-technical reading at its best. I am sure that anyone who has any interest at all in radio and wireless will find it fascinating reading. The price of each of the first two volumes is 4.5 English pounds which at the present rate of exchange is a little over $9.00. The book is well printed on good quality paper, and is handsomely bound in hard covers for lasting service. If there is enough reader interest I will find out where it can be purchased.

I have received several letters regarding restoration of wood and plastic cabinets. I touched lightly on this subject in the book, "Budget Electronics," published by Davis Publications. Because of the interest in patching veneer, refinishing cabinets, and other cabinet repairs I will devote a whole column to this subject very soon.

So long for now. I'll be back with you in the next issue with more news, technical information, and restoration tips on antique radios and collecting.■

DECORATOR PHONES/NEW ANTIQUES

There's a new look in telephones to please even the most discerning home decorators. The Design Line telephones, in eight new styles now being marketed by Bell System Telephone Companies, are being assembled. tested, and decoratively packaged at Western Electric's Indianapolis Works. Each of the telephones has its own style and personality. There are even two—The Accent and the Exeter—which you can decorate yourself.

Telephone manufacture at Western Electric is nothing new. All Bell System telephones are made at the Indianapolis Works or at the Shreveport Plant in Louisiana. But Design Line phones have added a new dimension to production at Indianapolis. Because the Design Line phones are constructed with materials previously unknown to telephone manufacture, Western Electric had some lessons to learn in woodworking, leather care, chrome and gold plating, and wicker purchasing.

In addition to new styling, Western has made improvements into basic parts of the Design Line phones.

Other factors contributing to high quality include the thorough testing of each phone, hand assembly, and each of the phones is polished right at the location before packing. Chrome and gold plate are used on The Celebrity, The Mediterranean, the Early American, and Antique Gold models. Assemblers are careful to handle those parts gingerly as well as to wipe off any smudges or fingerprints. The phones are then ready for direct shipment to subscribers.

With a Design Line Phone, each telephone user can now have a phone to

(Continued on page 90)

Polishing and shining the handsome Celebrity telephone are assemblers, Sharon Thompson, foreground and Carol Quinn. Sharon and Carol work at the Indianapolis Works, where new styles in telephones are being manufactured.

TAKING THE MEASURE OF ARCTIC ICE

With the help of electronics, scientists keep tabs on the comings and goings of Alaska s pack ice.

by David Long

PAT MARTIN'S THOUGHTS were temporarily absorbed by the unloading of a large wooden crate outside his office window. Two men were slowly easing the crate down the truck's ramp. When it was almost at the bottom, the crate lurched suddenly and hit the pavement with a short, hard bounce. Martin winced. "Hope nothing is broken," he murmured, turning back to his desk. "We can't afford any delays now."

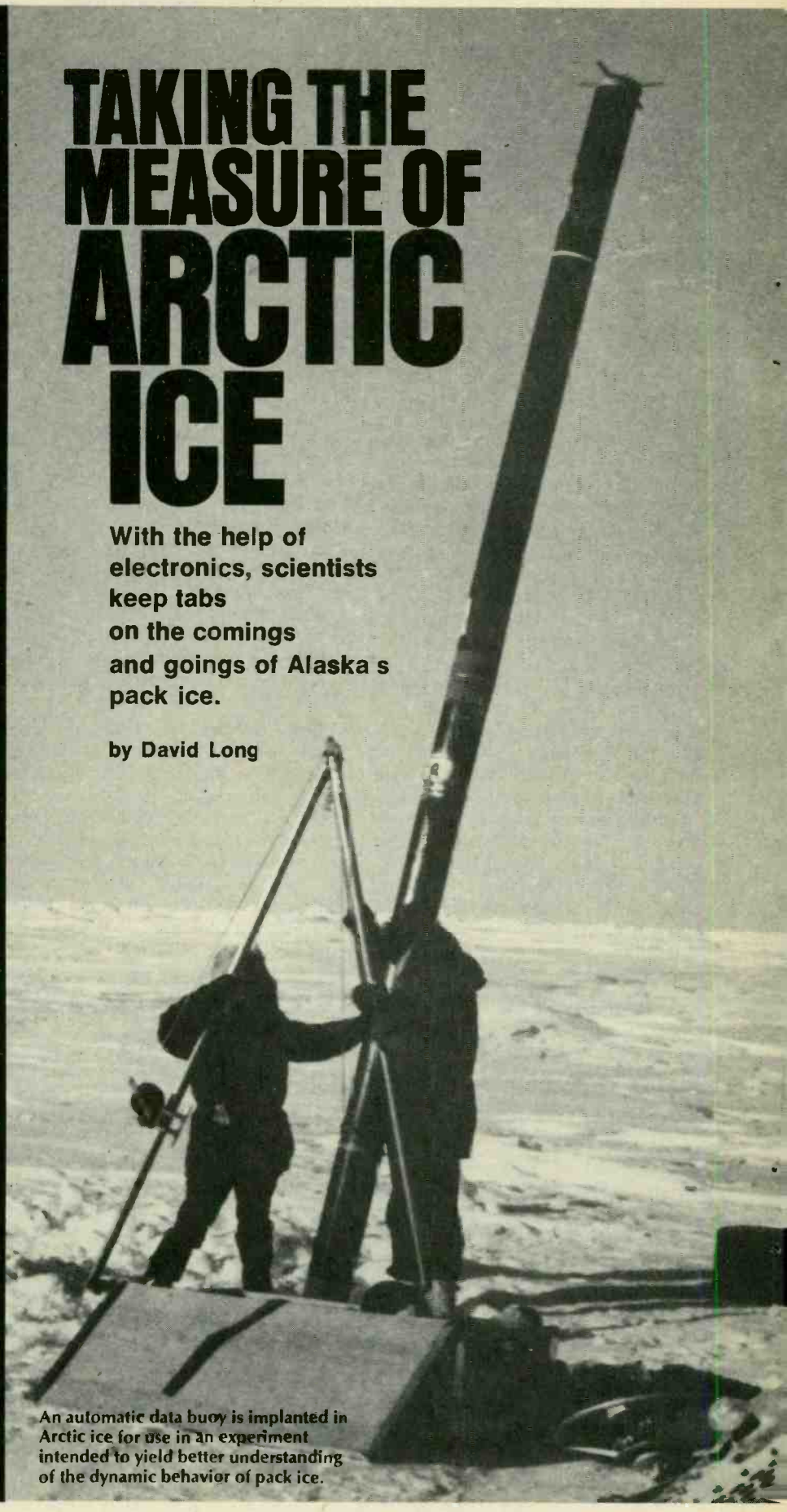
Time had become one of Martin's major concerns. The expedition was only three weeks away. He knew the project posed some unusually high risks, particularly when he thought of all the people and machines that had to function properly and simultaneously in an environment as harsh as the Arctic's. He didn't need anything more, like a damaged data processor, to complicate matters.

Most of the equipment already had been sent to the staging area at Point Barrow on Alaska's northernmost tip. Soon Martin and the other members of the AIDJEX field team, about 70 in all, would rendezvous there for their flight some 300 miles farther north, to the frozen heart of the Arctic's Beaufort Sea.

AIDJEX, for Arctic Ice Dynamics Joint Experiment, represents the most ambitious scientific experiment ever undertaken in the Arctic. Headquartered at the University of Washington in Seattle, it encompasses nearly a dozen agencies of the United States and Canadian governments and several major universities. The National Science Foundation, through its Office of Polar Programs, is the principal funding agency, with major research and logistics support provided by the Office of Naval Research.

Martin, 30, who has been technical coordinator for AIDJEX since its creation in 1969, described the project as an effort to better understand the dynamic behavior of Arctic pack ice, to learn how the ice moves and the consequences of that movement on the environment and atmosphere. Some of the practical uses to which that information can be applied include more accurate long-range weather forecasting and the ability to predict ocean ice conditions for shipping and resource development.

"We aren't concerned about being able to predict where a given piece of ice will be six months from now," Martin explained, "but we are interested in being able to predict where the pack will be a week from now. People



An automatic data buoy is implanted in Arctic ice for use in an experiment intended to yield better understanding of the dynamic behavior of pack ice.

already are talking about drilling for oil off Alaska, and when they do, it will be extremely important for them to know whether or not the ice will be coming in. And I don't mean just an iceberg or two—I mean the ice field, the pack."

After Five Years. The AIDJEX main experiment, which will run until May 1976, is the culmination of five years of theoretical and experimental investigation, pilot studies, technical development, and organizational planning. It calls for the emplacement of four manned camps and 20 automatic data buoys within a ringed area some 500 miles in diameter. Both the manned camps and the data buoys will function as drifting stations from which scientists will be able to track the movement of the ice and monitor its interactions with the sea and air.

The most intensive investigations will take place in the manned camps, located in a triangular area about 40 miles apart in the center of the ring. The data buoys will be deployed in pairs at ten locations in a 200-mile radius from the manned camps. Changes in the position of each drifting station, along with measurements of surface temperatures and atmospheric pressure, will be made several times each day and transmitted automatically to a central data acquisition unit in the main camp.

Data buoys are used primarily because they offer a relatively inexpensive way of measuring a few crucial parameters, such as position and atmospheric temperature and pressure, from a number of locations. Using manned camps to collect the data would be prohibitively expensive.

Vibrasense. Atmospheric pressure measurements, used in calculating wind stresses and other climatic conditions, will be obtained from each of the data buoys through a highly accurate pressure-sensing device called Vibrasense®, developed by United Technologies' Hamilton Standard division. At the heart of Vibrasense is a vibrating cylinder that reacts to changes in pressure by increasing or decreasing the natural frequency of the cylinder. These frequency changes are interpreted by built-in electronics which provide a digital measurement of the change in pressure.

In addition to accuracy, Vibrasense also was selected for use in the drifting data buoys because it maintains its stability for extended periods in even the most severe environments.

The device has demonstrated its reliability in a wide range of applications where precise pressure measurements are required. For example, it is used in the air inlet control of the Air Force's McDonnell Douglas F-15 fighter, in an advanced encoding altimeter for business aircraft, in an instrument for detecting leaks in nuclear reactor containment vessels, and in production testing of automobile carburetors.

Satellites, Too. In the AIDJEX project, pressure and temperature measurements are meaningful to investigators only when the position of the drifting buoy is known at the time the information is collected. In this experiment, polar orbiting satellites will be used to determine buoy positions. Several times each day, ten of the data buoys, one at each site, will have their positions fixed by an orbiting U.S. Navy navigation satellite. After receiving its position signal from the satellite, the buoy will transmit the data, along with the temperature and pressure readings it has collected, to a central processor in the main camp.

The other ten buoys will provide similar information, but in a somewhat different way. This set of buoys will operate through an orbiting Nimbus-F weather satellite. The buoys will transmit position signals and temperature and pressure information to the satellite as it passes overhead. The satellite, in turn, will relay the data to the National Aeronautics and Space Administration's Goddard Space Center in Greenbelt, Maryland, where it will be analyzed and the results reported to AIDJEX in Seattle.

Global Weather. Learning more about the behavior of the pack ice and its complex interactions with the sea and air will help scientists better understand the large-scale impact the Arctic region has on global weather systems and possibly some of the deeper, theoretical questions about the nature of the pack itself.

Scientists, for example, are not certain if the Arctic Ocean has always been frozen. Evidence indicates that there probably was a time when it wasn't, but no one knows when that might have been.

"We are aware that there are delicate balances between such things as the runoff of fresh waters from the continents and the extent of the ice," Martin said. "But what would happen if we were to cut off the flow of water from the Mackenzie River and some of the

(Continued from page 90)

The Vibrasense pressure-sensing device atop this data buoy is used in calculating wind stresses and other climatic conditions.

Pat Martin, bearded and bushy-haired, is technical coordinator for the project, which involves nearly a dozen agencies of the U.S. and Canadian governments and several major universities.

Thanks to Bee-Hive, the magazine of United Technologies, for permission to reprint this article from their Spring 1975 issue.

7400N TTL

SN7400N	.16	SN7451N	.27	SN74151N	1.25
SN7401N	.16	SN7453N	.27	SN74153N	1.35
SN7402N	.21	SN7454N	.41	SN74154N	1.25
SN7403N	.16	SN7459A	.25	SN74155N	1.21
SN7404N	.21	SN7460N	.22	SN74156N	1.30
SN7405N	.24	SN7470N	.45	SN74157N	1.30
SN7406N	.45	SN7472N	.39	SN74160N	1.75
SN7407N	.45	SN7473N	.45	SN74161N	1.45
SN7408N	.25	SN7474N	.45	SN74163N	1.65
SN7409N	.25	SN7475N	.80	SN74164N	1.65
SN7410N	.20	SN7476N	.47	SN74165N	1.65
SN7411N	.30	SN7480N	.50	SN74166N	1.70
SN7412N	.42	SN7482N	1.75	SN74167N	5.50
SN7413N	.85	SN7483N	1.15	SN74170N	3.00
SN7414N	.70	SN7485N	1.12	SN74172N	18.00
SN7416N	.43	SN7486N	.45	SN74173N	1.70
SN7417N	.43	SN7488N	3.50	SN74174N	1.95
SN7418N	.25	SN7489N	3.00	SN74175N	1.95
SN7420N	.20	SN7490N	.59	SN74176N	.90
SN7421N	.39	SN7491N	1.20	SN74177N	.90
SN7423N	.37	SN7492N	.82	SN74180N	1.05
SN7425N	.43	SN7493N	.82	SN74181N	3.55
SN7426N	.31	SN7494N	.91	SN74182N	.95
SN7427N	.37	SN7495N	.91	SN74184N	2.30
SN7429N	.42	SN7496N	.91	SN74185N	2.20
SN7430N	.26	SN74100N	1.25	SN74187N	6.00
SN7432N	.31	SN74107N	.49	SN74190N	1.50
SN7437N	.47	SN74121N	.55	SN74191N	1.50
SN7438N	.40	SN74122N	.49	SN74192N	1.50
SN7439A	.25	SN74123N	1.05	SN74193N	1.40
SN7440N	.21	SN74125N	.60	SN74194N	1.45
SN7441N	1.10	SN74126N	.81	SN74195N	1.00
SN7442N	1.08	SN74132N	3.00	SN74196N	1.25
SN7443N	1.05	SN74141N	1.15	SN74197N	1.00
SN7444N	1.10	SN74142N	6.50	SN74198N	2.25
SN7445N	1.10	SN74143N	7.00	SN74199N	2.25
SN7446N	1.15	SN74144N	7.00	SN74200N	7.00
SN7447N	.89	SN74145N	1.15	SN74251N	2.50
SN7448N	.99	SN74148N	2.50	SN74284N	6.00
SN7450N	.26	SN74150N	1.10	SN74285N	6.00

20% Discount for 100 Combined 7400's

CMOS

CD4000	.25	CD4050	.79	74C154	3.00
CD4001	.25	CD4051	2.98	74C157	2.15
CD4002	.25	CD4053	2.98	74C160	3.25
CD4006	2.50	CD4060	3.25	74C161	3.25
CD4007	.25	CD4066	1.75	74C163	3.00
CD4009	.59	CD4069	.45	74C164	3.25
CD4010	.59	CD4071	.45	74C173	2.60
CD4011	.25	CD4081	.45	74C193	2.75
CD4012	.25	CD4047	2.75	74C195	2.75
CD4013	.47	CD4049	.79	74C151	2.90
CD4016	.56	CD4050	.79	74C154	3.00
CD4017	1.35	CD4051	2.98	74C157	2.15
CD4019	.55	CD4053	2.98	74C160	3.25
CD4020	1.49	CD4060	3.25	74C161	3.25
CD4022	1.25	CD4066	1.75	74C163	3.00
CD4023	.25	CD4069	.45	74C164	3.25
CD4024	1.50	CD4071	.45	74C173	2.60
CD4025	.25	CD4081	.45	74C193	2.75
CD4027	.69	74C00N	.39	74C195	2.75
CD4028	1.65	74C02N	.55	80C97	1.50
CD4029	2.90	74C04N	.75		

LINEAR

LM100H	15.00	LM373N	3.75	LM1310N	2.95
LM106H	2.50	LM377N	4.00	LM1351N	1.65
LM171H	3.75	LM380N	1.39	LM1414N	1.75
LM212H	7.00	LM380CN	1.05	LM1458C	.65
LM300H	.80	LM381N	1.79	LM1496N	.95
LM301H	3/1.00	LM381CN	1.79	LM1556V	1.85
LM301CN	3/1.00	LM382N	1.79	LM2111N	1.95
LM302H	.75	LM383N	1.79	LM2901N	2.95
LM304H	1.00	NE501K	8.00	LM3065N	.69
LM305H	.95	NE510A	6.00	LM3900N	.55
LM307CN	.35	NE531A	3.00	LM3905N	1.85
LM308H	1.00	NE536T	6.00	LM5556N	1.85
LM308CN	1.00	NE540L	6.00	MC5558V	1.00
LM309H	1.10	NE550N	.79	LM7525N	.90
LM309K	1.25	NE553	2.50	LM7528N	2.20
LM310CN	1.15	NE555V	.49	LM7534N	2.20
LM311H	.90	NE565H	.99	LM7535N	1.25
LM311N	.90	NE565N	1.25	8038B	4.95
LM318CN	1.50	NE566CN	1.95	LM75450	.49
LM319N	1.30	NE567H	1.25	75451CN	.39
LM319D	9.00	NE567V	1.50	75452CN	.39
LM320K 5	1.35	LM703CN	.45	75453CN	.39
LM320K 5.2	1.35	LM709H	.29	75454CN	.39
LM320K 12	1.35	LM709N	.29	75491CN	.79
LM320K 15	1.35	LM710N	.79	75492CN	.89
LM323K-5	10.50	LM711N	.39	75494CN	.89
LM324N	1.80	LM722N	.55	RCA LINEAR	
LM339N	1.70	LM723H	.55	CA3013	1.70
LM340K 5	1.95	LM733N	1.00	CA3023	2.15
LM340K 12	1.95	LM739N	1.29	CA3035	2.25
LM340K 15	1.95	LM741CH	3/1.00	CA3039	1.35
LM340K 24	1.95	LM741CN	3/1.00	CA3046	1.15
LM340T05	1.75	LM741-14N	.39	CA3059	2.46
LM340T06	1.75	LM747H	.79	CA3060	2.80
LM340T012	1.75	LM747N	.79	CA3080	.85
LM340T015	1.75	LM748H	.39	CA3083	1.60
LM340T024	1.75	LM748N	.39	CA3086	.59
LM350N	1.00	LM1303N	.90	CA3089	3.25
LM351CN	.65	LM1304N	1.19	CA3091	8.25
LM370N	1.15	LM1305N	1.40	CA3123	1.85
LM370H	1.15	LM1307N	.85	CA3600	1.75

DATA HANDBOOKS

7400	Pin-out & Description of 5400/7400 ICS	$2.95
CMOS	Pin-out & Description of 4000 Series ICS	$2.95
LINEAR	Pin-out & Functional Description of Linear Circuits	$2.95

6' POWER SUPPLY CORDS . . . .

2 CONDUCTORS SPECIAL 3/$1.00

THUMBWHEEL SWITCHES

THUMBWHEEL SWITCH ONLY
SF - Front Mount SR - Rear Mount

Part No.	Description	Price
SR-10	Single Pole 10 Position	$2.00
SR-12	Decimal	3.00
SR-BCD	10 Position BCD only	4.00
SR-21		3.00

Snap together — No Hardware

SF-H1 & SF Panel Mount Assembly ($11.70)

ACCESSORIES

Part No.	Description	Price
SF-EP	End Plate (Pair)	$1.00
SF-DP	Divider Plate (each)	.40
SF-BB	Blank Body (each)	.40
SF-HB	Half Body (each)	.40

SR-H1 & SR Rear Mount Assembly ($13.70)

ACCESSORIES

Part No.	Description	Price
SR-EP	End Plate (pair)	$1.00
SR-DP	Divider Plate (each)	.40
SR-BB	Blank Body (each)	.40
SR-HB	Half Body (each)	.40

Ordering: Order desired switch or switches and add necessary accessories for your particular application.

JAMES MONTHLY SPECIALS

DIODES

IN4001	50V @ 1 Amp	15/$1.00
IN4002	100V @ 1 Amp	15/$1.00
IN4003	200V @ 1 Amp	15/$1.00
IN4004	400V @ 1 Amp	15/$1.00
IN4148	Switching	20/$1.00

TRANSISTORS

2N2907A	PNP Switching	6/$1.00
2N2222A	NPN Switching	6/$1.00
2N3904	NPN Amp	8/$1.00
2N3906	PNP Amp	6/$1.00
2N918	NPN RF	5/$1.00
2N5951	NJ Fet	6/$1.00
C106B1	3.6 Amp SCR	2/$1.00

TTL/LINEAR

7400	Gate	7/$1.00
7447	Decoder	.79
7490	Counter	.49
74100	8 Bit Latch	.99
74154	Decoder	.99
74197	Counter	.75
LM391H—LM741H		4/$1.00
LM324N—Quad 741		1.19
LM309H	5V Reg TO-5	.79
LM309K	5V Reg TO-3	.99

MM5262 DYNAMIC 2K RAM $2.95

CLOCK & CALC. CHIPS

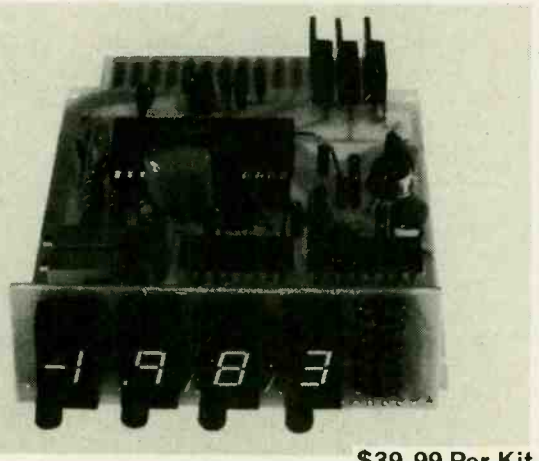
MM5311N	6 Digit	$2.95
MM5312N	4 Digit	2.95
MM5313N	6 Digit	2.95
MM5314N	6 Digit	2.95
MM5316N	6 Digit Alarm	3.95
MM5725N	8 Digit-4 Funt.	1.85
MM5736N	6 Digit-4 Funt.	1.95
MM5738N	8 Digit-5 Funt.	2.95

26 Awg RIBBON CABLE

Ft. Minimum	1.9 ft.	10 ft.
4 Cond.	.29 ft.	.25 ft.
8 Cond.	.59 ft.	.49 ft.
16 Cond.	.89 ft.	.79 ft.
32 Cond.	1.89 ft.	1.69 ft.

DIGITAL VOLTMETER

JE801 DVM



$39.99 Per Kit SINGLE UNIT

GENERAL DESCRIPTION

The JE801 is a three and one half digit, auto polarity digital voltmeter, in a kit form. It features several options not available in any commercial digital voltmeter. Its low cost is perhaps the most important feature, which is achieved by offering it in a kit form. A kit allows the unit to be used by small OEM's where cost effectiveness is an important factor, and by the hobbyist who has to be concerned with cost. The unit also features on card regulators, allowing it to be operated off a single plus and minus fifteen volt, unregulated power supply. The unit has a small size of three inches width, three and three quarters of an inch length, and one and a quarter inch height.

DISPLAY LEDS

FND70	Com. Cath.	.250	.59
MAN 1	Com. Ano.	.270	$1.95
MAN 2	5x7 Matrix	.300	3.95
MAN 3	Com. Cath.	.125	.39
MAN 4	Com. Cath.	.187	1.95
MAN 7	Com. Ano.	.30	1.50
DL33	Com. Cath.	.125	1.95
DL747	Com. Ano.	.625	1.95

DISCRETE LEDS

MV 10	Red	5/$1.00
MV 50	Red	6/$1.00
MV 5024	Red	5/$1.00
MV 5024	Green	4/$1.00
MV 5024	Yellow	4/$1.00
MV 5024	Orange	4/$1.00
MV 50*	Red 1/4" Leads	5/$1.00

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin	$.17	.16	.15	24 pin	$ .38	.37	.36
14 pin	.20	.19	.18	28 pin	.45	.44	.43
16 pin	.22	.21	.20	36 pin	.60	.59	.58
18 pin	.29	.28	.27	40 pin	.63	.62	.61
22 pin	.36	.37	.36				

SOLDERTAIL STANDARD (GOLD)

8 pin	$.30	.27	.24	24 pin	$ .70	.63	.57
14 pin	.35	.32	.29	28 pin	1.10	1.00	.90
16 pin	.38	.35	.32	36 pin	1.55	1.40	1.26
18 pin	.52	.47	.43	40 pin	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

10 pin	$.45	.41	.37	24 pin	$1.05	.95	.85
14 pin	.39	.38	.37	28 pin	1.40	1.25	1.10
16 pin	.43	.42	.41	36 pin	1.59	1.45	1.30
18 pin	.75	.68	.62	40 pin	1.75	1.55	1.40

50 PCS. RESISTOR ASSORTMENTS $1.75 per assort.

Each assortment contains 50 pcs. of ¼ watt, 5% resistors

ASST. 1	5 ea:	10 OHM-12 OHM-15 OHM-18 OHM-22 OHM 27 OHM-33 OHM-39 OHM-47 OHM-56 OHM			
ASST. 2	5 ea:	68 OHM-82 OHM-100 OHM-120 OHM-150 OHM 180 OHM-220 OHM-270 OHM-330 OHM-390 OHM 470 OHM-560 OHM-680 OHM-820 OHM-1K			
ASST. 3	5 ea:	1.2K	1.5K	1.8K	2.2K	2.7K
		3.3K	3.9K	4.7K	5.6K	6.8K
ASST. 4	5 ea:	8.2K	10K	12K	15K	18K
		22K	27K	33K	39K	47K
ASST. 5	5 ea:	56K	68K	82K	100K	120K
		150K	180K	220K	270K	330K
ASST. 6	5 ea:	390K	470K	560K	680K	820K
		1M	1.2M	1.5M	1.8M	2.2M
ASST. 7	5 ea.	2.7M	3.3M	3.9M	4.7M	5.6M

14 PCS. POTENTIOMETER ASSORTMENTS $9.95

Each assortment contains 14 pcs of 10 turn pots.

ASST. A 2 ea: 10 OHM-20 OHM-50 OHM-100 OHM-200 OHM-250 OHM-500 OHM

ASST. B 2 ea: 1K, 2K, 2.5K, 10K, 20K, 25K, 50K

ASST. C 2 ea: 50K, 100K, 200K, 250K, 500K, 1M, 2M

All pots are available in single unit quantities. $.99 ea.

DPST C & K ROCKER SWITCH

They are rated at 125 Vac @ 5A.
They are excellent in application such as Microcomputer Panel Switches
$0.69
Dim: 1"x1"x¾"

PRIME INTEGRATED CIRCUIT ASSORTMENTS

ASST. 8	3 ea.	SN7400	7401	7402	7403	7404	SSI/TTL	$5.95 ASST.
		SN7410	7430	7438	7440	7472		
ASST. 9	2 ea.	SN7447	7490	7491	74100	74121	MSI/TTL	$9.95 ASST.
		SN74145	74175	74180	74181	74193		
ASST. 10	2 ea.	CD4001	4062	4011	4012	4013	CMOS	$7.95 ASST.
		CD4016	4017	4019	4022	4030		
ASST. 11	2 ea.	LM301T	301N	3027	3077	309K	LINEAR	$10.95 ASST.
		LM311T	565T	567T	741T	741N		

Satisfaction Guaranteed. $5.00 Min. Order. U.S. Funds.
California Residents — Add 6% Sales Tax
Write for FREE 1976 Catalog — Data Sheets .25¢ each

JAMES
P.O. BOX 822, BELMONT, CA. 94002
PHONE ORDERS — (415) 592-8097

MICROPROCESSOR COMPONENTS

8008 — $19.95 2102 — $2.95

CPU'S			RAM'S		
8008	8 bit CPU	$19.95	1101	256x1 Static	$ 2.25
8080	8 bit Super 8008	149.95	1103	1Kx1 Dynamic	2.95
4040	4 bit 8080	39.95	2102	1Kx1 Static	2.95
UARTS			2107	4Kx1 Dynamic	19.95
AY-5-1013		6.95	7010	1Kx1 Mimos	29.95
PROM'S			7489	16x4 Static	2.49
8223	32x8 Prom	3.00	8101	1Kx1 Static	7.95
1702A	2K E Prom	15.95	8111	1Kx1 Static	7.95
5203O	2K E Prom	14.95	8599	16x4 Tristate	3.49
74S287	1Kx4 Prom	7.95	91L02	1Kx1 Low Power	3.95
SR'S			74200	256x1 Static	6.95
2401	2K OSR	9.95	74LS670	4x4 Register	3.95
2533	1K SSR	7.95	93410	256x1 Static	2.95

91L02 1K Static RAM Direct Replacement for 2102-1 with 40% Less Current Drawn 2.49

Vector General Purpose Logic CARD Board 14.95
*Very High Noise Immunity * Holds 12 ea. 14 pin DIPS
*44 pin Edge Connection

THE KILOBYTE-RAM CARD Per Kit $49.95
*Complete 1K x 8 Memory * High Noise Immunity Components
*Single 5v supply *500NS Access Time &Kit includes sockets, ICS & Board

4 PDT SWITCHES, HIGH QUALITY P.B. TYPES .69

KITS EXAR ICS

XR-2206KA SPECIAL $17.95

Includes monolithic function generator IC, PC board, and assembly instruction manual.

XR-2206KB SPECIAL $27.95

Same as XR-2206KA above and, includes external components for PC board.

TIMERS		STEREO DECODERS	
XR-555CP SPECIAL	$ .69	XR-1310P	$3.20
XR-320P	1.55	XR-1310EP	3.20
XR-556CP	1.85	XR-1800P	3.20
XR-2556CP	3.20	WAVEFORM GENERATORS	
XR-2240CP SPECIAL	3.25	XR-205	8.40
PHASE LOCKED LOOPS		XR-2206CP SPECIAL	4.49
XR-210	5.20	XR-2207CP	3.85
XR-215	6.60	MISCELLANEOUS	
XR-567CP	1.95	XR-2211CP	6.70
XR-2567CP SPECIAL	2.99	XR-2261	3.79

Special Requested Items

RC4194	Dual Track V Reg	$5.95	NBT97	$3.00	2533	$7.95
RC4195	±15V Track Reg	3.25	4024P	2.25	8263	5.95
F9368	Decoder	3.95	2513	11.00	8267	2.75
LO110/111	OVM Chip Set	28.00	2518	7.00	8288	1.15
CA3130	Super CMOS Op Amp	1.49	2524	3.50	8826	3.00
MC1408L7	A/D	9.95	2525	6.00	8880	1.35
F3341	FIFO	8.95	2527	5.00	7497	5.00

ZENERS—DIODES—RECTIFIERS

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
IN746	3.3	400m	4/1.00	IN4003	200 PIV	1 AMP	.10
IN751A	5.1	400m	4/1.00	IN4004	400 PIV	1 AMP	.10
IN752	5.6	400m	4/1.00	IN3600	50	200m	6/1.00
IN753	6.2	400m	4/1.00	IN4148	75	10m	15/1.00
IN754	6.8	400m	4/1.00	IN4154	35	10m	12/1.00
IN965B	15	400m	4/1.00	IN4734	5.6	1w	.28
IN5232	5.6	500m	.28	IN4735	6.2	1w	.28
IN5234	6.2	500m	.28	IN4736	6.8	1w	.28
IN5235	6.8	500m	.28	IN4738	8.2	1w	.28
IN5236	7.5	500m	.28	IN4742	12	1w	.28
IN456	25	40m	6/1.00	IN4744	15	1w	.28
IN458	150	7m	6/1.00	IN1183	50 PIV	35 AMP	1.60
IN485A	180	10m	5/1.00	IN1184	100 PIV	35 AMP	1.70
IN4001	50 PIV	1 AMP	.09	IN1186	200 PIV	35 AMP	1.80
IN4002	100 PIV	1 AMP	.10	IN1188	400 PIV	35 AMP	3.00

MPS A05	5/1.00	PN3567	3/$1.00	PN4249	4/$1.00
MPS A06	5/$1.00	PN3568	4/$1.00	PN4250	4/$1.00
2N2219A	3/$1.00	PN3569	4/$1.00	PN4400	4/$1.00
2N2221	4/$1.00	2N3704	5/$1.00	PN4401	4/$1.00
2N2222A	5/$1.00	2N3705	5/$1.00	2N4402	4/$1.00
2N2369	5/$1.00	2N3706	5/$1.00	2N4403	4/$1.00
2N2369A	4/$1.00	2N3707	5/$1.00	2N4409	5/$1.00
FN2415	5/$1.00	2N3711	5/$1.00	2N5086	4/$1.00
2N2484	4/$1.00	2N3724	5.65	2N5087	4/$1.00
2N2906A	4/$1.00	2N3725	$1.00	2N5088	4/$1.00
2N2907A	5/$1.00	2N3903	5/$1.00	2N5089	4/$1.00
2N2925	5/$1.00	2N3904	4/$1.00	2N5129	5/$1.00
2N3053	2/$1.00	2N3905	4/$1.00	2N5138	5/$1.00
2N3055	$.89	2N3906	4/$1.00	2N5139	5/$1.00
MJE3055	$.89	2N4013	3/$1.00	2N5209	5/$1.00
2N3392	5/$1.00	2N4014	3/$1.00	2N5851	5/$1.00
2N3398	5/$1.00			C106B1	SCR 2/$1.00

TRANSISTORS

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-49	50-100		1-9	10-49	50-100
10pf	.05	.04	.03	.001	.05	.04	.035
22 pf	.05	.04	.03	.0047	.05	.04	.035
47 pf	.05	.04	.03	.01	.05	.04	.035
100 pf	.05	.04	.03	.022	.06	.05	.04
220 pf	.05	.04	.03	.047	.06	.05	.04
470 pf	.05	.04	.035	.1	.12	.09	.075

100 VOLT MYLAR FILM CAPACITORS

.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

± 20% DIPPED TANTALUMS (SOLID) CAPACITORS

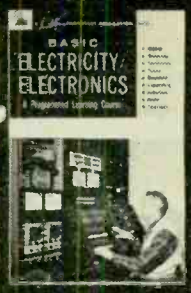
1 35v	.28	.23	.17	15 35v	30	26	.21
15 35v	.28	.23	.17	2.2 25v	31	.27	.22
.22 35v	.28	.23	.17	3.3 25v	31	.27	.22
.33 35v	.28	.23	.17	4.7 25v	32	.28	.23
.47 35v	.28	.23	.17	6.8 25v	36	.31	.25
.68 35v	.28	.23	.17	10 25v	40	.35	.29
1.0 35v	.28	.23	.17	15 25v	.63	.50	.40

MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead				Radial Lead			
.47	50	15	13	.10	47	25	.15	.13	.10
1	50	16	14	.11	47	50	.16	.14	.11
3.3	50	15	13	.10	1	16	.15	.13	.10
4.7	25	16	14	.12	1	25	.16	.14	.11
10	25	15	13	.10	1	50	.16	.14	.11
10	50	16	14	.12	4.7	16	.15	.13	.10
22	25	17	15	.12	4.7	25	.15	.13	.10
22	50	24	20	.18	4.7	50	.16	.14	.11
47	25	19	17	.15	10	16	.14	.12	.09
47	50	25	21	.19	10	25	.15	.13	.10
100	25	24	20	.18	10	50	.16	.14	.12
100	50	35	30	.28	47	50	.24	.21	.19
220	25	32	28	.25	100	16	.19	.15	.14
220	50	45	41	.38	100	25	.24	.20	.18
470	25	33	29	.27	100	50	.35	.30	.28
1000	16	55	50	.45	220	16	.23	.17	.16
2200	16	70	62	.55	470	25	.31	.28	.26

CIRCLE 20 ON READER SERVICE COUPON

e/e BASIC COURSE IN ELECTRICITY & ELECTRONICS



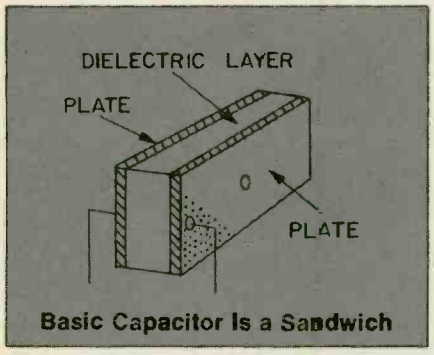
This series is based on BASIC ELECTRICITY/ELECTRONICS, Vol. 2, published by HOWARD W. SAMS & CO., INC.

What You Will Learn. Practically every circuit in electronics contains the property of capacitance. This property is one of the most important concepts you will learn in your study of electricity and electronics. Many electronic devices, such as time delay relays, photoflash units and even complicated computer circuits depend upon the property of capacitance for their operation.

You will learn how capacitance can be used to block direct current (DC) and to pass alternating current (AC) signals. You will also learn how capacitance causes applied AC voltage to lag behind the current in a given circuit, and how capacitance distorts the voltage waveform of pulses. When you have finished you will be familiar with the units we use to measure capacitance and the factors influencing the size of a capacitor.

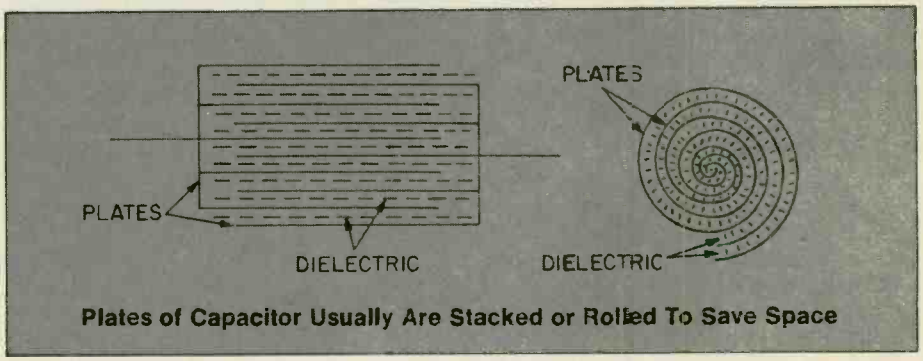
WHAT IS CAPACITANCE?

Capacitance is the property of an electrical circuit that **opposes a change in voltage.** Capacitance has the same reaction to voltage that inductance has to current. This means that if the voltage applied *across* a circuit is increased, the capacitance will resist that change. If the voltage applied across a circuit is decreased, the capacitance will oppose the decrease and try to maintain the original voltage.



Basic Capacitor Is a Sandwich

In a DC circuit, capacitance has an effect only when voltage is first applied, and then again when it is removed. **Note that direct current cannot flow through a capacitance.** However, alternating current **apppears** to flow through a capacitance—you will learn how later. Since voltage is constantly changing in AC circuits, capacitance acts at all times to retard these changes in voltage.



Plates of Capacitor Usually Are Stacked or Rolled To Save Space

A basic capacitor is shown in the first diagram. It consists of two conducting metal plates separated by a layer of air or other insulating material, such as paper, glass, mica, oil, etc. The insulating layer is call the **dielectric.**

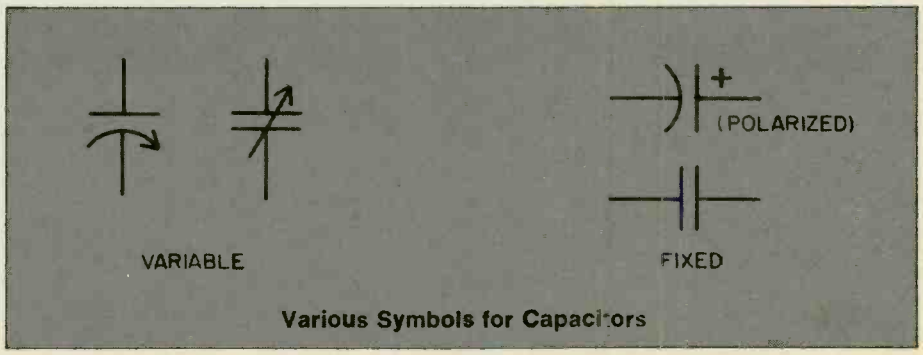
All capacitors have these two plates and a separating layer. In practice, the plates and dielectric are often stacked or even rolled into a compact form. Sometimes the dielectric is a paste or a liquid instead of a solid.

The circuit symbols for a capacitor are shown on this page.

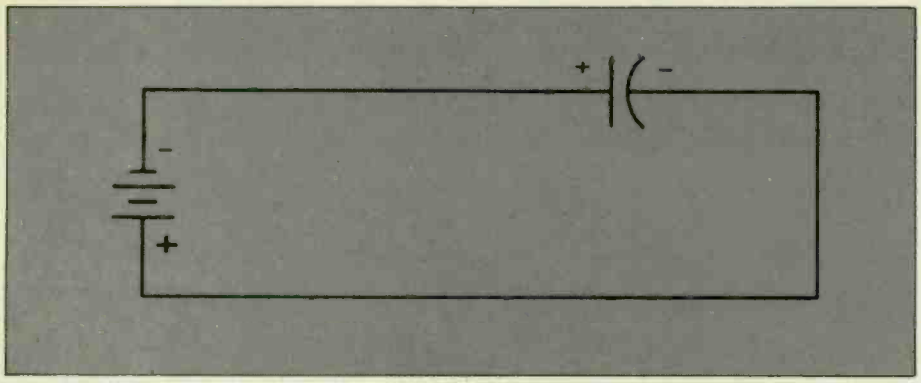
When a capacitor is first connected to a battery, electrons from the negative terminal of the battery flow to the nearest capacitor plate and remain there. They can go no farther, since the opposite plate is separated from the first by an insulating layer. Electrons are attracted from the opposite capacitor plate and flow into the positive terminal of the battery. After this initial movement of electrons, the negative-most plate of the capacitor is filled with all the electrons that the battery voltage can force into it, and the other capacitor plate loses the same number of electrons to the battery's positive terminal. This means that one plate has a negative charge and the other plate has a positive charge—the charge being equal to the battery's potential. No further current flows; the capacitor is "charged."

Positive and negative charges attract each other, so there will be a force between the plates of the capacitor. There is also a voltage between them that is equal to, and which opposes the voltage of the battery.

Because it takes a certain specific



Various Symbols for Capacitors



number of electrons to fill the negative plate, we say that the capacitor has a certain capacity, or **capacitance.**

QUESTIONS

Q1. Name two differences between capacitance and inductance.

Q2. Draw a circuit diagram of a capacitor connected across the terminals of a battery.

Q3. Explain what happens when you disconnect the battery terminals from a charged capacitor and place a wire across the leads of the capacitor.

ANSWERS

A1. Capacitance opposes a change in voltage while inductance opposes changes in current. **Capacitance blocks DC** while inductance does not.

A2. Your circuit diagram should look like this.

A3. The **electrons** from the capacitor's negative plate **flow through the wire to the positive plate** until both plates have the same number of electrons. The **voltage across the plates is then zero.**

CAPACITANCE MEASUREMENTS

The usual written symbol for capacitance is **C.** Capacitance is measured in **farads.** The amount of capacitance in a capacitor is the quantity of electrical charges (measured in coulombs) which must be moved from one plate to the other in order to create a potential difference of 1 volt between plates. The number of coulombs transferred is called the **charge.**

One farad is the capacitance in which a charge of 1 coulomb produces a difference of 1 volt between the plates. The larger the area of a capacitor's plates, and the closer these plates are to each other, the more charge (current) the capacitor will hold with the same voltage applied across the plates.

Capacitance values are usually specified in microfarads (millionths of a farad, abbreviated **mfd** or **μF**) or in **picofarads** (millionths of a microfarad, abbreviated **pF**).

HOW DOES CAPACITANCE AFFECT AC?

Although current cannot flow through a capacitor, an AC current appears to do just that. The reason lies in the nature of capacitance. If the voltage across the plates is continuously varied, the number of electrons on the plates varies.

Increasing the number of electrons on one plate of a capacitor repels electrons from the other plate. Decreasing the number of electrons on the first plate allows electrons to be attracted back to the other plate.

An AC current can, **in effect,** get across the dielectric. Since the voltage is alternating, it causes a corresponding varying current to flow between one side of the capacitor to the other side. In other words, **voltage changes** appear to be transmitted across the dielectric gap.

If a capacitor has the same voltage as the applied voltage, no current will flow to or from it. If the applied voltage changes, the capacitor voltage will no longer equal the applied voltage. Current will flow, **trying to equalize** the two potential sources.

In a circuit this means that if an AC sine-wave voltage is applied across a capacitor, an AC sine-wave current will appear on the opposite side, even though no electrons flow through the dielectric layer.

QUESTIONS

Q4. The capacitance of a capacitor is measured in .....

Q5. A millionth of a farad is called a ..... and is abbreviated as ..... or .....

Q6. A ..... is a millionth of a microfarad and is abbreviated .....

Q7. Current will flow from one plate of a capacitor to the other plate only when ..... is changing.

ANSWERS

A4. The capacitance of a capacitor is measured in **farads.**

A5. A millionth of farad is called a **microfarad** and is abbreviated as **mfd** or **μF.**

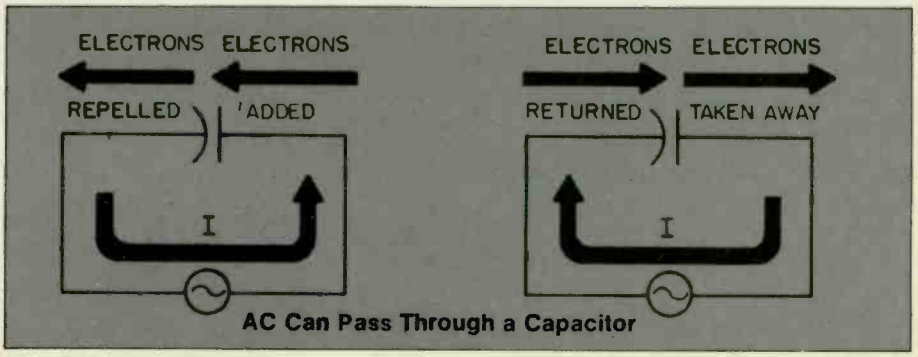
A6. A picofarad is a millionth of a microfarad and is abbreviated **pF.**

A7. Current will flow through a capacitor only when **voltage** is changing.

FACTORS AFFECTING CAPACITANCE VALUE

The amount of electrical charge that can be stored in a capacitor (the number of electrons that can be placed on the plate) varies with the **area** of the plates. Consequently, capacitance varies directly with area – if the area is doubled, the capacitance is doubled. When the area is doubled, or twice as many plates are connected in parallel, there is twice as much area to store electrons. Therefore the capacitance is twice as great.

Capacitance can also be increased by placing the plates closer together. When the plates are closer the attraction between the negative charges on one side



AC Can Pass Through a Capacitor

(Continued on page 87)

(Continued from page 84)

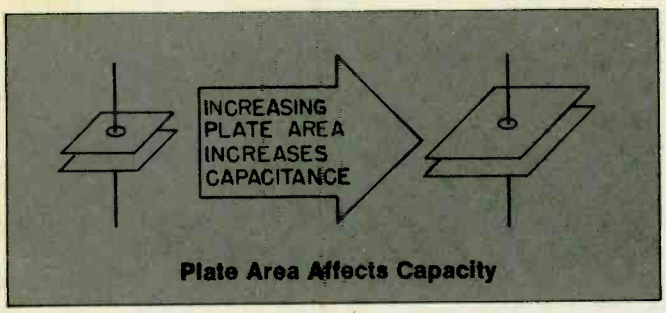
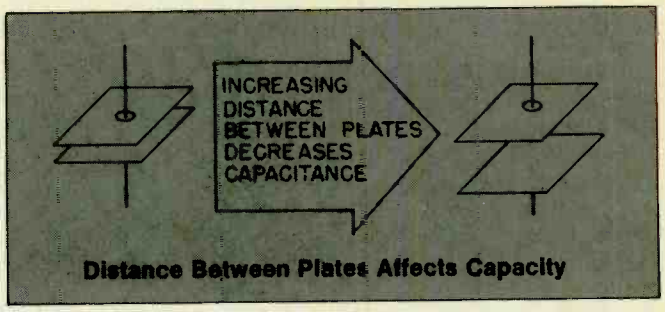


Plate Area Affects Capacity



Distance Between Plates Affects Capacity

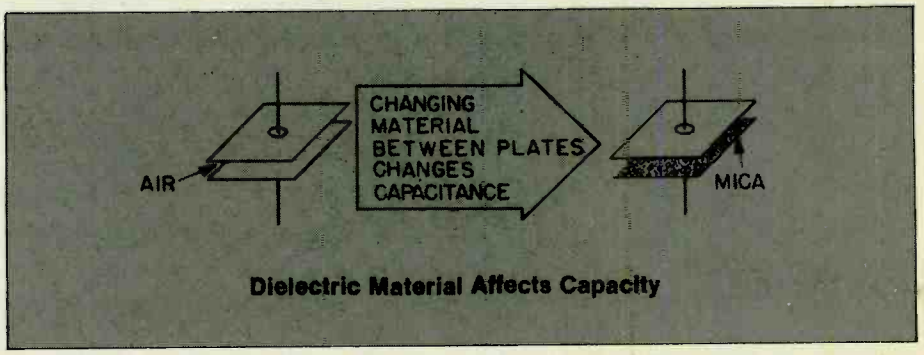
and the positive charges on the other side is greater. It is, of course, necessary to keep the plates sufficiently separated so that the charge does not jump through the dielectric, possibly damaging the capacitor.

Higher values of capacitance can be obtained by using an insulating material (dielectric) other than air. In this way the plates can be placed closer together.

Dielectrics such as mica, glass, oil, and **Mylar** are a few of the materials that can withstand a high electric potential without breaking down. This property is called **dielectric constant.** The higher the dielectric constant, the better its ability to retain its insulating characteristics under unusual operating conditions. Air has a dielectric constant of 1, glass about 5, and mica 2.5 to 6.6.

Besides allowing the plates to be placed closer together, a dielectric has another effect on capacitance. Dielectric material contains a large number of electrons and other carriers of electrical charge. Although electrons cannot flow as in a conductor, they are held rather loosely in the structure and can move slightly. The distortion of the structure of the dielectric, which is caused by charging the capacitor, has a large effect on the forces of attraction and repulsion that aid or oppose the flow of the electrons. This factor has a substantial effect on capacitance.

When materials such as mica or glass are used as the dielectric, the capacitors have a much higher value than the same size units with an air dielectric.



Dielectric Material Affects Capacity

QUESTIONS

Q8. How does a mica capacitor differ from an air capacitor of the same physical size?

Q9. What are three factors that affect the capacitance of a capacitor?

Q10. A screw-type variable capacitor is made with an adjusting screw that is used to vary the distance between the capacitor plates. How would you increase its capacitance?

ANSWERS

A8. A mica capacitor has a **higher capacitance** than an air capacitor of the same physical size.

A9. The capacitance of a capacitor depends on these three factors: the **area** of the plates, the **spacing** between the plates, and the nature of the **dielectric material.**

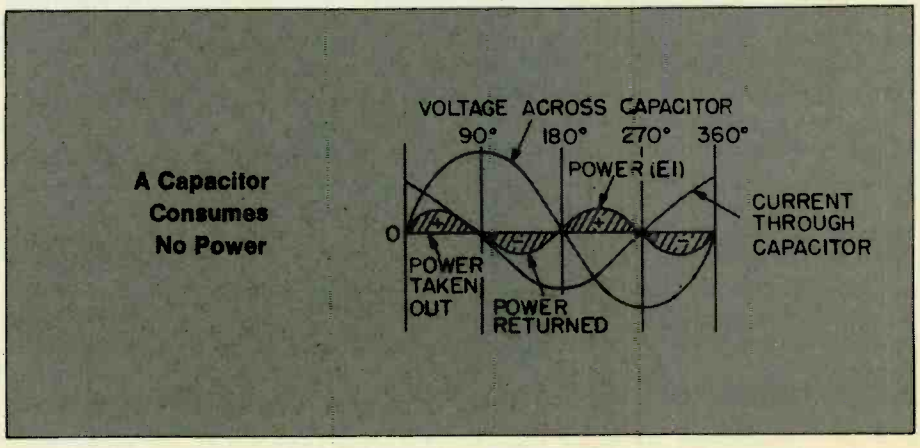
A10. Tightening the screw moves the plates closer together and **increases capacitance.** Loosening the screw **decreases the capacitance.**

POWER

A perfect capacitor consumes no power. During the sine-wave cycle, the capacitor takes energy out of the circuit and stores it in the form of an electric field during a quarter cycle. The capacitor returns it to the circuit in the next quarter cycle. **Energy is borrowed, but it is returned later.**

If the product of E times I is taken at every instant of the cycle, the power waveform will show that energy is taken out and returned in alternate quarter cycles.

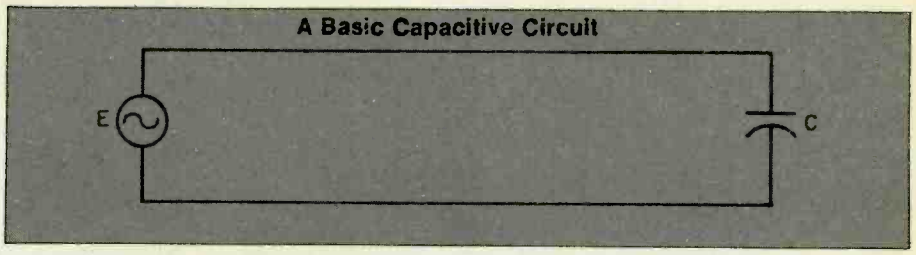
To find the amount of energy (in **coulombs**) stored in a capacitor, multiply the capacity in farads by the applied voltage. In a circuit containing only pure capacitance, it makes no difference how long the voltage is applied –the same amount of energy will always be stored at a given voltage.



CAPACITIVE REACTANCE

Like inductance, capacitance has a reactance—an opposition to the flow of AC. But capacitive reactance **decreases** as frequency increases.

Suppose a capacitor is connected in series with an alternating voltage source. There is no resistance in the circuit.



Because the circuit above contains no resistance, the voltage across the capacitor will be the same value as the source voltage at every instant.

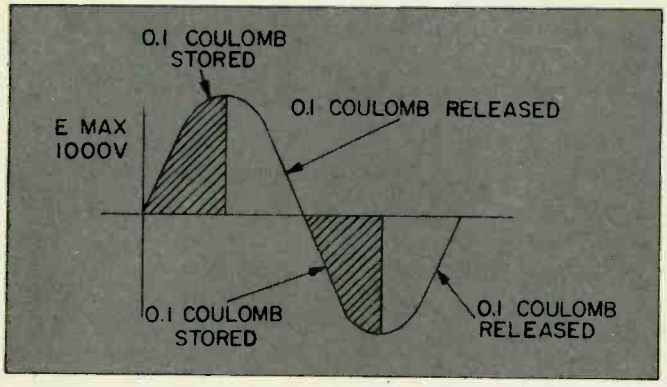
When a capacitor is charged up to voltage E, it stores an amount of energy equal to the capacitance times the voltage. If the peak voltage of the AC source is E, the capacitor will have stored a particular amount of energy every time the voltage sine wave reaches its peak, and again stores that amount whenever the voltage reaches its negative peak. The energy depends only on capacitance and peak voltage.

QUESTION

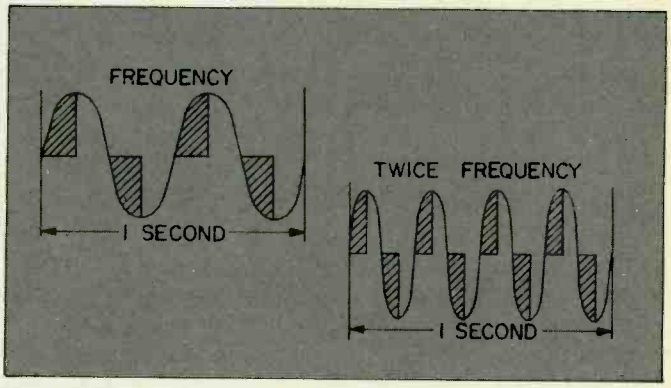
Q11. How much energy will be stored in a 100-mfd capacitor in the first quarter cycle of an applied AC voltage of 1,000 volts maximum?

ANSWER

A11. 1,000 volts × .0001 farad = **0.1 coulomb**



Equal Amounts of Energy Must Flow in Each Cycle



Doubling the Frequency Doubles the Capacitor Current

What happens when the frequency of the power source is doubled? If the peak voltage (E) is unchanged, the capacitor will charge every half cycle to the same amount as before. But it will have to do this twice as fast because the energy is doubled. This means that the same amount of energy must flow into the capacitor in only half the time. And since the voltage is the same, we must have twice the current to supply this same amount of energy.

What does this mean? The frequency was doubled, and this doubled the current flowing into the capacitor. Yet, the input voltage remained the same. A pure capacitance lets twice as much current flow if the frequency is doubled.

Capacitive reactance is the opposition that pure capacitance offers to the flow of current. It is expressed in **ohms**, and its symbol is X_c. Capacitive reactance depends on frequency. As the frequency increases, the rate of change of applied voltage increases, and the current flowing also increases. As the frequency is reduced, the rate of change of voltage goes down, and less current flows.

At this point you can more easily see why capacitor current leads the voltage across the capacitor. It is necessary for the capacitor to charge up to the given voltage, and this charging is done by the current. Hence, the charging current will reach its maximum value at the time the charging is going on at the greatest rate; that is, when the rate of change of voltage is the most rapid.

As the capacitor approaches full charge, the voltage rate of change slows down, and the current decreases. When the capacitor is fully charged and its voltage has reached maximum, there is no charging current flowing at all—the current has already dropped to zero at this time. A similar process occurs during discharging. At all times, current leads the voltage by 90°, or one quarter of the cycle. In a steady-state AC situation, when the applied voltage is a sine wave, both voltage and current will be sine waves.

Capacitive reactance depends on frequency. Since it lets more current flow as frequency increases, **capacitive reactance must decrease as the frequency increases.**

Capacitive reactance also depends on the size of the capacitance. As capacitance increases, more current must flow into the capacitor to charge it to the same voltage (since the amount of energy stored equals C times E). As a result, **capacitive reactance decreases when capacitance increases.**

The formula for capacitive reactance is:

$$X_c = \frac{1}{2\pi fC} \text{ ohms}$$

where,

f is the frequency in Hz,

C is the capacitance in farads.

Capacitive reactance can be used in calculating current in a purely capacitive circuit by Ohm's law.

$$I = \frac{E}{X_c}$$

QUESTIONS

Q12. What is X_c if f = 6,000 Hz and C = 200 mfd?

Q13. What is the current in the circuit at the top right on page 89?

Q14. What would the current in the above circuit be if the input signal were 0.01 volt at 120 kHz?

ANSWERS

A12. $X_c = \frac{1}{2\pi fC} =$

$$\frac{1}{2 \times 3.14 \times 6{,}000 \times 200 \times 10^{-6}}$$

$$= \frac{1}{7.53} = \textbf{0.133 ohm}$$

A13. $I = \frac{E}{X_c} = \frac{0.2}{0.133} = \textbf{1.5 amps}$

A14. $I = \frac{0.01}{0.0066} = \textbf{1.52 amps}$

STRAY CAPACITANCE

Capacitive reactance decreases as frequency increases. In communications, pulse, and radar work, where very high frequencies are used, **stray capacitance** can present quite a problem.

In a vacuum tube, an antenna, or a receiver chassis, there are always small capacitances between adjacent conductors and between conductors and nearby objects which are meant to be isolated from each other. With audio and lower radio frequencies these capacitances are not important. But as the frequency increases, the capacitive **reactances** of these small capacitances decrease. Enough decrease in reactance can actually cause leakage of the signal.

Thus, at high frequencies, placement of wires and components is very important in order to keep the effects of stray capacitance to a minimum.

QUESTIONS

Q15. How does capacitance affect pulses?

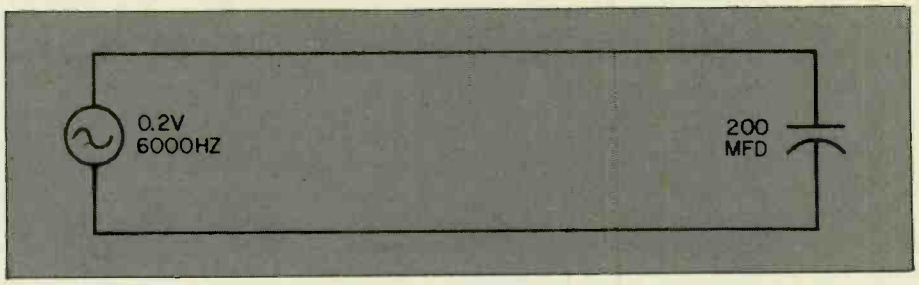
Q16. Compare and contrast capacitive reactance and inductive reactance on these points:

1. **Effect of an increase in frequency on reactance.**
2. **Effect of reactance on DC.**
3. **Effect of phase relations in AC.**

Q17. What constant value appears in the formulas for both capacitive and inductive reactance?

ANSWERS

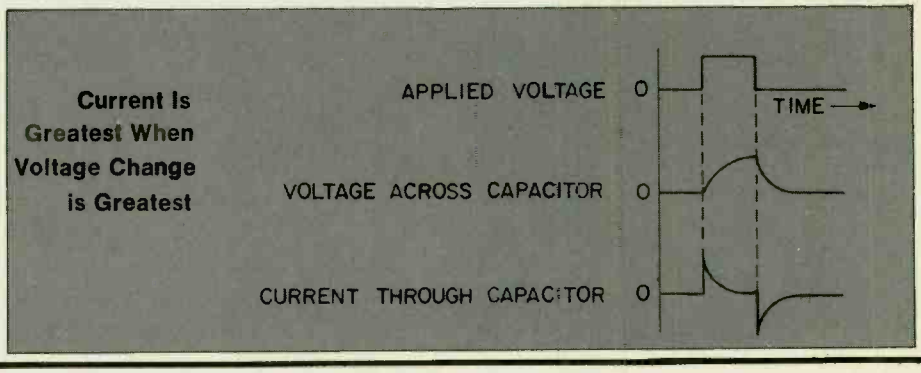
A15. Capacitance **rounds off the voltage waveform and produces spikes in the current waveform.**



PULSE RESPONSE OF CAPACITANCE

When a sharp pulse, such as a square wave, is applied to a circuit containing capacitance, the capacitance opposes the sudden change of voltage. This results in a rounding off of the sudden voltage rise. Similarly, when the pulse voltage is suddenly decreased, the voltage across the capacitor does not decrease suddenly, but it trails off. Current is greatest when the change of voltage is greatest, so the current waveform will have a peak when the voltage rises suddenly, and another peak (but in the opposite direction) when it drops.

There is always some resistance in a practical circuit. By choosing the right values of capacitance and resistance, a circuit can be designed in which the voltage takes a predetermined length of time to reach a certain value. This type of circuit can provide a time delay.



A16. 1. X_c **decreases** as frequency increases, while X_L, **increases.**
2. X_c **blocks DC,** while X_L **passes DC.**
3. Capacitance causes current to **lead** the applied voltage, while inductance causes it to **lag.**

A17. 2π appears as a constant in both formulas.

WHAT YOU HAVE LEARNED

1. Capacitance offers opposition to any change in voltage.
2. A basic capacitor consists of metal plates separated by a dielectric.
3. A capacitor stores electrical energy in the form of an electric field as the capacitor charges, and releases this energy when it discharges.
4. Capacitance is a measure of the energy storage capacity of a capacitor. This capacity is measured in farads.
5. A capacitor blocks DC but allows AC to flow.
6. Pure capacitance in a circuit causes current to lead the applied voltage by 90°.
7. The amount of capacitance is determined by the area of the plates, the distance between them, and the dielectric material.
8. A capacitor stores energy and returns it to the circuit.
9. The opposition of capacitance to the flow of AC is called capacitive reactance.
10. The formula for capacitive reactance is:

$$X_c = \frac{1}{2\pi fC}$$

11. Capacitance rounds off the voltage waveform of a pulse.
12. Stray capacitance can cause signal leakage at high frequencies.

Sandbagging

(Continued from page 44)

Someone will eventually request a radio check, giving you the opportunity to answer them. Many times we have conversed with another driver and, when finished, found we had driven 40 or 50 miles while doing it. Relaxed, interesting conversation takes the monotony out of driving. It is far better than a coffee break, and you will probably arrive at your destination more alert and relaxed than ever.

Sandbagging on channel 11 as you pass towns on your journey will let you in on some of the townspeople's secrets. And getting near the ocean or big lakes be sure to tune to channel 13 and sandbag the fishermen. They too, find CB a must when following schools of fish far out from shore. They report to each other where the fish are, where *they* are, what kind, number, and size of fish they catch and of course in case of an emergency, help is not far away. No one should venture far from shore without a CB radio, and it is part of the CBer's code to sandbag channel 13 in case of an emergency.

Lending a hand. Camper and Recreational Vehicle owners have gone CB. They get good use out of their sets, always sandbagging a pre-determined channel, which enables them to run in convoy without getting lost or separated. They relay information about camp sites, road conditions, gas outlets, repairs, restaurants, weather, construction, detours, and answers to many other questions as they travel. And if they need assistance, CB will get it for them in short order.

If you see a long, straight pole on a tower or on the roof of your neighbor's house, you can bet they are CBers. Visit with them some day or evening and ask them to tune in on CB. You can spend an enjoyable evening with them, sharing your sandbagging.

Skip reception is another attraction for CBers who sandbag. Sometimes ionospheric conditions cause the CB waves to skip up and over, coming down many hundreds of miles away. Don't be surprised to hear someone in New York talking to someone in Georgia, or Michigan talking to South Carolina. You can't count on it, because it's freak reception. But it does happen!

Sandbagging is the coming, cost free fad, reserved for no one and always there for you to enjoy.

10-4, Catch ya later, we gone. ■

Arctic Ice

(Continued from page 81)

principal Russian rivers into the Arctic Ocean, forcing it to become more salty? What effect would that have on the ice covering?"

Another question scientists ask focuses on what would happen if the ice cap suddenly melted. Would it reform?

"That is one of the classic questions," says Martin. "It comes about because the ocean is much darker than the ice and tends to absorb heat, whereas the ice tends to reflect it. If the ice did melt, there is no question that there would be major changes in the climate of the northern hemisphere where most of the world's population lives.

On the Ice. The fact that the Arctic remains one of earth's least understood regions is not difficult to comprehend. It is not an easy place in which to live, even with today's modern survival techniques. Contend with the perennial cold and the mind-numbing emptiness of the place, and there is still the shifting, ever-moving ice to worry about.

"The ice is in constant motion out there, and there's no way of predicting where or when a crack will occur," said Martin. "It can move relatively fast at times, covering hundreds of yards in hours. Usually, though, it is ponderously slow, because the floes are so massive.

But working on the ice pack isn't nearly so ominous as it may seem, he added. "Generally, it is a very benign environment. Standing out there in the winter is actually like being on a huge, frozen Sahara Desert. That is, until the ice cracks and you look down and realize there are two miles of ocean underneath you." ■

CB Mobile Antennas

(Continued from page 56)

around the trunk lip with the U-bracket; it doesn't get damaged because it squeezes between the lid and the rubber rain channel gasket. The gasket is pliable and gives so the coax isn't damaged. Just about every manufacturer makes a similar trunk lip mount, though the Newtronics XBLT-4 is slightly different. Instead of the coax being connected directly to the antenna, the coax from the front of the car terminates in a plug. A short length of cable with a jack at one end connects to the antenna. If you want to remove the mount, or need to get the cable out of the way to utilize the entire trunk you simply pull the connector apart with your hands. On other types of trunk lip mounts pliers

(Continued on page 92)

Newscan

(Continued from page 24)

contact with the atmosphere, for example. It is only at higher temperatures that energy is lost in appreciable amounts through infrared emission. Because the paths of infrared emission of the new tungsten material are restricted to a cone-shaped volume, the material has a distinct advantage over hemispherically emitting blackbody absorbers at high temperature. So look to a tunsten dendrite surface on solar cells in the future. ■

Phones/Antiques

(Continued from page 79)

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or wrenches are needed to disconnect the cable at the mount; but then, how often will you have to disconnect the mobile mount?

Though the trunk lip mount is perhaps the most convenient to use in terms of ease-of-installation and no holes to drill in the car's body, it does have one disadvantage—the antenna will move with the trunk lid. You have to be certain the mount is positioned in such a manner that the antenna does not slam into the rear window when the trunk is opened. Generally, you can find a mounting position that keeps the antenna clear of the window, but not always. If there's no way to mount the trunk lid antenna so it doesn't strike the window your best bet is to use a different type of mount: either a rain channel mount (as previously described) or a permanent body-mounting antenna.

The permanent body-mounting antennas no longer require a hole almost as big as your fist, with reinforcing rings and at least three mounting screws. The new body mount loaded antennas such as the Radio Shack 21-925 snap right into a ⅜-inch hole that is easily plugged when you go to trade in your car. Or, you can simply enlarge the hole and install a rear car radio antenna.

Disguise antennas. Speaking of radio antennas, several outfits manufacture "disguise" antennas such as the Antenna Specialists M-264. A disguise antenna looks just like (or almost like) an ordinary car radio antenna and in fact can be installed in place of the regular radio antenna. The disguise antenna is actually a loaded CB whip, and feeds into a coupler that connects to both the CB transceiver and an AM, or AM/FM car radio.

For those who need an almost perfect omnidirectional radiation/reception antenna pattern a small antenna mounted in the center of the car roof is your best bet. Fortunately, you no longer have to hack away at the roof. Using an antenna such as the Turner SK101 Roof Mount CB Antenna you can snap the whole assembly onto the roof from the outside.

Mobile beams. If you do most of your driving on the interstates there is a special mobile beam called a Co-Phased Antenna Array that will concentrate your signal straight ahead and behind the car. With this system you put the signal on the road where it's needed. The Shakespeare Model 464 Co-Phased Array consists of two top loaded whips connected by a pre-cut phasing transmission line. The antennas mount in the rain channel on both sides of the car trunk. If you want more signal on the ground there's an electrical ½-wave length version from Shakespeare that mounts on the bumper; it's the Model 4038.

Special models of the co-phased array are made for trucks. They're designed to mount directly to the West Coast or Hollywood mirror you see on those 18-wheelers. Typical mirror-mount co-phased arrays are the Turner SK802 and Newtronics "Hustler" HTM-1. A special miniature co-phased array, the Newtronics DTG "Mini Hustler," mounts on any car's rain gutter.

1/2 Wave whips. Most of you are familiar with the ½-wave length base station antennas that provide about 3 dB gain over a standard base station groundplane. Well, ½-wave length antennas are also available for mobiles. Naturally, they are kept short by using electrical loading, but they do provide up to 3 dB gain over a ¼-wave length whip. We've mentioned the ½-wave length co-phased array. If you want a single whip with gain you can use the Antenna Specialists M-306, a ½-wave length fiberglass antenna specifically designed for use without a ground plane—meaning it can be used easily on fiberglass boats, cars, campers, and other vehicles.

Speaking of campers, there are sev-

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Allied Electronics
P.O. Box 1544
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Anixter-Mark
5439 West Fargo
Skokie, Illinois 60076

Antenna Specialists Co.
12435 Euclid Avenue
Cleveland, Ohio 44106

Avanti
340 Stewart Avenue
Addison, Illinois 60101

Breaker Corporation
1101 Great Southwest Parkway
Arlington, Texas 76011

Hy-Gain Electronics Corp.
8601 Northeast Highway Six
Lincoln, Nebraska 68505

New-Tronics Corporation
15800 Commerce Park Drive
Brook Park, Ohio 44142

Radio Shack
P.O. Box 1052
Fort Worth, Texas 76101

Shakespeare
P.O. Drawer 246
Columbia, S.C. 29202

Surveyor Manufacturing Corp.
Madison Heights, Michigan 48071

Turner
909 17th Street
Cedar Rapids, Iowa 52402

eral antennas and mounts especially designed for ease of installation on RVs (recreational vehicles). Generally, these have a flat-base mounting surface and some form of swivel so the antenna can be made vertical regardless of the angle of the mounting surface. Typical examples of the RV antennas are the Antenna Specialists M-247 and Shakespeare "Little Giant" models.

And speaking of Little Giants, Shakespeare has made a breakthrough in miniature CB antennas; both their "Little Giant" at 36-inches, and their "Mighty Mite" at 24-inches, are a good deal less than the 48-inches or so that's typical of "short" CB antennas.

Do it yourself. For those who like to "roll their own," Lafayette Electronics, Radio Shack, Calectro and Ultratec (Workman Electronic Products) have special display racks of individually packaged antenna mounting components. You can find everything from just the cover for a trunk lip mount to a heavy duty spring for a full length whip to a "gutter clip" for holding the antenna down against the car.

Summing up. Whether you're looking for a standard ordinary whip antenna to mount on a standard Detroit Iron, or some special mobile beam for a custom-chassis street rod, you'll find exactly the mount and antenna you need in today's marketplace. CB has become so big, with so many antenna manufacturers offering so much hardware, there's no reason you must ever settle for second best when it comes to a mobile CB antenna. ■

Lite-Com

(Continued from page 63)

fiber. The signal output of the phototransistor is then amplified by an external amplifier to drive a loudspeaker.

Although we used a handy pocket-size amplifier with built-in speaker (see the Parts List), there's no reason you can't design and build your own small amplifier. You can also use the *Tape* or *Aux* input on your hi-fi receiver or amplifier. Try bending the light fibers, and you can show how light goes around corners.

Simple Circuits. Lite-Com's two circuits are quite simple and straightforward. Resistor R1 and the DC resistance of T1's secondary winding determine the quiescent current through the LED (5-10 mA). C1 bypasses R1

Lite-Com demonstration using single optical glass fiber to feed infra-red light from transmitter to receiver. Music signals fed from portable radio travel over glass fiber and are heard through small amp/speaker. Optional digital voltmeter at left shows interesting amplitude variations at receiver output.

to increase the AC gain of the circuit. Transformer T1 matches the low impedance of the radio output circuit to the relatively high impedance of the LED circuit thus providing voltage amplification. An alternate circuit shown in the same diagram does away with T1 at the expense of a few decibels of gain.

The receiving photo-transistor is connected in the common-emitter configuration with RC coupling. Capacitor C2 leads to the amplifier-speaker. You can increase R2 and C2 from the values shown and observe the effect of changes on sound quality. To simplify the circuit we use separate power supplies for the transmitter and receiver. This avoids the problems of coupling through the battery.

Construction. Wiring and length of the connections are not critical. You can build the whole unit (receiver and transmitter) on a single perf board as shown in the illustrations or you can use separate boards. After checking your wiring, connect the output of the receiver to whatever amplifier-speaker combination you've decided on. Turn the volume of the amplifier up to full, and place the light receiver under an AC light source. Best is a fluorescent or neon light, but even a normal incandescent light bulb will do. You should hear a loud hum or buzz. Covering up the photo-transistor with your finger will kill the hum or buzzing.

Now connect the output of a radio, tape machine, ceramic phono pickup (most hi-fi systems use magnetic pickups, which must be amplified before they're strong enough to drive the transmitter) or amplified microphone output to the input of your LED transmitter. You will not see any light coming from the LED if you are using the infrared LED. If you are using the visible-light LED you should see red.

Now you can connect the light (visible or infrared) from the LED to the photo-transistor by placing one end of a glass fiber atop each so as to connect them. You will find that the glass fiber transmits the light waves perfectly from the LED transmitter to the photo-transistor receiver, and you will hear the sounds coming from your amplifier-speaker (or hi-fi system) with perfect fidelity. ■

Radio Repair

(Continued from page 54)

kHz end of the range. Set the pointer at this figure and clip it to the cord. Now turn the shaft and see if the pointer slides in the right direction. If it goes in the wrong direction you came off the drum going the wrong way. In most sets you can move the drum with your fingers before you start to restring it, and tell which way the pointer will go. It often helps to turn the radio around and see which end of the dial is 550. Turn it back and mark this figure on the back of the frame with a pencil. It'll help you "keep it straight" while you're restringing.

Your Hand Tools. You won't need a lot of tools to work on these little radios. However, the ones you use are important. The right tool speeds up the work in all cases; in some cases you can't even do the job at all without the right tool. Fig. 12 shows a typical set. You'll need small screwdrivers, both Phillips (cross-point) and standard blade type, and perhaps a few small special socket wrenches. In many sets you will find tiny hex-head screws down inside of a hole in the chassis; the only tool that will even touch these is a socket wrench. A small pair of long-nosed pliers, and a pair of "diagonal cutters" (if you want them to think you're a pro, say "dikes") and a low-wattage electric soldering iron. Get one of about 30-watts rating—with a very sharp tip—for getting into tight places on the PC boards. Keep the tip clean for best results.

The No-Nos. As in any kind of repair work, there are things you ought to do, and there are things that you should *never* do. Knowing what *not* to do is as important as knowing what to do. Here are a few of the most important.

You must never turn any of the alignment adjustments. These are of two kinds: little square cans with a "screw" visible through a hole in the top, and

(Continued on page 96)

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(Continued from page 94)

little screws on the tuning capacitor assembly. If you do, you will invariably wind up with a much worse problem in addition to the one you already had. You'll have to take it to a shop for realignment with precision equipment. Also, if a radio is playing and suddenly stops, this is *never* due to one of the alignment adjustments being off. They don't "drift" by themselves. Fig. 12 shows a typical radio chassis; the ones marked "T3," "T4," "L1," and "C2B/C2D" are the alignment adjustments.

Second: Never poke around in a transistor radio chassis with a metal screwdriver or similar tool while it is turned on. You can cause a short circuit which will blow transistors out, or do other damage. This precaution also applies to the metal tips of your test prods. When you're taking a reading of voltage, be *sure* that your test prod doesn't short to a nearby conductor or part. Same results. If you must move parts or wires while checking, use an insulated tool. An old toothbrush can be made into a very good one. Shape it like a screwdriver tip.

So there you are. Use these tests properly, and you can save a good deal of money and learn something about a very interesting profession. Of course, the chances are you will never become a radio-TV repairman, but with solid basics and determination you can save dollars for yourself and friends on minor repair jobs that would otherwise have cost 10 and 20 dollars a throw. ■

Rig-Kwik

(Continued from page 43)

the power supply printed circuit board if you hold off soldering the power transformer and output connection wires until later. The best bet is to provide tie points for the input and output connections. Use Radio Shack #270-1392 terminals and enlarge the connecting holes with a 3/64-in. drill bit. Don't try to jam the terminals into the holes—they just won't go without damage. Solder the terminals to the foil and then cut off any remaining terminal material on the foil side of the board. The printed circuit board has no mounting holes—Bullet Electronics lets you do it your way. Use a three point mounting. Drill holes for #6 screws (but use #4 screws to mount the board) at two corners away from the ground foil running around the perimeter of the board. Drill the third mounting hole on the opposite edge approximately midway between the two sides—anyplace you can get clear of the foil.

To avoid shorting the foil to the cabinet the board must be mounted on standoffs at each mounting hole. A ¼-in. standoff spacer is sufficient. (Do not use a stack of metal washers unless you are certain no washer comes in contact with the foil on the board.)

Protection. In the unit shown we have provided three fuseblocks on top of the cabinet. These fuseblocks are made for the ¼ x 1¼ inch fuse (3AG) type, and will accommodate both the 8AG and 3AG sizes. In this way you can use either size fuse without using two sets of fuseblocks. Note, however, that two different types of fuseholders have been used. When working with experimental circuits requiring two or more power supply voltages it is possible to get the wiring crossed when the power wires come from the same general location—and a crossed power wire can wipe out a handful of components. So a different fuseholder was used for the 5-volt power supply. If you can only get hold of one kind of fuseholder paint the 5-volt one a distinctive color that cannot be confused with the fuseblocks used for the two 15-volt supplies. The fuses must be fast-acting (8AG) because solid-state components will blow out long before a standard fuse (such as the 3AG) blows.

Though the power supply kit is not supplied with a fuse for the power transformer's primary (AC power-line side), the instructions included with the kit suggest the use of a fuse, and a fuseholder should be installed in the base of the cabinet, as shown.

To avoid confusing the power output connections the use of different-colored 5-way binding posts is suggested. The standard colors for a bipolar power supply are *Black* for negative (ground) and, *red* for positive and *blue* or *green* for negative voltage. The 5-volt power output should be any other color (don't use *red* again). If you cannot locate binding posts in assorted colors paint them with Testor's model paints, which come in very small bottles for about 25 cents each. Model paints are available in hobby stores which stock model trains, planes, rockets, etc.

Using Rig-Kwick. The QT socket terminals can handle wire sizes #22 (solid) and #24. You can insert a #20 wire but it takes a strong push with long-nose pliers. The QT sockets provide a firm grip on the wire and can be re-used indefinitely after the breadboard is cleared—this is not a one-shot project board. Most transistor, resistor, capacitor and connecting wires will fit the QT terminals. The wires on high power SCRs and transistors, 1 watt resistors, and high-voltage (250 V and higher) capacitors are just a shade too large for the QT terminals, and if you try to force them in you'll either break the component or damage the socket. If, for some reason, you must use oversize components solder a short piece of #22 wire to their leads so they can

(Continued on page 100)

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101. Get acquainted with the new *EICO* products, designed for the professional technician and electronics hobbyist. Included in brochure are 7 IC project kits, *EICO's* "Foneaids," security products and many varied kits.

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* 1976 line-up of CB transceivers & scanner receivers (for police, fire, weather, & other public service emergency boadcasts).

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'* catalog of latest mobile antennas, test equipment, wattmeters, 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.

110. *Turner* has two booklets on their Signal Kicker antennas. They give specifications and prices on their variety of CB base and mobile line. Construction details help in your choice.

111. *Midland Communications'* line of base, mobile and hand-held CB equipment, marine transceivers, scanning monitors, plus a sampling of accessories are covered in a colorful 18-page brochure.

112. The *EDI (Electronic Distributors, Inc.)* catalog is updated 5 times a year. It has an index of manufacturers literally from A to X (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.

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).

118. CBers, *GC Electronic's* 8-page catalog offers the latest in CB accessories. There are base and mobile mikes; phone plugs; adaptors and connectors; antenna switchers and matchers; TVI filters; automotive noise suppressor kits; SWR Power and FS meters, etc.

119. *Browning's* mobiles and its famous Golden Eagle base station, are illustrated in detail in the new 1976 catalog. It has full-color photos and specification data on Golden Eagle, LTD and SST models, and on "Brownie," a dramatic new mini-mobile.

120. *Edmund Scientific's* new catalog contains over 4500 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* 1976 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. Get *Lafayette Radio's* "new look" 1976 catalog with 260 pages of complete electronics equipment. It has larger pictures and easy-to-read type. Over 18,000 items cover hi-fi, CB, ham rigs, accessories, test equipment and tools.

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 1976 catalog listing project builders' parts, popular CB gear, and test equipment. It features semiconductors—all from *Circuit Specialists*.

130. There are over 350 kits described in *Heath's* new catalog. Virtually every do-it-yourself interest is included—TV, radios, stereo & 4-channel, hi-fi, etc.

131. *E. F. Johnson* offers their CB 2-way radio catalog to help you when you make the American vacation scene. A selection guide to the features of the various messenger models will aid you as you go through the book.

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.

137. *Pace* communications equipment covers 2-way radios for business, industrial and CB operations. Marine radiotelephones and scanning receivers are also in thjs 18-p. book.

138. *Shakespeare's* new pocket-size catalog lists and describes their full line of fiberglass CB antennas, mounts and accessories offered in 1976.

142. *Royce Electronics'* new full-color catalog updates information on their CB transceivers (base, mobile, handheld). It also describes new product lines—CB antennas and a VHF marine radiotelephone.

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 CBers 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.

150. Send for the free *NRI/McGraw Hill* 100-page color catalog detailing over 15 electronics courses. Courses cover TV-audio servicing, industrial and digital computer electronics, CB communications servicing, among others. G.I. Bill approved, courses are sold by mail.

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

153. *MFJ* offers a free catalog of amateur radio equipment—CW and SSB audio filters, electronic components, etc. Other lit. is free.

154. A government FCC License can help you qualify for a career in electronics. Send for information from *Cleveland Institute of Electronics*.

155. New for CBers from *Anixter-Mark* is a colorful 4-page brochure detailing their line of base station and mobile antennas, including 6 models of the famous Mark Heliwhip.

156. Send for *Continental Specialties* new breadboarding prototest devices. They vary in prices from a mini-budget kit at $19.95. Featured is the new logic monitor, giving information on what it does, how it works, and how to use it.

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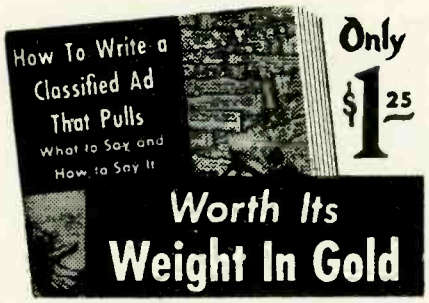

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(Continued from page 96)

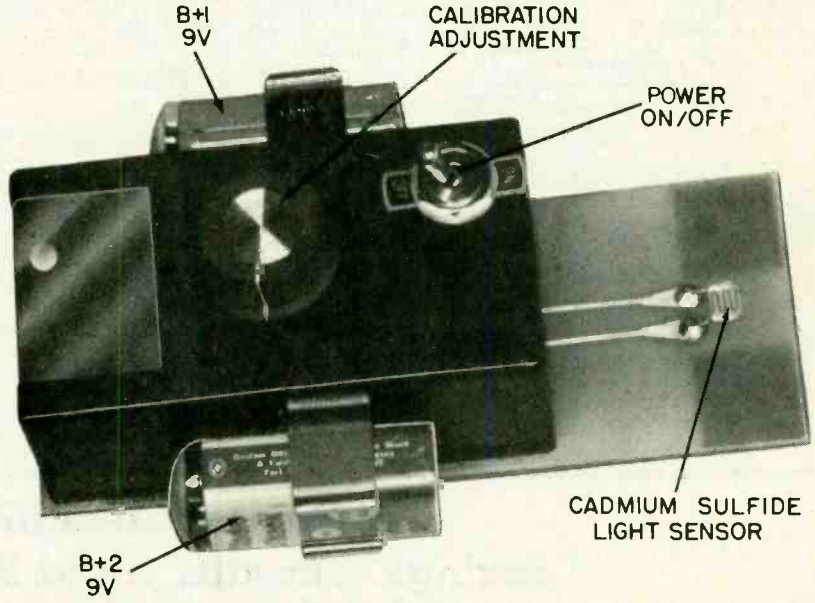
be easily connected to the sockets.

Choosing Fuses. Fuses should never be rated higher than the maximum rated current of the associated power supply. For example, if you are using an *external* 5-ampere/5-volt supply the fuse should be no larger than 5-amperes. If you are using the internal 1.5-ampere/5-volt supply the fuse should be no larger than 1.5 amperes. But fusing for the supply's maximum rating protects only the power supply, not the circuit you're building. Such fusing in the presence of a wiring error could lead to an undamaged power supply—with crispy-fried experimental components! It is better to fuse so that the experimental circuit gets full protection, or as much protection as you can give it. For example, assume you are building a TTL project whose maximum current including the readout display is 150 mA. Using the next higher fuse value, in this instance 3/16 or 2/10 ampere, will protect both the project and the power supply. Thus, whenever you use the Rig-Kwik for breadboarding a project you can protect the project, as well as the power supply, by choosing a fuse just large enough for the project itself (each time). You now have a fast, convenient, and inexpensive laboratory breadboard. Enjoy! ■

LED/Chip Photo-Helper

(Continued from page 72)

LED/Chip Photo-Helper, connect the batteries and turn the power switch On. One LED should immediately come On. Rotate the control from one extreme to the other, and note that at some point each LED will come On in succession, but only one LED will be On at any given time. If more than one LED lights at a time, check whether you are working under fluorescent lighting. If so, move to a room lit with an incandescent lamp and repeat the test. If there is no fluorescent light near, the



Assembled LED/chip Photo-Helper has light sensor on board, at right. Five LEDs are mounted under the transparent window at left. Only one LED lights at a time.

fault is in the circuit itself. Check the PC board for solder bridges, loose pigtails or wires, or defective foil traces. If none of these can be found, the fault is in one of the integrated circuits, and it should be replaced with another of the same type. If one of the LEDs fails to light, but otherwise the circuit operates normally, exchange the LED for another one known to be good. When the LED/chip meter is operating properly, proceed with calibration.

The Photo-Helper was designed to be used with a photographic enlarger, to ensure making black-and-white and color prints with repeatable success. If a good-quality enlarger is available, and you have access to a transparent step-tablet (gray scale), calibrate the LED/chip as follows.

Calibration. With the step-tablet in the enlarger's negative slide, measure each segment, using the LED/chip by noting the setting of the control that causes the center LED (LED3) to come On. Next, make a series of test prints, using different exposures and development times, to produce a succession of prints of the step-tablet of differing contrasts. Note on the print the exposure and development used, and beside each segment of the step-tablet note down the setting of the LED/chip control.

When ready to print a negative, measure the lightest and darkest areas of the negative with the LED/chip. Select the test print (made earlier) with the most desirable contrast range within the measured values, and use the exposure and development information recorded on the test print to determine the exposure to be used.

When setting the LED/Chip control with light from the enlarger, you can use a diffusion lens in conjunction with the enlarger lens to average out the illumination from the various parts of the negative. This ensures that the light being measured is a fair sampling from the entire area of the negative, and avoids measuring a too-dark, or too-light part of the picture. Of course the diffusion lens is swung out of the way after the LED/Chip Photo-Helper is calibrated, so that the negative may be properly exposed.

Transparent step-tablets can be purchased at any photo-supply shop or graphic-arts store for a few dollars. They come in a number of types, from some with 25 or more segments to those that include a color analyzing section containing color spots. Most low-cost step-tablets are not calibrated for their photographic densities but have instead an arbitrarily-numbered scale on one side. Calibrated step-tablets are available, of course, but their high cost makes them unreasonable for use with the LED/Chip. An inexpensive step-tablet can be calibrated by placing each segment under a transmission densitometer and recording each reading. Most newspaper and many color printing shops usesuch a desitometer.

Another useful function the photometer has is to ensure that a constant amount of light will reach the enlarger easel, regardless of the lens used or the magnification (enlargement). Make a mark on the LED/Chip control scale at the setting that corresponds to the desired light intensity, reading the LEDs as before. In most cases, this may be a particular segment in a step-tablet. When making a print or, in the author's case, a process color separation, include the step-tablet with the negative. With the desired lens in place and the enlarger set to the correct enlargement, locate the photocell under the same segment in the step-tablet that was used earlier. Adjust control R2 to the mark made earlier, and then set the lens aperture until the center LED comes on. This feature is especially useful in the graphic arts, where a common set of exposures is desired for any type of halftone or color-separation work done on a particular enlarger.

Using the components in our parts list, the LEDs will automatically respond at increments of one f/stop (f/stop is the term used to describe the setting of the lens aperture, one f/stop higher or lower means that either half or double the amount of light is transmitted by the enlarger lens.) If another type of CdS cell is used in place of the photocell listed in the Parts List, the values of resistors R3 through 7 may have to be changed to allow for the different response characteristics of the new photocell. All the components are easy to come by, and the total cost of the LED/Chip Photo-Helper should not be more than $10.00—considerably less if parts are scrounged from your junk box. ■

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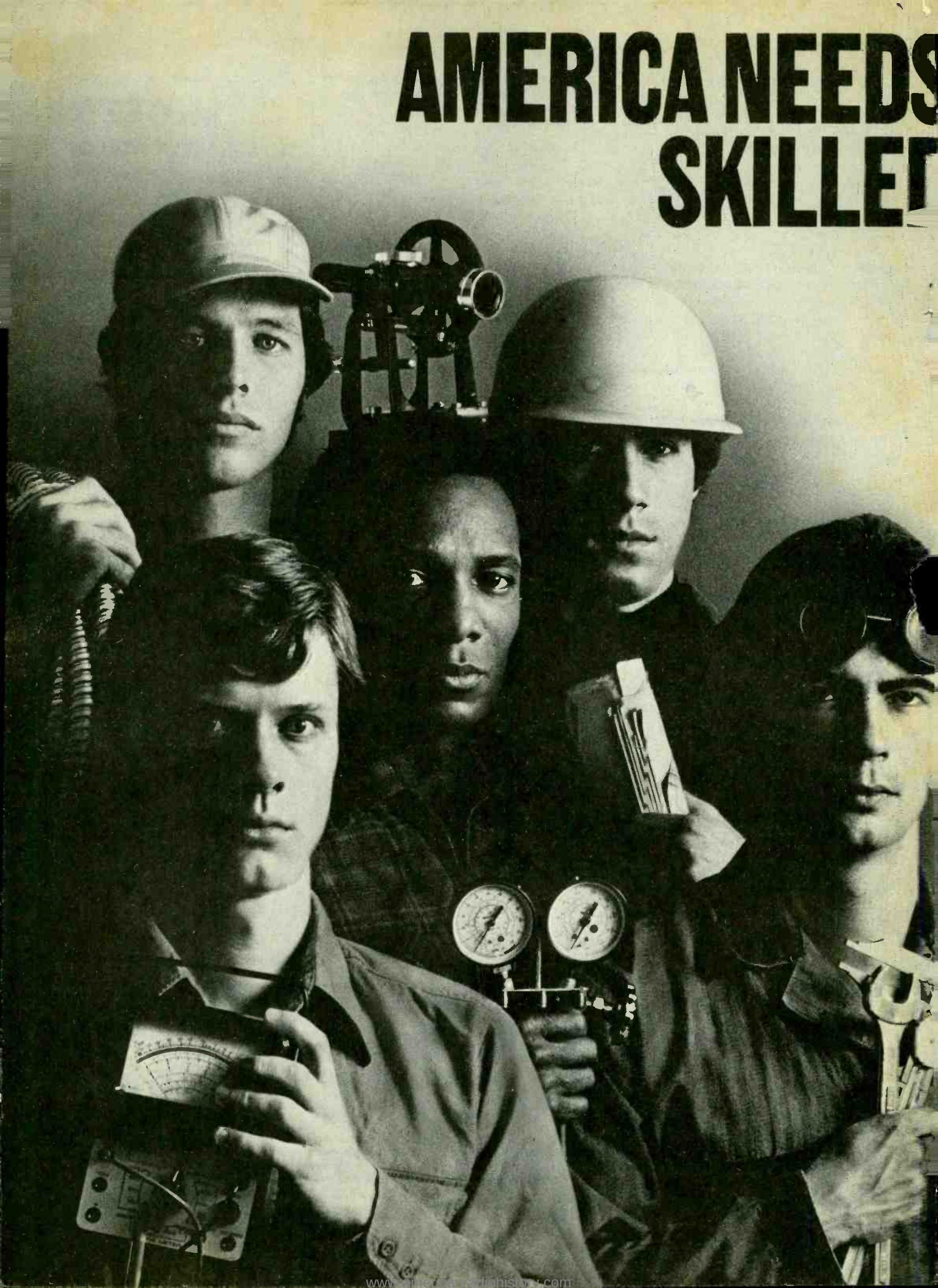

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And the ICS Center for Degree Studies is authorized by the Pennsylvania Department of Education to grant the Associate in Specialized Business degree in Accounting and Business Management, and the Associate in Specialized Technology degree in Civil, Mechanical, Electrical, and Chemical Engineering Technologies.

These degree programs are not mere stepping-stones to higher education nor are they primarily intended for transfer toward more advanced degrees. They are practical, career-oriented programs designed to help you reach your objectives without further academic training.

If you already have some college education, you may be able to receive advanced standing toward your degree. With a degree from ICS, you'll be able to apply with pride for jobs that call for career training.

Careers	Average annual job openings, 1972-85†	% increase new job openings, 1972-85†
Auto Mechanics	22,300	18.4%
Air Conditioning Refrigeration and Heating Mechanics	13,100	96.3%
TV and Radio Service Technicians	4,400	18.1%
Electricians (Construction and Maintenance)	20,900	30.0%
Engineering and Science Technicians	39,600	48.9%

*Source: U.S. Office of Education publication, "25 technical careers you can learn in 2 years or less."
†Source: 1974 U.S. Dept. of Labor *Occupational Manpower and Training Needs*

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No one can promise success, but if you *want* more—more money, more security, more day-to-day satisfaction and more future—our free Career Booklet and free Demonstration Lesson can help you get started in the right direction.

Remember, it's your life. You might as well make the most of it.

FOR A FREE CAREER BOOKLET & DEMO LESSON, CHECK BELOW.

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- ☐ Engineering
- ☐ Accounting
- ☐ Drafting
- ☐ Electronics Technician
- ☐ TV Service & Repair
- ☐ Surveying & Mapping
- ☐ Diesel Mechanic
- ☐ Air Conditioning & Refrigeration
- ☐ Automotive Mechanics
- ☐ Business Management
- ☐ Civil Engineering
- ☐ Interior Decorating
- ☐ Construction Electrician
- ☐ Appliance Service & Repair
- ☐ Income Tax
- ☐ Motel/Restaurant Mgt.
- ☐ Mechanical Engineering
- ☐ High School

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